DEVELOPMENT SERVICES DEPARTMENT
ENVIRONMENTAL COORDINATOR
450 110th Ave NE., P.O. BOX 90012
BELLEVUE, WA 98009-9012

OPTIONAL DETERMINATION OF NON-SIGNIFICANCE (DNS) NOTICE MATERIALS

The attached materials are being sent to you pursuant to the requirements for the Optional DNS Process (WAC 197-11-355). A DNS on the attached proposal is likely. This may be the only opportunity to comment on environmental impacts of the proposal. Mitigation measures from standard codes will apply. Project review may require mitigation regardless of whether an EIS is prepared. A copy of the subsequent threshold determination for this proposal may be obtained upon request.

Publish:	December 18, 2014
File No.	14-144286-LM
Project Name/Address:	6th Street Tunnel/500 Bellevue Square
Planner:	Carol Hamlin
Phone Number:	(425)-452-2731
Minimum Comment Period:	**January 5, 2015, 5PM**

Materials included in this Notice:

- [x] Blue Bulletin
- [x] Checklist
- [x] Vicinity Map
- [x] Plans
- [ ] Other:

Development Services
Permit Processing 425-452-4898

Application for LAND USE APPROVAL

APPLICATION DATE 11/14/2014	TECH K	CIP PROJ #	PROJECT FILE # 14-144286 LM

◻Administrative Conditional Use-LA ◻Binding Site Plan-LF ◻Boundary Line Adjustment-LW ◻Conditional Use-LB ◻Conditional Use Shoreline Mgmt-WA ◻Critical Land Use Permit Admin-LO ◻Design Review-LD ◻Final Plat-LG ◻Final Short Plat-LF	◻Land Use Approval Amendment-LI ◻Land Use Exemption-LJ ◻Master Development Plan – LP ◻Planned Unit Development-LK ◻Planned Unit Dev. Combined w/Plat-LK ◻Preliminary Plat-LL ◻Preliminary Short Plat-LN ☒Preliminary SEPA Review-LM	◻Shoreline Development-WG ◻Shoreline Exemption w/o SEPA-WD ◻Shoreline Exemption w/SEPA-WE ◻Shoreline Variance-LS ◻Variance-LS ◻WCF in ROW - CA

NOTICE OF COMPLETENESS: Your application is considered complete 29 days after submittal, unless otherwise notified.

1. **Property Address** 500 BELLEVUE WAY Zoning DOWNTOWN 01
   Project Name (if applicable) 6th STREET TUNNEL Tax Assessor # 067002-0010
2. **Applicant** KEMPER DEVELOPMENT COMPANY Phone (425) 646-3660
   Address 575 BELLEVUE SQUARE City, State, Zip BELLEVUE, WA. 98004
3. **Contact Person** MICHAEL D. CHAPLIN, AIA Phone (206) 624-8682
   E-Mail Address michael.chaplin@sclaterarch.com FAX # ( )
   Address 414 OLIVE WAY, SUITE 300 City, State, Zip BELLEVUE, WA. 98004.
4. ~~Engineer~~/Architect/~~Surveyor~~ SCLATER ARCHITECTS Phone (206) 624-8682
   Address SAME AS CONTACT. City, State, Zip
5. **Project Type:** ___Single Family Residential ___Multi Family Residential X Non-Residential
6. **Description of proposed project, use, exemption, or variance:**
   CONSTRUCT A BELOW GRADE PEDESTRIAN AND VEHICLE TUNNEL BETWEEN LINCOLN SQUARE AND LINCOLN SQUARE EXPANSION BELOW 6th STREET.
   Proposed Building Gross Square Footage 1,350 SF Proposed Structure Parking Gross Square Footage NA
7. **Nature of Project (if applicable)**
   Current use of property and existing improvements: PROPOSED IMPROVEMENTS ARE BELOW GRADE OF THE EXISTING STREET.
   Identify any adjacent water area/wetlands or significant natural features (i.e., streams, wetlands, views, significant trees, water bodies, etc) on or within 200 feet of the property. NONE
8. If **SHORT PLAT or SUBDIVISION** Application: Total Acreage ______ Number of Proposed Lots ______
   N/A Has this property been previously subdivided? If yes, Date ______ Recording # ______
   If this is a Final Plat or Final Short Plat, what is the Preliminary project file # ______

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NOV 17 2014
Permit Processing

9. If **SHORELINE MANAGEMENT**: Total cost or fair market value of the project (whichever is higher) $ ______
   N/A If a single family residence or pier is proposed, is it intended for the owner's own personal use? ◻Yes ◻No

   If Shoreline Variance, the development will be located:
   ◻ Landward ◻ Waterward of the ordinary high water mark. **AND/OR** ◻ Outside ◻ Inside areas designated as marshes, bogs or swamps by the Dept. of Ecology. (Chapter. 173.22. WAC)

BCC 23.10.033 - Agreement regarding vested rights: The filing of an application for any of these required approvals prior to the filing of a valid and complete application for a building permit shall not establish or create a vested right to proceed with construction of any proposed project.

I certify that I am the owner or owners authorized agent. If acting as an authorized agent, I further certify that I am authorized to act as the Owners agent regarding the property at the above-referenced address for the purpose of filing applications for decision, permits, or review under the Land Use Code and other applicable Bellevue City Codes and I have full power and authority to perform on behalf of the Owner all acts required to enable the City to process and review such applications.
I certify that the information on this application is true and correct and that the applicable requirements of the City of Bellevue, RCW and the State Environmental Policy Act (SEPA) will be met.

Signature ______ (~~Owner~~ or Owners Agent) Date 11/14/2014

Revised 7/16/13

S C L
A
T E R
ARCHITECTS

6^{th} Street Tunnel

November 14, 2014

Description of Proposal & Design Intent

The proposed 6^{th} Street Tunnel is a below grade vehicular and pedestrian tunnel connecting the Lincoln Square level 5 to Lincoln Square Expansion level P4. The tunnel will have a drive lane for each direction and a single path for pedestrian access. The pedestrian access will be designed to meet accessibility requirements. Signage will be provided within the garage to direct vehicles to the tunnel.

The tunnel design is a single curve structure supporting itself without any intermediate supports down the middle of the tunnel. The drive lanes within the tunnel are sloped to connect the two proposed levels of the garage. Lighting will be provided within the tunnel for general purpose and emergency. Fire doors will be provided at both ends of the tunnel to allow isolation of the tunnel from either garage, if required for emergency purposes.

The tunnel will be excavated into the Lincoln Square Expansion garage while the garage is under construction. The Excavated material will be pulled to the surface be way of hoisting through a garage ventilation shaft up to grade and into trucks for hauling off-site. Construction materials will be brought in through the Lincoln Square Garage.

Proposed Materials and Colors

The interior finish of the tunnel will be smooth concrete painted white. The driving surface will be concrete slab-on-grade. The pedestrian walk way will be concrete. All metals will be painted. Doors will be pre-finished and/or painted to match color of other doors in the garage. Lighting will be hung from the structure of the tunnel. Exposed fire sprinkler lines will be galvanized.

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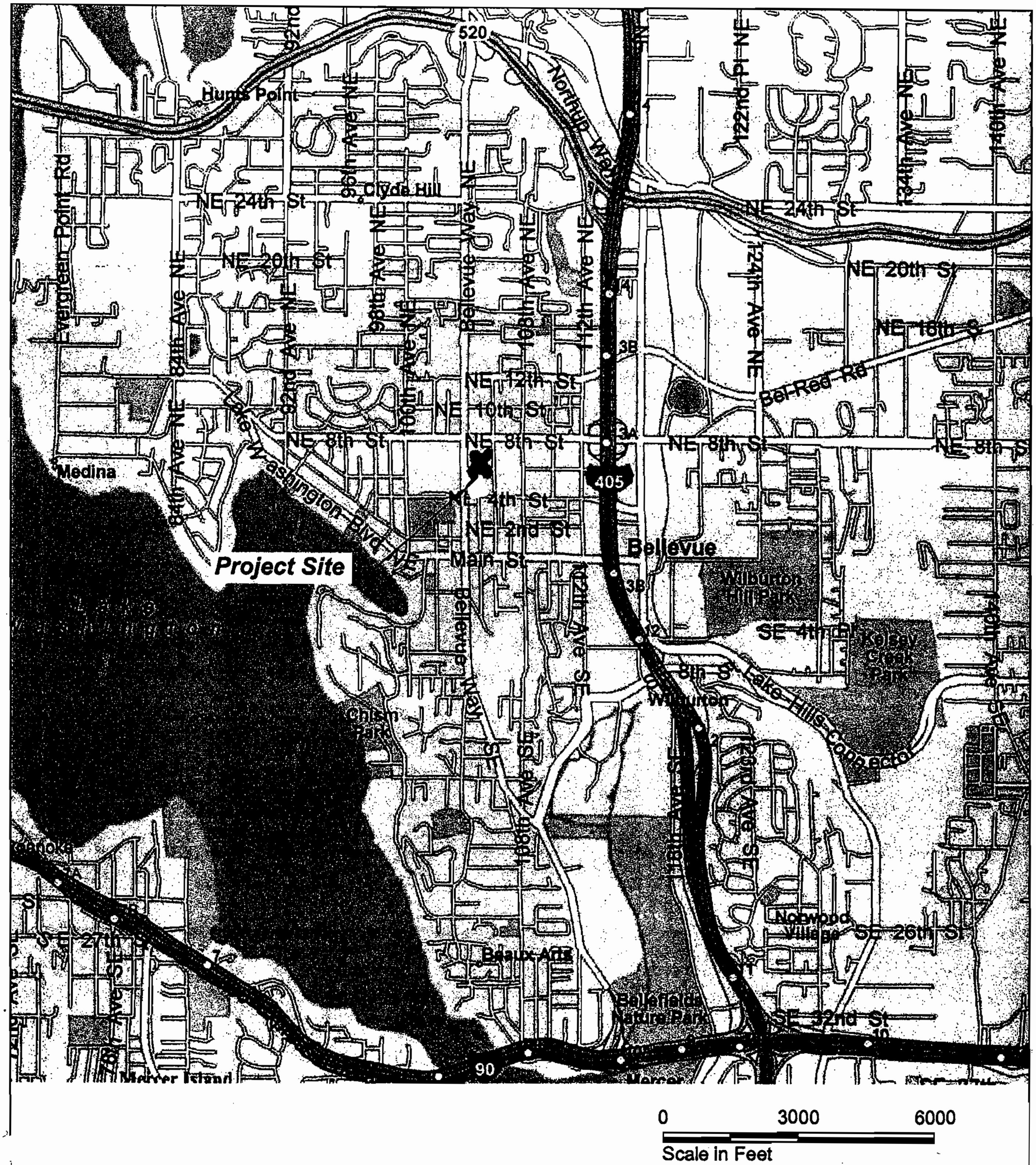
206 624 8682
206 621 8445
414 OLIVE WAY
SUITE 300
SEATTLE WA 98101
SCLATERARCHITECTS.COM



N

Bellevue, Washington

Vicinity Map

7355-05

12/12

Figure

1

ENVIRONMENTAL CHECKLIST

10/9/2009

Thank you in advance for your cooperation and adherence to these procedures. If you need assistance in completing the checklist or have any questions regarding the environmental review process, please visit or call Development Services (425-452-6800) between 8 a.m. and 4 p.m., Monday through Friday (Wednesday, 10 to 4). Assistance for the hearing impaired: Dial 711 (Telecommunications Relay Service).

INTRODUCTION

Purpose of the Checklist:

The State Environmental Policy Act (SEPA), Chapter 43.21c RCW, requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. An environmental impact statement (EIS) must be prepared for all proposals with probable significant adverse impacts on the quality of the environment. The purpose of this checklist is to provide information to help you and the City of Bellevue identify impacts from your proposal (and to reduce or avoid impacts from the proposal, if it can be done) and to help the City decide whether an EIS is required.

Instructions for Applicants:

This environmental checklist asks you to describe some basic information about your proposal. Answer the questions briefly, with the most precise information known, or give the best description you can. You must answer each question accurately and carefully, to the best of your knowledge. In most cases, you should be able to answer the questions from your own observations or project plans without the need to hire experts. If you really do not know the answer or if a question does not apply to your proposal, write "do not know" or "does not apply." Giving complete answers to the questions now may avoid unnecessary delays later.

Some questions ask about governmental regulations such as zoning, shoreline, and landmark designations. Answer these questions if you can. If you have problems, the Planner in the Permit Center can assist you.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. Include reference to any reports on studies that you are aware of which are relevant to the answers you provide. The City may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impacts.

Use of a Checklist for Nonproject Proposals: *A nonproject proposal includes plans, policies, and programs where actions are different or broader than a single site-specific proposal.*

For nonproject proposals, complete the Environmental Checklist even though you may answer "does not apply" to most questions. In addition, complete the Supplemental Sheet for Nonproject Actions available from Permit Processing.

For nonproject actions, the references in the checklist to the words *project*, *applicant*, and *property* or *site* should be read as *proposal*, *proposer*, and *affected geographic area*, respectively.

Attach an 8 ½" x 11 vicinity map which accurately locates the proposed site.

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BACKGROUND INFORMATION

Property Owner: City of Bellevue Right of Way

Proponent: Kemper Development Company

Contact Person: Michael D. Chaplin, AIA - Sclater Architects
(If different from the owner. All questions and correspondence will be directed to the individual listed.)

Address: 414 Olive Way, Suite 300
Seattle WA, 98101

Phone: (206) 624-8682

Proposal Title: 6th Street Below Grade Tunnel

Proposal Location: 6th Street, between Bellevue Way and 105th.
(Street address and nearest cross street or intersection) Provide a legal description if available.

Please attach an 8 ½" x 11" vicinity map that accurately locates the proposal site.

Give an accurate, brief description of the proposal's scope and nature:

1. General description: Excavate and construct a two way vehicular tunnel with a pedestrian walkway. Tunnel will connect Lincoln Square level P5 to Lincoln Square Expansion level P4.
2. Acreage of site: N/A
3. Number of dwelling units/buildings to be demolished: N/A
4. Number of dwelling units/buildings to be constructed: N/A
5. Square footage of buildings to be demolished: N/A
6. Square footage of buildings to be constructed: 1,350 SF
7. Quantity of earth movement (in cubic yards): 800 Bank Cubic Yards
8. Proposed land use: Vehicular and pedestrian below grade tunnel
9. Design features, including building height, number of stories and proposed exterior materials:
   Tunnel will be a single level connecting Lincoln Square level P5 to Lincoln Square Expansion level P4. Tunnel will have a drive lane for each direction along with a pedestrian walkway. Inside of the tunnel will be a troweled
10. Other

Estimated date of completion of the proposal or timing of phasing:

Completion of the tunnel will be the same as the completion of the Lincoln Square Expansion below grade garage.

Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

No.

List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

Soil Report for Lincoln Square Expansion.

Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain. List dates applied for and file numbers, if known.

None.

List any government approvals or permits that will be needed for your proposal, if known. If permits have been applied for, list application date and file numbers, if known.

Land Use Exemption Approval - LJ - Submittal Date 11/14/2014
Building Permit - BM - Submittal Date 11/30/2014

Please provide one or more of the following exhibits, if applicable to your proposal.
(Please check appropriate box(es) for exhibits submitted with your proposal):

☐ Land Use Reclassification (rezone) Map of existing and proposed zoning

☐ Preliminary Plat or Planned Unit Development
Preliminary plat map

☐ Clearing & Grading Permit
Plan of existing and proposed grading
Development plans

☑ Building Permit (or Design Review)
Site plan
Clearing & grading plan

☐ Shoreline Management Permit
Site plan

A. ENVIRONMENTAL ELEMENTS

1. **Earth**

a. General description of the site: ☑ Flat ☐ Rolling ☐ Hilly ☐ Steep slopes ☐ Mountains ☐ Other

b. What is the steepest slope on the site (approximate percent slope)? N/A

c. What general types of soil are found on the site (for example, clay, sand, gravel, peat, and muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

Glacial Till

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

None.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

No fill is anticipated. No grading. All activity is below grade excavation.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

No.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Proposed project is below grade. Existing surface conditions above the tunnel are undisturbed.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

None as all activities are below grade.

2. AIR

a. What types of emissions to the air would result from the proposal (i.e. dust, automobile odors, and industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.

Typical Construction Activities from use of machinery.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

None known.

c. Proposed measures to reduce or control emissions or other impacts to the air, if any:

Standard construction measures.

3. WATER

a. Surface

(1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

None.

(2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If Yes, please describe and attach available plans.

No.

(3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

None.

(4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

No.

(5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

Below grade.

(6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

No.

b. Ground

(1) Will ground water be withdrawn, or will water be discharged to ground water? Give general description.

No, all activities are above the current known ground water table.

(2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals...; agricultural; etc.) Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

None.

c. Water Runoff (Including storm water)

(1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

None.

(2) Could waste materials enter ground or surface waters? If so, generally describe.

No.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

All activities are below grade.

4. Plants

a. Check or circle types of vegetation found on the site:

- ☐ deciduous tree: alder, maple, aspen, other
- ☐ evergreen tree: fir, cedar, pine, other
- ☐ shrubs
- ☐ grass
- ☐ pasture
- ☐ crop or grain
- ☐ wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other
- ☐ water plants: water lily, eelgrass, milfoil, other
- ☐ other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

None - all construction is below grade.

c. List threatened or endangered species known to be on or near the site.

None.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

None - Completed project is below grade.

5. ANIMALS

a. Check or circle any birds and animals which have been observed on or near the site or are known to be on or near the site:

- ☐ Birds: hawk, heron, eagle, songbirds, other:
- ☐ Mammals: deer, bear, elk, beaver, other:
- ☐ Fish: bass, salmon, trout, herring, shellfish, other:

b. List any threatened or endangered species known to be on or near the site.

None.

c. Is the site part of a migration route? If so, explain.

Not known

d. Proposed measures to preserve or enhance wildlife, if any:

None.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy need? Describe whether it will be used for heating, manufacturing, etc.

Electric power for lighting.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No.

c. What kinds of energy conservation features are included in the plans of the proposal? List other proposed measures to reduce or control energy impacts, if any:

None.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

None.

(1) Describe special emergency services that might be required.

None known

(2) Proposed measures to reduce or control environmental health hazards, if any.

None.

b. Noise

(1) What types of noise exist in the area which may affect your project (for example, traffic, equipment, operation, other)?

Daily traffic on street.

(2) What types and levels of noise would be created by or associated with the project on a short-term or long-term basis (for example, traffic, construction, operation, other)? Indicate what hours noise would come from the site.

Construction noise only. Daily activity within tunnel will be below grade.

(3) Proposed measures to reduce or control noise impacts, if any:

None.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

Mixed use projects with Retail, Office, Hospitality and Residential.

b. Has the site been used for agriculture? If so, describe.

Not known.

c. Describe any structures on the site.

None.

d. Will any structures be demolished? If so, what?

None.

e. What is the current zoning classification of the site?

Downtown 0-1

f. What is the current comprehensive plan designation of the site?

Downtown

g. If applicable, what is the current shoreline master program designation of the site?

N/A

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

Not to the applicant's knowledge.

I. Approximately how many people would reside or work in the completed project?

None

j. Approximately how many people would the completed project displace?

None.

k. Proposed measures to avoid or reduce displacement impacts, if any:

No displacement.

i. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

Proposed project is a below grade tunnel providing connection between garages and taking potential trips off the surface streets.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

N/A

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

N/A

c. Proposed measures to reduce or control housing impacts, if any:

N/A

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

Proposed tunnel is below grade and has no visible structure at surface.

b. What views in the immediate vicinity would be altered or obstructed?

None.

c. Proposed measures to reduce or control aesthetic impacts, if any:

Tunnel is below grade.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

None.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No.

c. What existing off-site sources of light or glare may affect your proposal?

None.

d. Proposed measures to reduce or control light or glare impacts, if any:

None.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

Bellevue Park is two blocks away.

b. Would the proposed project displace any existing recreational uses? If so, describe.

None.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

None.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

None.

b. Generally describe any landmarks or evidence of historic, archeological, scientific, or cultural importance known to be on or next to the site.

None.

c. Proposed measures to reduce or control impacts, if any:

None.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

Tunnel is below 6th street in Downtown Bellevue.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

N/A

c. How many parking spaces would be completed project have? How many would the project eliminate?

None.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

None.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

None.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

None.

g. Proposed measures to reduce or control transportation impacts, if any:

Tunnel will connect two existing garages and will allow vehicles to transfer between garages and potentially take trips off the surface streets.

15. Public Services

a. Would the project result in an increased need for the public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.

None.

b. Proposed measures to reduce or control direct impacts on public services, if any:

None.

16. Utilities

a. Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other.

Electricity, water, sanitary sewer.

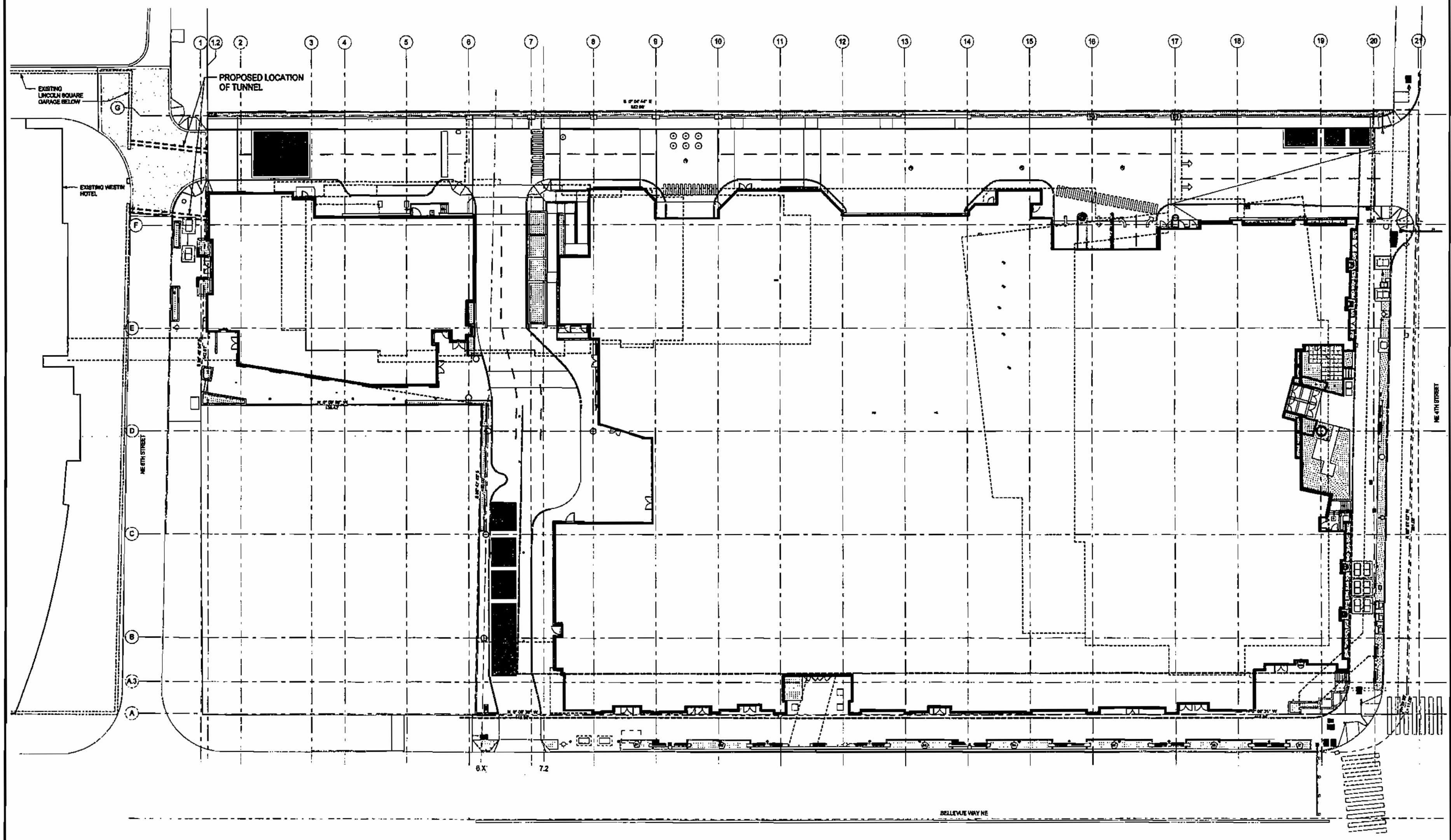
b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

Electricity.

Signature

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature...Date Submitted 11/14/2014..



Site Plan - Tunnel

SCALE: 1/16" = 1'-0"

1

A ARCHITECTS

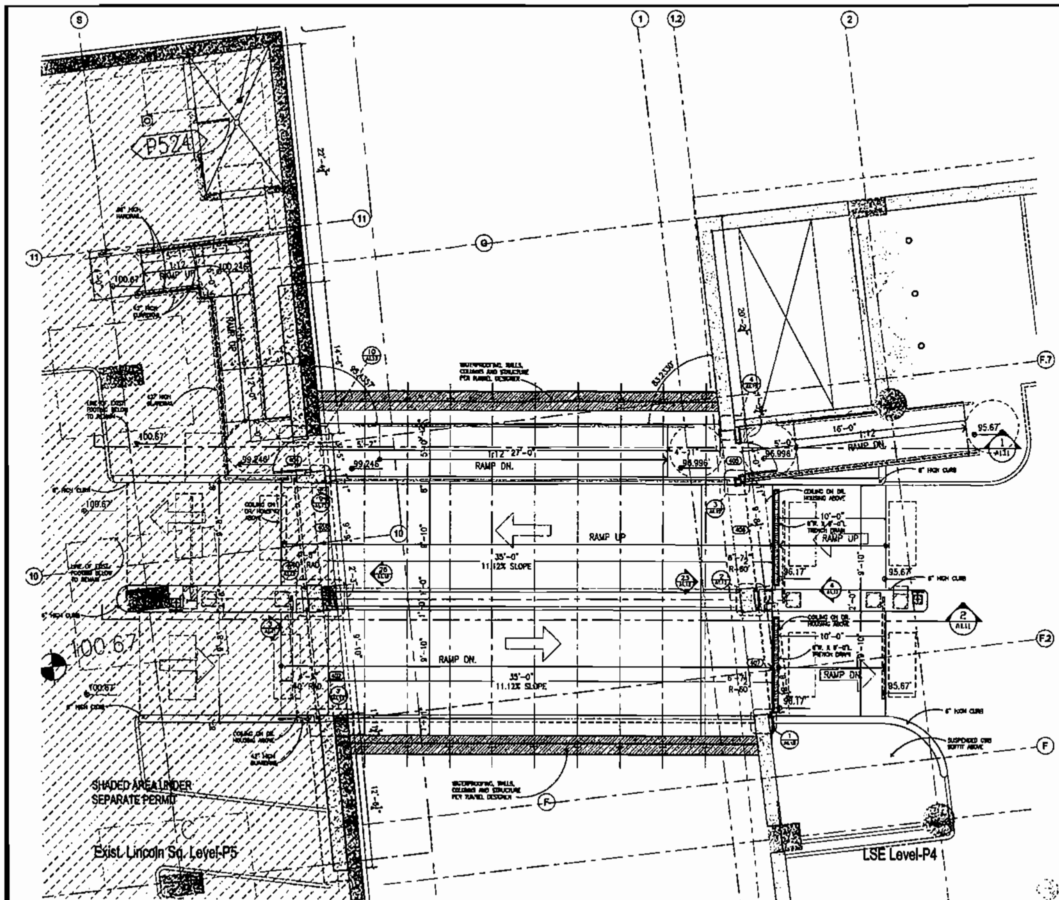
Lincoln Square Expansion
410 Bellevue Way NE, Bellevue Washington

6th Street Tunnel Permit
November 14, 2014

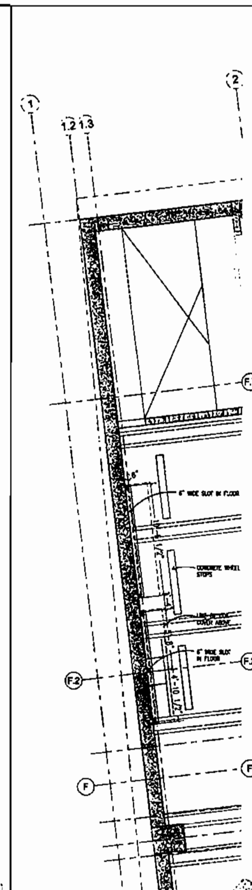
Site Plan "6"

11/14/14 | 0706.000

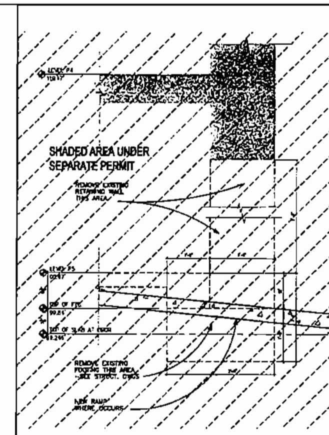
ST-1



Partial Floor Plan - Level P4 (Tunnel) SCALE: 1/4" = 1'-0" 5

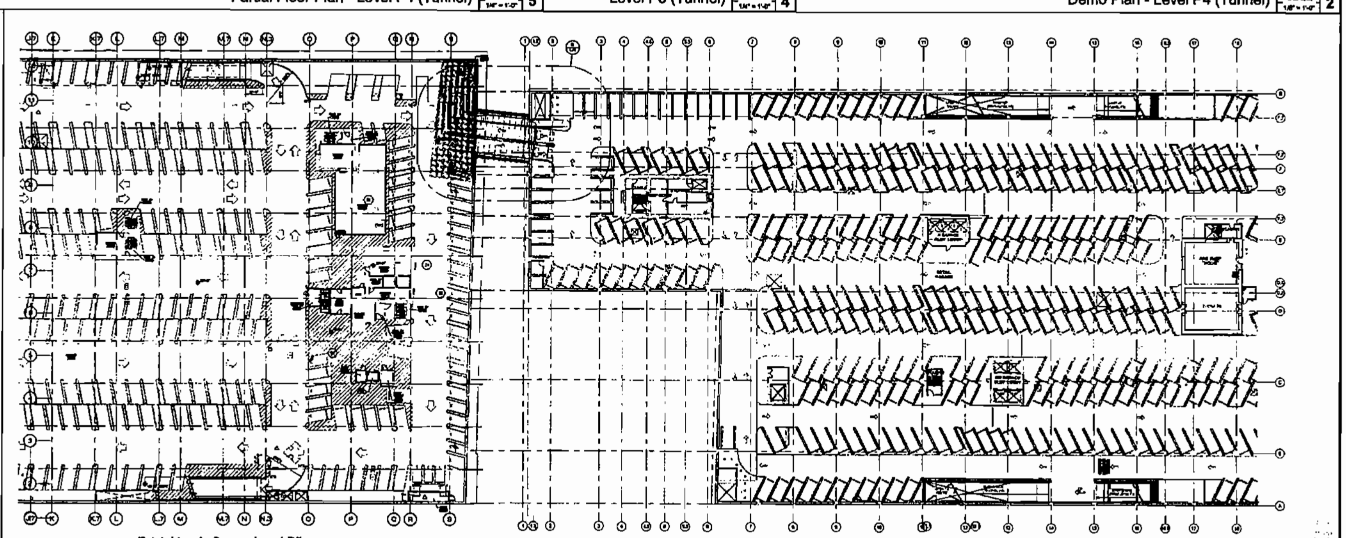


Partial Floor Plan - Level P3 (Tunnel) SCALE: 1/4" = 1'-0" 4



Demo Footing Section (Tunnel) SCALE: 3

Demo Plan - Level P4 (Tunnel) SCALE: 1/8" = 1'-0" 2



Overall Plan - Level P4 (Tunnel) SCALE: 1/16" = 1'-0" 1

A ARCHITECTS

Lincoln Square Expansion
410 Bellevue Way NE, Bellevue Washington

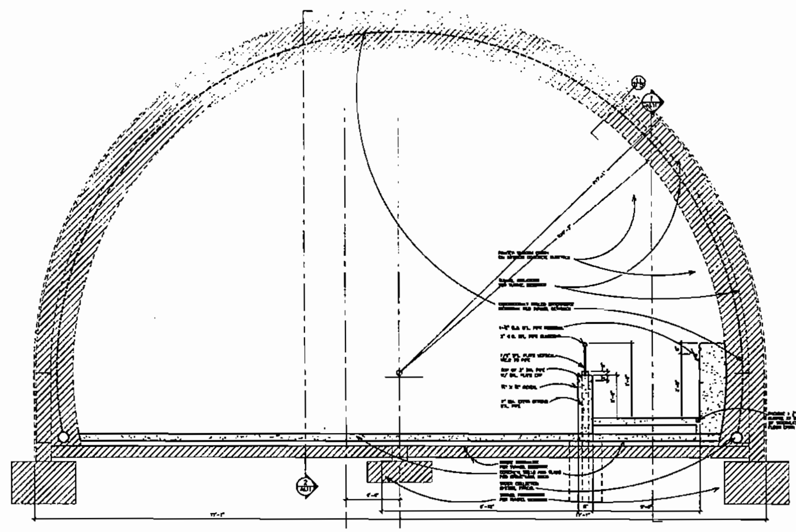
6th Street Tunnel Permit
November 14, 2014

Tunnel Overall Floor and Demo. Plans

SITE PLAN "B"

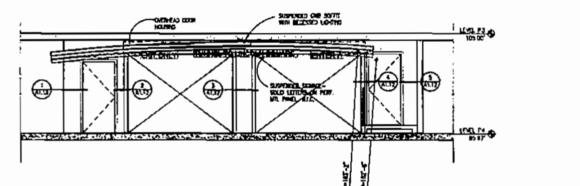
11/14/14 | 0706.000

A1.10

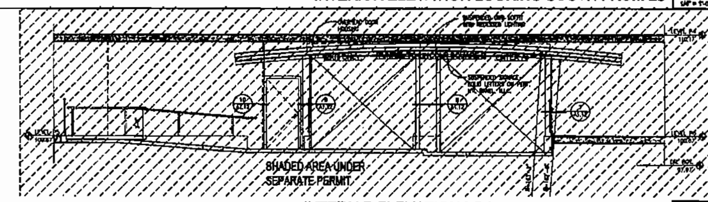


TUNNEL SECTION LOOKING NORTH | SCALE: 1/2" = 1'-0" | 6

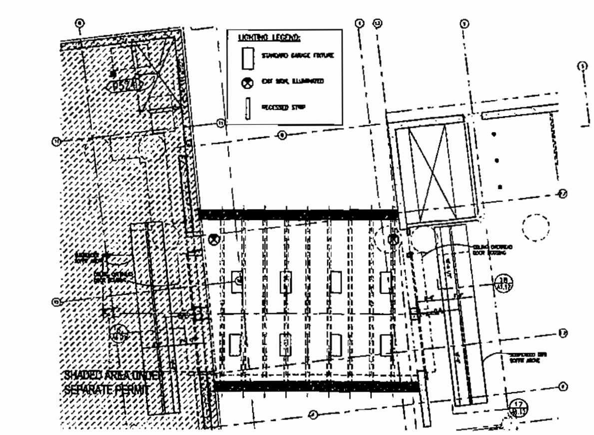
N/A | SCALE: 1/4" = 1'-0" | 5



INTERIOR ELEVATION LOOKING SOUTH FROM LS | SCALE: 1/4" = 1'-0" | 4



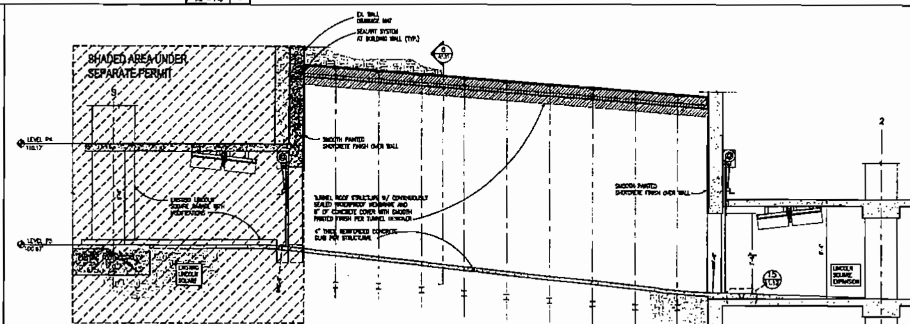
INTERIOR ELEVATION LOOKING NORTH FROM LSE | SCALE: 1/4" = 1'-0" | 3



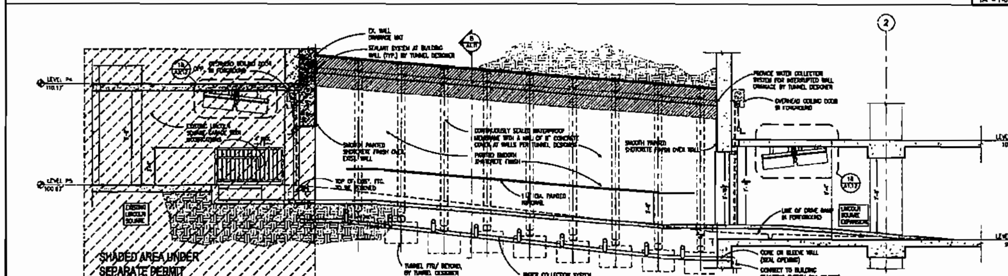
Exist. Level-P5

LSE Level-P4

REFLECTED CEILING PLAN | SCALE: 1/8" = 1'-0" | 7



TUNNEL SECTION | SCALE: 1/4" = 1'-0" | 2



TUNNEL SECTION | SCALE: 1/4" = 1'-0" | 1

A

ARCHITECTS

Lincoln Square Expansion

410 Bellevue Way NE, Bellevue Washington

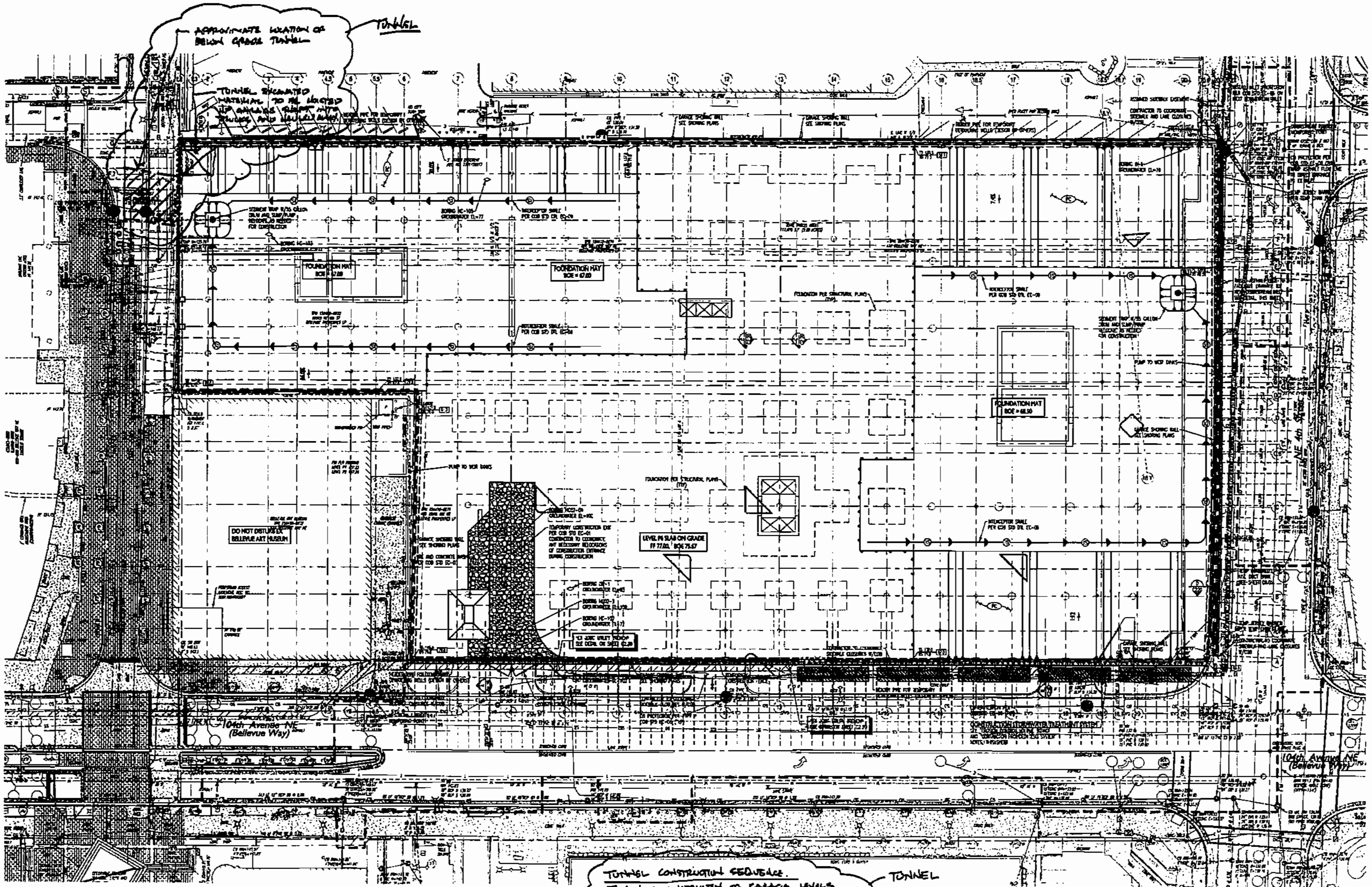
6th Street Tunnel Permit

November 14, 2014

Tunnel Sections Elevations and Reflected Ceiling Plan

11/14/14 | 0706.000

A1.11



TUNNEL CONSTRUCTION SEQUENCE.
- FOLLOWING CONSTRUCTION OF GARAGE LEVELS P6, P5, P4 & P3, TUNNEL EXCAVATION WILL BEGIN.
- EXCAVATED MATERIALS TO BE LIFTED OUT OF GARAGE ONTO TRUCKS ON 6TH ST.

TUNNEL

SCALE 1"=20'

Call before you Dig. 8-1-1 or 1-800-424-5555

Legend

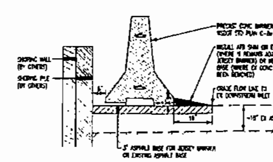
B.M.P. Legend

Conditions of Approval for Rainy Season Clearing and Grading

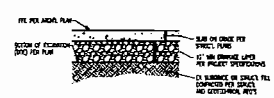
Turbidity Monitoring Notes

Construction Sequence

Erosion Control Volume Sizing



Jersey Barrier Drainage Detail



Bottom of Excavation Section

NOTE: CIVIL SHEET C2.00 IS SUBMITTED AS REFERENCE ONLY FOR TUNNEL PRELIMINARY SEPA REVIEW AS TUNNEL WILL BE EXCAVATED BELOW GRADE INTO GARAGE OF LINCOLN SQUARE EXPANSION.

GD#12-132832
Grid #E-7, Section 27, Township 25, Range 5. UE#12-121838

A ARCHITECTS

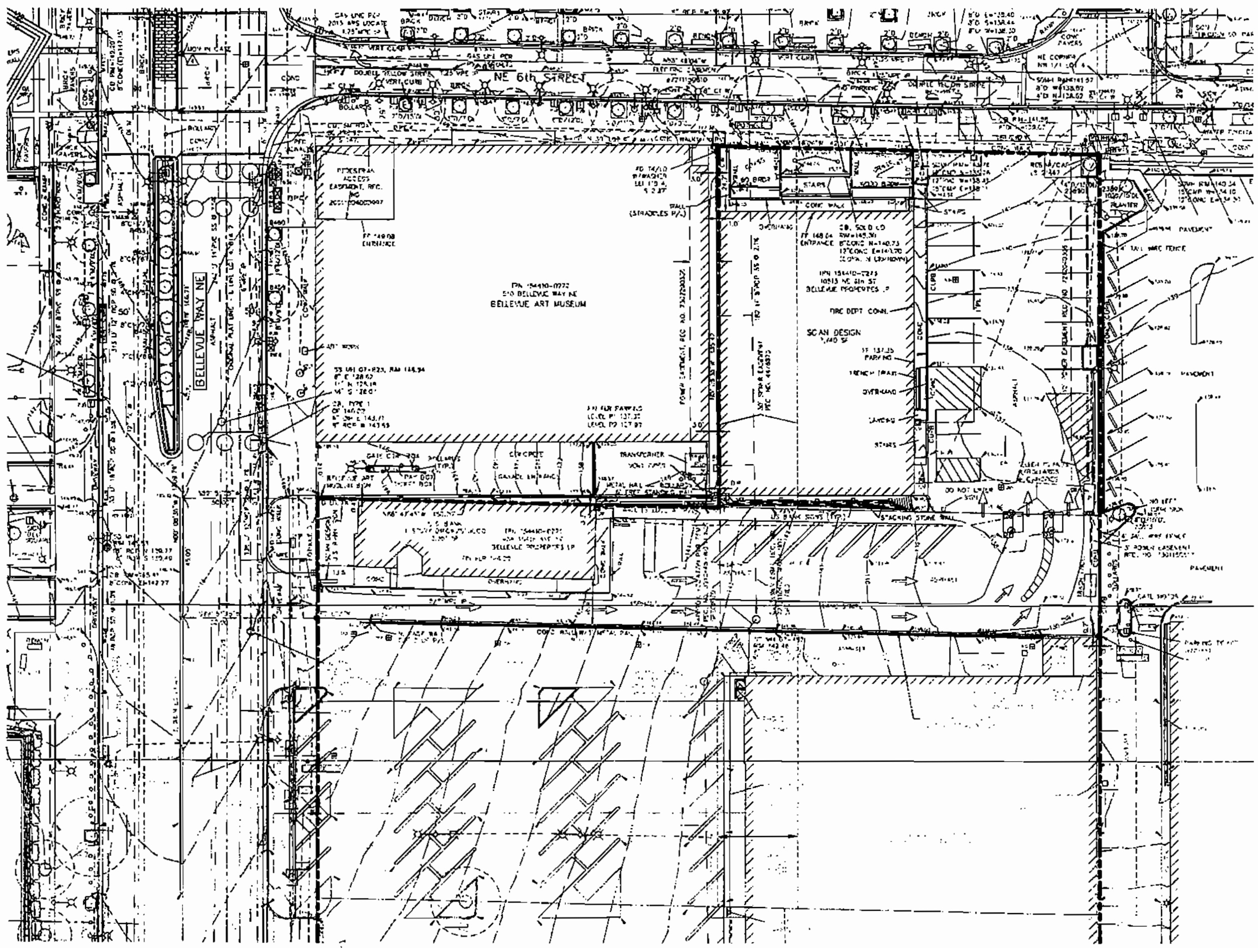
COUGHLIN PORTER LUNDEEN
A CONSULTING STRUCTURAL AND CIVIL ENGINEERING CORPORATION

Lincoln Square Expansion
410 Bellevue Way NE, Bellevue Washington
6th Street Tunnel Permit
November 14, 2014

Excavation And Temporary Erosion Control Plan

11/14/14 C081576-01

C2.00



Survey - North
SCALE: 1/16" = 1'-0"
1

A ARCHITECTS

Lincoln Square Expansion
410 Bellevue Way NE, Bellevue Washington

6th Street Tunnel Permit
November 14, 2014

Survey - North

11/14/14
0706.000

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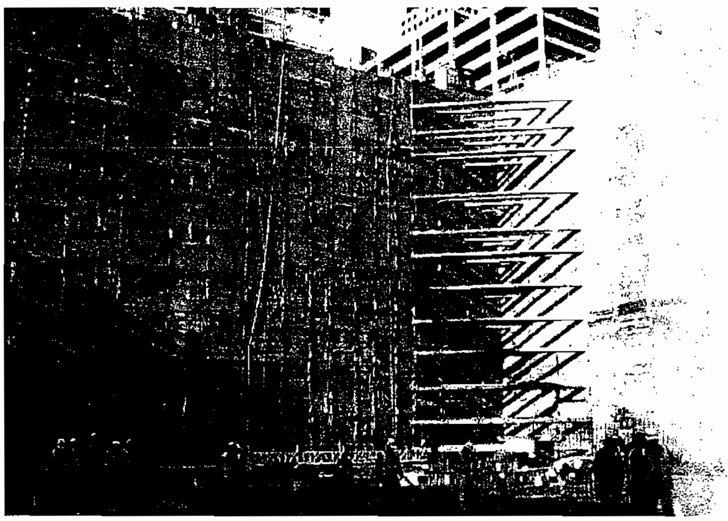

Geotechnical Engineering
Design Study
Lincoln Square Expansion
Bellevue, Washington

Prepared for
Kemper Development Company

April 9, 2013
7355-05

HARTCROWSER

HARTCROWSER

www.hartcrowser.com

Geotechnical Engineering Design Study
Lincoln Square Expansion
Bellevue, Washington

Prepared for
Kemper Development Company

April 9, 2013
_7355-05_

Prepared by
Hart Crowser, Inc.

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4/9/13
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GEOTECHNICAL ENGINEERING DESIGN STUDY
LINCOLN SQUARE EXPANSION
BELLEVUE, WASHINGTON

1.0 INTRODUCTION

This report presents our geotechnical engineering design recommendations for the proposed expansion at Lincoln Square located in Bellevue, Washington. This report contains several sections. The main body of the report presents our recommendations and is organized as follows:

- Introduction;
- Purpose, Scope, and The Use of This Report;
- Site and Project Descriptions;
- Subsurface Conditions;
- Seismic Considerations;
- Geotechnical Engineering Design Recommendations; and
- Recommended Additional Geotechnical Services.

Tables are presented in the text and figures are presented at the end of the text. Figure 1 shows the project location on a Vicinity Map, and Figure 2 presents a Site and Exploration Plan showing existing explorations that were performed by Hart Crowser and other consultants. The field exploration procedures and logs of explorations that we performed in 2007 and 2008 are presented in Appendix A. The laboratory procedures and soil test results from 2007 are presented in Appendix B. Appendix C presents additional field exploration logs and laboratory results performed by Hart Crowser and others. Appendix D discusses the results of slug tests we conducted in 2007.

2.0 PURPOSE, SCOPE, AND THE USE OF THIS REPORT

2.1 Purpose

The purpose of our work is to assess subsurface conditions at the site and provide geotechnical engineering recommendations for design and construction of the proposed development.

2.2 Scope

We completed a Geotechnical Engineering Design Study draft report for the site in 2007. The work detailed in that report was the basis of this updated final report combined with additional available subsurface information and modifications to the proposed development since then. Our scope of work for the geotechnical design aspects of the project included:

- Review of existing subsurface information at the project site;
- Development of geotechnical engineering recommendations considering current project plans; and
- Presentation of the results of our study in this report.

We developed our geotechnical design recommendations based on the combined geotechnical data from previous explorations.

2.3 The Use of This Report

We completed this work in general accordance with our proposal dated November 16, 2012. We received written authorization to proceed on November 19, 2012. This report is for the exclusive use of Kemper Development Company and their consultants for specific application to this project and site. We completed this design study in accordance with generally accepted geotechnical practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. We make no other warranty, express or implied.

The subsurface information used for this study represents conditions at discrete locations across the project site and actual conditions in other areas could vary. Furthermore, the nature and extent of any variations may not become evident until additional explorations are performed or until construction begins. If significant variations are observed at that time, we may need to modify our conclusions and recommendations accordingly to reflect actual site conditions.

3.0 SITE AND PROJECT DESCRIPTIONS

The project site is located at the northeast corner of the intersection of NE 4th Street and Bellevue Way NE (104th Avenue NE). Overall, the site is about 600 feet from north to south and about 300 feet from east to west. The exception to this site footprint is the northwest corner (about 160 by 140 feet) where the Bellevue Arts Museum will remain and will not be a part of the proposed development. Based on an available survey map, the site grades from approximately elevation 146 feet in the northwest corner of the site to elevation 128 feet in the southeast corner.

Currently, the site is occupied by buildings and asphalt-paved parking areas. These structures will be demolished before construction of the new development.

We understand that the Lincoln Square Expansion plans include a 44-story hotel/residential tower in the northeast portion of the site and a separate 31-story office tower in the southeast corner. Three levels of retail will surround the towers. The structures will essentially occupy the entire site.

Six levels of below-grade parking are planned. The lowest parking slab (level P6) will be at about elevation 77 feet, approximately 51 to 69 feet below street level. The excavation will require shoring around the entire perimeter of the site.

The Bellevue Arts Museum off the northwest corner of the site, and a building east of the site, will remain during construction. The Bellevue Arts Museum includes two below-grade levels.

We understand that the development may also include a tunnel between the Lincoln Square Expansion parking garage and the existing Lincoln Square parking garage to the north. At the time of this report, the elevation of the tunnel has not been determined. When additional information about the tunnel becomes available, we can provide recommendations.

We expect that foundation loads will be significant and anticipate that a combination of mat foundations (beneath the towers) and high-capacity spread footings will be suitable for foundation support. We also understand that the below-grade parking garage will incorporate a permanent dewatering system to handle groundwater around the perimeter and at the base of the structure.

4.0 SUBSURFACE CONDITIONS

Our understanding of the subsurface conditions in the area of the proposed development is based on information obtained from five mud rotary borings (HC-101 through HC-105), which were drilled to depths from 148.5 to 199 feet in 2007. In addition, a downhole seismic survey to measure primary (compression) and shear wave (P- and S-wave) velocities was completed in boring HC-104 on September 12, 2007. The P- and S-wave velocity profiles obtained from the seismic survey were used in our analysis for geotechnical seismic basis of design to develop the site-specific design response spectra. These profiles were also useful in assessing soil strength parameters relevant to our geotechnical design recommendations. P- and S-wave velocity profiles obtained from the downhole seismic survey are provided on Figure A-5A (Appendix A).

Shallow borings for environmental assessment and other earlier borings that we performed, together with borings performed by others at the site, provided additional geotechnical data for this study. Approximate locations of these explorations are shown on Figure 2.

Detailed boring logs of the subsurface conditions we observed in the explorations we completed in 2007, together with compression and shear wave velocity profiles from downhole measurements in HC-104, are shown on the logs included in Appendix A, and should be referred to for specific information. Results of our laboratory tests from 2007 are presented in Appendix B. Appendix C provides the logs of other explorations performed at the site by us and by others.

4.1 Soil Conditions

Four basic soil units represent the on-site soils as indicated by our 2007 borings. These soil units reflect the geologic depositional history at the site, and are, in order of increasing age, Fill, Weathered Till, Glacial Till, and Glacially overridden Sand and Silt. We completed four generalized subsurface cross sections based on the subsurface conditions we encountered in these explorations (Figures 3 through 6). Descriptions of these soils are presented in the following paragraphs.

Fill. This layer consists of very loose to loose, brown and tannish brown, moist to wet, slightly silty to very silty, slightly gravelly to gravelly Sand and sandy Gravel. Most of the site is covered by asphalt pavement and crushed rock base course, which is noted in several of the boring logs above the Fill material. The thickness of Fill is variable across the site, ranging from 0 to 10 feet, but is generally about 5 feet.

Weathered Till. Underlying the FILL material, this material consists of dense to very dense, damp to moist, gray-brown, slightly gravelly to gravelly, silty SAND. In the explorations where weathered till was observed, the layer extended to depths ranging from 7 to 20 feet.

Glacial Till. The Glacial Till generally consists of dense to very dense, gray-brown, non-gravelly to very gravelly, slightly silty to very silty Sand. In several borings we noted gravel/cobble zones and silty, sandy Gravel layers. The Glacial Till extends to depths ranging from 38 feet (corresponding to elevation 91 feet) in the southeast corner of the site to 87 feet (corresponding to elevation

58 feet) in the northwest corner of the site. In general, it appears that the bottom of the Glacial Till slopes downward toward the west.

Possible cobble zones were encountered in several explorations in the Glacial Till unit. Based on our experience in similar materials and the soil strata of this area, we anticipate cobbles and boulders may be present across the site. Such large materials could make drilling and/or excavation difficult. Therefore, the contractor should be prepared to deal with large obstructions. In addition, the Glacial Till unit may also contain relatively clean sand and/or gravel zones, where groundwater may accumulate and be more prone to caving when exposed in a vertical face or encountered in a drilled hole. Provisions should be made in contract documents to account for the possibility of these conditions.

Glacially Overridden Sand/Silt. Very dense/hard, glacially overridden Sand and Silt was encountered across the site below the Glacial Till. This unit generally consists of hard, moist to wet, gray and brown, trace to very sandy Silt and very dense, moist to wet, trace to very silty Sand. This material is of low plasticity, and has been glacially overridden. Within this unit we encountered zones of relatively non-silty Sand, which may contain significant groundwater as described below. Borings also encountered possible cobble zones in several explorations in this soil unit. Therefore, the contractor should be prepared to deal with large obstructions.

4.2 Groundwater

Our understanding of groundwater conditions at the site is based on our explorations, water level measurements, slug tests, and a pump test performed by others (Bender, 2008).

Groundwater occurs primarily in the Glacial Till and glacially overridden Sand/Silt units. The Glacial Till unit consists of relatively impermeable material. Within the Till, perched groundwater occurs mostly in discontinuous relatively permeable sand and gravel zones. During excavation, low-volume seepage should be expected from these permeable zones.

In general, we expect the Sand/Silt unit to be relatively impermeable (hydraulic conductivity less than about 1×10^{-4} cm/sec [0.28 ft/day]). However, the zones of relatively non-silty sand within this unit are expected to be more permeable.

Boring logs indicate that groundwater was generally encountered near the top of the Sand/Silt unit at depths of 45 to 67 feet (elevation 58 to 84 feet). Several wells at the site are screened in the more permeable sand zones within the Sand/Silt unit as summarized in Table 1. Groundwater measurements summarized in Table 1 indicate that groundwater in the Sand/Silt unit is generally confined; water levels in the wells rise above the levels observed at the time of drilling.

Table 1 – Groundwater Observation in Borings and Monitoring Wells

Boring	Date Boring Completed	Groundwater Depth at the Time of Drilling in Feet	Groundwater in Screened Monitoring Wells			
			Date Measured	Depth in Feet	Elevation in Feet	Screened Elevation Range in Feet
HC-102	8/17/07	87	9/18/07	68	77	43 - 53
HC-103	8/22/07	55	9/18/07	62	77	70 - 80
HC-105	9/04/07	42	9/18/07	62	77	49 - 59
B-3	4/12/00	85	5/8/00	39	102	56 - 86
B-6	4/11/00	45	5/8/00	49	76	40 - 70
HC02-3	9/26/02	44	10/1/02	36	109	100 - 110
HC02-4	9/27/02	-	10/1/02	42	100	97 - 107
DW-1*	2/20/08	-	2/21/08	61	83	35 - 75

* Drilling and observation by others.

Based on slug tests conducted in 2007 (Appendix D) the hydraulic conductivity of the relatively non-silty zones within the Sand/Silt unit ranges from 0.00023 to 0.004 cm/sec (0.7 to 11.3 ft./day), averaging 0.001 cm/sec (2.8 ft/day). The measured hydraulic conductivities are consistent with values typical of silty sand to sand.

Note that measured groundwater levels represent the times indicated. Fluctuations in groundwater levels may occur due to variations in rainfall, temperature, seasons, and other factors. It is important that the contractor provides contingencies for dealing with groundwater on this project.

5.0 SEISMIC CONSIDERATIONS

We completed the Geotechnical Seismic Design Study dated January 14, 2008, to develop the site-specific design response spectra. Our analysis and the results of this study are provided under separate cover (Geotechnical Seismic Design Study dated January 14, 2008).

5.1 Seismically Induced Geotechnical Hazards

Potential seismically induced geotechnical hazards at the project site include surface rupture, liquefaction and subsidence, and landslides. Our review of these hazards is based upon the existing soil explorations presented in this report, regional experience, and our knowledge of local seismicity.

5.1.1 Surface Rupture

The northernmost splay of the Seattle Fault exists approximately 3 kilometers (about 1-3/4 miles) south of the site (EERI 2005). There is a remote potential for surface rupture at the site from a new splay of the Seattle Fault; however, this hazard is very low due to the Seattle Fault's approximately 3,000-year recurrence interval (USGS 2006), the large number of possible locations for surface rupture, and the expected probability that the fault would not produce surface rupture in this segment of the fault.

5.1.2 Liquefaction and Subsidence

When cyclic loading occurs during a seismic event, the shaking can increase the pore pressure in loose to medium dense saturated sand and cause liquefaction, or temporary loss of soil strength. This can lead to surface settlement. We did not encounter saturated soil in a loose to medium dense condition in the borings conducted for this project.

This does not mean that isolated, relatively loose, portions of saturated sand and gravel that we did not encounter in our borings will not liquefy under the design level ground motion. Rather, we estimate the likelihood of widespread liquefaction capable of causing damage to be very low for the assumed level of ground motion.

5.1.3 Lateral Spreading

Lateral spreading is typically associated with slope movement caused by the liquefaction of underlying soils. Although the site is slightly sloped, widespread liquefaction is not expected; therefore, the hazard associated with lateral spreading is considered to be low.

5.1.4 Landslides

Based on the site location, slope inclination, and absence of reported landslides in the area, the landslide hazard is considered to be very low.

6.0 GEOTECHNICAL ENGINEERING DESIGN RECOMMENDATIONS

This section of the report presents our conclusions and recommendations for the geotechnical aspects of design and construction on the project site. We have developed our recommendations based on our current understanding of the project and the subsurface conditions encountered by our explorations. If the nature or location of the development is different than we have assumed, we should be notified so we can change or confirm our recommendations.

6.1 General Considerations

Based on the current design plans and our discussions with the design team, the primary geotechnical considerations for this project include:

- The proposed development will have extensive excavation, requiring temporary shoring to accommodate the proposed underground parking structure. In addition, underpinning existing structures, such as the Bellevue Arts Museum, will be necessary. The close proximity to the existing Lincoln Square to the north is also a design consideration. Both soldier piles with tiebacks and soil nail shoring systems are suitable to support the excavation, provided that easements are granted by neighboring properties. If easements cannot be obtained, an internally braced shoring system would be necessary. A dewatering system, likely in the form of sumps, wellpoints, and/or deep wells should be expected for installation of any shoring system.

- The site soils at depth are suitable to provide support of mat foundations and high-capacity shallow spread and continuous footings, based on our review of the boring logs.

- Groundwater was encountered in our borings around the site and is expected to be a significant issue during construction. Because of potential groundwater seepage, heaving or caving soils, and probable precipitation runoff during excavation, the contractor should be prepared to provide temporary drainage or other groundwater control (e.g., ditches, sump pumps, deep wells, wellpoints) to maintain the excavation in a stable, workable condition. We recommend that a permanent dewatering system be used to manage groundwater for the service life of the building, since the base of the building will be below the groundwater table.

6.2 Site Preparation

6.2.1 General Site Preparation

Site preparation will involve demolishing structures and removing pavement, sidewalks, and landscaping. We recommend that the removed asphalt not be reused as Structural Fill (as defined in Section 6.9). Initial site preparation will also include removing existing foundation elements and abandoning underground utilities or completely grouting them. Ends of remaining abandoned utility lines should be sealed to prevent piping of soil or water into the pipe.

Environmental issues such as underground storage tanks (USTs) or potentially contaminated soil and groundwater will be addressed separately.

6.2.2 Site Dewatering

As previously stated, groundwater was encountered during our field investigation. Allowances should be made during construction for temporary dewatering to handle perched water, groundwater, and wet weather conditions. We understand that the below-grade parking garage will incorporate a permanent drainage system to manage groundwater around the perimeter and at the base of the structure. Refer to Section 6.7 for Construction Dewatering recommendations.

6.3 Excavation Shoring and Support of Existing Structures

The ground surface elevation in the area requiring mass excavation ranges from approximately 128 to 146 feet. The planned basement floor elevation for most of the proposed structure (approximately 77 feet), minus approximately 10 feet for foundations, will require up to about 80 feet of excavation (to up to elevation 66 feet) across the entire site. A properly designed shoring system will be required to provide temporary lateral support for the excavation and for the safety and stability of the adjacent structures, streets, utilities, and properties. The foundations of the Bellevue Arts Museum will require underpinning. The close proximity of the Lincoln Square Phase 1 structures to the north will also require consideration in the design of the shoring system.

6.3.1 General Shoring Considerations

Based on the subsurface soil conditions and the need for underpinning to protect existing footings in some areas, it is our opinion that the project excavation could be supported using conventional soldier piles with tieback anchors, a soil nail shoring system, or a combination of the two.

The selection of the system will depend on numerous factors including contractor experience and cost. The advantages and disadvantages of each system should be carefully weighed to account for cost and construction benefits that may be lost or gained with either retaining system.

If a soldier pile and tieback shoring system is selected, we recommend that shoring be designed by a Professional Engineer registered in the State of Washington and that we be given the opportunity to review the proposed shoring design before construction.

We assume that simultaneous below-grade construction across streets (for example, NE 4th Street and Bellevue Way NE) adjacent to the site, resulting in simultaneous excavation on either side of the street, will not occur. Hart Crowser should be informed if such conditions are expected or likely to occur so that we can confirm or modify our recommendations.

It is generally not the purpose of this report to provide specific criteria for the contractor's construction means and methods. It should be the responsibility of the shoring contractor to verify actual ground conditions at the site and determine the construction methods and procedures needed for the installation of an appropriate shoring system.

6.3.2 Soldier Pile/Tieback Excavation Support

The geotechnical criteria for the design of a conventional soldier pile and tieback shoring wall include lateral soil pressures, friction for tiebacks and soldier piles, and end bearing for soldier piles. Figures 7 and 8 illustrate and outline these recommended parameters, which are discussed in this section. It may be necessary, in areas adjacent to existing structures, to use a modified shoring system to avoid any nearby basements. The soldier pile and tieback designer should consult with us about this situation.

Lateral Pressures

Lateral earth pressures for shoring design depend on the type of shoring and its ability to deform. If the top of the shoring is allowed to deform on the order of 0.001 to 0.002 times the shoring height, and if no settlement-sensitive structures or utilities are within the zone of deformation, the shoring may be designed using active earth pressures. If settlement-sensitive structures or utilities exist within the potential zone of deformation, or where the shoring system is too stiff to allow sufficient lateral movement to develop an active condition, at-rest earth pressures should be used to design the shoring. If settlement-sensitive utilities are present, we should be consulted to evaluate the impact of the shoring system.

Temporary Shoring. The mass excavation may be supported by soldier piles with multiple levels of tiebacks. The lateral earth pressure distribution presented on Figure 7 is appropriate for multilevel tieback-supported soldier piles with level ground conditions behind the wall. Intermediate cantilevered shoring cases can be designed per the recommendations for backfilled walls presented in Section 6.5. Based on the borings conducted for this and previous studies, we have developed a composite lateral earth pressure profile. Lateral earth pressures can be approximated by a trapezoidal pressure distribution for the soil profile. Figure 8 provides methods to evaluate various surcharge scenarios for active and at-rest conditions for the site soils.

Important. The lateral earth pressures presented herein are based on dewatered conditions so that hydrostatic pressures do not act on the walls. We recommend that at least 2 feet be added to the proposed excavation depth for computations to provide some allowance for possible surface pressures near the excavation (e.g., light vehicles, small material stockpiles). Surcharge pressures from heavier loads (e.g., buildings, footings, heavy equipment, large material stockpiles) should be calculated using Figure 8. These additional loads would be added to those calculated for the shoring walls based on Figure 7.

Soldier Pile Design

Soldier piles must be designed to carry the bending stresses between tiebacks and the vertical loads resulting from down-angled tieback anchors. The stresses can be calculated from the earth pressure diagrams. The soldier pile must be embedded deeply enough to resist these vertical loads and to provide kickout resistance for the portion of the wall below the lowest support. General soldier pile design information is presented on Figures 7 and 8, as discussed above. We also make the following recommendations:

- Soldier piles should bear in the glacially overridden, dense to very dense Sand or hard, sandy Silt;
- Allowable pile end bearing and skin friction are presented on Figure 7;
- Pile embedment depth (D) should be at least 10 feet below the excavation bottom after allowing 2 feet for disturbance;

- The excavation depth should account for overexcavation required for footings, if necessary;

- Design soldier piles for bending using a uniform loading equivalent to 80 percent of the design values and analyze for shear using total load; and

- For design against kickout, compute the lateral resistance on the basis of the passive pressure presented on Figure 7, acting over three times the diameter of the concreted soldier pile section or the pile spacing, whichever is less.

The above recommendations are based on proper installation of the soldier piles as described below.

Soldier Pile Installation

Conditions such as caving soil and groundwater can loosen soil at the bottom of the soldier pile borehole and reduce bearing capacity in the zone of disturbed soil. Destressing the tiebacks and failure of the shoring could occur if soldier piles settle under the vertical component of the inclined tieback load in combination with any other vertical loads. We recommend that our representative monitor soldier pile installation so that construction methods can be verified and adjusted as necessary.

We make the following recommendations for soldier pile installation:

- Require that the Contractor be prepared to case the soldier pile installations. The need for casing should be determined in the field at the time of installation.

- Require the Contractor to tremie concrete from the bottom of the hole to displace groundwater. Given the potential depth of the soldier pile excavations and the potential for water in the excavation, end-dumping of concrete should not be permitted.

- Require the Contractor to excavate the soldier piles in a manner that prevents "heave" or "boiling" at the bottom of the soldier pile excavation. It may be possible to over-drill the borehole and backfill the bottom of the borehole with structural concrete bearing on undisturbed soil.

- Prohibit the use of drilling mud unless reviewed and approved by the geotechnical and structural engineer.

Lagging

Loss of ground between the soldier piles is prevented by using lagging. The most common form of lagging is timber planks. The lagging is attached to the soldier pile. Because of soil arching and the ability of the lagging to deflect, lagging is generally designed for some fraction of the applied pressure on the wall.

Prompt and careful installation of lagging, particularly in areas of seepage and loose soil, is important to maintain the integrity of the excavation. Proper lagging installation should be the responsibility of the shoring contractor to prevent soil failure, sloughing and loss of ground, and to provide safe working conditions.

We recommend that the temporary timber lagging thickness (rough cut) be sized using the values below. These lagging sizes are based on recommendations in the Federal Highway Administration *Geotechnical Engineering Circular* No. 4, "Ground Anchors and Anchored Systems" (FHWA 1999) and our experience with similar excavations in Bellevue.

Table 2 - Recommended Lagging Thickness

Excavation Depth (feet)	Recommended Lagging Thickness (rough-cut) for Clear Spans of:					
	5 feet	6 feet	7 feet	8 feet	9 feet	10 feet
0 to 25	2 inches	3 inches	3 inches	3 inches	4 inches	4 inches
25 to 130	3 inches	3 inches	3 inches	4 inches	4 inches	5 inches

Soldier pile shoring system construction may be difficult if cobbles, boulders, or loose sand and gravel are encountered in the excavation. If these conditions are encountered, substantial raveling of the soil could occur. The contractor should be prepared to place lagging in small vertical increments and should also be prepared to backfill voids behind the shoring system during construction due to loss of ground.

We make the following recommendations for lagging:

- Design the lagging using an applied lateral pressure of 60 percent of the design load if the free space is more then three-pile diameters, and 40 percent if the free space is less than three-pile diameters.

- Backfill voids greater than 1 inch using sand, pea gravel, or a porous slurry. Backfill the void spaces progressively as the excavation deepens. The backfill must not allow potential hydrostatic pressure build-up behind the wall. Drainage behind the wall must be maintained. If not, hydrostatic water pressure should be added to the recommended lateral earth pressures.

The lateral earth pressures presented herein are based on dewatered conditions so that hydrostatic pressure does not act on the walls. We recommend installing continuous full-face geocomposite drainage material, consisting of a 3-dimensional core covered with a filter fabric, (such as Miradrain or Battledrain) directly to the lagging between each pair of soldier piles.

Install extra lagging above the shoring wall if there is a slope above the wall, to provide a partial barrier for material that could ravel down from the slope face and fall into the excavation.

Tieback Anchor Design

We anticipate that tieback anchors may be used for external lateral support of the soldier pile walls. We make the following recommendations concerning tieback anchor design:

- Locate anchor portions of the tiebacks behind the no-load zone shown on Figure 7.

- Our tieback anchor design recommendations are based on the assumption that cased, pressure-grouted boreholes that are at least 6 inches in diameter will be used. We understand that the anchors will be installed by single stage, high-pressure grouting as the casings are withdrawn. Recommended allowable load transfer (adhesion) values on Figure 6 should be used for design purposes when pressure-grouted anchors described herein are used. We will provide separate recommendations if anchors are to be grouted under gravity using tremie methods.

- Locate anchors no closer to each other than 3-tieback diameters.

- For verification anchors, fill the portion of the tieback within the no-load zone using a non-cohesive "gunk" mixture. A sand-pozzolan-water mixture, or equivalent non-cohesive mixture is recommended. For production and verification anchors, install a bond breaker such as plastic sheathing or a PVC pipe around the tie rods within the no-load zone.

- Grout and backfill drilled installations immediately after drilling. Do not leave holes open overnight. This will help prevent possible collapse of the holes, loss of ground, and surface subsidence.

- If drilling with a continuous flight auger, take care to not "mine out" large cavities in granular soils.

- Maintain continuous cutting return if using pneumatic drilling techniques so that air pressure is not "channeled" to nearby utility vaults, corridors, or subgrade slabs, which may damage such structures.

- Design anchor lengths so that they do not conflict with any underground utilities and/or support elements of the adjacent structures. Coordination with the Bellevue Arts Museum and its design consultants will be needed during shoring design and installation.

- Require the Contractor to verify the presence of existing facilities adjacent to the project site, including buried utilities and foundations, as these may affect the location and the length of the anchor holes.

- To allow for latitude in method of installation, we recommend that materials selection and installation technique be left to the shoring contractor. The shoring contractor should be contractually responsible for the design of the tieback anchors, as tieback capacity is largely a function of the means and methods of installation. The selected tieback anchor installation method must be subject to field verifications with performance testing and proof testing as discussed in Attachment 1.

- The anchor holes should be installed in a manner that will minimize loss of ground and not disturb previously installed anchors. During tieback drilling, wet or saturated zones may be encountered, and caving or "blow-in" could occur. Drilling with a casing would reduce the potential for these conditions and loss of ground.

- Hart Crowser should review the design for anchor locations, capacities, and related criteria before implementation.

For anchor pullout, we recommend a factor of safety of at least 2.0. This factor of safety provides a reasonable additional load capacity should an unforeseen increase in unit soil load develop because of irregularities that can occur during anchor installation. Variable soil conditions and unit friction values mean that some field changes in anchor length may be necessary. For planning, we recommend that anchors be designed according to the above criteria.

Tieback Anchor Testing

The tiebacks will be tested to confirm the appropriateness of the design friction values and to verify that a suitable installation is achieved. The procedure for performance and proof testing is presented in Attachment 1 and summarized below. For testing of tieback anchors, we recommend the following:

- Require the shoring contractor to complete successful 200 percent performance tests on a minimum of eight tiebacks in the building excavation. The final number of performance tests and their locations should be reviewed and approved by us once the final shoring plans are developed.

- For anchors installed for the 200 percent performance test, the specifications should include components to prevent friction contribution between the grout column and the soil in the no-load zone.

- In addition, proof load each production anchor to 130 percent of the design load to test for total movement, creep, and a structural bond.

Deflections

Based on the assumed loading conditions and the applied loads, we expect the shoring system to deflect an average of about 1.5 inches or less into the excavation. There may be some soldier piles that deflect more than 1.5 inches. It is also likely that some soldier piles will deflect away from the excavation. Such deflections can be caused by construction practices.

The geotechnical and structural engineer should review any soldier piles that deflect more than 1 inch in an attempt to identify the cause of the deflection. Remedial actions will be recommended if necessary.

6.3.3 Soil Nail Excavation Support

As an alternative to soldier piles, lagging, and tieback anchors, temporary support could be provided using soil nails and shotcrete facing. In our opinion, the site is generally conducive to the use of soil nailing. Our recent experiences with soil nailing near the site suggest that it may be a cost-effective alternative to a conventional soldier pile/tieback system or if used in conjunction with conventional construction techniques.

Typically, soil nail walls consist of a series of small diameter (typically 6- to 8-inch) holes drilled in a rectangular or diamond pattern, filled with reinforcing steel and structural grout, and connected to a shotcrete facing or "wall." The pattern and length of the nails (i.e., the reinforcing steel/grout installations) vary depending on the soil type, the depth of cut, and other factors. The nails and shotcrete are installed sequentially as the excavation proceeds downward. Along the Bellevue Arts Museum, special underpinning techniques would be required. Examples of these techniques are presented in Section 6.3.4.

Typical Soil Nail Design

In case the design team chooses to explore the use and costs of a soil nail shoring system, we provide preliminary recommendations within this section. A final design for a soil nail system is not part of this study, and is best completed after the owner and design team have finalized the proposed excavation geometry. A soil nail and shotcrete shoring system would typically be designed on the basis of a conventional limit equilibrium analysis approach developed for this purpose. Design would be based on an assumed pullout capacity for the soil nails that would depend on their size, anticipated subgrade conditions, and local experience with similar soils. During construction, the assumed capacity would need to be verified by a testing program to confirm that nail diameter, lengths, and installation techniques are suitable to meet the design assumptions.

For planning purposes, a typical soil nail design for a site similar to this would include the following elements:

- Design methods should be in accordance with Federal Highway Administration "Geotechnical Engineering Circular No. 7, Soil Nail Walls" (FHWA 2003).

- Soil nail wall design should consider surface loading from traffic, site equipment, and loads from adjacent structures. Perhaps the most important consideration at this site is the presence of Fill and Weathered Till in the upper soil layers up to about 20 feet. Vertical elements may be needed in the upper soils to improve face stability and reduce the risk of raveling or sloughing.

- Permanent wall drainage should be incorporated to relieve potential hydrostatic pressure, intercept and divert water away from the wall and toe of the wall, and convey water to the permanent drainage system. Typically, this drainage and pressure relief is provided by Miradrain (or equivalent) strips affixed to the soil behind the shotcrete. Surface water runoff should be directed away from the top of the wall.

- Soil nails should be steel bars without couplers, splices, or welds, and should be installed with centralizers.

- Soil nails should be between 3 and 6 feet apart horizontally and 3 to 5 feet apart vertically.

- Temporary wall facing may consist of a 6-inch-thick steel reinforced shotcrete wall. Reinforcement may include a single mat of 4- by 4-inch, W4.0 x W4.0, welded wire fabric as well as vertical and horizontal reinforcing bars. Actual facing design would be determined during the comprehensive design of the soil nail system.

- Soil nail lengths should be plotted and their layout compared with existing utilities and adjacent underground foundations to minimize interference.

The soil nail system should be designed to performance specifications, and the designer should be able to demonstrate that:

- No failure surface that has a factor of safety less than 1.35 against sliding exists through or outside the nails;

- The nails are not allowed to stress more than 80 percent of their yield strength; and

- The mobilized bond stress is less than half the ultimate adhesion between the grout and the soil. Ultimate adhesion is determined by the soil shear strength and must be justified by both pullout testing before nail installation and by limited production nail testing.

Typical Soil Nail Wall Construction and Installation

Construction sequencing is especially important in soil nail construction. Soil nail wall systems are designed so that the excavation must proceed in staged lifts (a lift is a single row of nails). For vertical cuts, we recommend:

- Test each material type to demonstrate that the unsupported face will be stable over the required "stand-up" time;

- Ensure that all surface water is controlled during construction;

- Excavate the initial cut so that it is a few feet below the first row of nails; and

- Limit excavation height to the minimum amount necessary for practical and timely application of shotcrete, typically no more than an unsupported height of about 6 feet. In caving ground, provide an initial stabilizing layer of shotcrete (flashcoat) and/or steel-reinforced flashcoat as soon as possible; in firm ground the nails may be installed first.

For soil nail wall installation, we recommend:

- Close excavation sections before the end of a work day, unless prior approval is given by the shoring designer and geotechnical engineer.

- Advance drill holes using rotary methods with air flush, dry auger, and cased methods (for less stable grounds). Drill the soil nail holes using equipment and techniques that will minimize caving and loss of ground. Drilling with a casing would reduce the potential for ground loss. Ensure that the hole is clean of disturbed material.

- Do not leave holes open overnight.

- Pump structural grout into the hole through the auger (wet bar installation method) or through a tremie tube extended to the bottom of the hole.

- Grout the hole as soon as possible after drilling to prevent caving.

- Require that nails consist of reinforced steel bars without couplers, splices, or welds, and that they be installed with centralizers.

- Minimize the duration of unsupported cuts and limit the total area of wall constructed during one shift to preserve face stability. We recommend that the initial duration of unsupported cuts be limited to one shift unless the contractor's demonstration test for each soil type shows that longer stand-up times are possible, and as approved by the shoring designer and Hart Crowser.

- Expect cobbles, boulders, debris, and/or groundwater seepage to be encountered.

- Take care not to "mine out" large cavities in granular soil if drilling with a continuous-flight auger.

- Maintain continuous cutting return if using pneumatic drilling techniques so that air pressure, which may damage subgrade structures, is not "channeled" to nearby utility vaults, corridors, or subgrade slabs.

- The shoring contractor should particularly note the presence of existing facilities adjacent to the project site, including buried utilities and foundations, as these may affect the location or extent of the anchor holes.

- Monitor potential movement of the shoring system and potential ground settlement adjacent to the excavation.

It is the responsibility of the contractor to verify actual ground conditions at the site and to determine appropriate construction methods and procedures for installing a suitable shoring system. Cobbles, boulders, or debris may be encountered and could impact construction.

For shotcrete wall construction, we recommend:

- Before production, shotcrete application test panels should be applied by each nozzleman under field conditions at the site, and the panels should be cored and examined for defects;

- Require that preparations for shotcrete include installation of drainage material, installation of soil nails, and placement of approved reinforcement; and

- If sloughing occurs, shorten the time a cut is left open, reduce the height of the cut, use a stabilizing berm, place a flashcoat of shotcrete, or place or complete the cut in sections or stages.

Typical Soil Nail Testing

We recommend that selection of the materials and the installation technique be left to the shoring contractor. The selected soil nail installation method must be subject to field verification with performance testing and proof testing.

Soil nails should be tested to confirm the design friction (adhesion) value and to verify that suitable installation has been achieved. Soil nail adhesion is highly dependent on soil conditions encountered during construction and on installation techniques. We recommend using performance-based specifications and that the shoring contractor be responsible for the installation techniques to achieve the design soil nail adhesion

- Soil nail specifications should include an appropriate number of verification load tests (200 percent) and proof load tests (150 percent) on production nails. We recommend a minimum of two successful verification tests for each soil type. Proof testing is normally required on 5 percent of the production nails.

- Verification test nails should have an unbonded length of at least 3 feet but not longer than a maximum length such that the nail load does not exceed 90 percent of the nail bar tensile allowable load. The nail hole should be fully grouted after testing.

- A load reaction system must be provided by the contractor, and is subject to the designer's approval.

We recommend that we select the test locations based on observation of the soil conditions as the excavation proceeds.

Deflections

In theory, a soil nail system should deflect more than a soldier pile/tieback system since the nails are not pre-stressed. However, observations of soil nail wall deflections in the Puget Sound area indicate that, if constructed in favorable soil conditions, deflections of the two systems tend to be similar. Typical horizontal movement for soil nail walls is approximately 0.1 to 0.5 percent of the excavation depth. Our recommendations for shoring monitoring are presented in Attachment 2.

6.3.4 Bellevue Arts Museum Building Foundation Underpinning

The northwest portion of the excavation is complicated by the adjacent Bellevue Arts Museum. The museum will need to be underpinned with a shoring system that is designed so that stability of its foundation support is not affected by the proposed construction. We understand that the Bellevue Arts Museum is supported on spread footings bearing at an elevation of approximately 125 feet, and that the design soil bearing pressure for the shallow foundations is 12 ksf. The shoring system would need to be designed for at-rest earth pressure conditions with the additional loading due to the existing footings. The lateral earth pressure can be estimated using Figure 8.

We have identified three potential shoring options that may be used to underpin the Bellevue Arts Museum.

- Direct underpinning with soldier piles;
- Indirect underpinning with soldier piles; and
- Indirect underpinning with soil nails.

Indirect underpinning may or may not be feasible depending on the proximity of existing footings from the shoring wall face. Direct underpinning with soldier piles is generally considered to involve less risk, but may be more expensive.

Underpinning with Soldier Piles

We expect that the Bellevue Arts Museum could be underpinned with a soldier pile and multiple tieback system. Figure 9, Item A, illustrates the cross section of direct and indirect underpinning of the Bellevue Arts Museum with soldier pile and tieback system. Soldier piles may be used for direct underpinning of the building as illustrated in Item A, with dashed lines. This involves placing the soldier piles directly beneath the Bellevue Arts Museum footings.

Alternatively, it may be feasible to indirectly underpin the Bellevue Arts Museum with soldier piles. Item A, on Figure 9 illustrates schematically with solid lines the finished construction for a soldier pile multiple tieback system that includes placing soldier piles in front of the building, including additional height/cutout at the pile top to provide resistance against sliding. Multiple solider pile-tiebacks would be installed along the building and lagging would be used to span between the soldier piles.

In both cases, the soldier pile extends below the base of the excavation, and the construction and design considerations for the soldier pile-tieback shoring system follow those presented in Section 6.3.2 and its subsections. The structural engineer should be consulted for the required jacking force needed to properly engage the underpinning piles.

The use of a soldier pile-tieback system is commonly used to underpin buildings, and it can be implemented by many contractors. However, use of soldier piles for shoring is generally considered less cost effective compared to a soil nail option. If necessary, use of a soldier pile and tieback system where underpinning is required in combination with a soil nail system elsewhere, may be considered.

Underpinning with Soil Nails

It may be feasible to underpin the existing Bellevue Arts Museum with soil nails as shown on Figure 9, Item B. The schematic illustrates the cross section of the finished construction for a soil nail wall system that uses slot cutting. In this alternative, the first soil cut below the Bellevue Arts Museum would be limited in height to the minimum amount necessary for practical and timely application of shotcrete, typically no more than an unsupported height of about 4 to 6 feet. In caving ground, an initial stabilizing layer of shotcrete (flashcoat) and/or steel-reinforced flashcoat may be required; in firm ground the nails may be installed first.

The slot width will need to be determined in the design process. The designer should consult the structural engineer to determine how wide the span can be between the existing foundation and avoid undermining the existing building footings. Once the initial cut or slot is made, the procedure for soil nail construction/ installation described in Section 6.3.3 should be followed. However, at each soil nail location, a strut nail would also be installed to take the vertical load of the building. We recommend alternating slots, or "hopscotching," on a single level to avoid undermining the existing foundations. Figure 9, Item C illustrates the concept of hopscotching slot cutting on a single level.

At some point in the excavation process, it is possible that strut nails would no longer be required and typical soil nail construction would resume (i.e., no slot cutting). The designer should determine how many levels of soil nails and strut nails would be required. This method would potentially be slow for the rows requiring slot cutting, but would potentially be less expensive as no steel sections are required.

An alternative to hopscotching and strut nails would be to include the use of sacrificial vertical elements. This alternative is shown on Figure 9, Item B with the dashed lines. A vertical element would be installed before excavation, much like soldier pile installation. The vertical element, however, would extend only part way down the excavation. The vertical element would replace the strut nails, as the vertical element would take the vertical load of the existing building. The procedure for soil nail construction/installation described in Section 6.3.3 should be followed. This method would require additional time and expense to install the vertical elements; however, since the vertical elements need not extend to full excavation depth, this alternative would potentially be less expensive than a traditional soldier pile-tieback shoring system.

It is important to select a soil nail contractor who is familiar with such installation methods. We recommend close monitoring of installation and construction procedures. If soil nails are selected to underpin the Bellevue Arts Museum, we should be consulted for additional recommendations.

Additional Shoring and Underpinning Alternatives

Several other methods are potential alternatives to underpinning the Bellevue Arts Museum. Variations of the methods just described are possibilities, and may be determined during the design process.

In addition, if easements cannot be obtained, the entire excavation could be designed to be internally braced in both directions with intersecting bracings connected to provide additional stability. This shoring alternative would also need to be designed to maintain the stability of the foundations of the Bellevue Arts Museum. A variation on internally braced excavations is top-down shoring. This would involve installing drilled shafts to serve as building columns and, ultimately, the building foundations. The individual floor slabs would be poured as slabs-on-grade and then excavated beneath as the construction progressed downward. The extra cost of this shoring method can be partially offset by a shortened construction schedule as the above-grade portion of the building could be constructed as the excavation proceeds down.

In the Puget Sound area, internally braced excavations and top-down construction are not commonly used. If these options are selected, it is important to select a contractor who is familiar with such installation and construction methods.

6.4 Building Foundations

For the proposed structures, we recommend mat foundations and/or high-capacity shallow foundations for the support of building columns. Footings should bear directly on the undisturbed glacially overridden, dense to very dense, silty Sand and hard, sandy Silt. Available plans indicate that the foundation elevations will be below about 77 feet, and may consist of either continuous wall footings or isolated spread footings.

6.4.1 Spread Footings

We make the following recommendations for the design and construction of spread footings:

- For isolated spread footings at least 10 by 10 feet in plan dimensions and bearing at least 3 feet below the lowest adjacent grade, use a maximum allowable bearing pressure of 12 ksf.

- For isolated footings as small as 4 by 4 feet in plan dimensions and bearing at least 3 feet below the lowest adjacent grade, use a maximum allowable bearing pressure of 7 ksf.

- For strip footings at least 4 feet wide and embedded at least 3 feet below the lowest adjacent grade, use a maximum allowable bearing pressure of 7 ksf.

- Use an increase in the allowable soil bearing pressure of up to one-third for loads of short duration, such as those caused by wind or seismic forces.

- Refer to Section 6.4.3 to design mat foundations using soil springs.

- Footings should be founded outside of an imaginary 1H:1V plane projected upward from the bottom edge of adjacent footings or utility trenches.

- For resistance to lateral loads, use an equivalent fluid density to represent the passive resistance of the soil. For a typical footing poured against *in situ* very dense, glacially overridden Sand/Silt above the groundwater table, we recommend an allowable passive equivalent fluid density of 370 pounds per cubic foot (pcf) in a triangular pressure distribution. Below the groundwater table, we recommend an allowable passive equivalent fluid density of 185 pcf. A factor of safety of 1.5 has been applied to these values.

- Use an allowable coefficient of friction of 0.3 for footings poured neat on the very dense glacially overridden Sand/Silt for resistance on the base of foundations. A factor of safety of 1.5 has been applied to this value.

- Overexcavation of loosened or disturbed soil can be near-vertical at the footing line. Backfill any excavation extending below the planned foundation elevation with either lean or structural concrete.

- Before placing concrete for footings, subgrade soil should be in a very dense, non-yielding condition. Any disturbed soil should be removed. Also, mud mats may be necessary to protect silty subgrade soil from being disturbed during construction after it is exposed.

- Have our representative observe exposed subgrades before footing construction to verify design assumptions about subsurface conditions and subgrade preparation.

Assuming proper subgrade preparation (as described in this report), we expect total settlement of the footings bearing on the very dense glacially overridden Silt and Sand unit to be less than 1 inch. Differential settlement is expected to be on the order of half the total settlement. Settlement is expected to occur essentially as the loads are applied.

It may be desirable to size and lay out the footings in a manner that would reduce the potential for differential settlement between adjacent foundation elements. Relatively large individual footings tend to settle more than smaller footings that are loaded to the same bearing pressure. Because of superposition effects of the footing pressures on the supporting soil, footings near the middle of the building will tend to settle more than those near the edges.

Once the foundations are designed and the design loads are known, we recommend that we be allowed to analyze and estimate post-construction settlement.

6.4.2 Mat Foundations

For large mat foundations bearing on undisturbed, natural, very dense, glacially overridden Silt and Sand, we recommend:

- Use a maximum allowable bearing pressure of 12 ksf for design.
- Increase allowable bearing pressures by one-third for infrequently applied loads such as seismic or wind forces as needed.
- Refer to Section 6.4.3 to design mat foundations using soil springs.

Based on an assumed mat size of 290 by 170 feet, embedment of 10 feet, and an average uniform pressure of 12 ksf, we anticipate total potential settlement at the center of the mat to be on the order of 2 inches and potential settlement at each corner to be less than 1 inch. We expect that the potential differential settlement between the center and corners of the mat will be approximately 1 to 1½ inch. This potential settlement estimate assumes that the mat is relatively flexible. Mat stiffness will affect actual settlement.

We expect that settlement will not be time dependent, and will occur as the loads are applied.

Once the foundations are designed and the design loads are known, we recommend that we be allowed to analyze and estimate post-construction settlements.

6.4.3 Spring Constants for Foundation Design

Modeling foundation behavior under loading conditions will require a modulus of subgrade reaction (vertical spring constant) applicable to the soils on which the foundations bear. Depending on the elevation of the foundation elements, the underlying soil may vary in its density and consistency. Loading type, such as static or dynamic loading, has a dramatic effect on the stiffness of the springs. Determining the subgrade modulus value to be used depends on:

- The structural and geotechnical engineer's experience designing similar foundations in similar soil conditions;

- The quantity, magnitude, and area of the mat foundation under various loads; and

- Back-checking settlement predicted from structural modeling with geotechnical settlement estimates for given foundation geometries.

Springs for Static Loading

Footings. For rectangular and strip footings under static loading conditions, we recommend using a vertical subgrade modulus (K_{V1}) of 180 pounds per cubic inch (pci). This value assumes groundwater will be within 1.5B below the footing, where B is the footing width. Note that the spring constant provided is based on a 1- by 1-foot vertically loaded plate, and obtained from standard charts. Subgrade moduli tend to decrease with increasing area of a foundation element. For this reason, the subgrade modulus will need to be reduced based on the actual dimensions of the foundation modeled.

For a square footing of size B, supported on the sandy soils identified at the site, adjust the modulus of subgrade reaction, k_V, per the following equation (U.S. Navy 1982):

$K_S = K_{V1}\ (B+1)^2/(4B^2)$ for footings for $B \leq 20$ feet

$K_S = K_{V1}\ (B+1)^2/(2B^2)$ for footings for $B \geq 40$ feet

Where B = foundation width in feet. Interpolate for intermediate values of B.

For a rectangular footing of dimension B x mB, where m is ≥ 1, k_V may be modified to obtain the modulus of subgrade reaction k_{VR} as:

$$k_{VR} = k_V[(m+0.5)/(1.5m)]$$

Mat Foundation. For static loading conditions, we recommend the use of a vertical subgrade modulus (K_s) of 60 pounds per cubic inch (pci) for the mat foundations bearing on the very dense, glacially overridden Sand/Silt. We consider this value a reasonable starting point for an iterative design process. We should review the displacement estimates from the structural model and perform settlement evaluations of the specific geometry and loading for compatibility. Based on these settlement evaluations, modifications to the subgrade modulus used in the structural model may be required.

Springs for Dynamic Loading

For dynamic loading conditions, we understand that the structural engineer intends to perform dynamic evaluations based on the 2009 IBC and ASCE 7-05 codes. For the dynamic analysis, the structural engineer will likely require soil springs to represent dynamic loading conditions on the foundations and basement walls. Dynamic spring recommendations will be provided at a later date after foundation plan details become available.

6.4.4 Foundation Settlement

Based on the nature of overconsolidated, glacially deposited soils, we expect settlement to be primarily elastic with any time-dependent consolidation component occurring very quickly. Settlement is expected to occur as the load is applied. At the time of this report, typical column loads are not available. When loads become available, we can provide estimates of total and differential settlement. Differential settlement is generally expected to be about half of the total settlement.

It is possible that the result of the structural engineer's analysis for the mat may realize peak edge and corner stresses in the mat that exceed the recommended allowable bearing capacity. We recommend that we be afforded the opportunity to work with the structural engineer to resolve any issues.

6.4.5 Foundation Preparation

The exposed subgrade should be carefully prepared and protected before concrete placement. Any loosening of the materials during construction could result in more settlement. It is important that foundation excavations be cleaned of loose or disturbed soil before placing any concrete and that there is no standing water in any foundation excavation. These conditions should be observed by our representative.

Maintain groundwater levels at least 3 feet below the base grade of the footing excavation at all times to prevent the risk of heave, piping, boiling, and other loss or disturbance of subgrade material. This groundwater level should be maintained until after the footing steel and concrete are placed.

Site preparation for shallow foundations and slabs-on-grade should include exposing the very dense, glacially overridden Sand/Silt. Local loose to medium dense sand and soft to medium stiff silt that occurs naturally or is disturbed during construction, should be overexcavated and replaced with lean concrete for footings. Any visible organic and other unsuitable material should be removed from the exposed subgrade.

The foundation settlement estimated herein assumes that careful preparation and protection of the exposed subgrade will occur before concrete placement. It may be beneficial to place a nominal 2- to 4-inch-thick "mud slab" consisting of lean concrete in footing excavations immediately after the excavation has been checked by the geotechnical engineer. The purpose of the mud slab is to protect the exposed soil against softening or disturbance from water or construction activities. Backfill any excavation extending below the planned foundation with lean or structural concrete, as noted above.

6.5 Lateral Pressures on Permanent Subgrade Walls

Permanent walls constructed flush with temporary shoring systems should be designed for the same active (or at-rest) pressures used in the design of the shoring system (Figure 7). The structural engineer will need to coordinate with the shoring engineer as final design earth pressures are based on the configuration of the shoring system.

We do not anticipate retaining walls that are backfilled on one side only to be used at the site; however, if there are such walls, the structural engineer can estimate the lateral load and resistance on the walls using an equivalent fluid to represent the soil. We make the following recommendations for walls with backfill material placed per structural fill recommendations:

- For a yielding (active) wall with level backfill, use an equivalent fluid density to represent the soil of 35 pcf for the design. We define a yielding wall as one where the top moves, when loaded, at least 0.1 percent of its height.

- For a non-yielding (at-rest) wall with level backfill, use an equivalent fluid density of 55 pcf for design.

- Use passive and sliding resistances as described in Section 6.4 of this report.

- Footings that are behind and adjacent to subgrade walls will impose additional lateral loads on the walls. These and additional uniform or various other surcharges can be evaluated using the recommendations presented on Figure 8.

Note that the equivalent fluid density does <u>not</u> include any surface loading conditions or loading due to hydrostatic conditions.

6.5.1 Lateral Earth Pressures due to Seismic Loads

Depending upon the design approach used by the project structural engineers, the lateral earth pressures for permanent foundation walls described above may need to be increased to account for seismic earth pressures. This additional lateral earth pressure can be approximated as a rectangular uniform load. We have assumed level ground conditions for the backslope. We recommend 8H (where H is the total wall height) be used as a seismic surcharge against all permanent walls at the site.

Important. The lateral earth pressures presented herein are based on dewatered conditions so that hydrostatic pressure does not act on the walls. We recommend that a surcharge of 250 psf be applied to the top of the proposed excavation for computations to provide some allowance for possible surface pressures near the excavation such as light vehicles or small material stockpiles. Surcharge pressures resulting from heavier loads such as buildings, footings, heavy equipment, or large material stockpiles should be calculated using Figure 8. These additional loads would be additive to the soil pressure calculated for permanent foundation walls.

6.6 Design of Floor Slabs

The lowest floor slab may be constructed as slab-on-grade above a drainage layer. The drainage layer should be at least 12 inches thick. This layer serves as a capillary break and drainage layer and is intended to reduce the potential build-up of hydrostatic pressure beneath the slab and to provide permanent control of groundwater beneath the floor slab and behind the perimeter walls.

We make the following recommendations for floor slabs:

- Compact the drainage layer to the criteria of structural fill as discussed in Section 6.8;
- A modulus of subgrade reaction of 90 pci may be used where appropriate for the design of the slab-on-grade;
- Any soil that is to be considered as capillary break or drainage material should be submitted to us for gradational analysis and approval; and
- Note that if the bottom of the excavation is soft, wet, and disturbed, the contractor should be prepared to place a temporary working surface (this surface should not be considered part of the drainage layer).

6.7 Construction Dewatering

The proposed development will include six levels of underground parking. The top-of-slab elevation is assumed to be elevation 77 feet with the base of excavation potentially at elevation 67 feet. This is significantly below observed groundwater levels in borings (about elevation 80 feet). Construction below the permanent groundwater level will require significant groundwater control during construction and throughout the life of the development.

Dewatering will be required when the excavation extends below the groundwater. Perched water will be encountered in the Glacial Till unit. The amount will be variable and depend on the season. Dewatering methods for the Glacial Till unit could include trenches, sumps, and wellpoints. In the Sand/Silt unit, deep wells may be required for dewatering, and should be planned and designed by a specialty contractor.

6.8 Drainage Considerations

Groundwater was encountered at elevations above the bottom of the proposed building; therefore, after construction dewatering, groundwater seepage will produce flow into the excavation. It will be necessary to install a permanent drainage system and pressure relief for the subgrade walls and the slab at the bottom of the excavation.

Drainage material should consist of well-graded coarse sand and gravel with a fines content of less than 3 percent by dry weight (percentage of material passing the U.S. No. 200 sieve based on the minus 3/4-inch fraction). We anticipate that a permanent drainage system for this project site would consist of the elements described below.

The subslab and wall drainage system recommendations presented herein are intended to prevent buildup of hydrostatic pressure that could damage the structure. The recommended systems may not result in a totally dry wall or slab.

6.8.1 Underslab Drainage Layer/Capillary Break

- Provide subslab drainage by using a combination of perimeter and cross drains beneath slabs-on-grade.
- Install cross drains on 20- to 30-foot centers. The cross drains (with cleanouts) should consist of at least 4-inch-diameter perforated pipe placed on a bed of and surrounded by 6 inches of drainage material. The cross drains and the perimeter drains should be tied together to a suitable sump.

The drainage pipes should be sloped to drain. Drainage material and piping should be compatible such that soil intrusion into the pipe does not take place. In the event that they are not compatible, the pipes could be wrapped with a filter fabric product.

- Connect all wall, perimeter, and underslab drainage pipes to one or more underslab sumps, complete with appropriate sump pumps. We estimate that inflow to the underslab drainage system will vary seasonally and is expected to be on the order of 50 to 150 gallons per minute (gpm).

- Use backup power supplies and pumps as required, to ensure that the underslab sumps are drained during a power outage or pump malfunction. As a precaution, pressure relief holes may be included in the floor slab and walls of the lowest garage level to prevent the build-up of excess pressure in the event of a system failure.

6.8.2 Basement Wall Drainage System

- This can consist of panels of drainage composite (i.e., a Miradrain-type system) laid flush on the outside of the timber or shotcrete lagging and connected to a collector pipe that runs along the footing at an elevation lower than the bottom of the floor slab. We recommend installing drainage panels from the top of the wall down the full face of the wall to drain any perched water. This will allow water collected outside the wall to be tight-lined beneath the slab and into the central drainage sump.

- Additional drainage and protection may be locally necessary if significant groundwater seepage is encountered during site excavation. Provisions should be available to supplement the recommended drainage system. Such additions may include weep holes through temporary or permanent walls.

6.8.3 Foundation Drainage

- For permanent drainage of the foundations, perimeter drains should be installed near the base of the perimeter or wall footings.

- The perimeter drains should be a minimum 4-inch-diameter perforated pipe and also should be surrounded by 6 inches of drainage material.

- All drainage pipes should be sloped to drain.

6.8.4 Waterproofing

If waterproofing is required below grade, we recommend that an extra waterproofing system such as a heavy plastic membrane liner, bentonite clay panels (i.e., Volclay or equivalent) or other interior or exterior sealants be used. Contact us if more detailed recommendations are needed to address this issue.

6.8.5 Backfilled Walls

Walls with soil backfilled on only one side will require drainage or must be designed for full hydrostatic pressure. We recommend:

- Place at least 18 inches of free-draining, well graded sand and gravel (less than 3 percent fines based on minus 3/4-inch fraction) or miradrain-type system against walls to prevent buildup of hydrostatic pressure.

- The backfill/drainage medium should be continuous and envelop the perimeter drains behind the walls so that they are in direct hydraulic connection to each other. We recommend that drains (with cleanouts) consist of 4-inch-diameter perforated pipe that is bedded in free-draining material. The drain holes or slots in the pipe should be compatible with the surrounding drainage material.

6.8.6 Site Drainage

Final grades should be sloped to carry surface water runoff away from adjacent structures to prevent water from infiltrating near the foundation walls. Roof drainage and new pavement drainage should not be tied into the subdrain system.

6.9 Structural Fill Selection, Placement, and Compaction

Backfill placed within the building area, or below paved areas, should be considered structural fill. The following sections include our recommendations for structural fill selection, placement, and compaction.

6.9.1 Reuse of Site Soil as Structural Fill

The suitability of excavated site soils for compacted structural fill will depend upon the gradation and moisture content of the soil when it is placed. As the amount of fines (that portion passing the No. 200 sieve) increases, the soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. Soil containing more than about 5 percent fines cannot be consistently compacted to a dense non-yielding condition when the water content is greater than about 2 percent above or below optimum. Reusable soil must also be free of organic and other unsuitable material.

In general, our explorations indicated that the site soils are generally not suitable for use as structural fill if wetter than optimum because they have fines contents substantially greater than 5 percent.

6.9.2 Selection of Import Fill

For import soil to be used as structural fill, we recommend using a non-silty, well-graded sand or sand and gravel with less than 5 percent passing the U.S. No. 200 sieve by dry weight (based on the minus 3/4-inch fraction) for imported structural fill placed during wet weather. Compaction of material containing more than about 5 percent fine material may be difficult if the material is wet or becomes wet during rainy weather. During dry weather, imported soil can contain 20 to 30 percent by weight passing the No. 200 mesh sieve (based on the minus 3/4-inch fraction) provided it is compacted at a moisture content within 2 percent of the optimum moisture content.

6.9.3 Placement and Compaction of Structural Fill

We make the following recommendations for structural fill:

- Before fill control can begin, the compaction characteristics of proposed fill material must be determined from representative samples of the structural and drainage fill. Samples should be obtained as soon as possible, but at least 5 days before use on site. A study of compaction characteristics should include determination of optimum and natural moisture content of the soil at the time of placement. Additionally, the grain size distribution of the fill should be determined as well as its maximum dry density.

- Structural fill can consist of either imported soil or recompacted on-site soil, if its moisture content is suitable and weather conditions allow.

- Compact structural fill to a minimum of 95 percent of the maximum dry density as determined by the modified Proctor (ASTM D 1557) test method.

- Maintain moisture content within 2 percent of the optimum moisture content (ASTM D 1557).

- Place structural fill only on dense, non-yielding subgrade soils.

- Place and compact all structural fill in even lifts with a loose thickness no greater than 10 inches. If small, hand-operated compaction equipment is used to compact structural fill, fill lifts should not exceed 6 to 8 inches in loose thickness.

- In wet subgrade areas, clean material with a gravel content (material coarser than a U.S. No. 4 sieve) of at least 30 to 35 percent may be necessary.

- The compacted densities of all lifts should be verified by testing. Any material to be used as structural fill should be sampled and tested prior to use on site, to determine its maximum dry density and gradation.

7.0 RECOMMENDED ADDITIONAL GEOTECHNICAL SERVICES

7.1 Design Services

Throughout this report, we recommend that we provide additional geotechnical input during the design and construction process. These recommendations are generally summarized in this section.

We recommend that, before construction begins, we:

- Continue to meet with the design team periodically as design concepts and design documents progress;

- Estimate settlement response once final footing loads and layouts are known;

- Provide recommendations for the tunnel as needed, when additional design information is available; and

- Review the final design plans and specifications to verify that the geotechnical engineering recommendations have been properly interpreted and implemented into the design. This review is generally required as part of the permitting process.

7.2 Construction Services

During the construction phase of the project, we recommend that we be retained to review contractor submittals and observe the following activities:

- Installation and testing of shoring system elements;

- Excavation and preparation of subgrades for footings, mat foundation, fill placement, and slabs-on-grade;

- Placement and density testing of structural fill at the site;

- Installation of sub-slab, foundation, and wall drainage; and

- Backfilling of utility trenches or around subgrade walls;

In addition, we recommend that we be retained to:

- Review shoring system displacement and monitoring results;

- Review construction dewatering systems and quantities of water produced to provide useful information for the permanent drainage system design, as appropriate; and

- Address other geotechnical considerations that may arise during the course of construction.

The purpose of these observations and services is to note compliance with the design concepts, specifications, or recommendations, and to allow design changes or evaluation of appropriate construction measures in the event that subsurface conditions differ from those anticipated prior to the start of or during construction.

8.0 REFERENCES

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FHWA 1999. Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchored Systems, June 1999, Publication No. FHWA-IF-99-015.

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Post Tensioning Institute 2004. Recommendations for Prestressed Rock and Soil Anchors, Third Edition.

Sound Transit Boring MP-3 by Milbor Pita & Associates, 2007.

U.S. Navy 1982. Soil Mechanics, Design Manual 7.1, NAVFAC DM-7.1/7.2.

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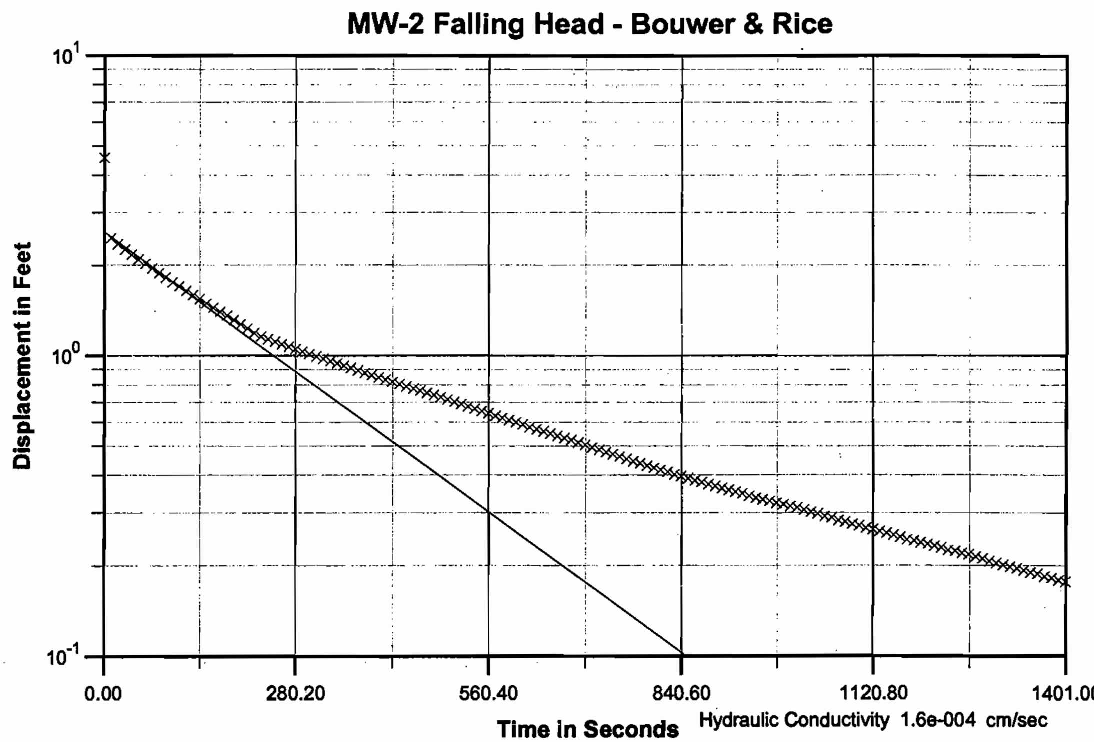
Slug Tests MW-2



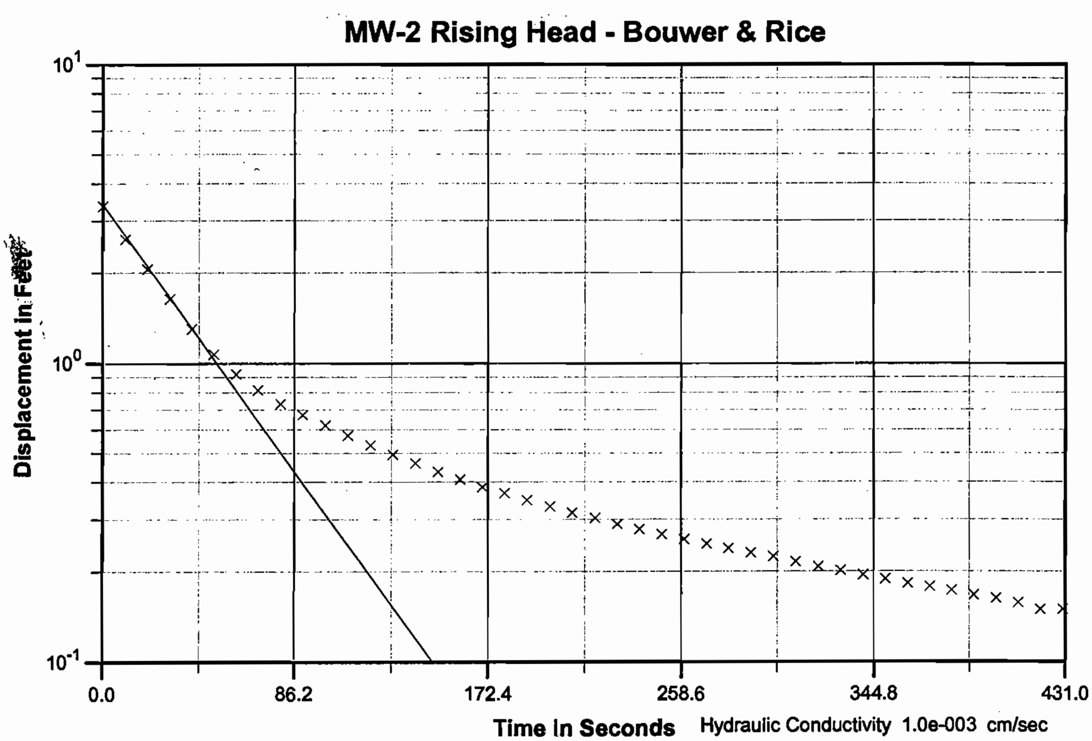


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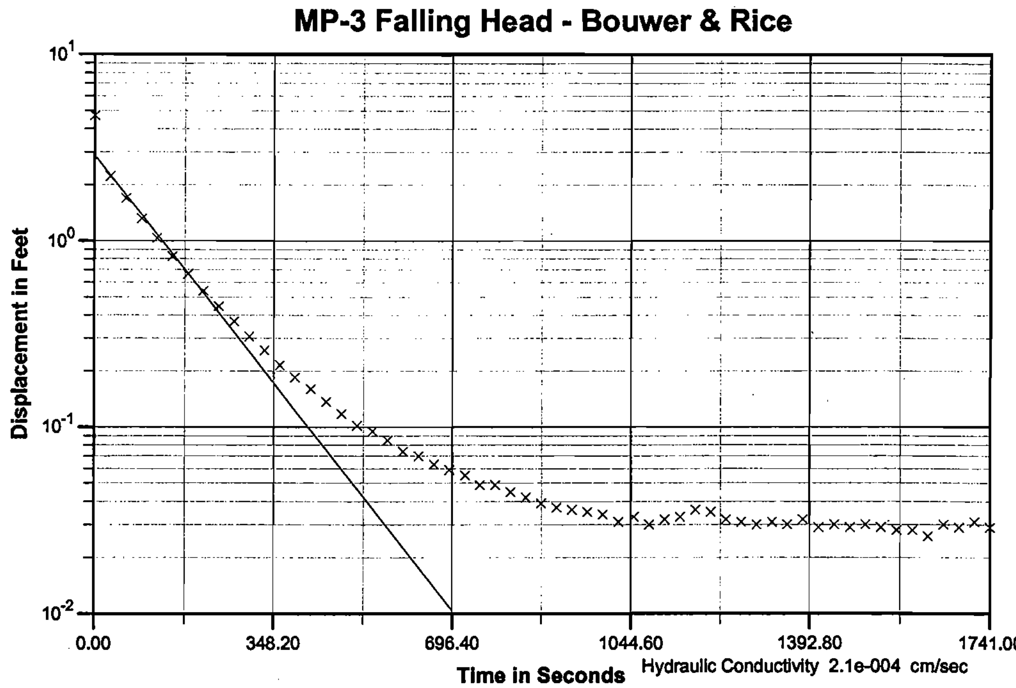
Figure D-14

Slug Tests MP-3



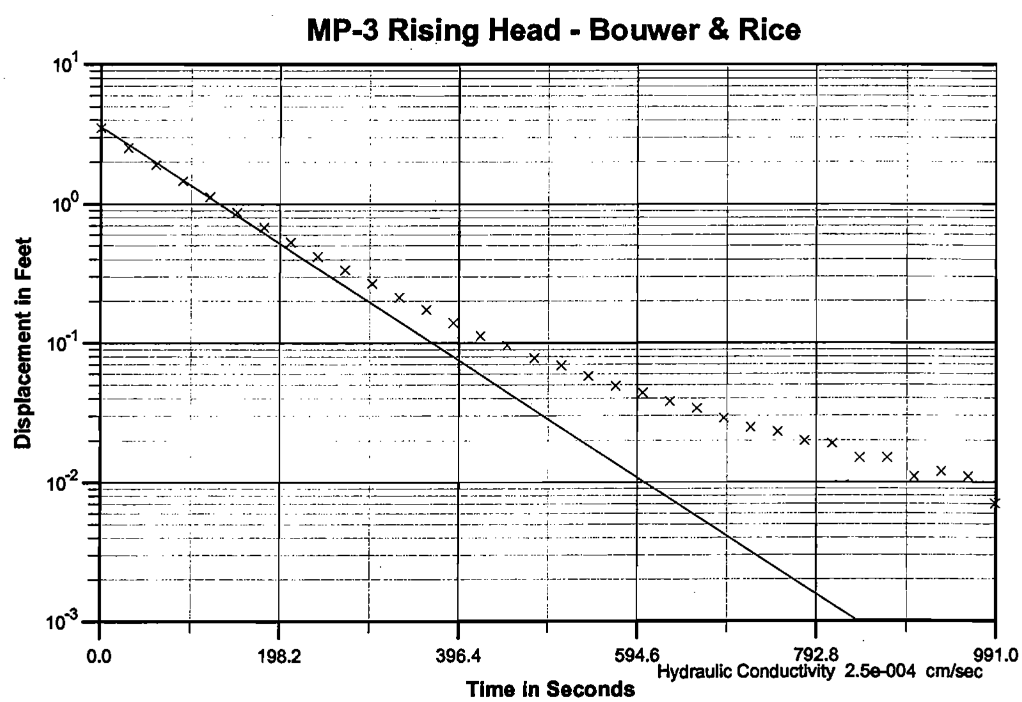


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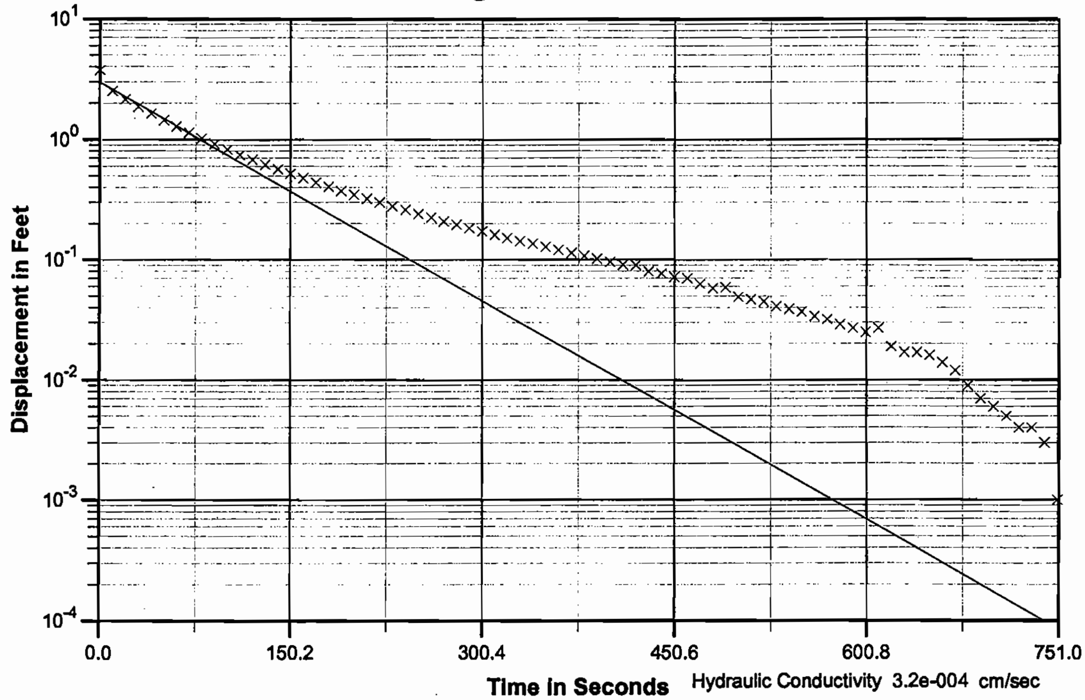
Figure D-13

Slug Tests B-6

B-6 Falling Head - Bouwer & Rice



B-6 Rising Head - Bouwer & Rice

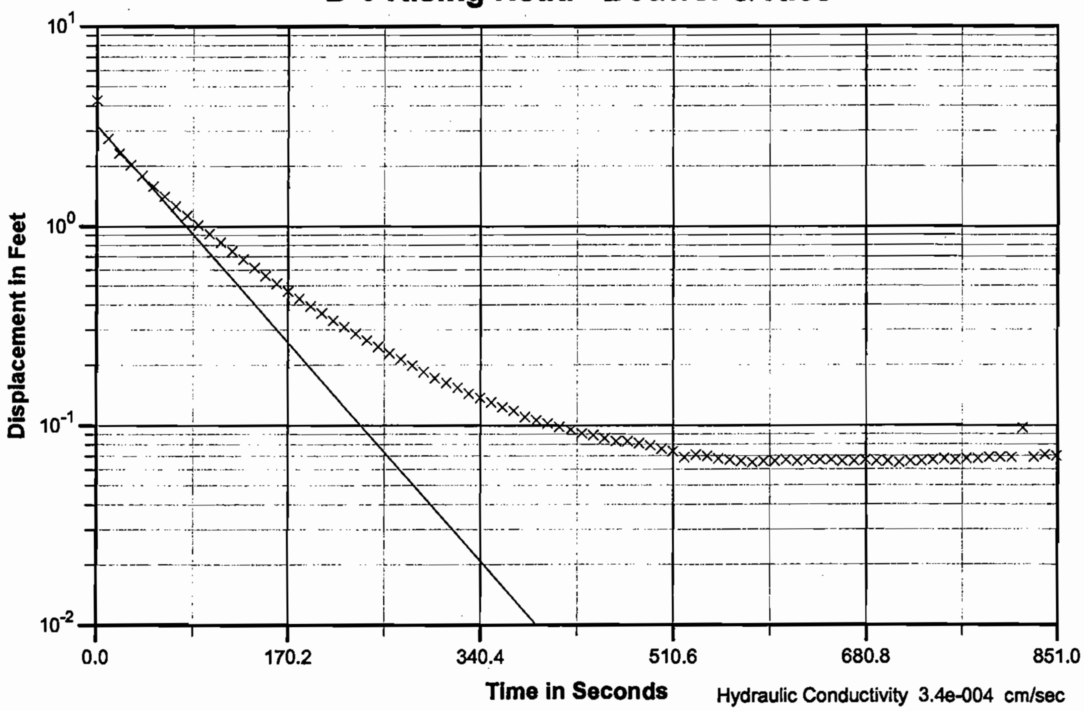


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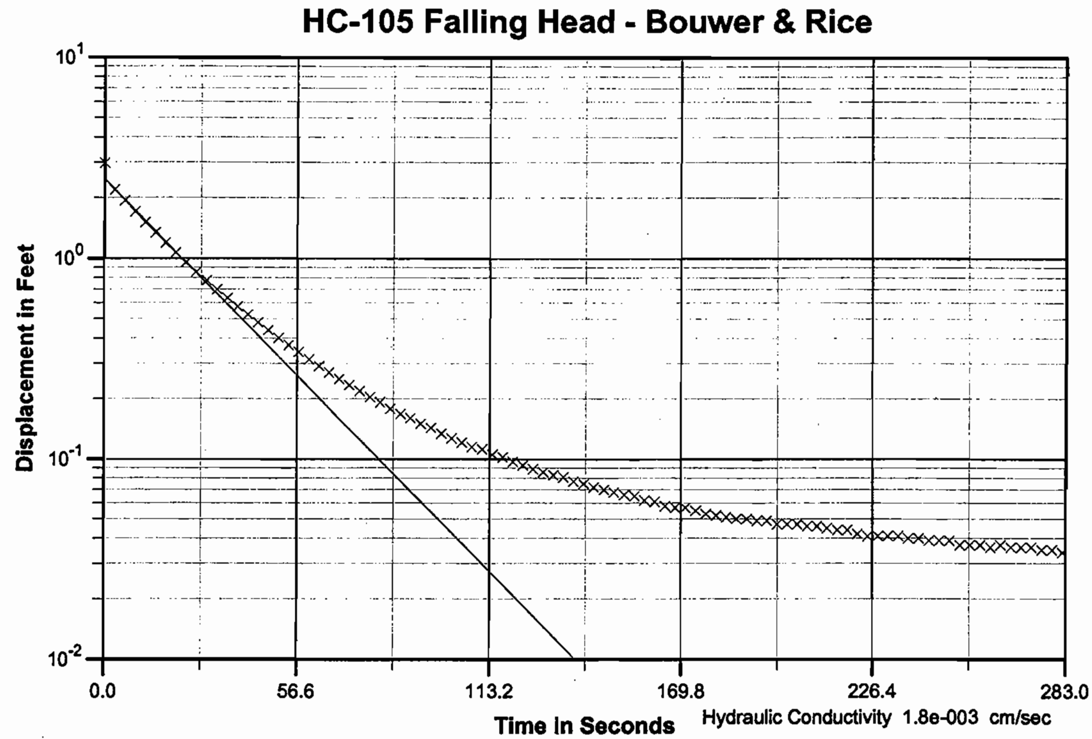
Figure D-12

Slug Tests HC-105



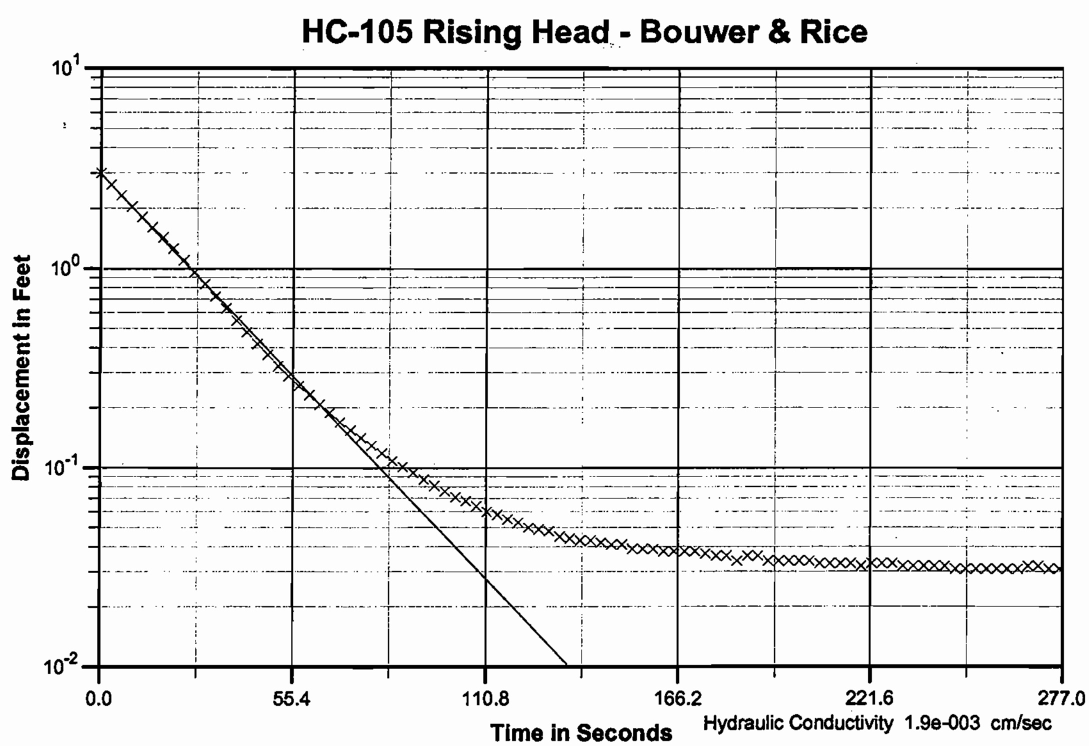


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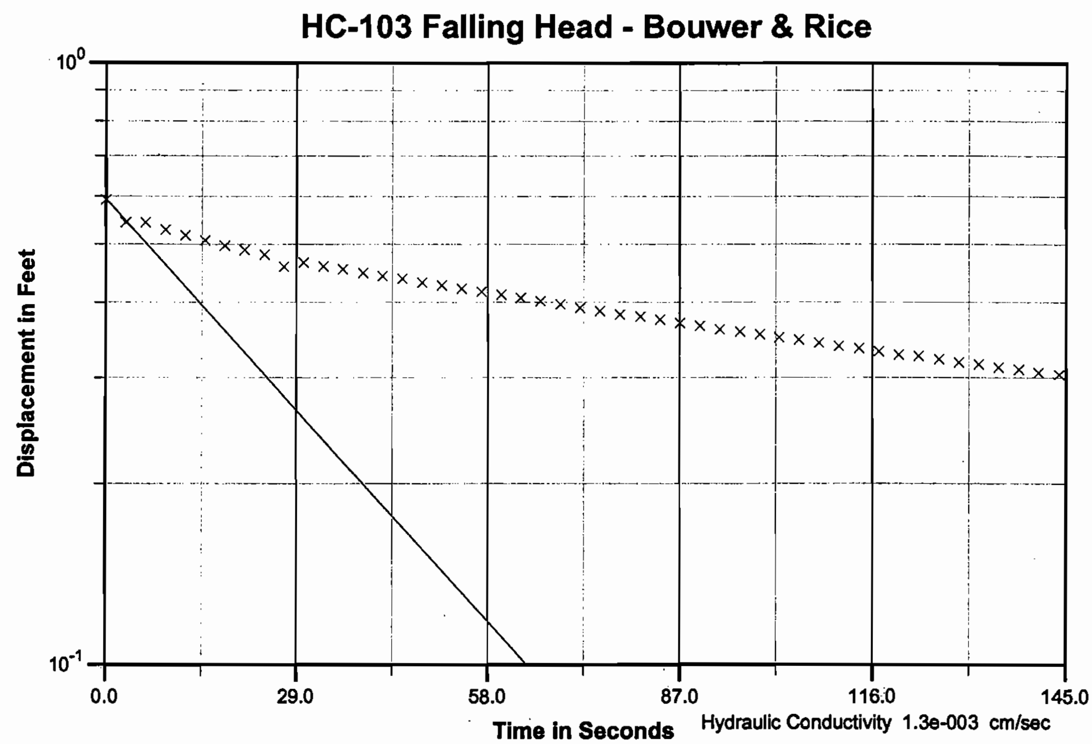
Figure D-11

Slug Tests HC-103



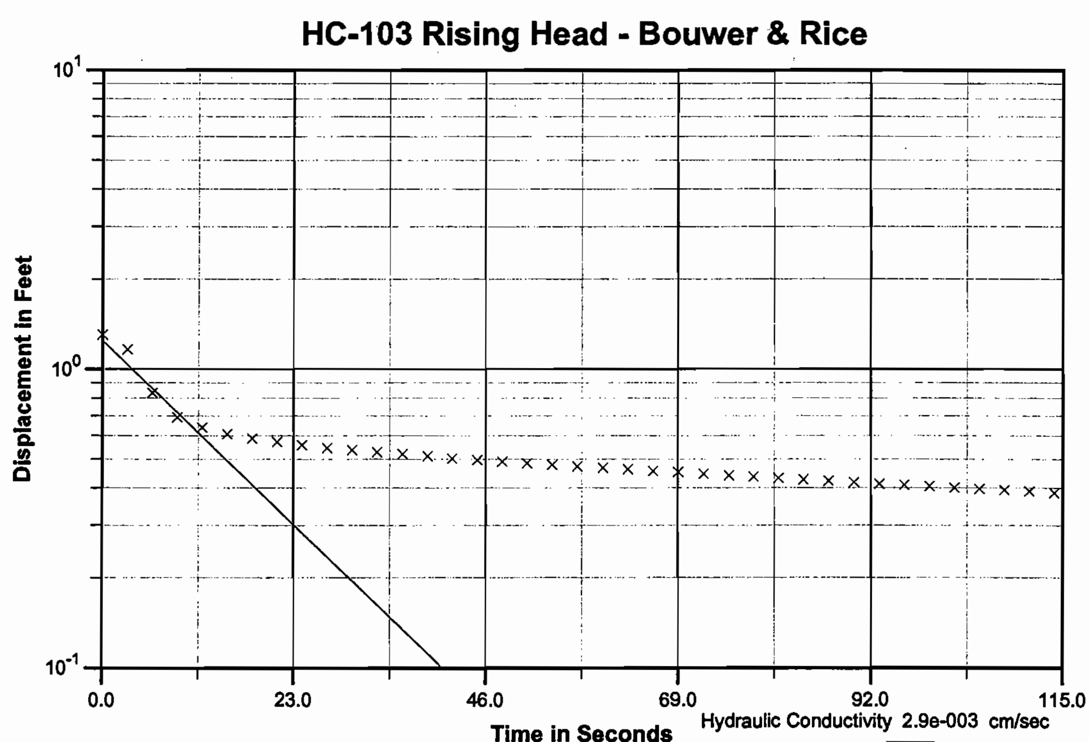


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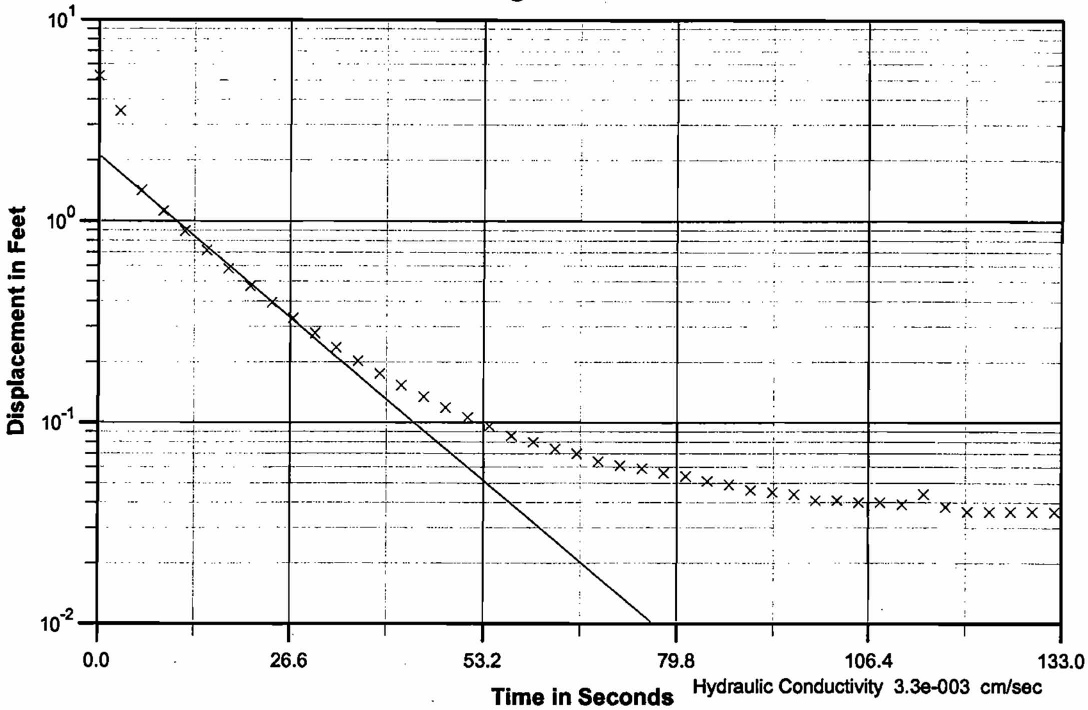
Figure D-10

Slug Tests HC-102

HC-102 Falling Head - Bouwer & Rice



HC-102 Rising Head - Bouwer & Rice

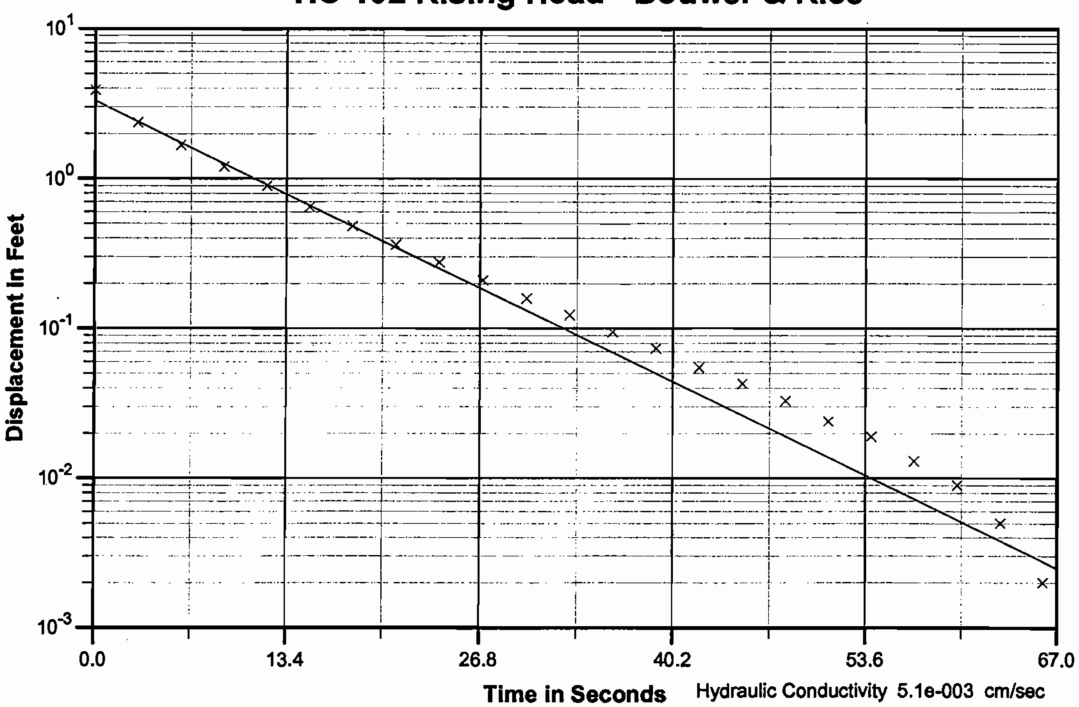


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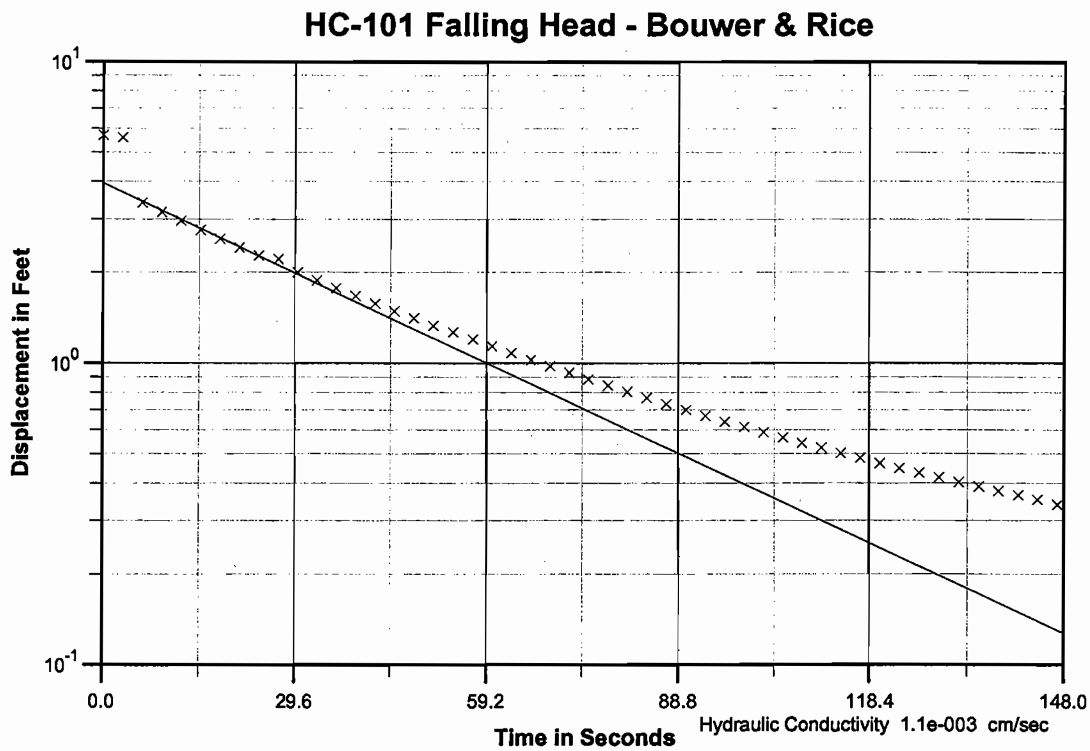
Figure D-9

Slug Tests HC-101



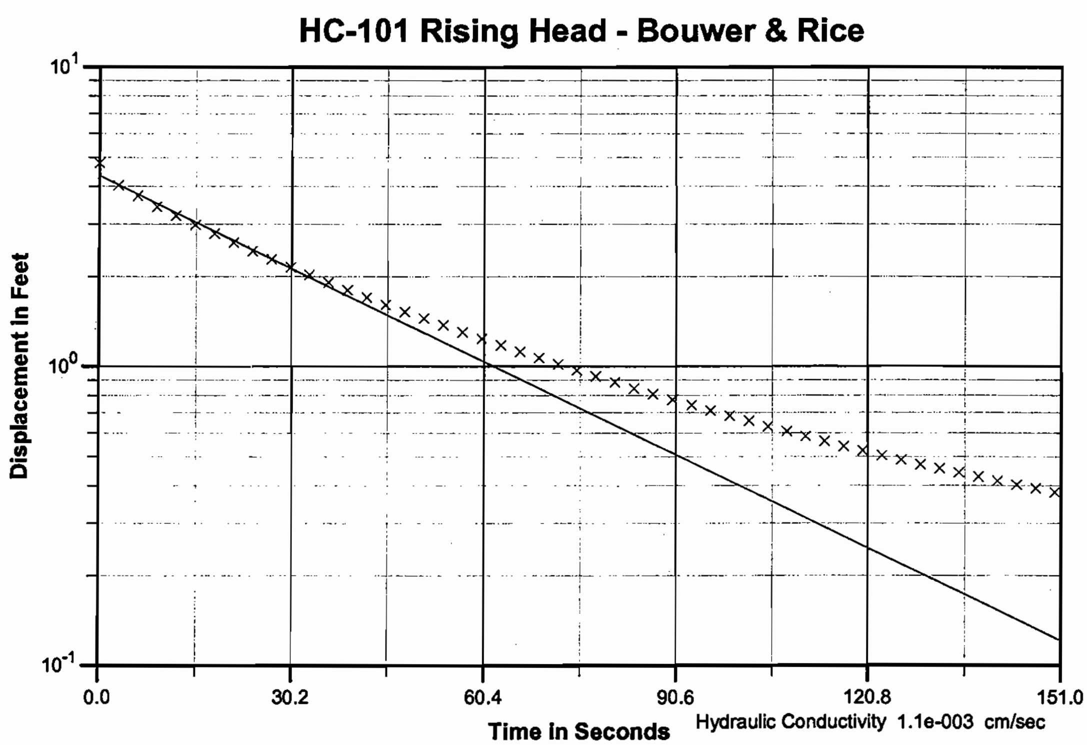


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Figure D-8

Hydrograph Slug Test MW-2

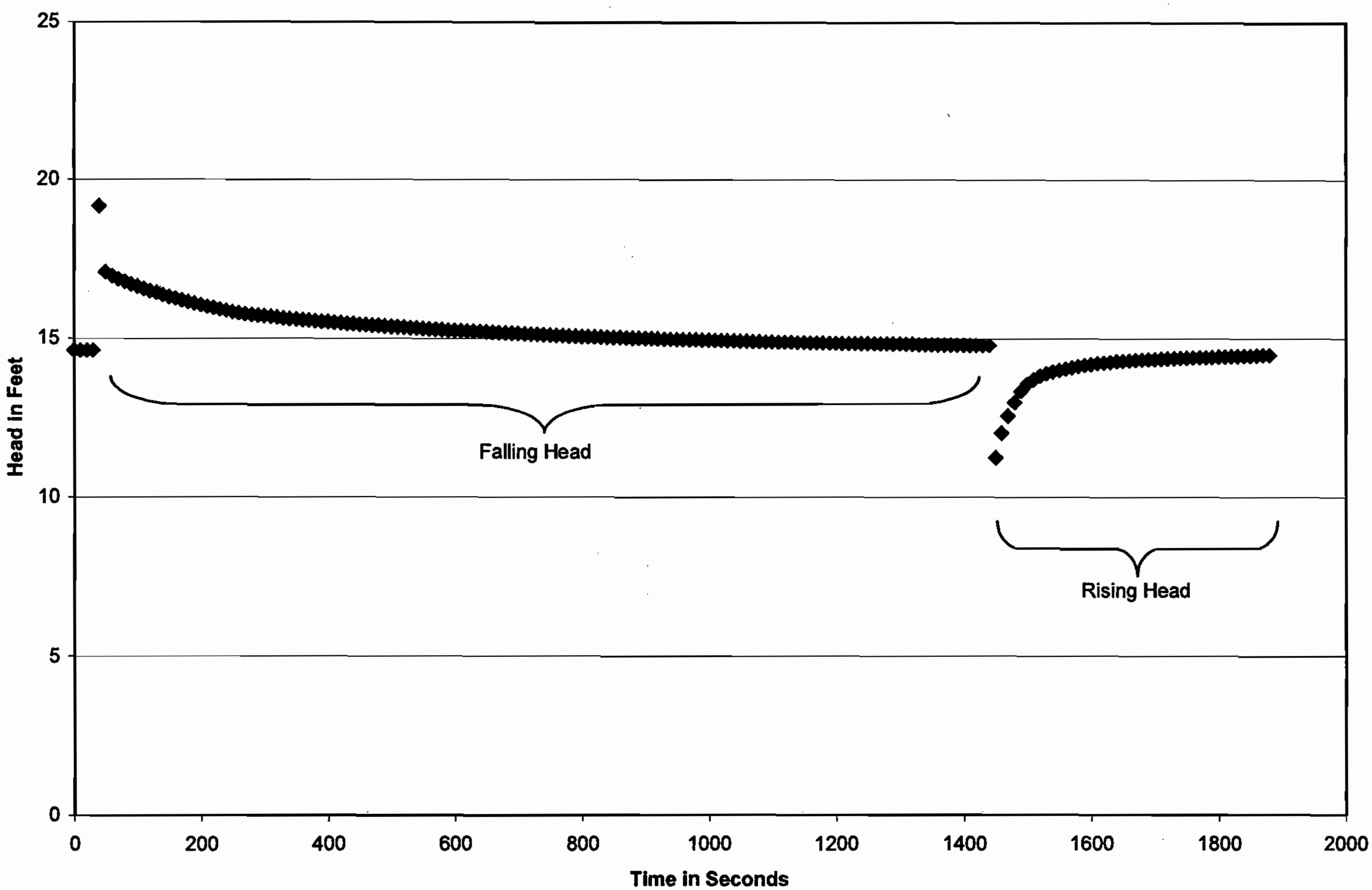

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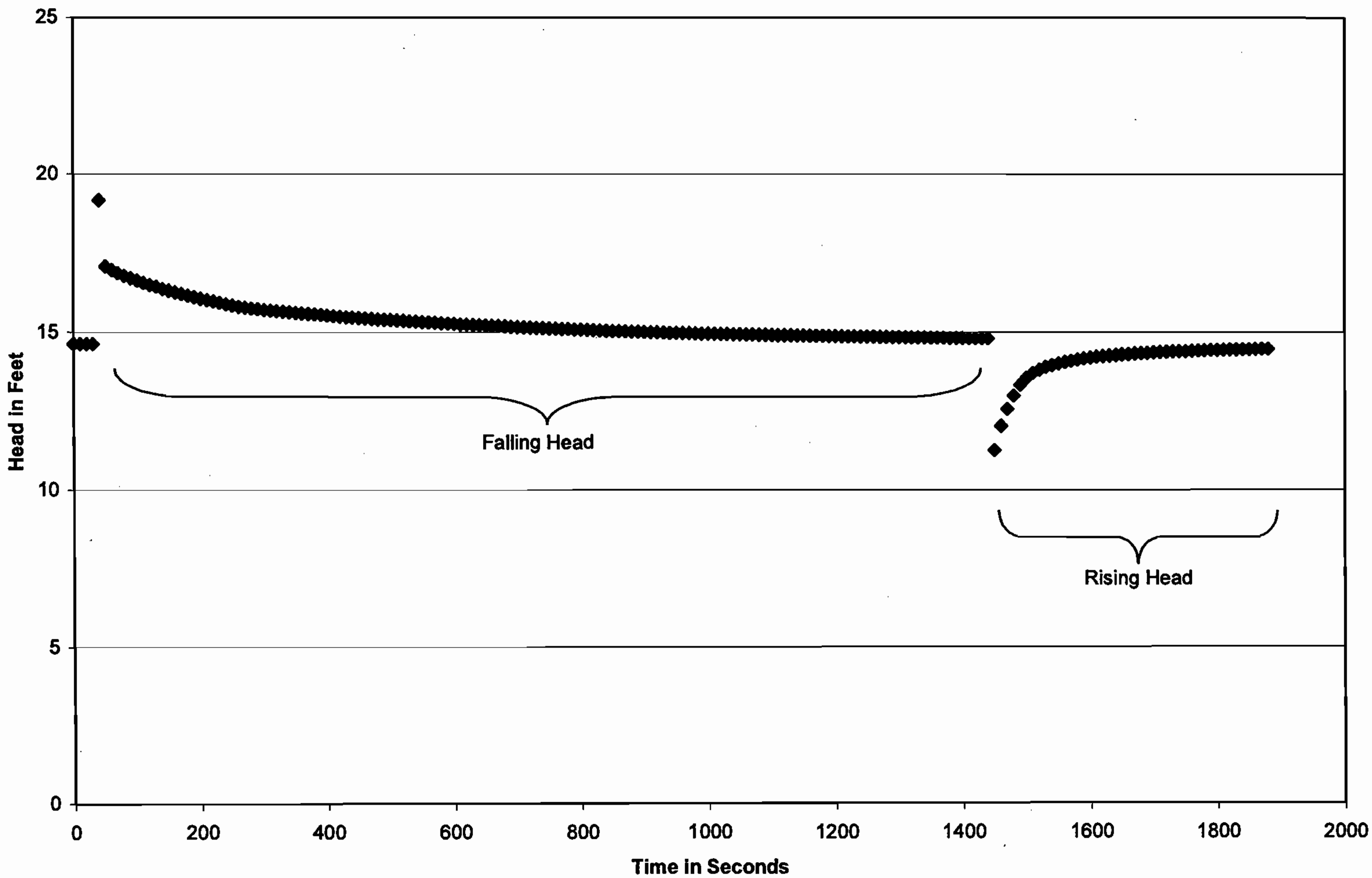
Figure D-7

Hydrograph Slug Test MP-3



Hydrograph Slug Test B-6

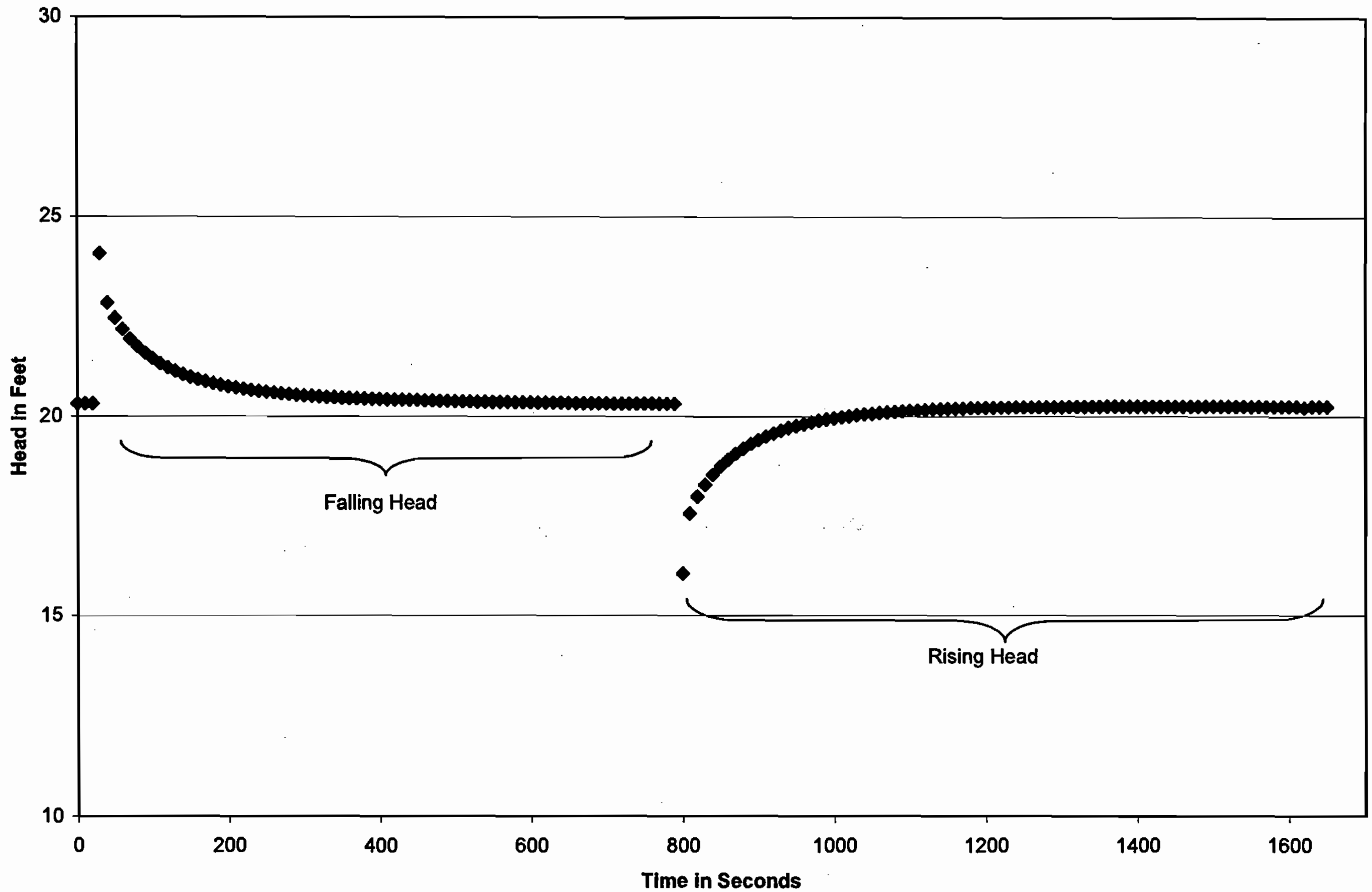


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Figure D-5

Hydrograph Slug Test HC-105

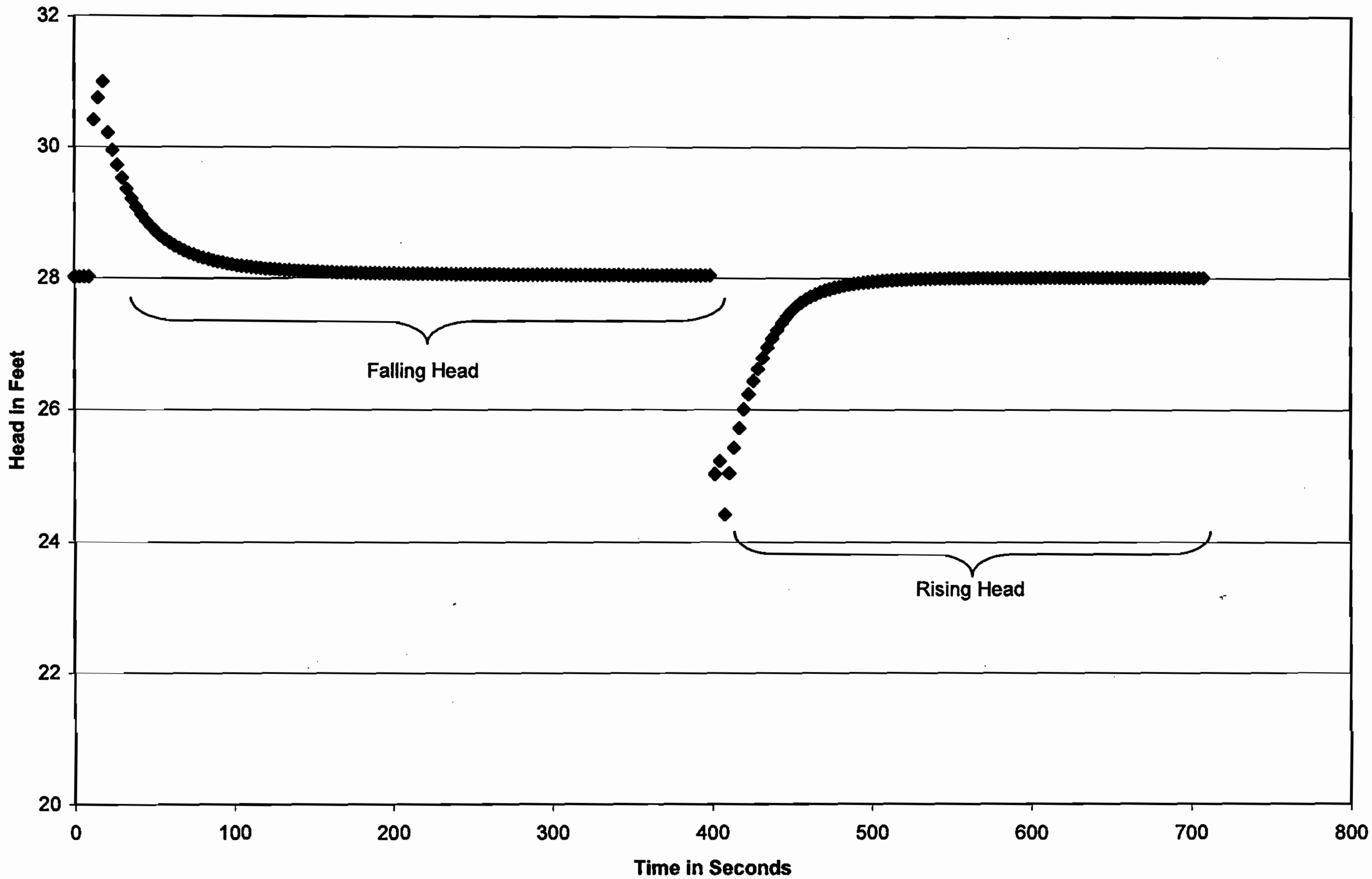

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Figure D-4

Hydrograph Slug Test HC-103

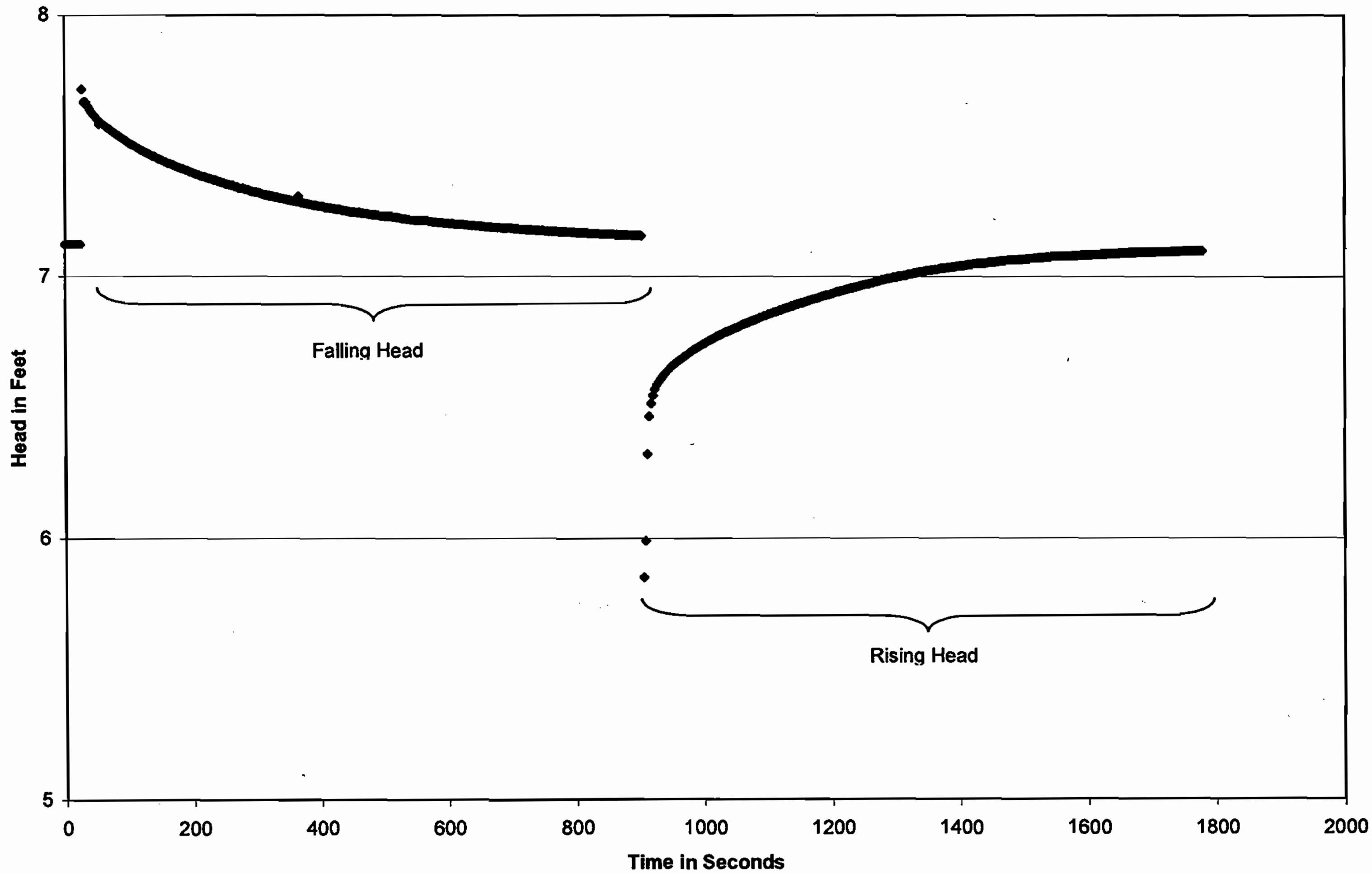

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Figure D-3

Hydrograph Slug Test HC-102

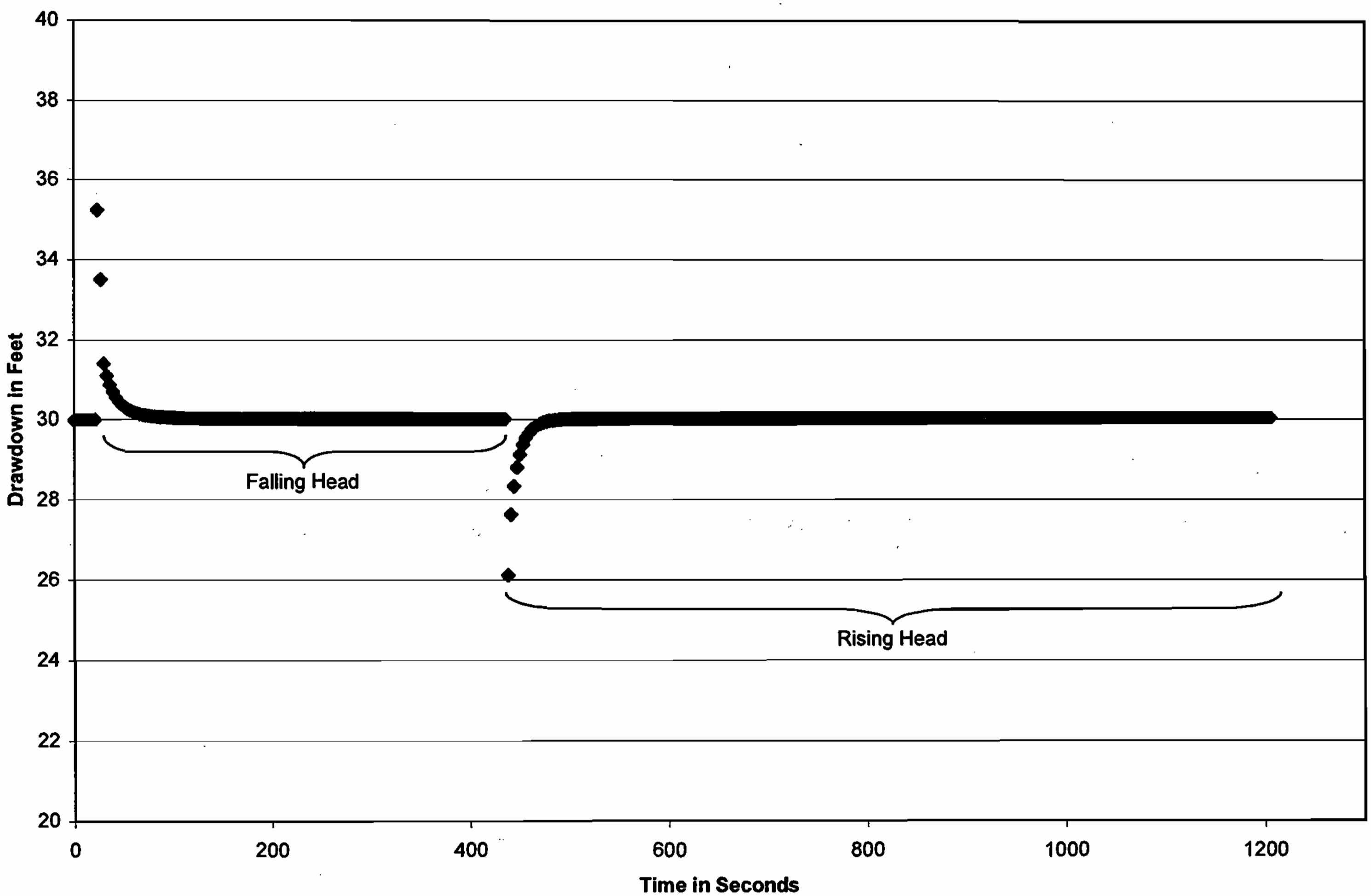

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Figure D-2

Hydrograph Slug Test HC-101

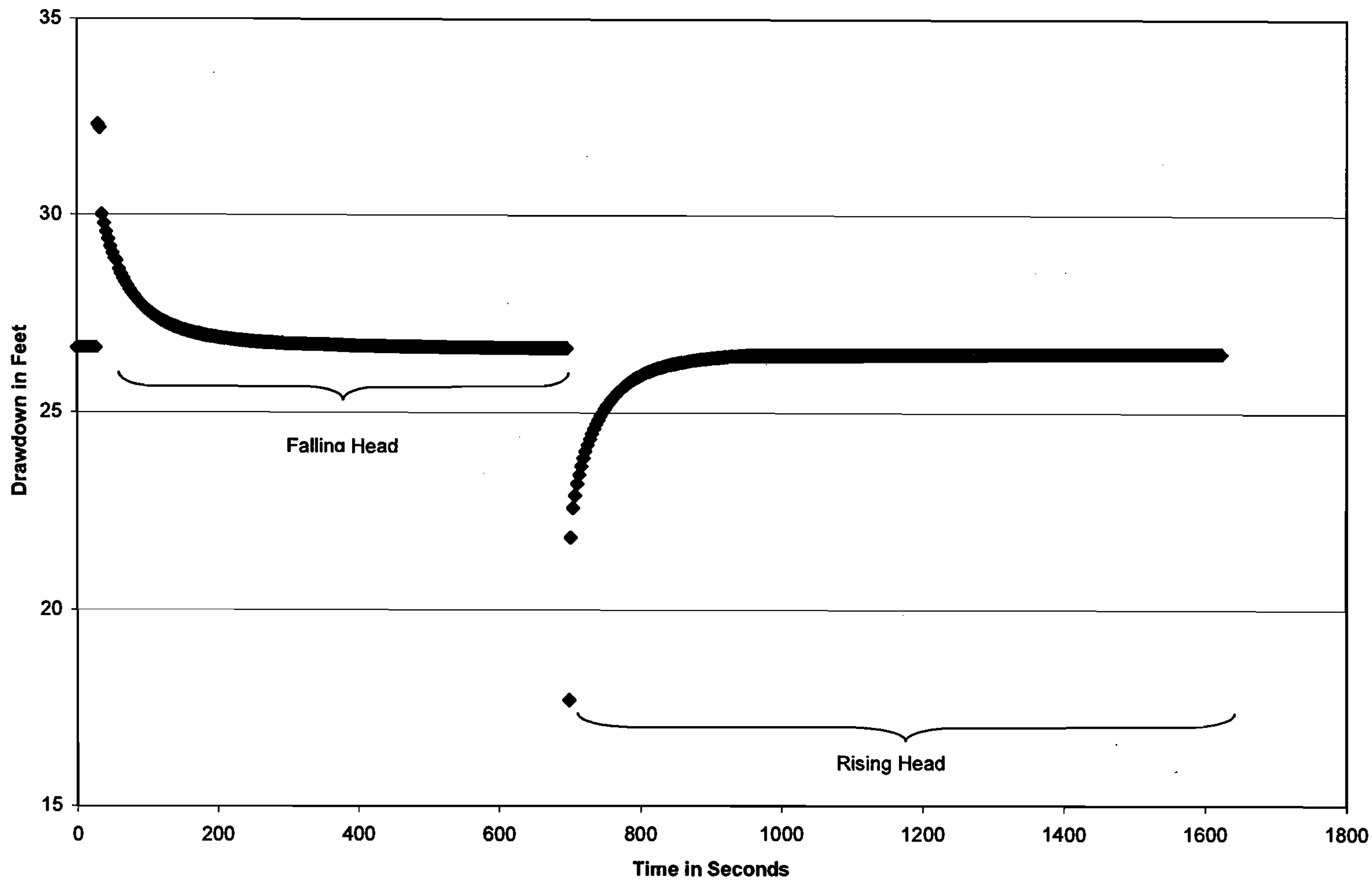

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Figure D-1

APPENDIX D
SLUG TESTING PROGRAM (2007)

Slug Testing

Slug tests were conducted in seven monitoring wells (HC-101, HC-102, HC-103, HC-105, B-6, MP-3 and MW-2) at the site. Slug tests are performed by suddenly inserting or removing a solid PVC rod in a well and measuring the recovery of the water levels during the test. A test conducted by inserting the PVC rod into the well is referred to as a falling head test and the test following removal of the rod is called a rising head test. The water level data generated from the tests were analyzed using the Bouwer and Rice method (Bouwer and Rice 1976; Bouwer 1989).

A summary of the results of slug testing is provided in Table D-1. The slug test plots are provided on Figures D-1 through D-14. The average hydraulic conductivity determined from slug tests is 0.001 cm/sec (2.7 ft/day).

Table D-1 – Slug Test Results

	Hydraulic Conductivity			
	Falling Head	Rising Head	Average	
Well Name	cm/sec	cm/sec	ft/day	cm/sec
HC-101	0.0011	0.0011	3.1	0.011
HC-102	0.0033	0.0051	11.9	0.0042
HC-103	0.0013	0.0029	6.0	0.0021
HC-105	0.0018	0.0019	5.2	0.00185
B-6	0.00032	0.00034	0.9	0.00033
MP-3	0.00021	0.00025	0.7	0.00023
MW-2	0.00018	0.001	1.7	0.00059
Average			4.2	0.0015
GeoMean			2.7	0.001

References for Appendix D

Bouwer H., 1989. "The Bouwer and Rice slug test - an update." Ground Water 27(3): 304-309.

Bouwer H. and R.C. Rice 1976. "A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells." Water Resources Research 12(3): 423-428.

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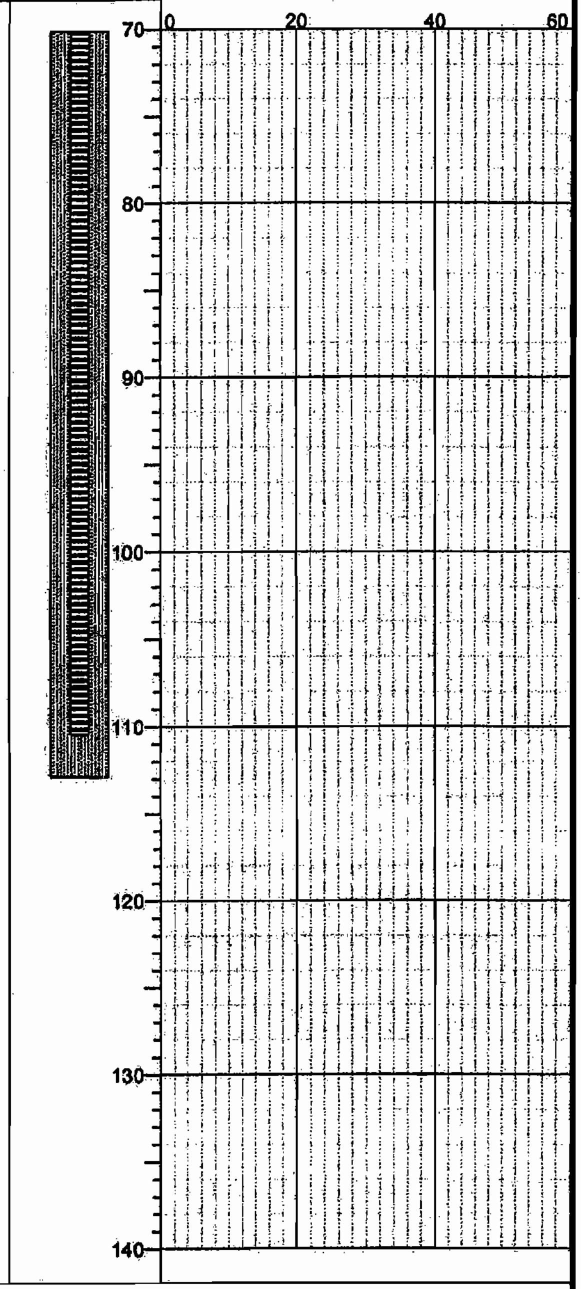
APPENDIX D
SLUG TESTING PROGRAM (2007)

Soil Description	Depth (ft)	USCS Symbol	Samples	Well Completion Detail	Depth (ft)	Standard Penetration Resistance (140 lb. weight, 30-inch drop) Blows per foot
(continued from Page 1) - interlayered with thin fine to medium sand						
Gray gravely silty SAND, trace cobble	77					
Gray slightly silty fine to medium SAND, trace gravel - oxide stained - slightly silty to silty fine to medium SAND - slightly silty to clean fine to medium SAND with occasional peat/wood fragments	90					
Layered brown silty to slightly silty SAND and gray fine to medium SAND, trace gravel, wood and peat fragmts	108					
Yellow-brown slightly sandy SILT	111					
Bottom of Boring, 113 ft						



NOTES

Drilling Date: February 20, 2008

Drilling Contractor: Malcolm Drilling Company, Inc

Drilling Method: 36" diam Bucket Auger

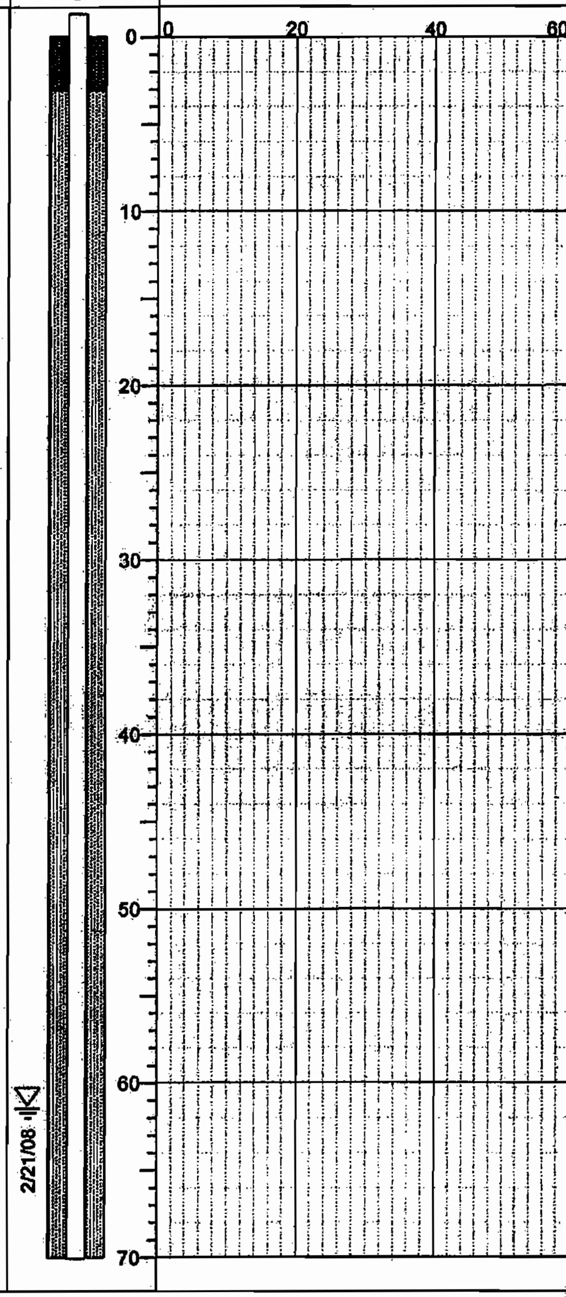
LEGEND

- Cement/bentonite grout
- Bentonite seal
- Gravel Pack: Glacier Product 8700
- 12-inch SDR 26 PVC 30-slot well screen
- 12-inch SDR 26 PVC riser

BENDER CONSULTING, LLC *Applied Groundwater Solutions*	Lincoln Square 2 Dewatering Design Recommendations GLY Construction	Log of Boring DW-1	0740-02 Figure 1 (page 2 of 2)

Depth (ft)	Soil Description
0	Brown gravelly silty SAND. TILL
	Slight seepage at 26 feet
41	Gray brown silty CLAY with thin layers of gray fine to medium sand
47	Brown fine to medium SAND with layers of slightly sandy gravelly SILT
50	Dark gray gravelly SILT, trace cobble
	Grades slightly sandy
65	Dark gray slightly sand gravelly SILT

Columns: Soil Description | Depth (ft) | USCS Symbol | Samples | Well Completion Detail | Depth (ft) | Standard Penetration Resistance (140 lb. weight, 30-inch drop) Blows per foot



NOTES

Drilling Date: February 20, 2008
Drilling Contractor: Malcolm Drilling Company, Inc
Drilling Method: 36" diam Bucket Auger
Approx Elevation: 145 feet

LEGEND

- Cement/bentonite grout
- Bentonite seal
- Gravel Pack: Glacier Product 8700
- 12-inch SDR 26 PVC 30-slot well screen
- 12-inch SDR 26 PVC riser

BENDER CONSULTING, LLC
Applied Groundwater Solutions

Lincoln Square 2
Dewatering Design Recommendations
GLY Construction

Log of Boring
DW-1

0740-01

Figure 1
(page 1 of 2)

Milbor-Pita & Associates, Inc.

DRILL HOLE LOG

Boring No.: MP-3

Project: Sound Transit Eastlink **Project No.:** 1605

Elevation and Depth (Ft.)	Well Detail	Graphic Log	USCS	Description	Sample No.	NM	SPT N Value	Test Results: Moisture ▲ SPT N-Value ● (10 30 50)
20 - 120			SM	Very dense, olive gray, little silt to silty, fine SAND, wet. (SM) (ADVANCE OUTWASH)	S-24		89	89
				Bottom of Boring = 121.5 feet.				
15 - 125								
10 - 130								
5 - 135								
0 - 140								
-5 - 145								
-10 - 150								
-15 - 155								

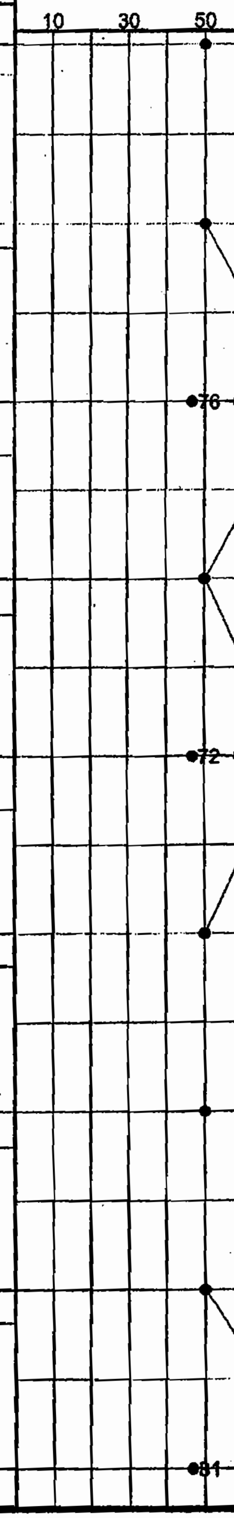
Milbor-Pita & ASSOCIATES, INC.

DRILL HOLE LOG

Boring No.: MP-3

Project: Sound Transit Eastlink **Project No.:** 1605

Elevation and Depth (Ft.)	USCS	Description	Sample No.	NM	SPT N Value
65 — 75	SM-ML	Very dense, olive gray, fine sandy, SILT grading to silty, fine to medium SAND, wet. (SM-ML) Driller reported encountering gravel at 77 feet.	S-15		50
60 — 80	SM	Very dense, olive gray, little to some silt, some fine gravel, fine to coarse SAND, moist. Gravel is faceted and socketed into matrix. (SM) (GLACIAL TILL)	S-16		50
55 — 85	SP-SM / SM	Very dense, olive gray, trace to little silt, fine SAND, wet. Little silt, fine to medium SAND present at top of sample at 85 feet. (SP-SM) (ADVANCE OUTWASH) Very dense, olive gray, silty fine SAND, wet. (SM)	S-17		76
50 — 90	SP-SM	Very dense, olive gray, interbedded, clean fine to coarse SAND grading to fine SAND, wet and some silt to silty, fine SAND, wet. (SP-SM) (ADVANCE OUTWASH)	S-18		50
45 — 95		Sample S-19 is interbedded clean fine to medium SAND and silty fine SAND, wet. Beds are approximately 6-inches thick.	S-19		72
40 — 100	SP-SM	Very dense, olive gray, fine SAND, wet. (SP) (ADVANCE OUTWASH) Driller reported five feet of heave at 100 feet.	S-20		50
35 — 105			S-21		50
30 — 110		Sample S-22 is silty, fine to medium SAND and fine SAND. (SM)	S-22		50
25 — 115		Sample S-23 contains only fine SAND.	S-23		81



Milbor-Pita & ASSOCIATES, INC.

DRILL HOLE LOG

Boring No.: MP-3

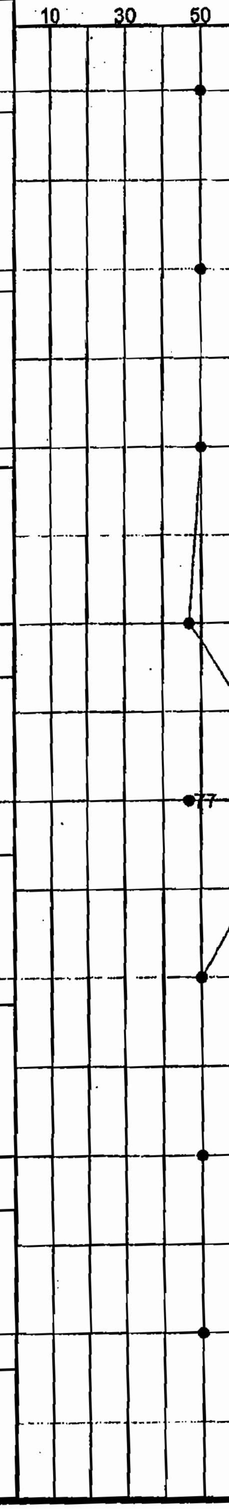
Project: Sound Transit Eastlink

Project No.: 1605

Elevation	Depth (Ft.)	Well Detail	Graphic Log	USCS	Description	Sample No.	NM	SPT N Value
105	35					S-7		50
100	40					S-8		50
95	45				Sampler was wet at sample S-9 at 45 feet. Water may be perched at 45 feet.	S-9		50
90	50				Glacial till becomes olive gray at 50 feet.	S-10		47
85	55					S-11		77
80	60					S-12		50
75	65					S-13		50
70	70				No recovery in sample S-14 at 70 feet.	S-14		50
					Driller reported encountering larger gravel between 70 and 75 feet.			

Test Results

Moisture ▲
SPT N-Value ●



Figure

Milbor-Pita & ASSOCIATES, INC.

DRILL HOLE LOG

Boring No.: MP-3

Project: Sound Transit Eastlink
Client: CH2M Hill
Location: On Bellevue Way near NE 4th in Safeway Parking Lot
Driller: Gregory Drilling
Drill Rig: CME 85 truck-mount with autohammer
Depth to Water: Date: 4/23/2007 **Depth:** 85 feet **Date:** **Depth:**

Project No.: 1605
Date Drilled: 4/23/2007
Elevation: 140
Logged By: JSS

Elevation and Depth (Ft.)	USCS	Description	Sample No.	NM	SPT N Value
140 / 0	SM	ASPHALT Loose to medium dense, reddish-brown to olive brown (oxidized), little fine to coarse gravel, some silt to silty, fine to coarse SAND, moist. (SM) (LOCALLY DERIVED FILL)			
135 / 5		Trace rootlets present in the top 6-inches of sample S-1.	S-1		10
130 / 10	SM	Dense, olive brown, little fine gravel, some silt, fine to coarse SAND, moist. Gravel is faceted and socketed. (SM) (GLACIAL TILL)	S-2		37
		Driller reported encountering wood fragments at 12 feet.			
125 / 15		Sample S-3 is very dense and contains some fine to coarse gravel.	S-3		50
120 / 20			S-4		50
115 / 25		Very dense, olive brown, trace to some fine to coarse gravel, some silt to silty, fine to coarse SAND, moist. (SM)	S-5		50
110 / 30		Tip of the sampler was wet at sample S 6. Perched water at 31 feet?	S-6		50

Test Results: Moisture ▲ SPT N-Value ● (scale 10, 30, 50)

Hollow Stem Auger drilling to bottom of boring at 121.5 feet.

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

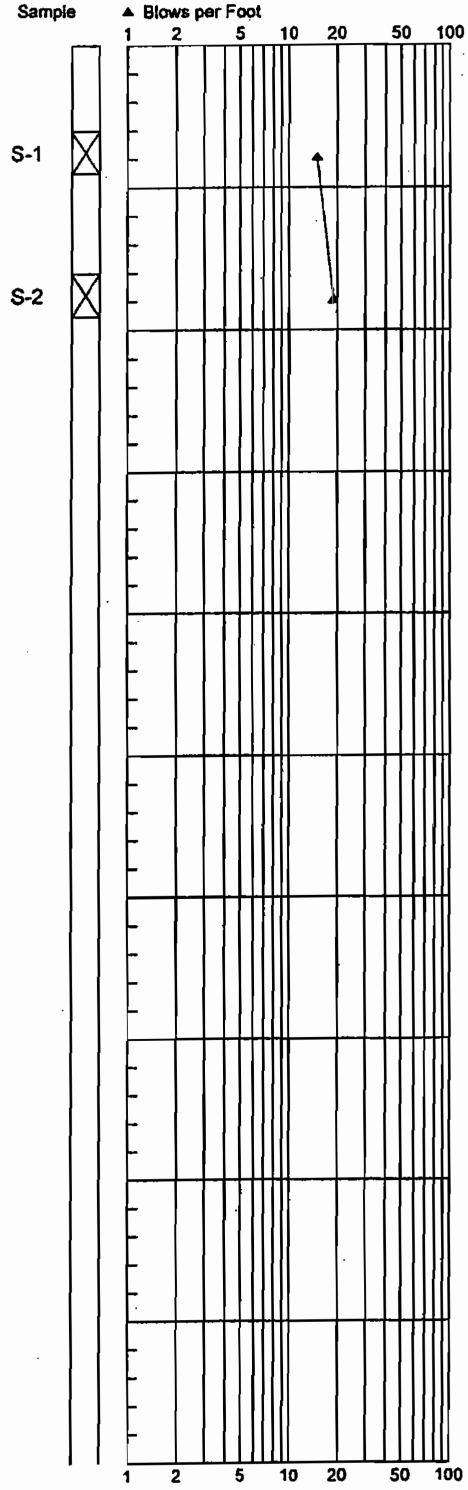
Figure

Boring Log HC-6 (HC02-6)

Soil Descriptions
Approximate Ground Surface Elevation in Feet:

Depth in Feet	Soil Descriptions
0	6 inches of Asphalt over medium dense, moist, dark brown, gravelly, silty SAND. (FILL)
~6.5	Encountered possible concrete slab.
~9	Encountered brick fragments. (FILL)
9.5	Bottom of Boring at 9.5 Feet. Completed 09/27/02.

STANDARD PENETRATION RESISTANCE



LAB TESTS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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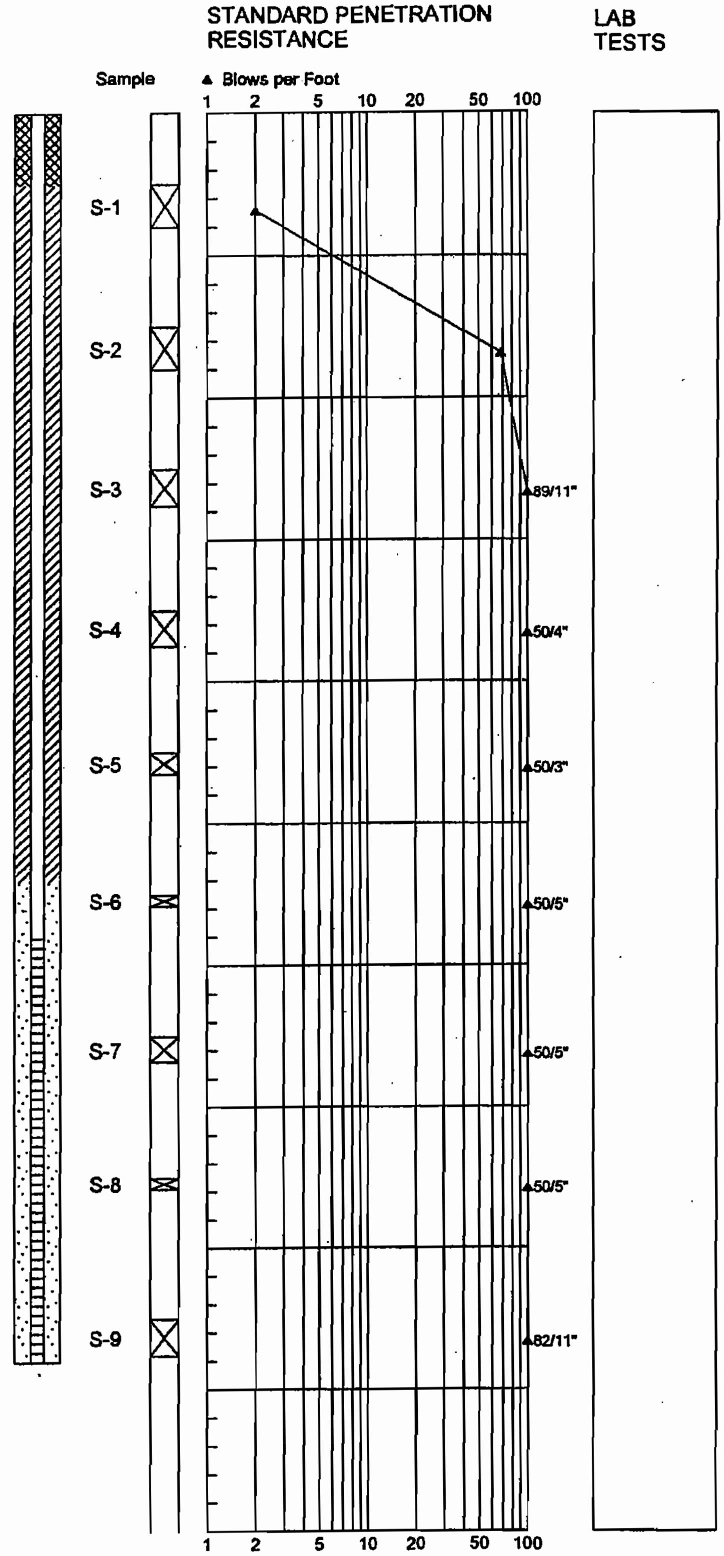
Figure A-7

Monitoring Well Log HC-5 (HC02-5)

Soil Descriptions
Approximate Ground Surface Elevation in Feet:

Depth in Feet

Depth (ft)	Soil Descriptions
0	Loose, moist, brown, silty, gravelly SAND. (FILL)
5	Very dense, moist, brown, gravelly, silty SAND. (TILL-like)
	Grades to gray-brown.
	Grades moist to wet.
44	Bottom of Boring at 44.0 Feet. Completed 09/26/02.
	Groundwater not encountered during drilling or sampling on 10/1/02.



OLD BORING LOG 735501MW.GPJ HC_CORP.GDT 9/6/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7355-01 9/02

Figure A-6

Monitoring Well Log HC-4 (HC02-4)

Soil Descriptions
Approximate Ground Surface Elevation in Feet:

3 inches of Asphalt over medium dense, damp, brown, gravelly, silty SAND. (TILL-like)

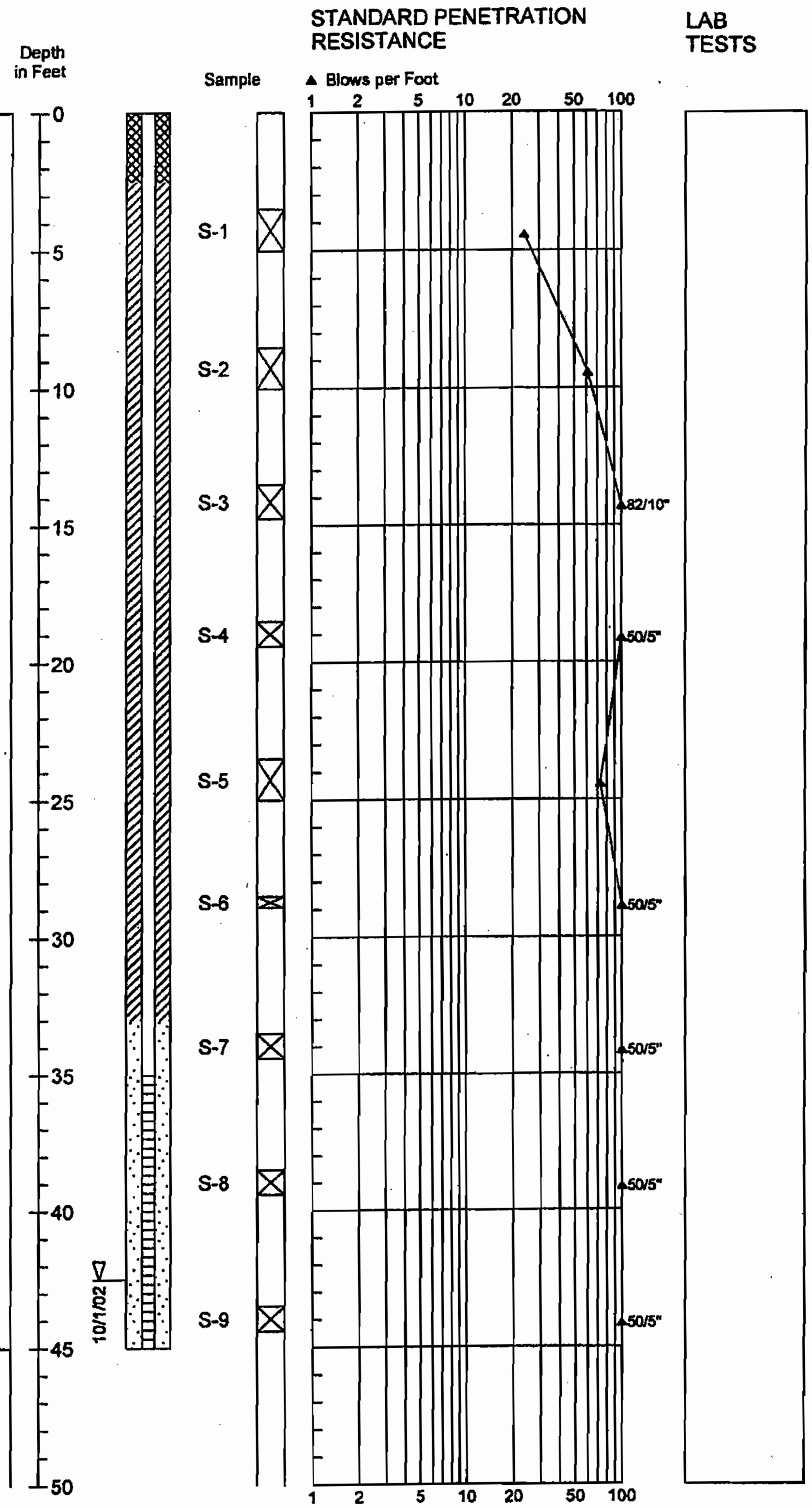
Grades to moist and very dense.

Grades moist to wet.

Grades to moist.

Grades moist to wet.

Bottom of Boring at 45.0 Feet.
Completed 09/27/02.



OLD BORING LOG 735501MW.GPJ HC_CORP.GDT 9/6/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7355-01 9/02

Figure A-5

Monitoring Well Log HC-3 (HC02-3)

Soil Descriptions
Approximate Ground Surface Elevation in Feet:

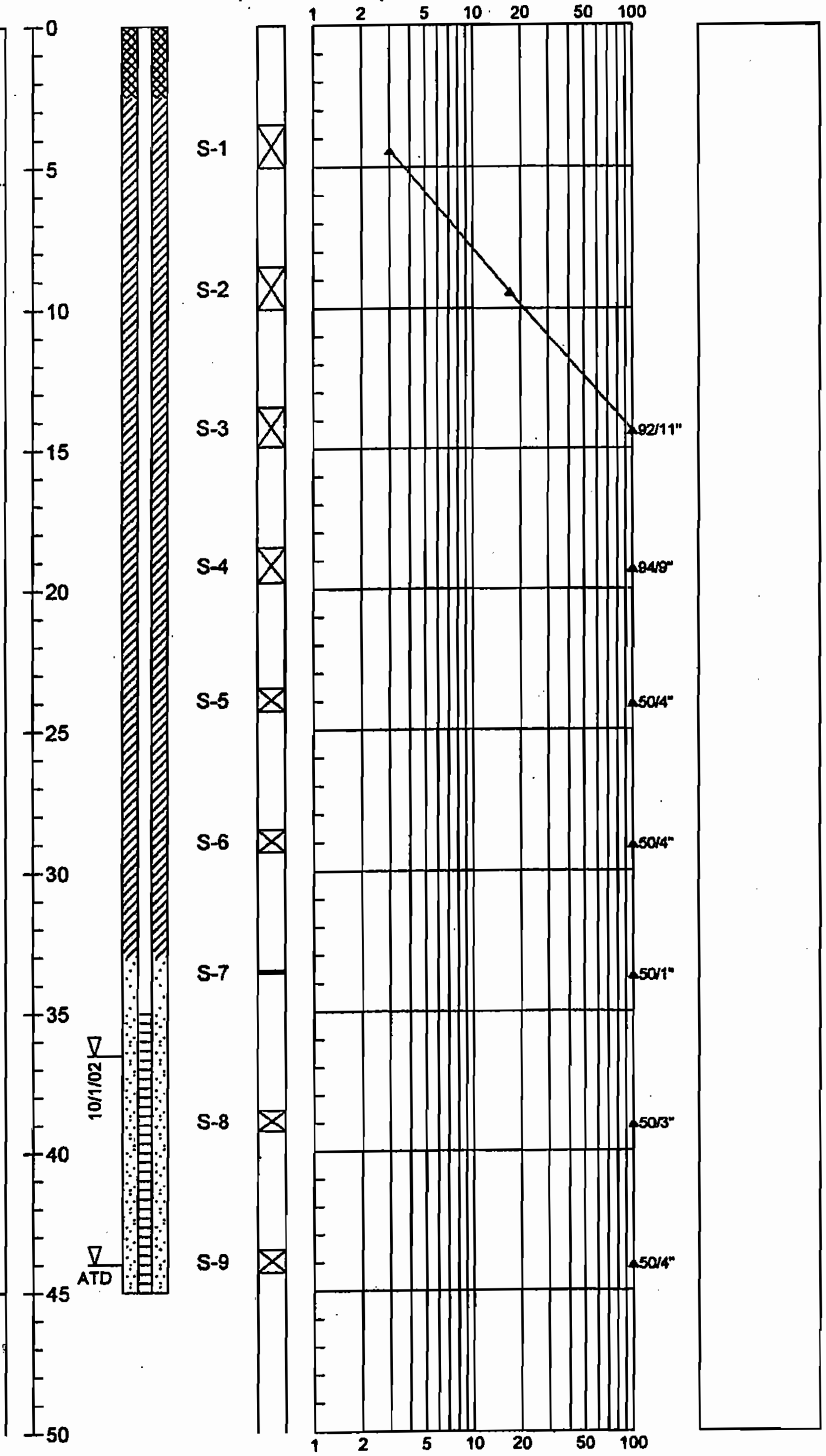
3 inches of Asphalt over very loose, damp, brown, slightly gravelly SAND. (FILL)

Medium dense, moist, gray-brown, slightly gravelly, silty SAND. (TILL-like)

Grades to very dense and gravelly.

2-inch medium SAND lens at a depth of 38.9 feet.

Bottom of Boring at 45.0 Feet.
Completed 09/26/02.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7355-01 9/02

Figure A-4

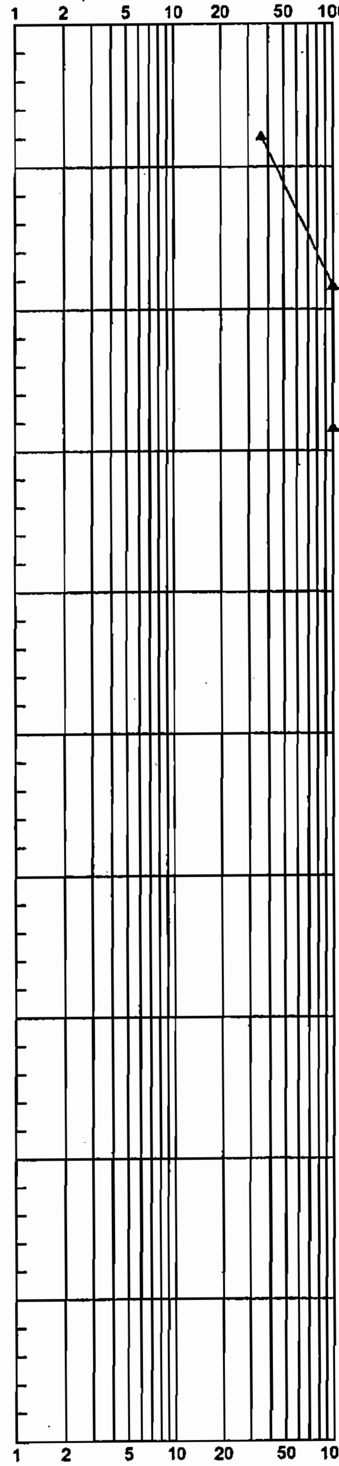
Boring Log HC-2 (HC02-2)

Soil Descriptions
Approximate Ground Surface Elevation in Feet:

Soil Descriptions	Depth in Feet	Sample	Lab Tests & (PID)
3 inches of Asphalt over dense, damp, light brown, very silty SAND with gravel and cobbles. (FILL)	0		
		S-1	(0.1)
Very dense, damp, light brown with red, silty SAND. (TILL-like)	5		
		S-2	(0.1)
	10		
		S-3	(0.1)
Bottom of Boring at 14.3 Feet. Completed 09/25/02.	15		

STANDARD PENETRATION RESISTANCE

▲ Blows per Foot



Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

OLD BORING LOG 735501MW.GPJ HC_CORP.GDT 9/6/07

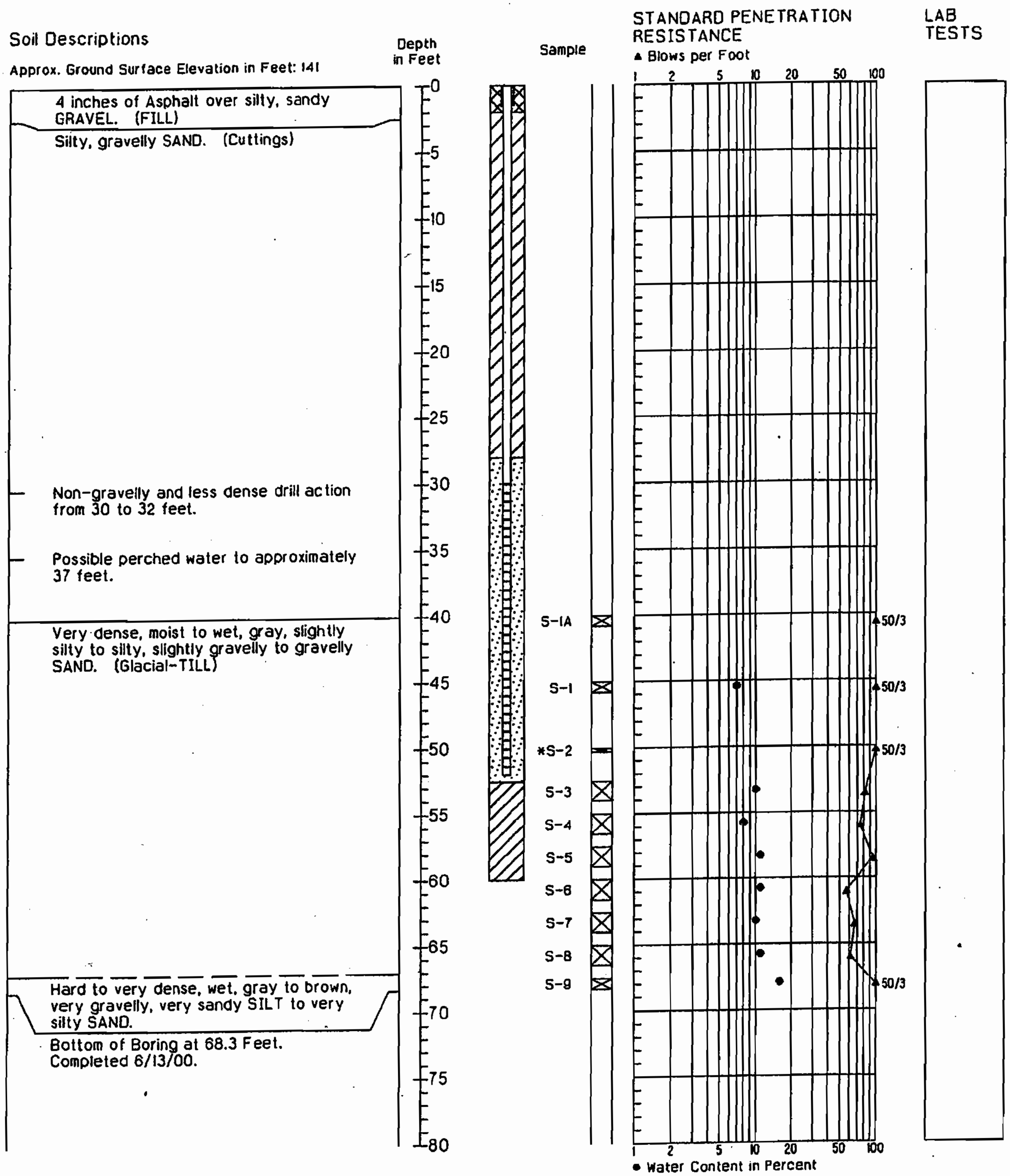
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7355-01 9/02

Figure A-3

Boring Log HC-1 (HC00-1)



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

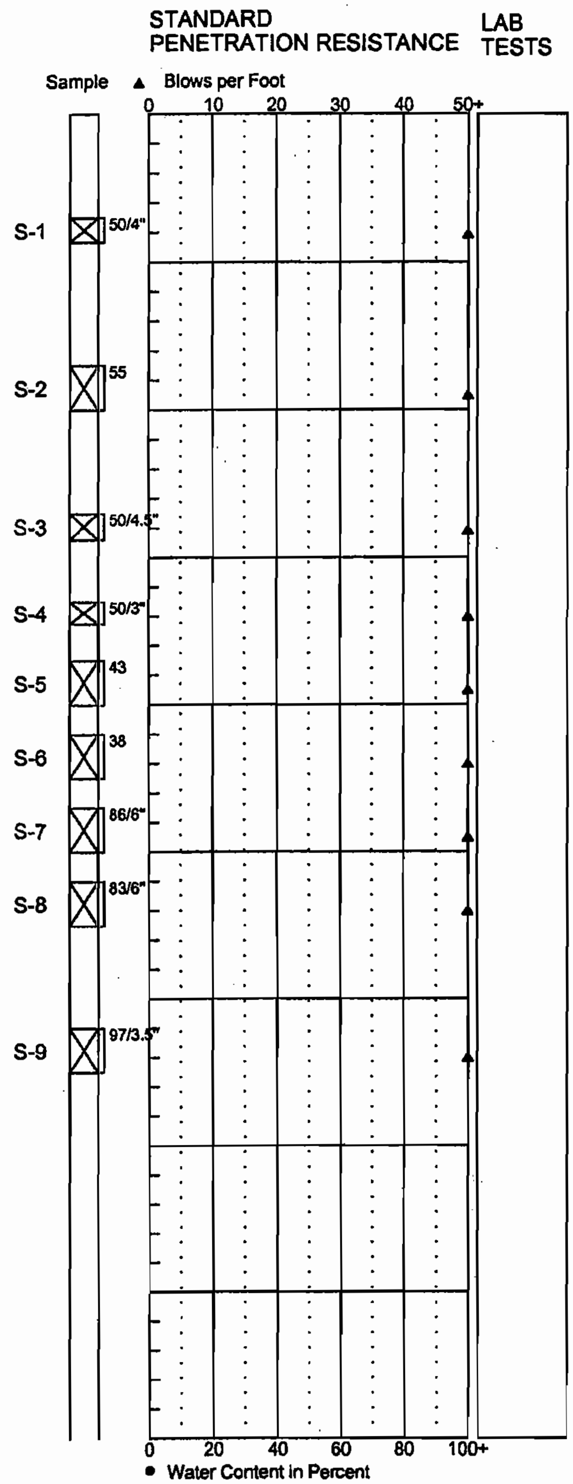
HARTCROWSER
J-7365 6/00
Figure A-8

Boring Log B-7

Location: N ~~343.5535 E 241.613~~
Approximate Ground Surface Elevation: 144.75 Feet
Horizontal Datum:
Vertical Datum:

Drill Equipment:
Hammer Type:
Hole Diameter: inches
Logged By: Reviewed By:

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
		No samples until 48.5 feet. (cont'd)	45
		Dense to very dense, wet, gray, slightly silty to silty SAND with trace gravel to slightly gravelly.	50
			55
			60
			65
			70
			75
		Bottom of Boring at 77.3 Feet. Started Completed 09/25/02.	80
			85
			90



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 11/7/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7355-03 9/02

Figure A-2 2/2

Boring Log B-7

Location: ~~N-843.6535 E -21.613~~
Approximate Ground Surface Elevation: 144.75 Feet
Horizontal Datum:
Vertical Datum:

Drill Equipment:
Hammer Type:
Hole Diameter: inches
Logged By: Reviewed By:

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
		No samples until 48.5 feet.	0
			5
			10
			15
			20
			25
			30
			35
			40
			45

Sample

STANDARD PENETRATION RESISTANCE

▲ Blows per Foot

0 10 20 30 40 50+

0 20 40 60 80 100+

● Water Content in Percent

LAB TESTS

NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 11/7/07

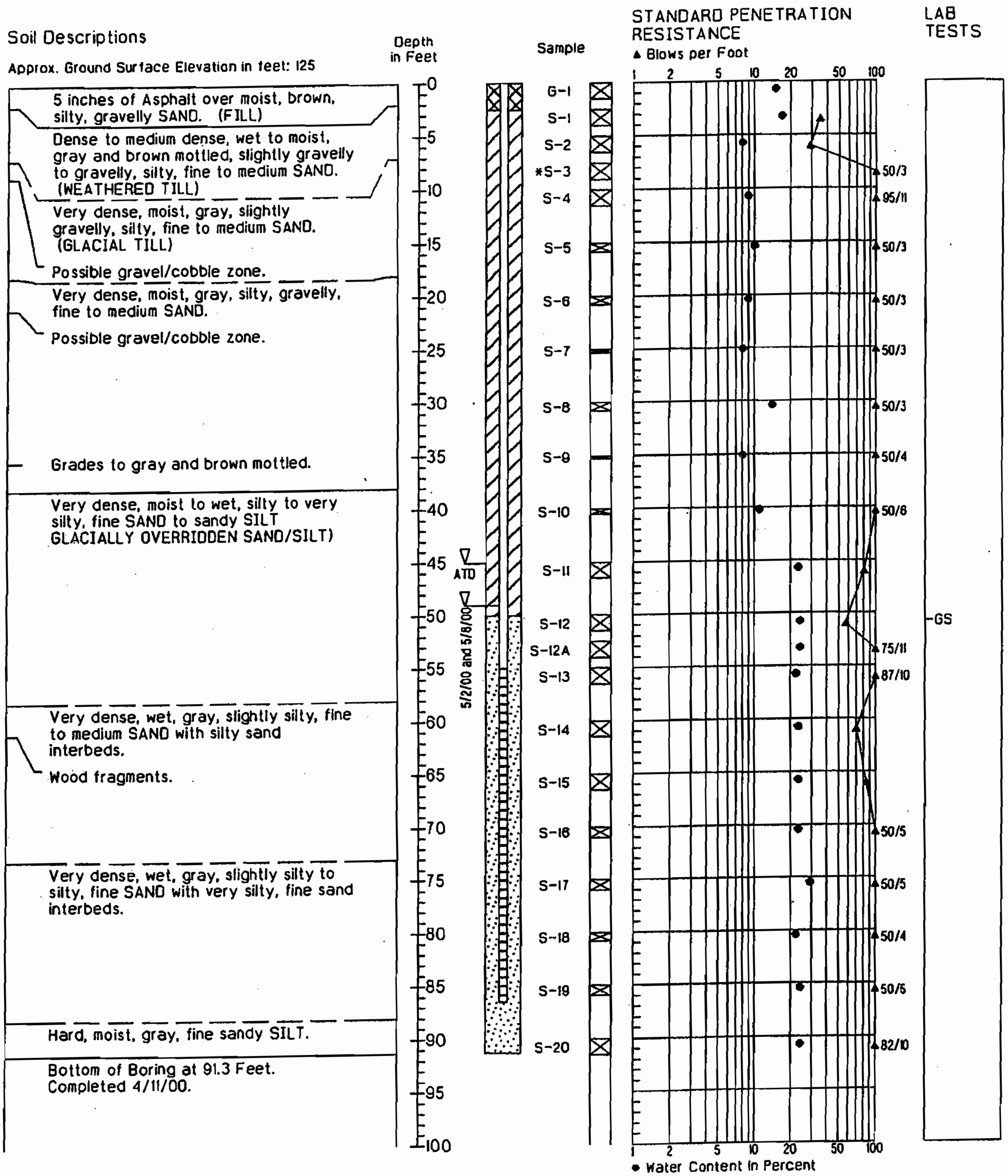
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7355-03 9/02

Figure A-2 1/2

Boring Log B-6



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Blow count may not be representative of soil density due to large gravels.

HARTCROWSER

J-7355 4/00

Figure A-7

Boring Log B-5

Soil Descriptions

Approx. Ground Surface Elevation in Feet: 131

Depth in Feet

5 inches of Asphalt over 3 inches of base rock over brown, slightly silty, gravelly SAND. (FILL)

Medium dense to dense, moist, light gray, slightly gravelly to gravelly, silty, fine to medium SAND. (WEATHERED TILL)

Very dense, moist to wet, light gray, slightly gravelly to gravelly, silty, fine to medium SAND. (GLACIAL TILL)

Possible gravel/cobble zone.

Possible gravel/cobble zone.

Possible gravel/cobble zone.

Very dense, wet, gray, slightly silty, fine, to medium SAND with silt interbeds. (GLACIALLY OVERRIDDEN SAND/SILT)

Very dense, wet, gray, silty to clean, fine to medium SAND.

Hard, wet, gray, fine sandy SILT.

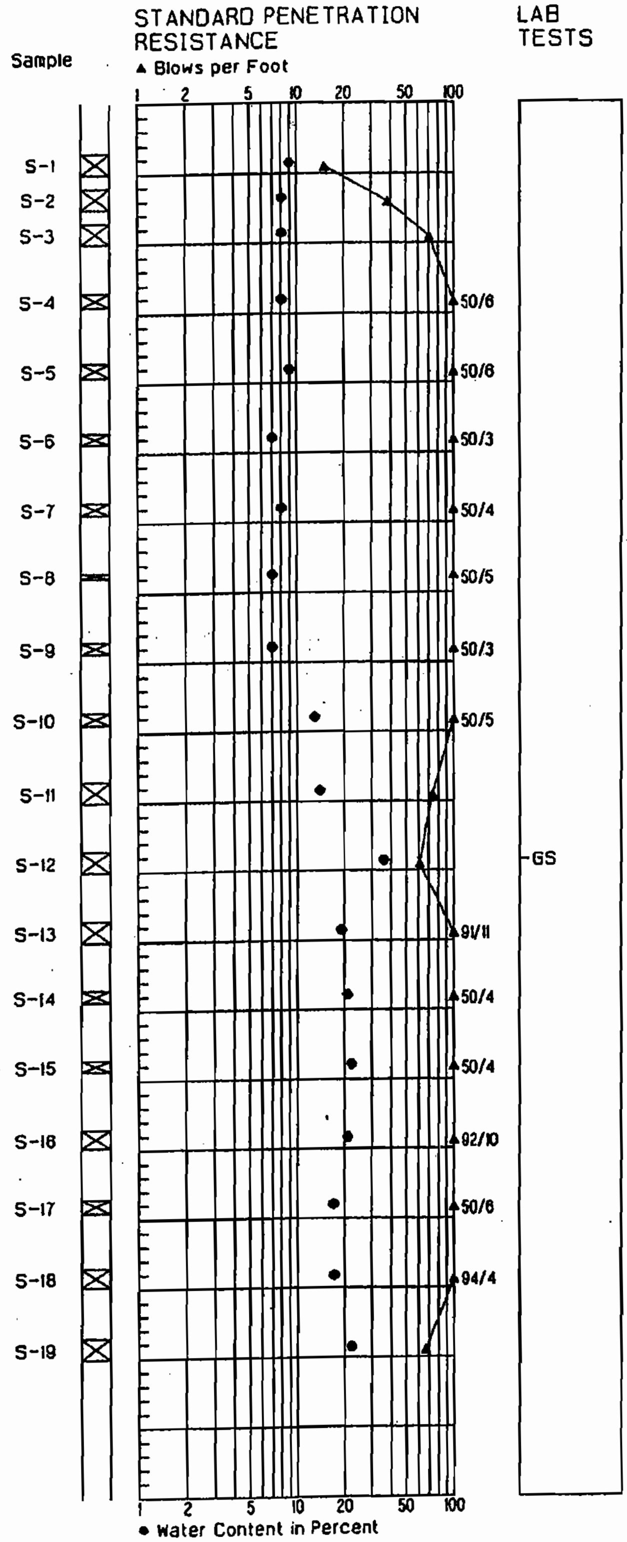
Hard, moist, gray, fine, sandy SILT to very silty, fine SAND.

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

Bottom of Boring at 90.0 Feet. Completed 4/18/00.

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

ATD



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Blow count may not be representative of soil density due to large gravels.

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Figure A-6

Boring Log B-4

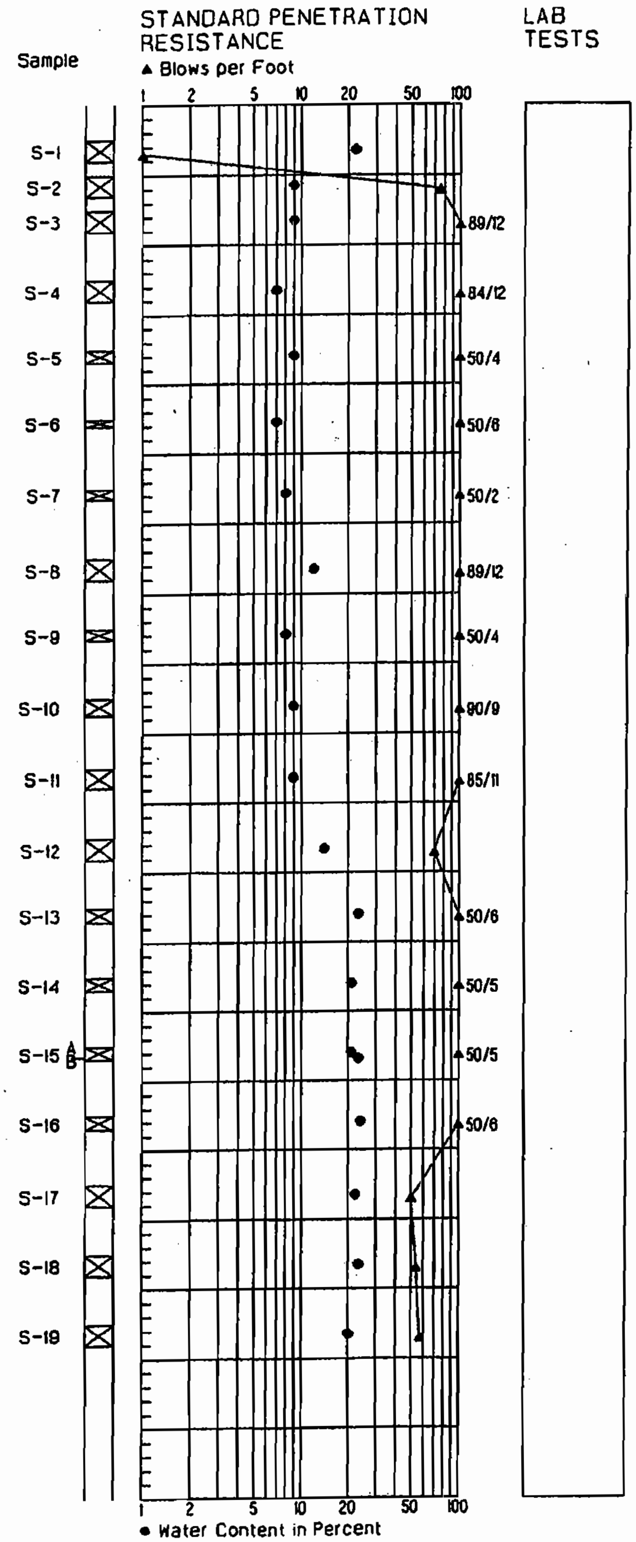
Soil Descriptions

Approx. Ground Surface Elevation in feet: 130

Depth in Feet

Depth (ft)	Soil Description
0	Concrete over very loose, wet, brown, silty, gravelly SAND. (FILL)
5	Very dense, moist, gray, silty, gravelly to very gravelly SAND. (GLACIAL TILL)
28	Possible gravel/cobble zone.
30	Very dense, moist, gray, slightly gravelly to gravelly, silty SAND.
40	Possible gravel/cobble zone.
45	Very dense, moist, gray, slightly gravelly, slightly silty, fine to medium SAND. (GLACIALLY OVERRIDDEN SAND)
55	Very dense, wet, gray, fine to medium SAND.
69	3-inch silty, fine sand layer.
75	Very dense, wet, brown silty to very silty, fine to medium SAND with fine sandy silt interbeds.
89	Bottom of Boring at 89.0 Feet. Completed 4/15/00.

ATD (ground water, approx. 52 ft)



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Blow count may not be representative of soil density due to large gravels.

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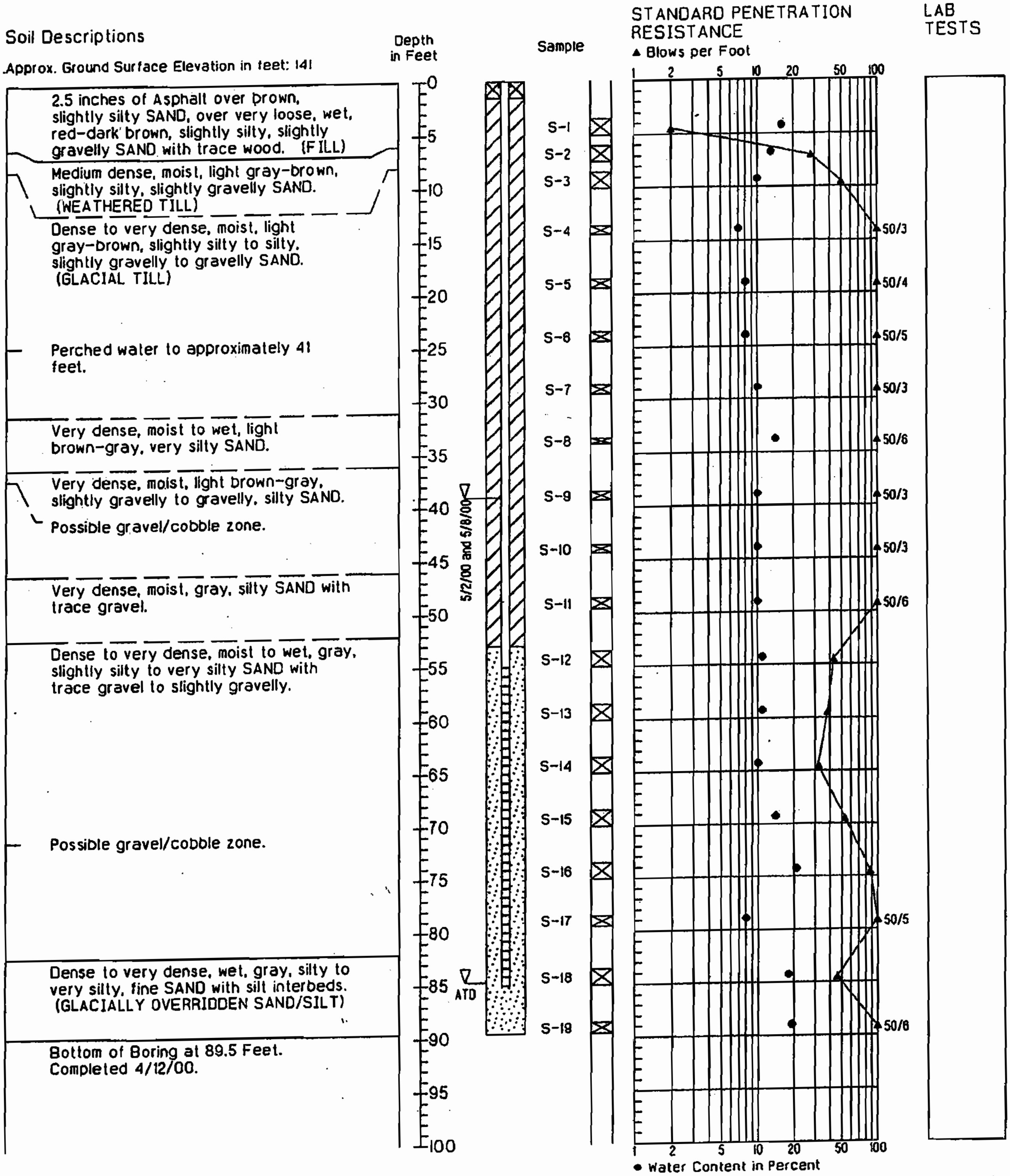
Figure A-5

Boring Log B-3



HARTCROWSER
J-7355 4/00
Figure A-4

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Blow count may not be representative of soil density due to large gravels.

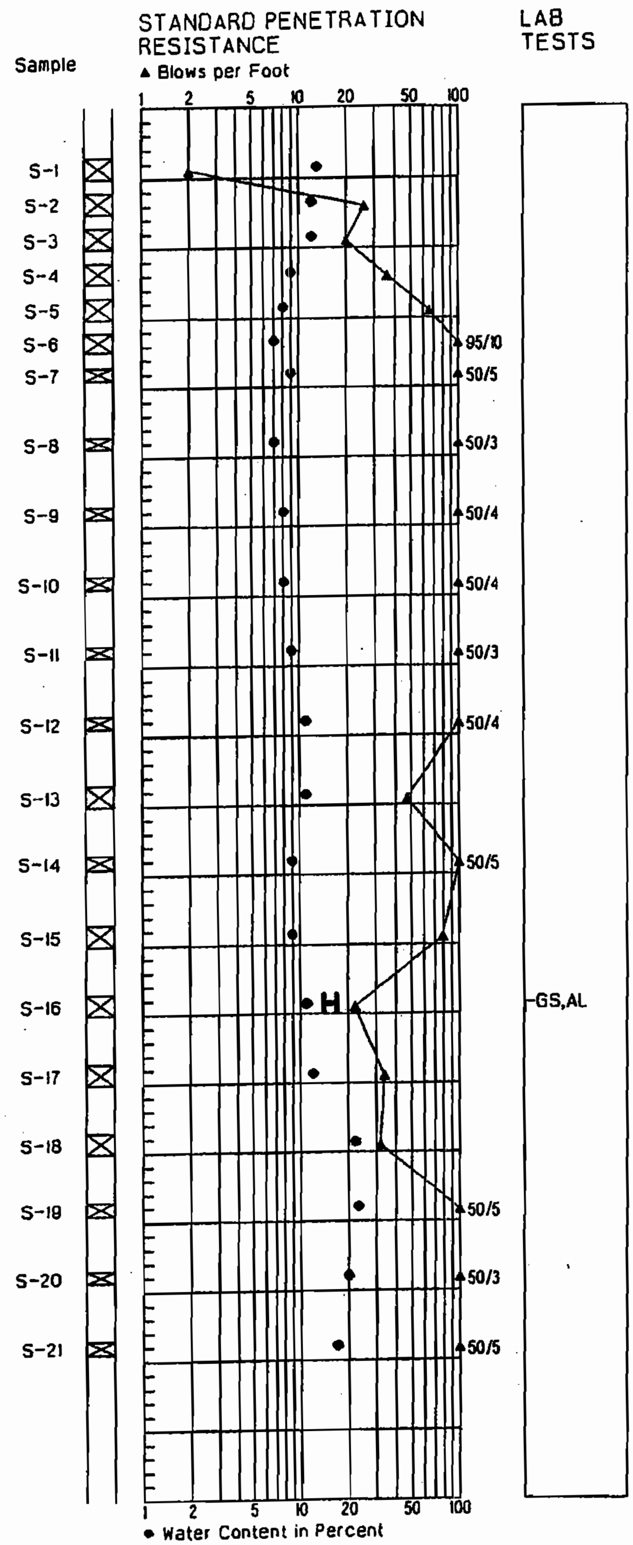
Boring Log B-2

Soil Descriptions

Approx. Ground Surface Elevation in feet: 137

Soil Descriptions	Depth in Feet
2 inches of Asphalt over brown, sandy GRAVEL over very loose, moist, light brown, slightly silty, gravelly SAND. (FILL)	0–5
Medium dense to dense, moist, light brown-gray, slightly silty to very silty, gravelly SAND. (WEATHERD TILL)	10
Very dense, moist, light gray-brown, slightly silty to very silty, slightly gravelly to gravelly SAND. (GLACIAL TILL) Possible gravel/cobble zone. Possible gravel/cobble zone. Perched water to approximately 51 feet.	15–45
Dense, moist, light gray-brown, very silty SAND with trace gravel.	50
Very dense, moist, light gray-brown, slightly silty to silty, gravelly SAND.	55–60
Medium dense to dense, moist, gray, gravelly, very silty, fine SAND. Possible gravel/cobble zone.	65–70
Dense to very dense, wet, light gray-brown, silty to non-silty, fine to medium SAND. (GLACIALLY OVERIDDEN SAND)	75–85
Bottom of Boring at 89.4 Feet. Completed 4/10/00.	90–100

ATD



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Blow count may not be representative of soil density due to large gravels.

HARTCROWSER

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Figure A-3

Boring Log B-1

Soil Descriptions

Approx. Ground Surface Elevation in feet: 132

Soil Descriptions	Depth in Feet
2.5 inches of Asphalt over brown, sandy GRAVEL, over very loose, brown, slightly silty SAND. (FILL)	0–5
Medium dense to dense, moist, light brown-gray, slightly silty to silty SAND with trace gravel to slightly gravelly. (WEATHERED TILL) Possible gravel/cobble zone.	5–16
Very dense, moist to wet, light brown-gray, non-gravelly to slightly gravelly, slightly silty to silty SAND. (GLACIAL TILL) Possible gravel/cobble zone. Perched water to approximately 36 feet.	16–36
Very dense, moist, light brown-gray, silty to very silty SAND with trace gravel.	36–41
Very dense, moist, gray, silty to very silty SAND with trace gravel. Perched water from approximately 60 to 61.5 feet.	41–61.5
Very dense, wet, gray, very silty fine SAND (GLACIALLY OVERRIDDEN SAND/SILT)	61.5–72
Very dense, wet, gray, fine to medium SAND.	72–82
Very dense, wet, gray, very sandy SILT or very silty, fine to medium SAND.	82–90
Bottom of Boring at 90.0 Feet. Completed 4/11/00.	90

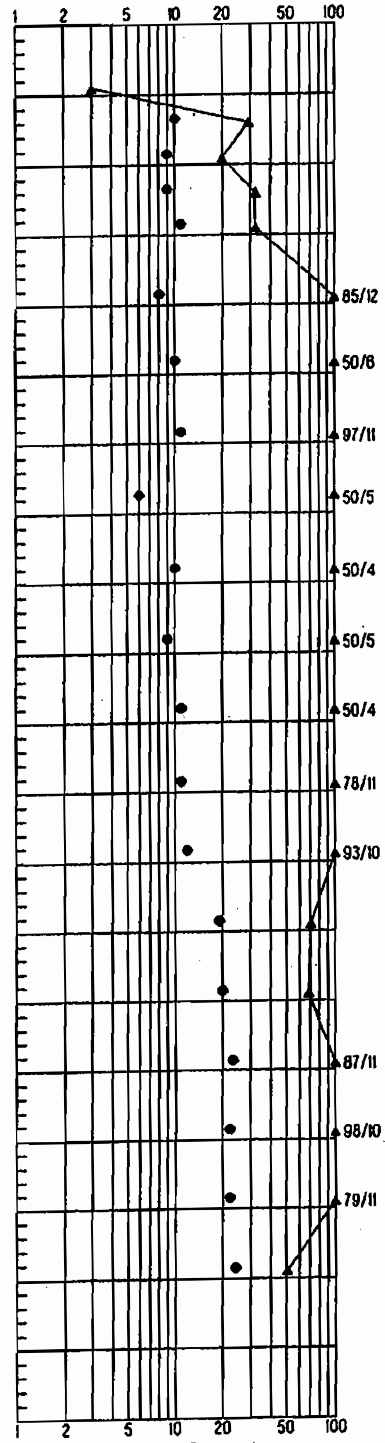
Depth in Feet: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

Groundwater: ATD at approximately 70 feet.

Sample: *S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8, S-9, S-10, S-11, S-12, S-13, S-14, S-15, S-16, S-17, S-18, S-19, S-20

STANDARD PENETRATION RESISTANCE

▲ Blows per Foot



● Water Content in Percent

LAB TESTS

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. Blow count may not be representative of soil density due to large gravels.

HARTCROWSER

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Figure A-2

APPENDIX C
ADDITIONAL EXISTING EXPLORATIONS BY HART CROWSER AND OTHERS

In addition to the explorations and laboratory test results presented in Appendices A and B, respectively, several previous soil explorations by Hart Crowser and others were used to gain an understanding of the subsurface conditions at the proposed Lincoln Square Expansion.

Borings previously performed by Hart Crowser at the project site were consulted for the current report. These logs, corresponding to several boring series, are included within this appendix. In addition, the exploration logs by others are presented on figures in this appendix. Logs produced by others are presented for reference only and Hart Crowser is not responsible for the accuracy or completeness of the information presented in the logs. Approximate locations of these borings are shown on Figure 2, actual locations may differ from those shown.

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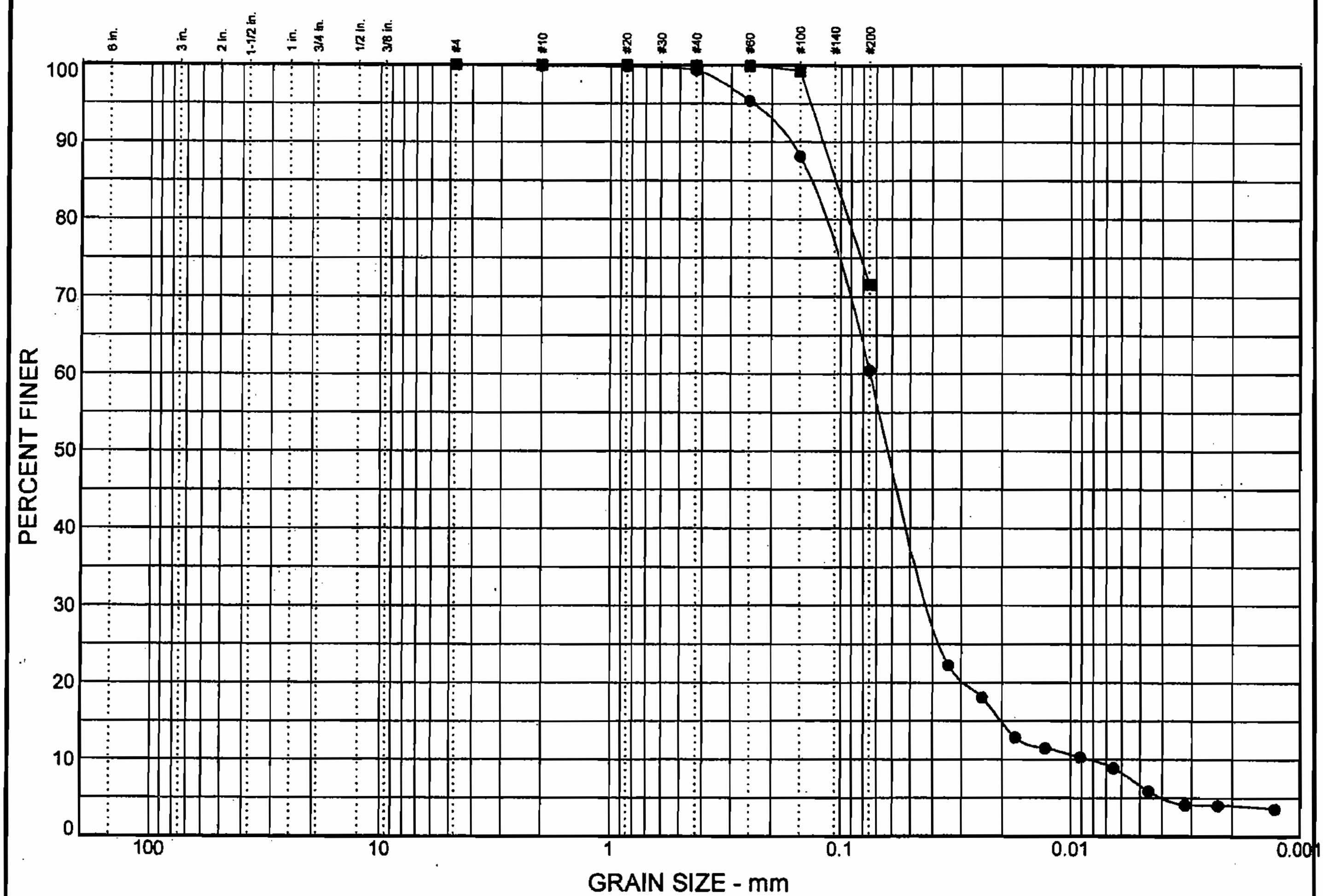
APPENDIX C
ADDITIONAL EXISTING EXPLORATIONS BY HART CROWSER AND OTHERS

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	39.5	60.5	
■	0.0	0.0	28.4	71.6	

☒	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.138	0.074	0.06	0.04	0.02	0.008	2.55	8.77
■			0.105							

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Slightly clayey, very sandy SILT	ML	23.8%
■ Sandy SILT	ML	25.5%

Remarks:

●

■

Project: Lincoln Square II

Client:

● Source: HC-105 Sample No.: S-17 Depth: 82.5 to 84.0

■ Source: HC-105 Sample No.: S-25 Depth: 122.5 to 124.0

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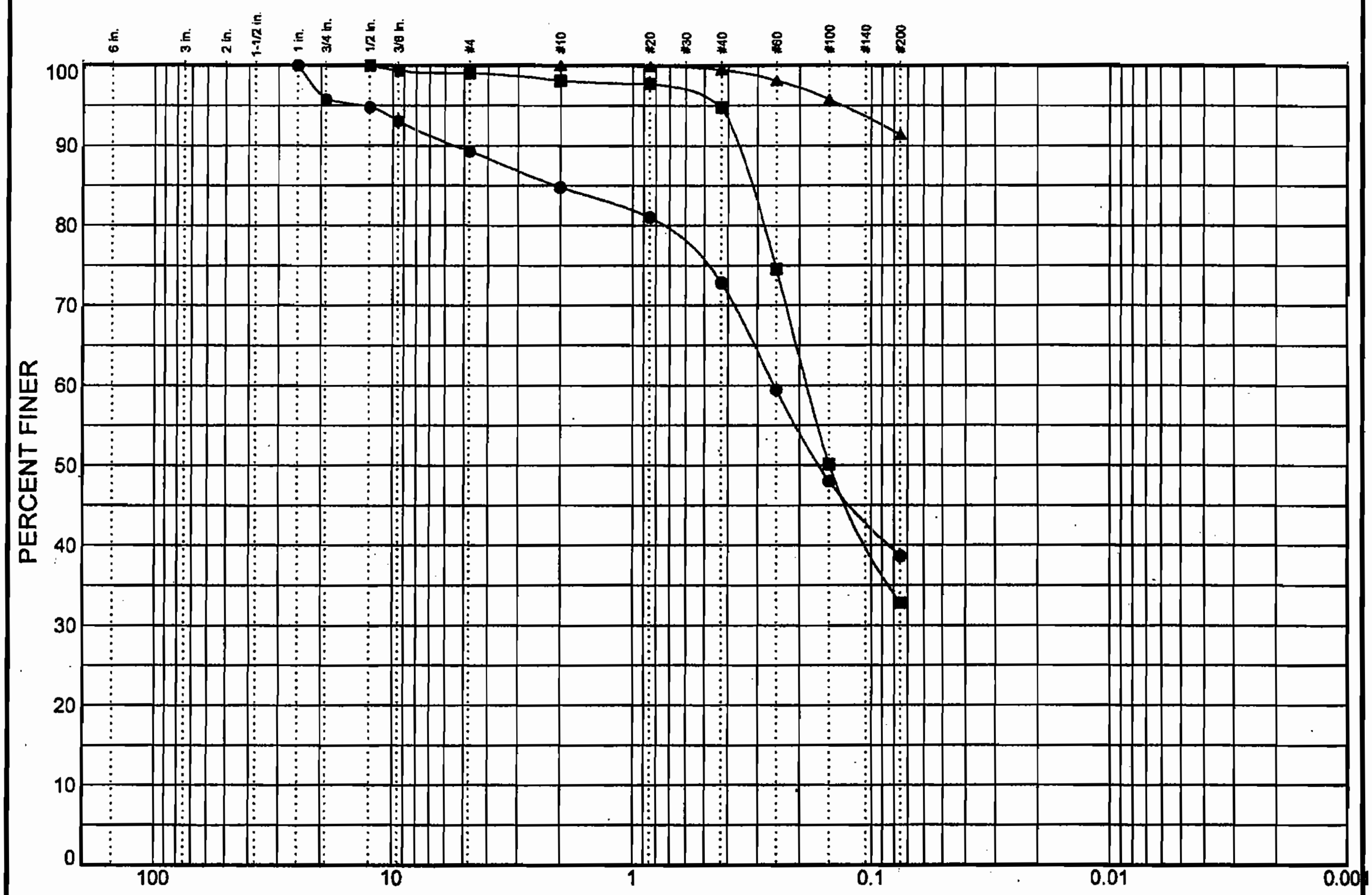
Figure B-11

GRAIN SIZE 735503-BL.GPJ 12/11/07

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	10.7	50.7	38.7	
■	0.0	1.0	66.2	32.8	
▲	0.0	0.0	8.6	91.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			2.077	0.255	0.164					
■			0.329	0.184	0.149					
▲										

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Slightly gravelly, very silty, medium to fine SAND	SM	12.3%
■ Very silty, fine SAND	SM	17.1%
▲ Slightly sandy SILT	ML	28.1%

Remarks:
●
■
▲

Project: Lincoln Square II

Client:

● Source: HC-105 Sample No.: S-2 Depth: 7.5 to 8.3
■ Source: HC-105 Sample No.: S-12 Depth: 57.5 to 58.3
▲ Source: HC-105 Sample No.: S-14B Depth: 68.0 to 68.8

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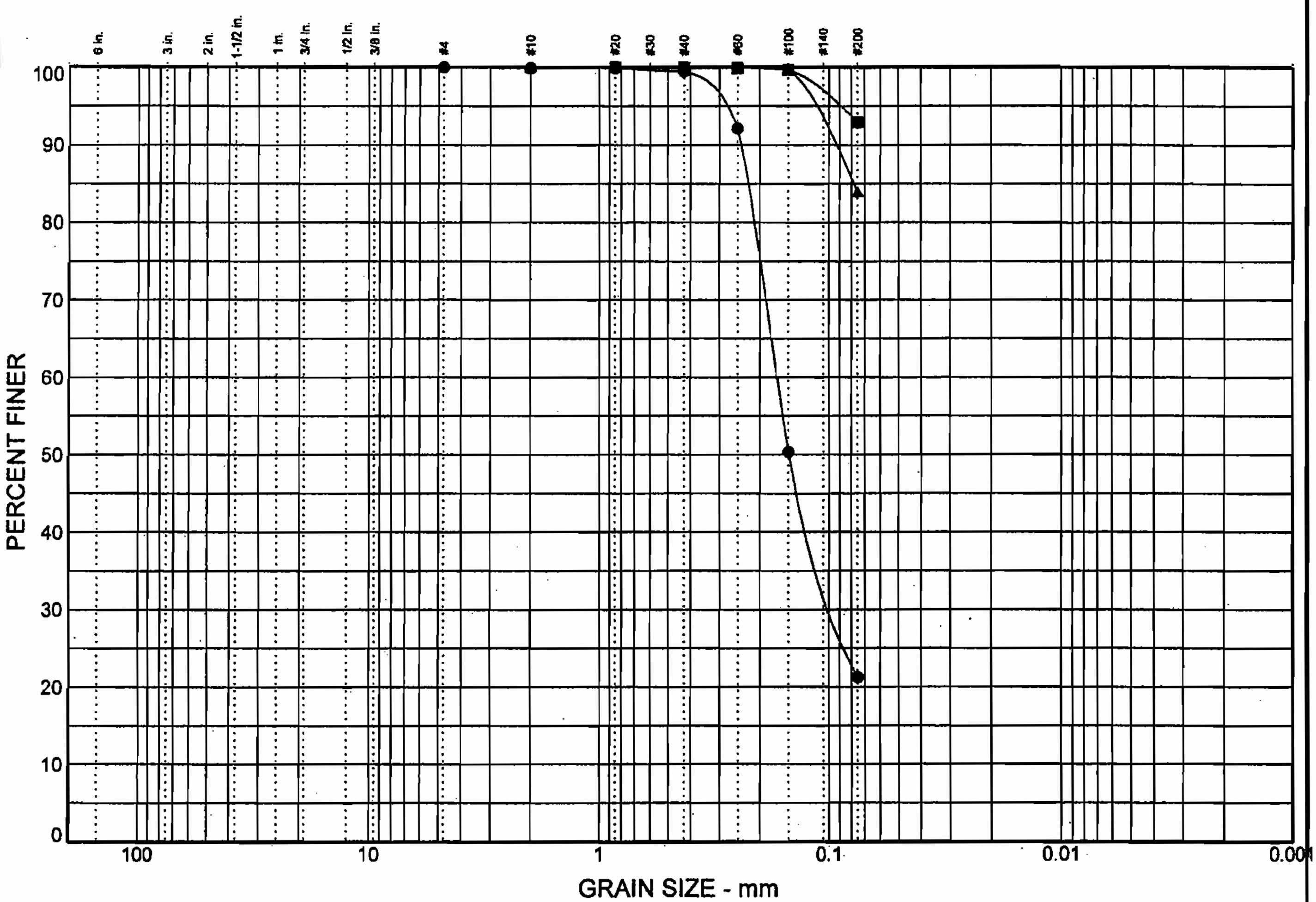
Figure B-10

GRAIN SIZE 735503-BL.GPJ 12/11/07

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	78.7	21.3	
■	0.0	0.0	7.1	92.9	
▲	0.0	0.0	16.0	84.0	

╳	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.229	0.169	0.149	0.092				
■										
▲			0.078							

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Silty, fine SAND	SM	20.7%
■ Slightly sandy SILT	ML	23.4%
▲ Sandy SILT	ML	22.8%

Remarks:
●

■

▲

Project: Lincoln Square II

Client:

● Source: HC-104 Sample No.: S-31 Depth: 152.5 to 154.0
■ Source: HC-104 Sample No.: S-37 Depth: 182.5 to 184.0
▲ Source: HC-104 Sample No.: S-38 Depth: 187.5 to 189.0

HARTCROWSER

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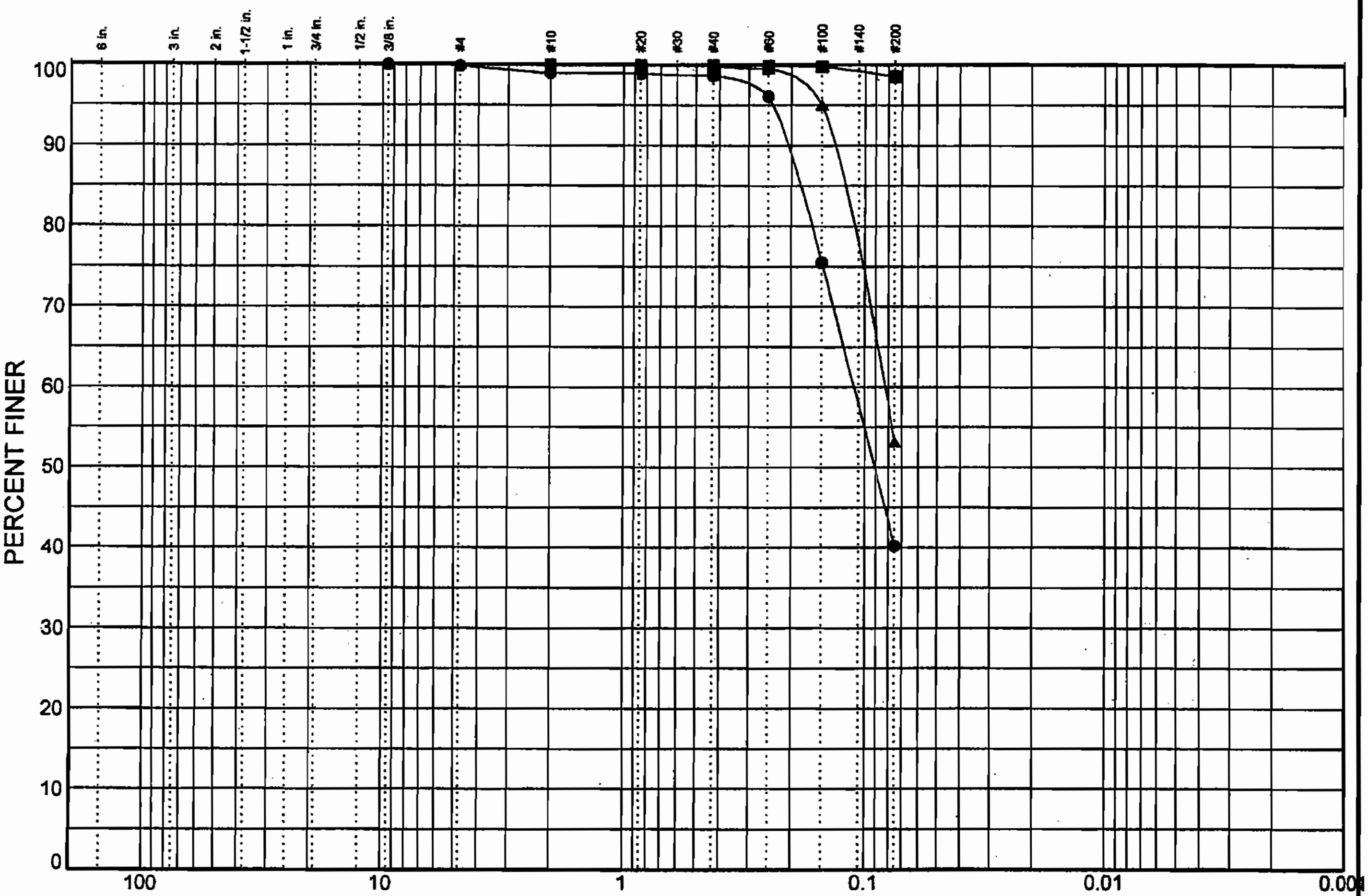
Figure B-9

GRAIN SIZE 735503-BL.GPJ 12/11/07

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.2	59.6	40.2	
■	0.0	0.0	1.5	98.5	
▲	0.0	0.0	46.8	53.2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.19	0.111	0.091					
■										
▲			0.127	0.084						

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Very silty fine SAND	SM	23.1%
■ SILT	ML	27.7%
▲ Very sandy SILT	ML	22.0%

Remarks:
●
■
▲

Project: Lincoln Square II

Client:

- ● Source: HC-104 Sample No.: S-17 Depth: 82.5 to 84.0
- ■ Source: HC-104 Sample No.: S-23 Depth: 112.5 to 114.0
- ▲ Source: HC-104 Sample No.: S-27 Depth: 132.5 to 134.0

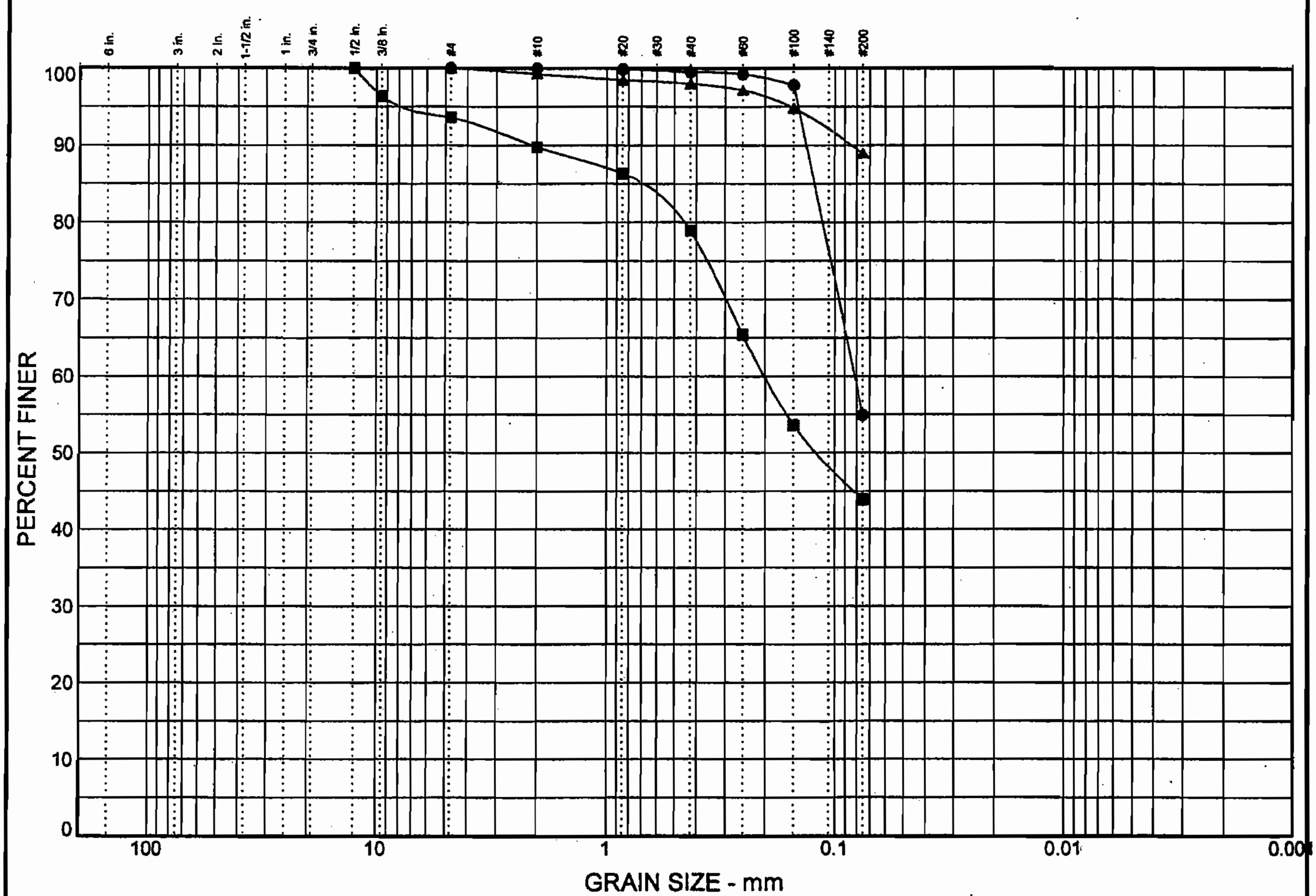
HARTCROWSER

7355-03 8/07

Figure B-8

GRAIN SIZE 735503-BL.GPJ 12/11/07

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	45.0	55.0	
■	0.0	6.4	49.7	43.9	
▲	0.0	0.0	11.0	89.0	

☒	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.122	0.081						
■			0.75	0.198	0.116					
▲										

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Very sandy SILT	ML	25.2%
■ Slightly gravelly, very silty, medium to fine SAND	SM	11.3%
▲ Slightly sandy SILT	ML	25.1%

Remarks:
●

■

▲

Project: Lincoln Square II

Client:

● Source: HC-103 Sample No.: S-25 Depth: 122.5 to 124.0
■ Source: HC-104 Sample No.: S-2 Depth: 7.5 to 9.0
▲ Source: HC-104 Sample No.: S-14 Depth: 67.5 to 69.0

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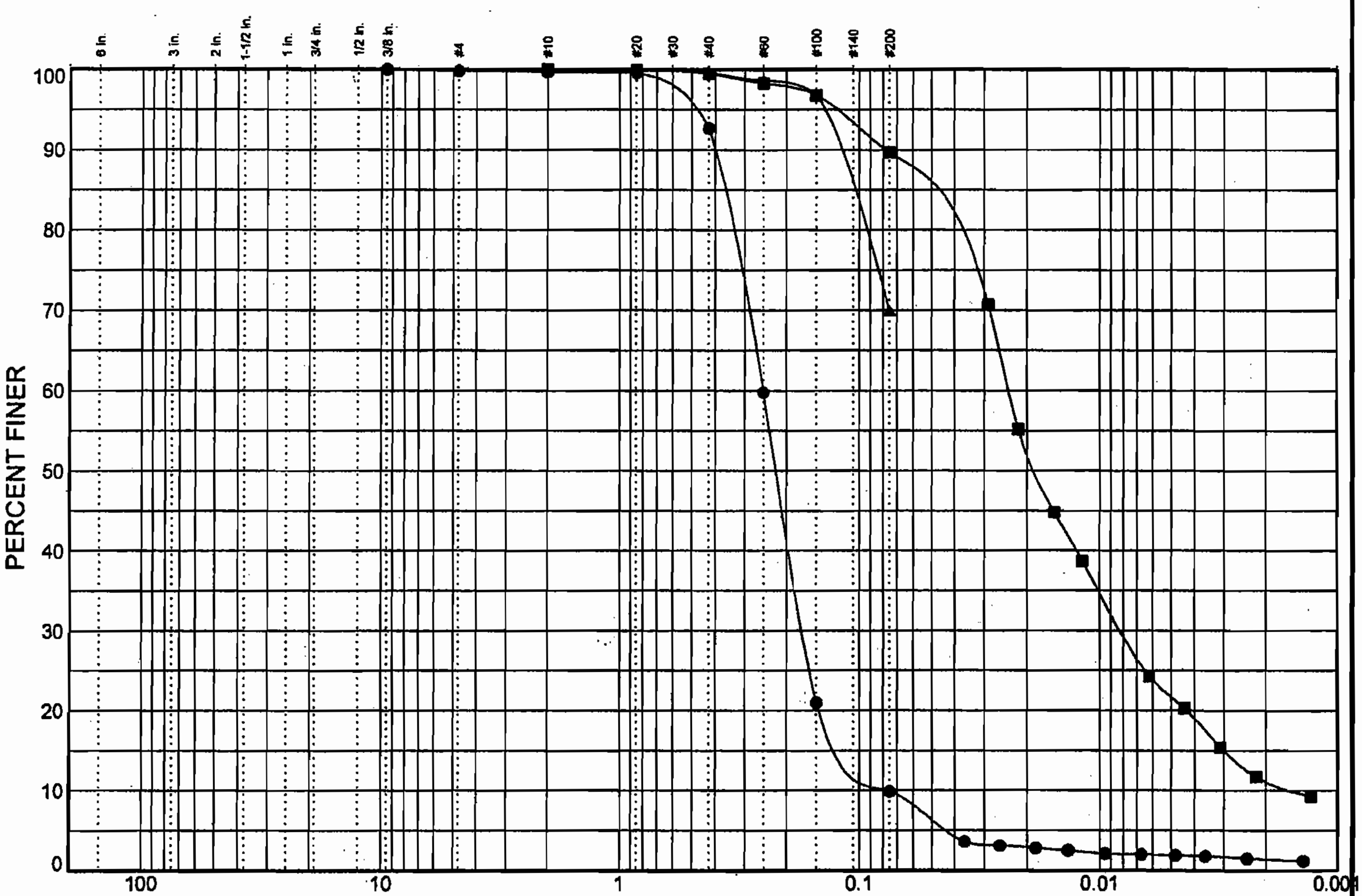
Figure B-7

GRAIN SIZE 735503-BL.GPJ 12/11/07

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.2	89.9	9.9	
■	0.0	0.0	10.3	89.7	
▲	0.0	0.0	30.1	69.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.375	0.251	0.22	0.169	0.103	0.075	1.51	3.32
■			0.059	0.024	0.018	0.008	0.003	0.002	1.78	15.65
▲			0.111							

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Slightly silty, medium to fine SAND	SP-SM	19.9%
■ Slightly sandy, clayey SILT	ML	28.8%
▲ Very sandy SILT	ML	24.7%

Remarks:
●

■

▲

Project: Lincoln Square II

Client:

● Source: HC-103 Sample No.: S-13 Depth: 62.5 to 64.0
■ Source: HC-103 Sample No.: S-14B Depth: 68.3 to 69.8
▲ Source: HC-103 Sample No.: S-17 Depth: 82.5 to 84.0

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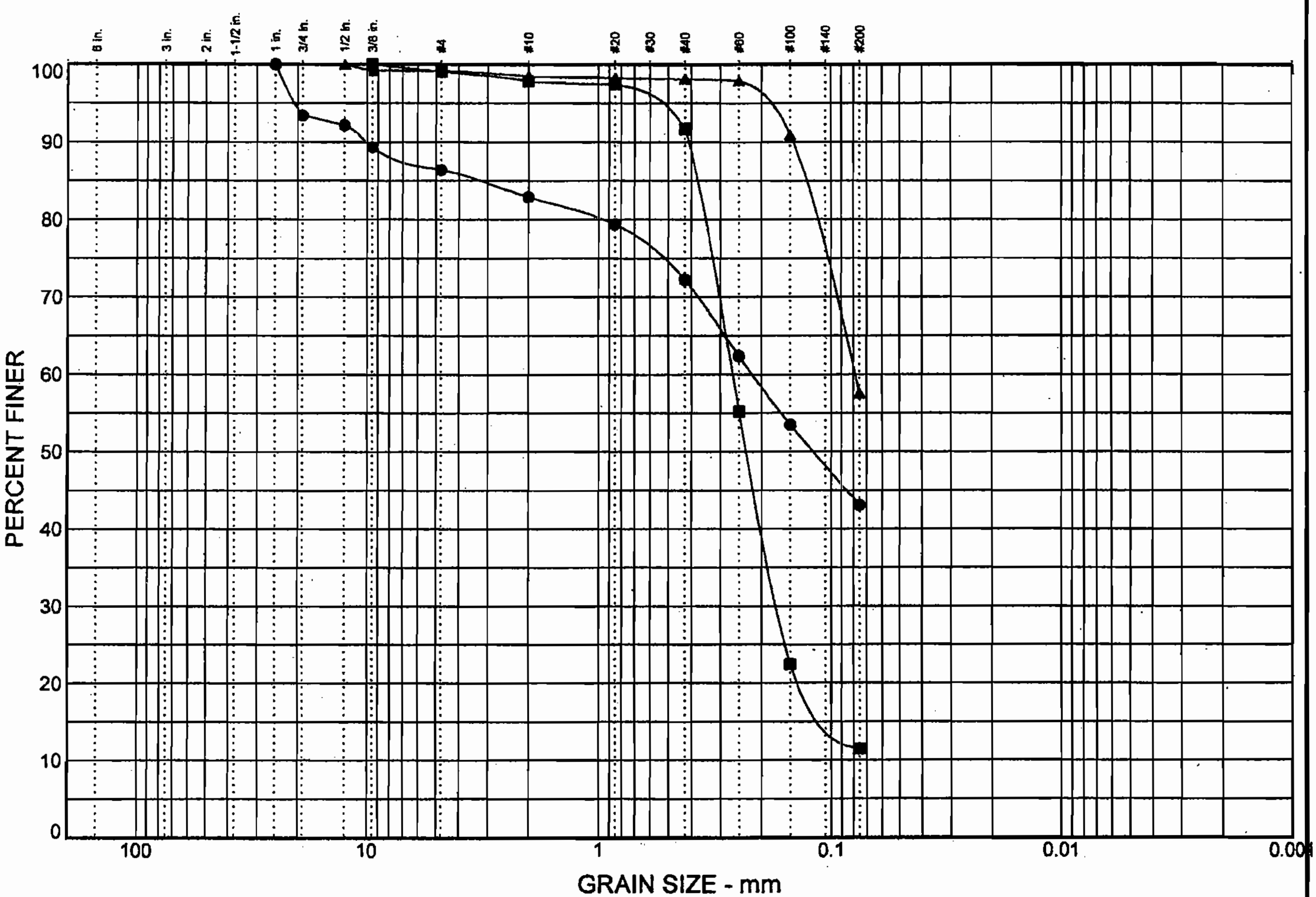
Figure B-6

GRAIN SIZE 735503-BL.GPJ 12/11/07

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	13.6	43.3	43.1	
■	0.0	0.9	87.6	11.4	
▲	0.0	0.9	41.6	57.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			3.34	0.218	0.119					
■			0.386	0.268	0.23	0.169	0.094		1.55	3.91
▲			0.133	0.079						

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Gravelly, very silty, medium to fine SAND	SM	11.7%
■ Slightly silty, medium to fine SAND	SP-SM	20.5%
▲ Very sandy SILT	ML	22.5%

Remarks:

●

■

▲

Project: Lincoln Square II

Client:

● Source: HC-102 Sample No.: S-12 Depth: 57.5 to 59.0

■ Source: HC-102 Sample No.: S-20 Depth: 97.5 to 99.0

▲ Source: HC-102 Sample No.: S-25 Depth: 122.5 to 124.0

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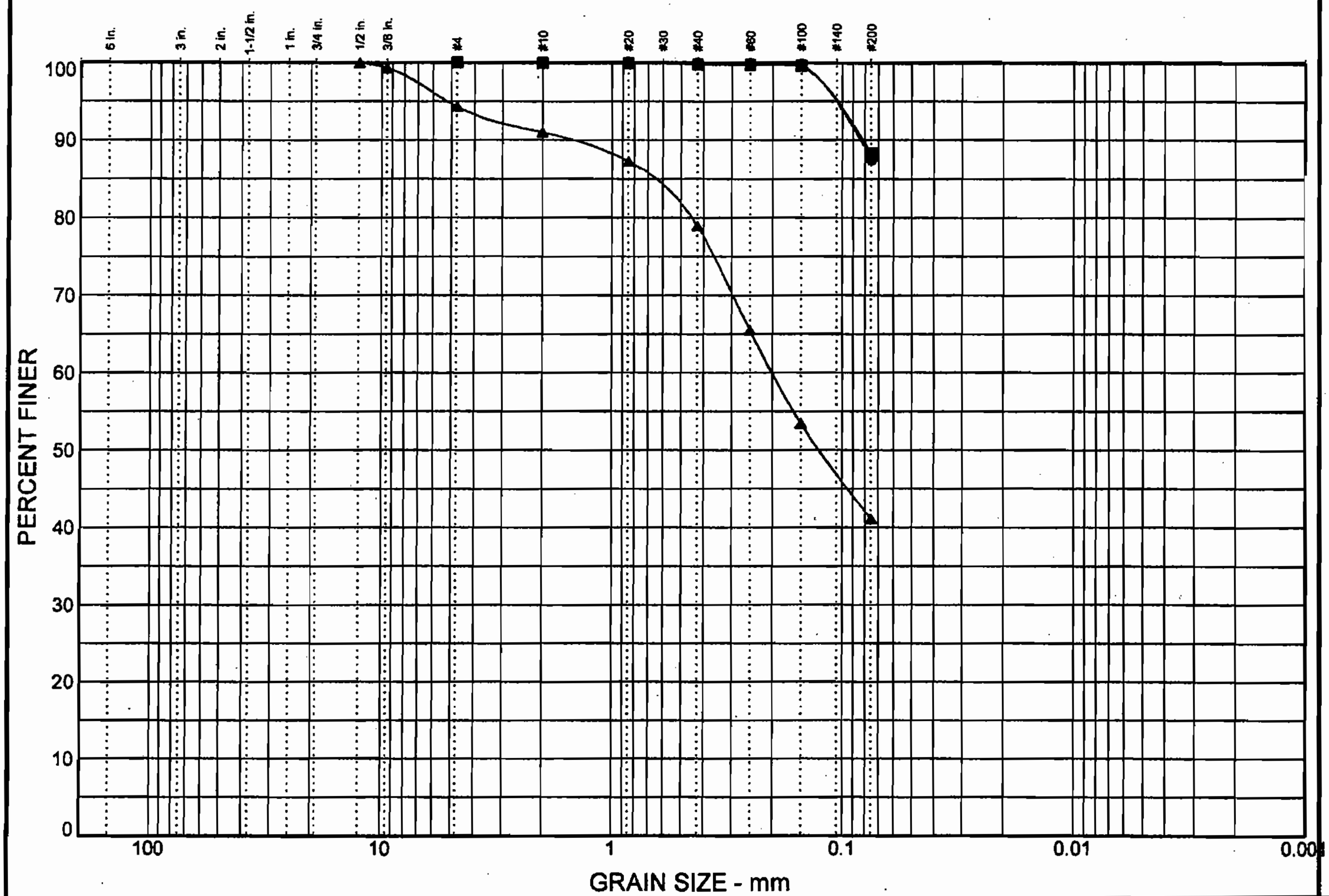
Figure B-5

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	12.4	87.6	
■	0.0	0.0	11.7	88.3	
▲	0.0	5.7	53.2	41.1	

☒	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●										
■										
▲			0.702	0.198	0.124					

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Sandy SILT	ML	25.5%
■ Slightly sandy SILT	ML	24.9%
▲ Slightly gravelly, very silty, medium to fine SAND	SM	11.9%

Remarks:

●

■

▲

Project: Lincoln Square II

Client:

● Source: HC-101 Sample No.: S-18 Depth: 87.5 to 89.0
■ Source: HC-101 Sample No.: S-25 Depth: 122.5 to 124.0
▲ Source: HC-102 Sample No.: S-2 Depth: 7.5 to 9.0

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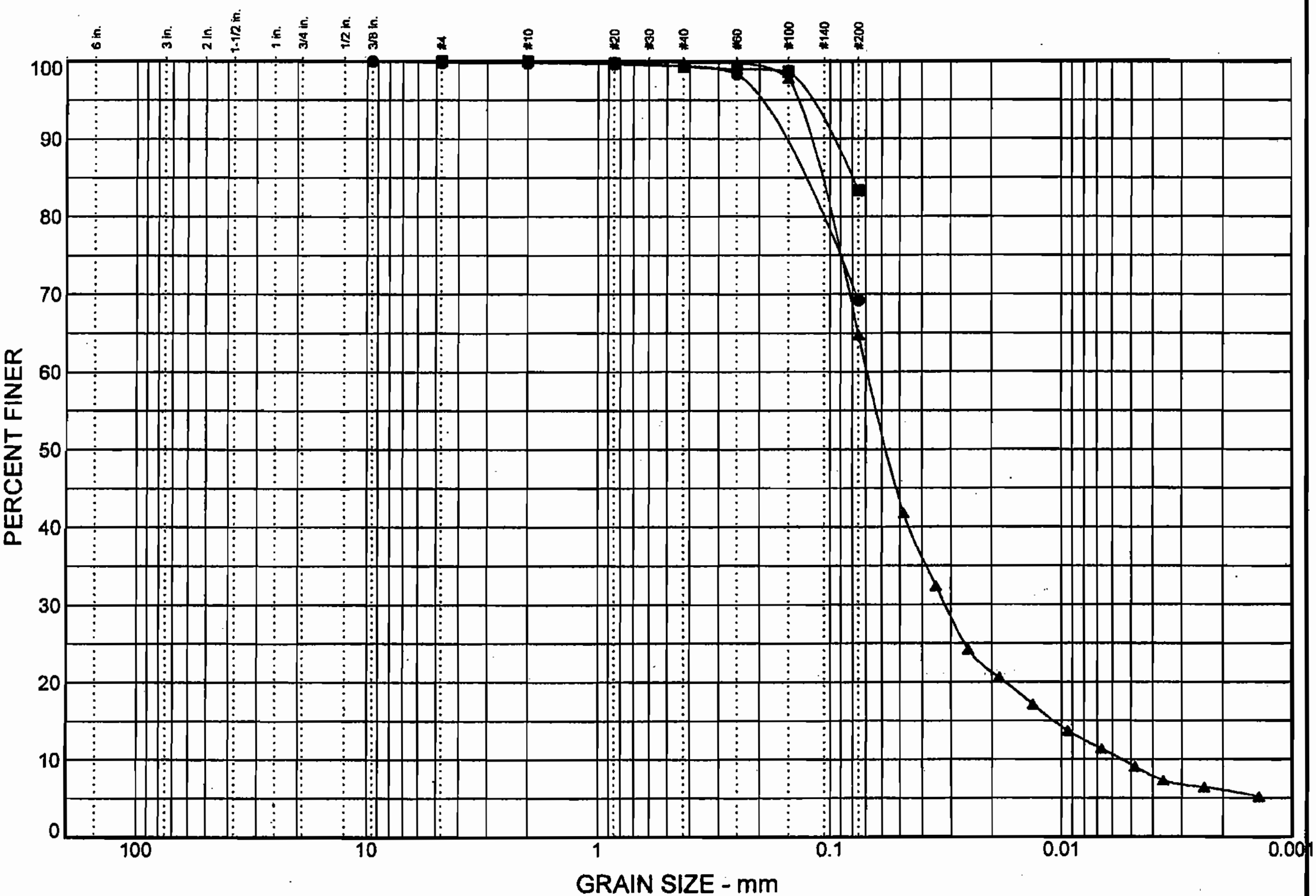
Figure B-4

GRAIN SIZE 735503-BL.GPJ 12/11/07

Particle Size Distribution Test Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.2	30.5	69.2	
■	0.0	0.0	16.7	83.3	
▲	0.0	0.0	35.2	64.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.144							
■			0.081							
▲			0.115	0.068	0.056	0.032	0.011	0.005	2.68	12.49

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
● Very sandy SILT	ML	20.5%
■ Sandy SILT	ML	25.0%
▲ Sandy SILT	ML	23.4%

Remarks:
●
■
▲

Project: Lincoln Square II

Client:

● Source: HC-101 Sample No.: S-11 Depth: 52.5 to 54.0
■ Source: HC-101 Sample No.: S-16 Depth: 77.5 to 79.0
▲ Source: HC-101 Sample No.: S-17 Depth: 82.5 to 84.0

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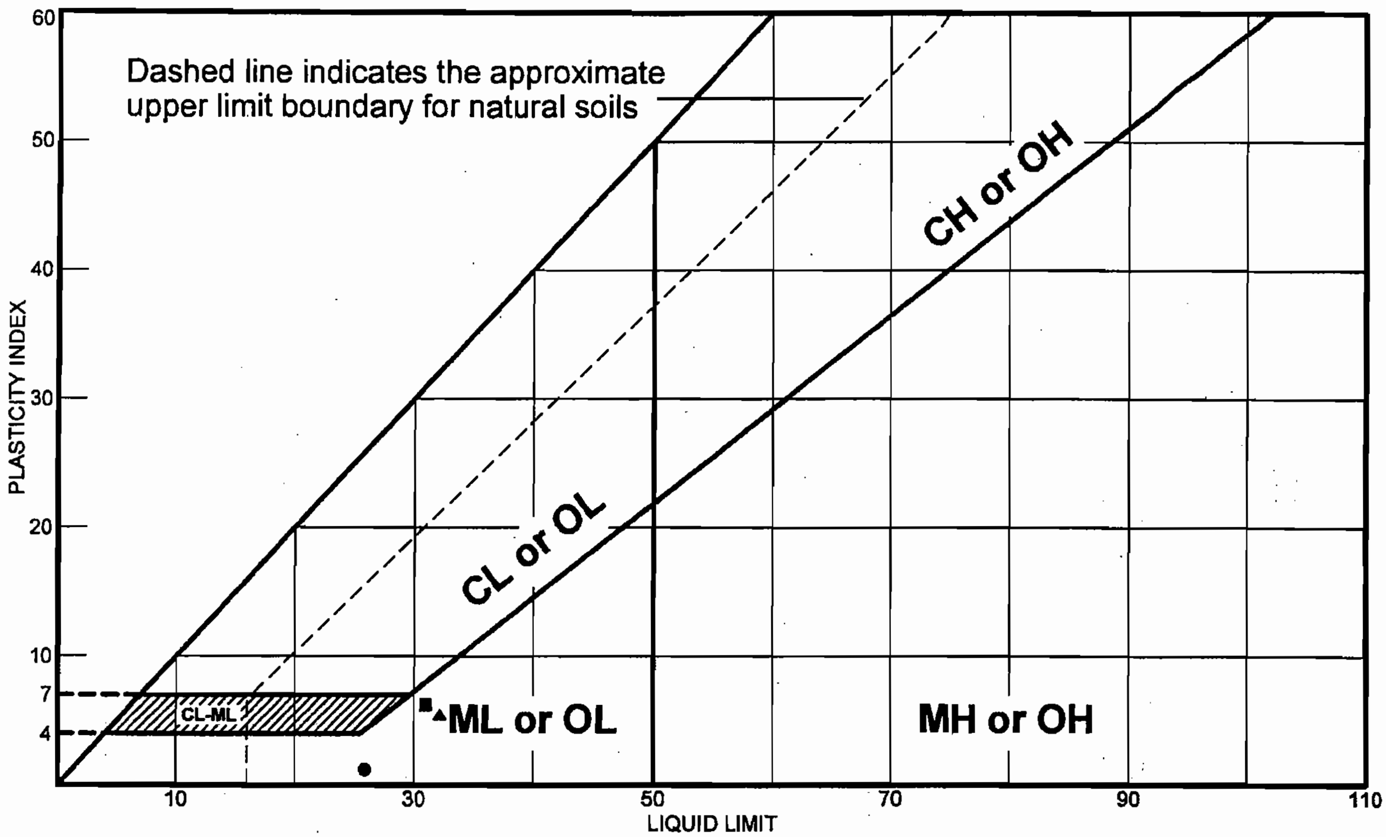
Figure B-3

GRAIN SIZE 735503-BL.GPJ 12/11/07

Liquid and Plastic Limits Test Report



Location + Description	LL	PL	PI	-200	USCS
● Source: HC-101 Sample No.: S-22 Depth: 107.5 SILT	26	25	1		ML
■ Source: HC-103 Sample No.: S-23 Depth: 112.5 SILT	31	25	6		ML
▲ Source: HC-105 Sample No.: S-28 Depth: 137.5 SILT	32	27	5		ML

Remarks:

●

■

▲

Project: Lincoln Square II

Client:

Location:

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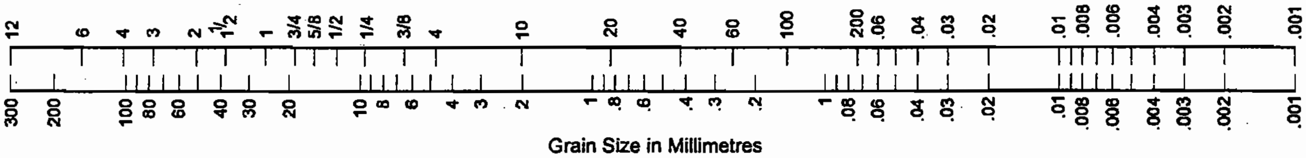
Figure B- 2

Unified Soil Classification (USC) System
Soil Grain Size

Size of Opening In Inches	Number of Mesh per Inch (US Standard)	Grain Size in Millimetres



COBBLES	GRAVEL	SAND	SILT and CLAY
Coarse-Grained Soils			Fine-Grained Soils

Coarse-Grained Soils

G W	G P	G M	G C	S W	S P	S M	S C
Clean GRAVEL <5% fines		* GRAVEL with >12% fines		Clean SAND <5% fines		* SAND with >12% fines	
GRAVEL >50% coarse fraction larger than No. 4				SAND >50% coarse fraction smaller than No. 4			
Coarse-Grained Soils >50% larger than No. 200 sieve							

G W and S W $\left(\frac{D_{60}}{D_{10}}\right)$ >4 for G W, >6 for S W & $1 \le \left(\frac{(D_{30})^2}{D_{10} \times D_{60}}\right) \le 3$

G P and S P Clean GRAVEL or SAND not meeting requirements for G W and S W

G M and S M Atterberg limits below A line with PI <4

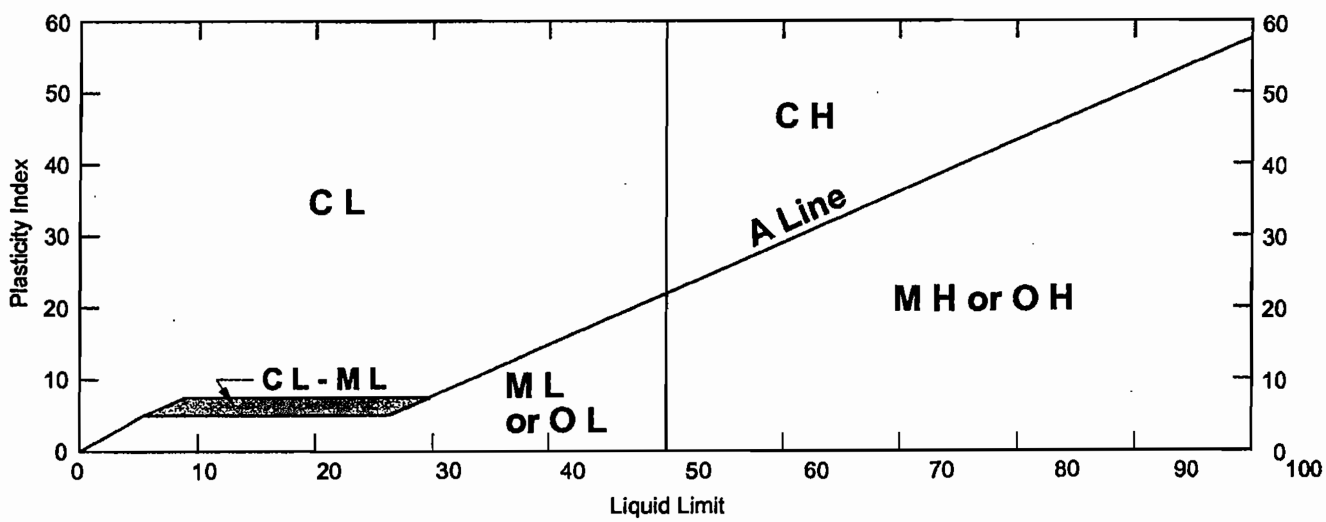
G C and S C Atterberg limits above A Line with PI >7

* Coarse-grained soils with percentage of fines between 5 and 12 are considered borderline cases requiring use of dual symbols.

D_{10}, D_{30}, and D_{60} are the particles diameter of which 10, 30, and 60 percent, respectively, of the soil weight are finer.

Fine-Grained Soils

M L	C L	O L	M H	C H	O H	Pt
SILT	CLAY	Organic	SILT	CLAY	Organic	Highly Organic Soils
Soils with Liquid Limit <50%			Soils with Liquid Limit >50%			
Fine-Grained Soils >50% smaller than No. 200 sieve						



SRF Grain Size (B-1).cdr 3/06

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Figure B-1

size distribution greater than the U.S. No. 200 mesh sieve. The size distribution for particles smaller than the No. 200 mesh sieve was determined by the hydrometer method for a selected number of samples. The results of the tests are presented as curves on Figures B-3 through B-11 plotting percent finer by weight versus grain size.

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TIEBACK ANCHOR TESTING PROGRAM

Conduct the performance and proof tests as follows:

Performance Test

A minimum of two performance tests per soil type should be completed before installation of production anchors. Each performance test should be conducted according to the following procedure:

1. The geotechnical engineer will select the testing locations with input from the shoring subcontractor.

2. The maximum stress in the anchor steel should not exceed 80 percent of the ultimate tensile strength for grade 150 ksi steel, or 90 percent of the yield strength for grade 60 or 75 ksi steel during performance testing (based on Post Tensioning Institute [PTI] manual.) The soldier piles, vertical elements, shotcrete facing, and/or anchor may require extra reinforcement to permit stressing to 200 percent of design load as required for the performance test.

3. The performance test will measure anchor stress and displacement incrementally to values of unit skin friction equal to 200 percent of the design stress. Load the anchor and measure deflections as follows:

   Load the anchor in increments of 25 percent of the design load (DL) and unload to the aligning load (AL) before incrementally loading to the next load increment (e.g., AL, 0.25 DL, AL, 0.25 DL, 0.50 DL, AL, 0.25 DL, 0.50 DL, 0.75 DL). Ensure that deflection readings stabilize for intermediate load increments (i.e., 0.25 DL and 0.50 DL, when the new maximum is 0.75 DL) before increasing the load to the next increment. Obtain and record deflection measurements for loading at intervals of 30 seconds, 1 minute, 2 minutes, 3 minutes, and 5 minutes. Measurements shall be made to an accuracy of 0.01 inch.

4. Perform a creep test at 200 percent of design stress reading by holding the load constant to within 50 psi and recording readings at 30 seconds, 1 minute, 2 minutes, 3 minutes, 5 minutes, 6 minutes, and 10 minutes; also record at 20 minutes, 30 minutes, 50 minutes, and 60 minutes if creep criteria are not met at the 10-minute interval.

5. A successful test: (1) exhibits a linear or near-linear relationship between unit stress and movement over the entire 200 percent stress range, (2) holds the

maximum test unit stress without noticeable creep, and (3) satisfies the apparent free length criteria. Noticeable creep is defined as a rate of movement of more than 0.04 inch between the 1- and 10-minute readings, or not more than 0.08 between the 6- and 60-minute readings. If the reading does not stabilize to 0.08 inch or less per log cycle, the test shall be considered to fail the creep criteria. Apparent free length criteria are as follows:

- Minimum apparent free length, based on the measured elastic and residual movement, should be greater than 80 percent of the designed free length plus the jack length; and

- Maximum apparent free length, based on the measured elastic and residual movement, should be less than 100 percent of the designed free length plus 50 percent of the bond length plus the jack length.

6. Perform tests without backfill ahead of the anchor, if the hole will remain open, to avoid any contributory resistance by the backfill. If the hole will not remain open during testing, provide a bond breaker on the anchor steel and backfill the no-load zone specified on the plans with a non-cohesive mixture.

Proof Test

Each production tieback anchor should be tested following the proof testing procedures outlined below.

5. Load each anchor to 130 percent of the design load in increments of approximately 25 percent of the design load (i.e., 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, and 1.30 DL). The maximum stress in the anchor steel should not exceed 80 percent of the ultimate tensile strength for grade 150 ksi steel, or 90 percent of the yield strength for grade 60 or 75 ksi steel during testing.

6. Hold each incremental load for a period long enough to obtain a stable deflection measurement while recording deflections at each load increment. Hold the 130 percent load for a minimum of 5 minutes, recording the movement at times of 30 seconds, 1 minute, 2 minutes, and 5 minutes.

7. A successful test: (1) exhibits a linear or near-linear relationship between unit stress and movement over the entire stress range, (2) holds the maximum test unit stress without noticeable creep, and (3) satisfies the apparent free length criteria as indicated for the performance testing. Note that the creep portion of the test need not exceed 10 minutes if the 10-minute creep criteria is met.

Typically, movement of the anchor in excess of about 3 inches indicates deficiencies in installation. Typically, total movement in excess of 12 inches is considered a failure requiring replacement. For total movements between 3 and 12 inches, the geotechnical and structural engineers will determine if a replacement or supplement is required.

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ATTACHMENT 2
SHORING MONITORING PROGRAM

ATTACHMENT 2
SHORING MONITORING PROGRAM

The purpose of the shoring monitoring program is to provide early warning if the shoring does not perform as anticipated. We recommend that the following components be included in the shoring monitoring program during construction:

- Adjacent property surveys, if applicable;
- Optical surveying; and
- Geotechnical instrumentation.

All data should be submitted weekly to the shoring designer, geotechnical engineer, and structural engineer for review. Details of our expectations for shoring monitoring are included in the following paragraphs.

Permitting agencies typically require that shoring monitoring plans establish displacement limits and associated remedial actions. We have found that the following approach has typically been acceptable.

- If more than 0.5 inch of displacement occurs, then Hart Crowser, the shoring designer, and the structural engineer should determine the cause and develop remedial measures with the owner and contractor, if warranted.
- If more than about 1 inch of displacement occurs, or if unacceptable performance or other adverse impacts occur, then the contractor should notify Hart Crowser, the shoring designer, and the structural engineer immediately to determine if contingency measures should be implemented.
- If warranted, the project team should confirm and the contractor should implement remedial measures specific to the situation.

Remedial measures may include more frequent shoring monitoring/surveying, and construction and/or design changes to limit and/or correct detrimental displacements. Construction may need to cease until remedial measures are implemented. When adjacent property or right-of-way (ROW) could be affected, the appropriate agency and property/ROW owner should be notified of the proposed remedy to gain approval before implementation.

Adjacent Property Surveys

We recommend surveying adjacent property (structures, sidewalks, utilities, etc.) before, during, and after construction. The pre-construction survey will establish the baseline documentation of existing conditions, such as identifying the size and locations of any cracks. The surveys should consist of a videotape and/or photographs of adjacent facilities and detailed mapping of all cracks. Any existing cracks could be monitored with a crack gage placed across the crack.

Optical Surveying

We recommend optical surveying of horizontal and vertical movement of the following: (1) the surface of the adjacent streets; (2) adjacent parking areas as applicable; and (3) the shoring system itself. The contractor should establish two reference lines adjacent to the excavation at horizontal distances back from the excavation face of about 1/3H and H, where H is the final excavation height. Typically, these lines should be established near the curb line and across the street from the excavation face. The points on the adjacent facilities should be set on sound points not prone to movement by normal traffic/use, preferably in areas not obstructed during construction. The surface and adjacent facility points should be spaced at about 50 feet horizontally, but each side of the excavation should have at least four equally spaced points. Points on the shoring wall should be placed at every other soldier pile or at about every 25 feet for soil nail walls.

The measuring system for the shoring monitoring should have a system accuracy (i.e., accounting for all factors) of at least 0.005 foot. All reference points on the ground surface and existing adjacent facilities should be installed and read before excavation. The frequency of readings will depend on the results of previous readings and the rate of construction. At a minimum, readings on surface streets and adjacent facilities should be taken every other week, or as recommended by Hart Crowser, until the permanent structure is completed to street grades. Readings on the top of the wall should be taken at least twice a week, and preferably three times a week. We recommend that the contractor conduct most of the readings and that their data be verified by an independent surveyor at least once per week.

Survey Points. Survey markers are typically used throughout the project site, on adjacent facilities and streets, and on soldier piles or other shoring elements. Routine surveying can show progressive movement in the shoring system due to soil movement behind the wall, and can provide an early warning in the event that adjacent roads or structures settle as a result of the excavation. Survey markers should be sufficiently permanent to last until the permanent structure is completed up to surrounding street grades. The contractor should be responsible to reset/replace damaged survey points. It is recommended that reflective sticker cross-hairs be scribed on the wall to facilitate easy survey point replacement.

Geotechnical Instrumentation

Inclinometers. Inclinometers are typically used to monitor lateral earth movement below the ground surface adjacent to the excavation. This device consists of a hollow casing placed in a borehole that is typically placed behind the shoring wall at selected locations around the excavation. Inclinometers are monitored regularly during construction. An instrument is lowered down the casing to measure casing deflections at discrete elevations for the entire profile of the casing. Inclinometer casings should extend below the base of the excavation so that the bottom is fixed in soil that will not deform due to the shoring system, typically at least about 15 feet.

Based on the soils, setting, and depth expected for this project, we expect that the inclinometers will be needed and recommend that they be installed around the perimeter of the excavation.

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Standard Penetration Test (SPT) Procedures

This test is an approximate measure of soil density and consistency. To be useful, the results must be used with engineering judgment in conjunction with other tests. The SPT (as described in ASTM D 1586) was used to obtain disturbed samples. This test employs a standard 2-inch outside diameter split-spoon sampler. Using a 140-pound hammer, free-falling 30 inches, the sampler is driven into the soil for 18 inches. The number of blows required to drive the sampler the last 12 inches only is the Standard Penetration Resistance. This resistance, or blow count, measures the relative density of granular soils and the consistency of cohesive soils. The blow counts are plotted on the boring logs at their respective sample depths.

Soil samples are recovered from the split-barrel sampler, field classified, and placed into watertight jars. They are then taken to Hart Crowser's laboratory for further testing as described in Appendix B.

In the Event of Hard Driving

Occasionally very dense materials preclude driving the total 18-inch sample. When this happens, the penetration resistance is entered on logs as follows:

Penetration less than 6 inches. The log indicates the total number of blows over the number of inches of penetration.

Penetration greater than 6 inches. The blow count noted on the log is the sum of the total number of blows completed after the first 6 inches of penetration. This sum is expressed over the number of inches driven that exceed the first 6 inches. The number of blows needed to drive the first 6 inches are not reported. For example, a blow count series of 12 blows for 6 inches, 30 blows for 6 inches, and 50 (the maximum number of blows counted within a 6-inch increment for SPT) for 3 inches would be recorded as 80/9.

Well Installation, Development, and Testing

Monitoring wells were installed in borings HC-101, HC-102, HC-103, and HC-105 after drilling and soil sampling were complete. The wells were constructed using 2-inch-diameter PVC, flush-threaded joints, and 10 feet of 10-slot screen. Following the mud rotary drilling, the borehole was flushed of the drilling fluid. The wells were constructed by lowering the PVC assembly into the borehole and backfilling the screened section with 10/20 silica sand. The wells were screened at depths ranging from between 60 to 102.5 feet below grade.

The sand pack was extended 3 to 5 feet above the top of the screen. Bentonite chips were placed in the remaining borehole to a depth of 2 to 3 feet below ground surface. Concrete fill was used to the hole to the ground surface and secured a steel flush-mounted monument over each well.

Hart Crowser developed the well using a 2-inch-diameter stainless-steel bailer. Bailed water was placed in drum and taken off-site by the drillers. A water level measurement was made just prior to purging. On September 18, 2007, slug tests were performed at the site to estimate the potential groundwater yields. The tests and results are discussed in Appendix D.

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Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance (N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 to 4	Very soft	0 to 2	<0.125
Loose	4 to 10	Soft	2 to 4	0.125 to 0.25
Medium dense	10 to 30	Medium stiff	4 to 8	0.25 to 0.5
Dense	30 to 50	Stiff	8 to 15	0.5 to 1.0
Very dense	>50	Very stiff	15 to 30	1.0 to 2.0
		Hard	>30	>2.0

Sampling Test Symbols

Symbol		Symbol	
☒	Split Spoon	▩	Grab (Jar)
◫	Shelby Tube (Pushed)	◩	Bag
▥	Cuttings	■	Core Run

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Moisture

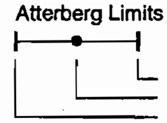
Dry	Little perceptible moisture
Damp	Some perceptible moisture, likely below optimum
Moist	Likely near optimum moisture content
Wet	Much perceptible moisture, likely above optimum

Minor Constituents

Minor Constituents	Estimated Percentage
Trace	<5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

Laboratory Test Symbols

GS	Grain Size Classification
CN	Consolidation
UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits



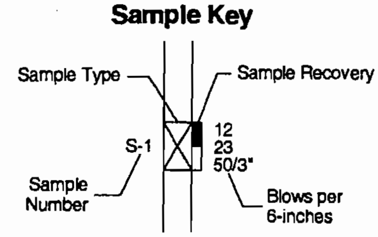
PID	Photoionization Detector Reading
CA	Chemical Analysis
DT	In Situ Density in PCF

Groundwater Indicators

∇ Groundwater Level on Date or (ATD) At Time of Drilling

Groundwater Seepage (Test Pits)

Sample Key



HARTCROWSER

7355-03 *12/07*

Figure A-1

KEY SHEET 735503-BL.GPJ HC_CORP.GDT 12/14/07

Boring Log & Construction Data for Monitoring Well HC-101

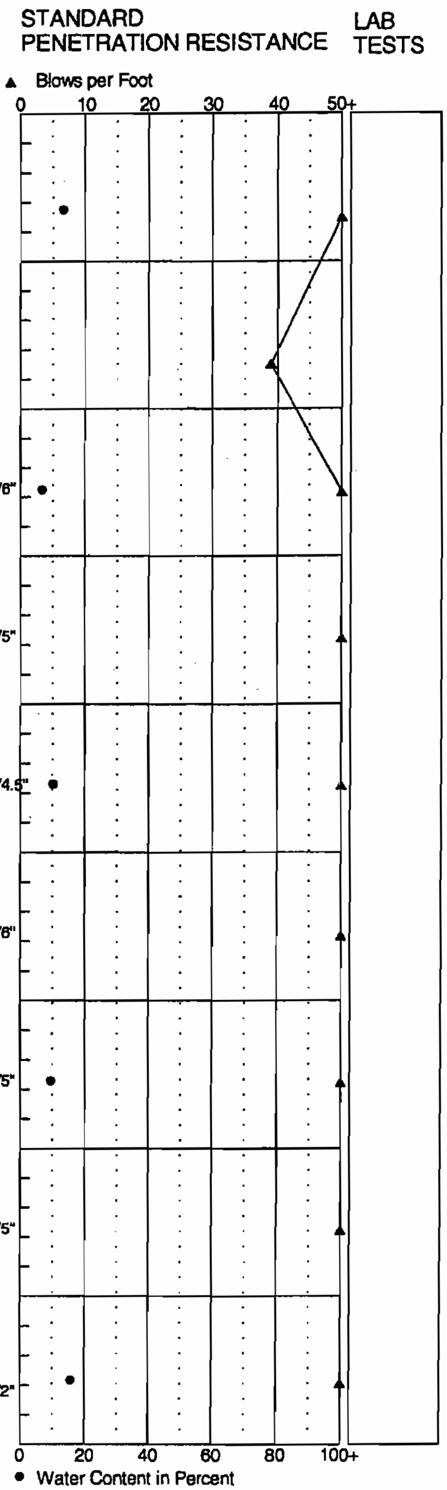
Location: N 18.7943 E 131.5061
Approximate Ground Surface Elevation: 132 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell   Reviewed By: S. Upsall

USCS Class	Soil Descriptions	Depth in Feet
SM	3 inches of Asphalt over dense to very dense, damp to moist, gray-brown, slightly gravelly to gravelly, silty SAND. (WEATHERED TILL)	0
	Trace of organic material.	
	Cobbles encountered during drilling.	
SM	Very dense, damp to moist, gray-brown, silty, gravelly SAND. (GLACIAL TILL)	
	Zone of wet sand observed.	
	Becomes wet.	45

Well Construction: Flush mount monument; Concrete; Bentonite chips

Sample	Blows
S-1	16 26 28
S-2	14 14 25
S-3	50/6"
S-4	50/5"
S-5	50/4.5"
S-6	50/6"
S-7	50/5"
S-8	50/5"
S-9	39 50/2"



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

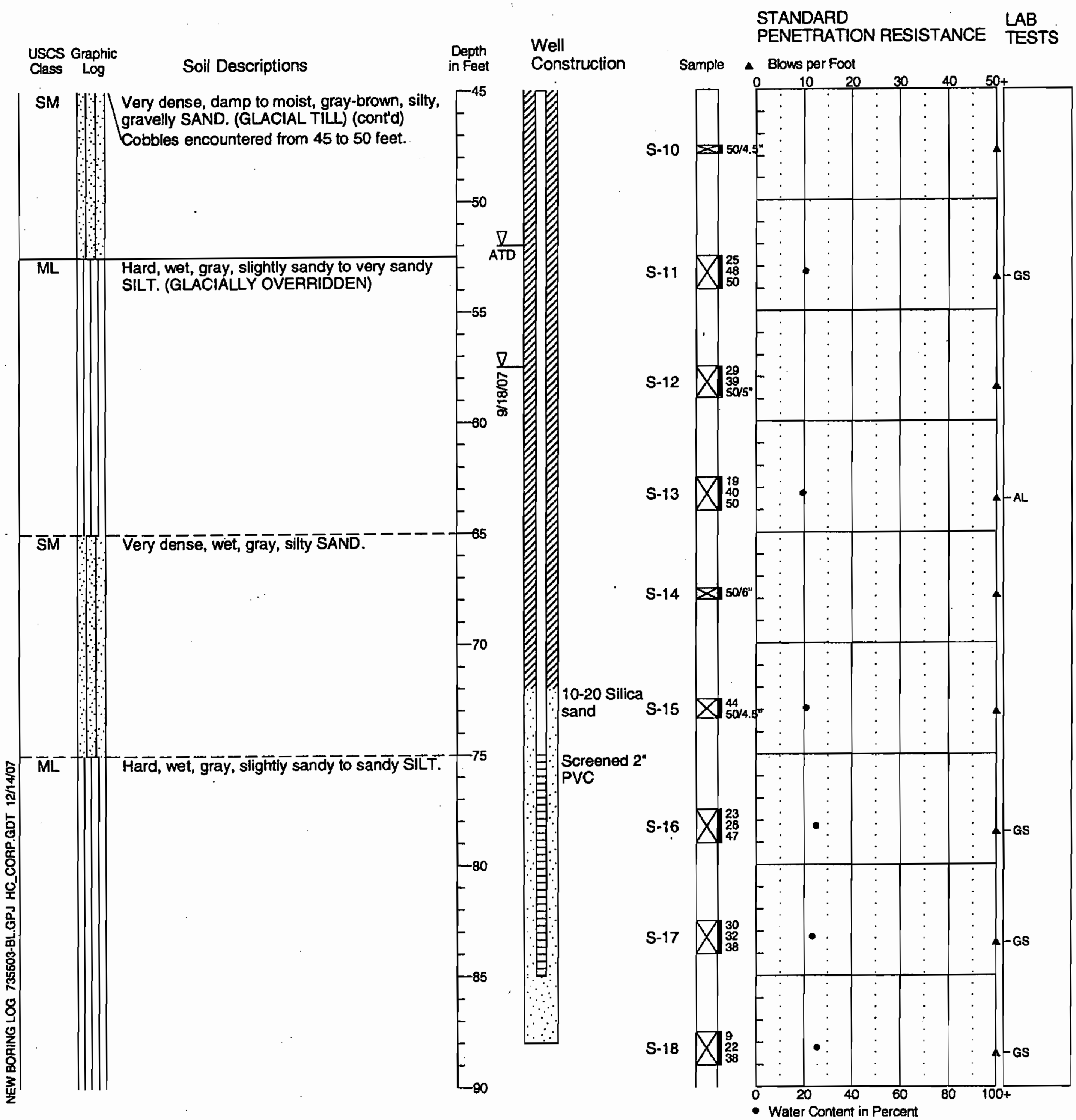
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
7355-03   8/07
Figure A-2   1/4

Boring Log & Construction Data for Monitoring Well HC-101

Location: N 18.7943 E 131.5061
Approximate Ground Surface Elevation: 132 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell   Reviewed By: S. Upsall



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

Boring Log & Construction Data for Monitoring Well HC-101

Location: N 18.7943 E 131.5061
Approximate Ground Surface Elevation: 132 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

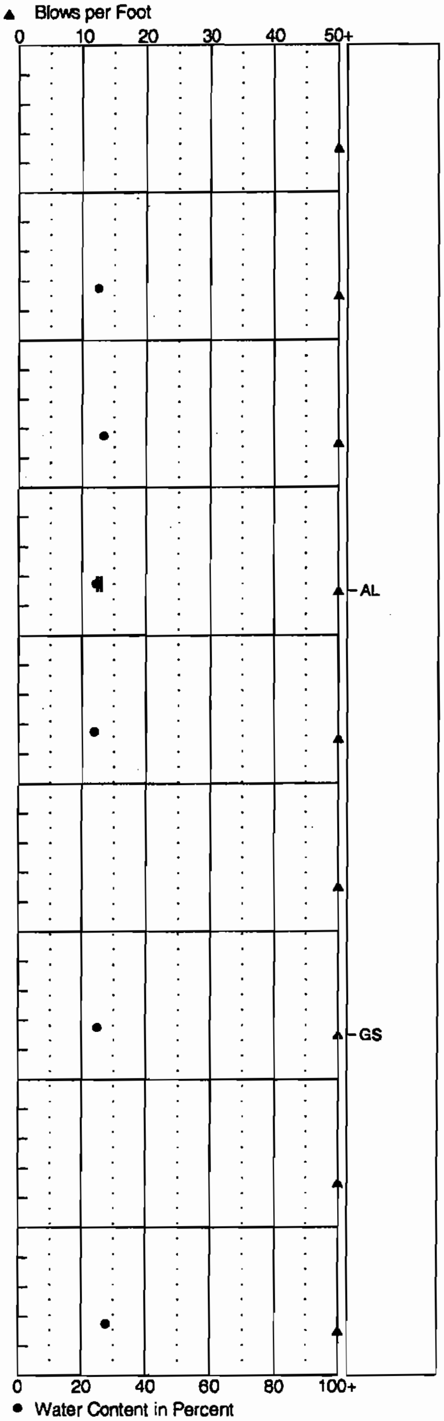
Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell   Reviewed By: S. Upsall

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
ML		Hard, wet, gray, slightly sandy to sandy SILT. (cont'd)	90 – 135

Depth scale: 90, 95, 100, 105, 110, 115, 120, 125, 130, 135

Well Construction

Sample	Blows	Lab Tests
S-19	13 27 39	
S-20	18 27 36	
S-21	12 26 40	
S-22	10 25 41	AL
S-23	15 36 43	
S-24	13 33 50	
S-25	21 31 45	GS
S-26	19 37 48	
S-27	17 33 50	



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

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Figure A-2   3/4

Boring Log & Construction Data for Monitoring Well HC-101

Location: N 18.7943 E 131.5061
Approximate Ground Surface Elevation: 132 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

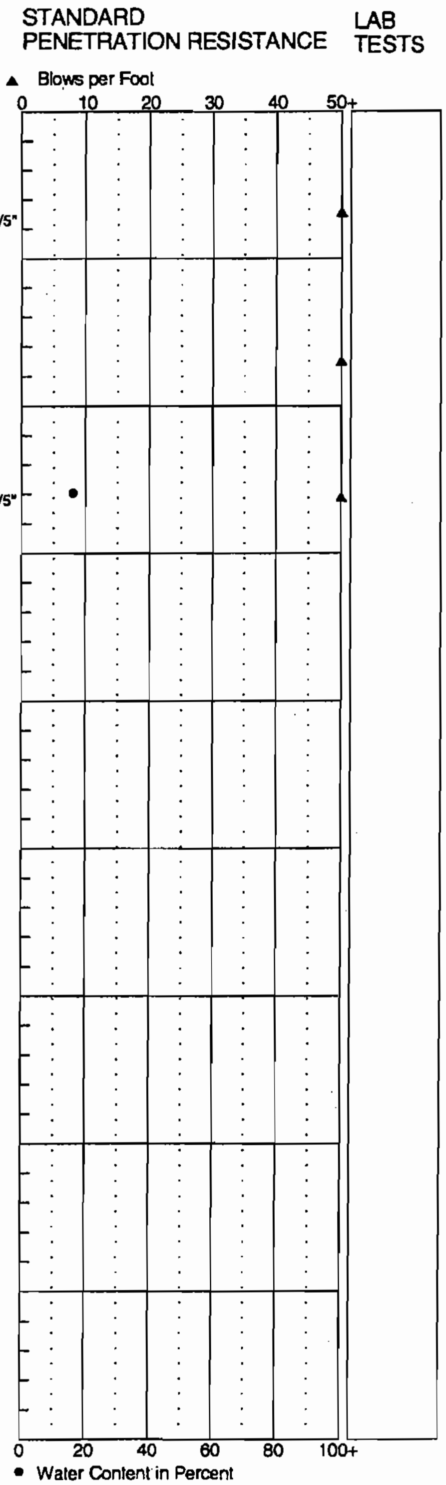
Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell Reviewed By: S. Upsall

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
ML		Hard, wet, gray, slightly sandy to sandy SILT. (cont'd)	135–148.5
		Bottom of Boring at 148.5 Feet. Started 08/13/07. Completed 08/14/07.	

Depth in Feet: 135, 140, 145, 150, 155, 160, 165, 170, 175, 180

Well Construction

Sample	Blows
S-28	17 36 50/5"
S-29	19 33 50
S-30	43 50/5"



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
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HARTCROWSER

7355-03 8/07

Figure A-2 4/4

Boring Log & Construction Data for Monitoring Well HC-102

Location: N 360.6333 E -18.5435
Approximate Ground Surface Elevation: 145 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 5.5 inches
Logged By: P. Cordell   Reviewed By: S. Upsall

USCS Class	Soil Descriptions	Depth in Feet
GM	Loose, wet, tannish brown, silty, sandy GRAVEL. (FILL)	0
SM	Dense to very dense, moist to wet, gray-brown, slightly gravelly to gravelly, very silty SAND. (WEATHERED TILL)	
SM	Very dense, moist, gray-brown, silty, gravelly SAND. (GLACIAL TILL) Very gravelly	20
GM	Very dense, moist, gray, silty, sandy GRAVEL.	

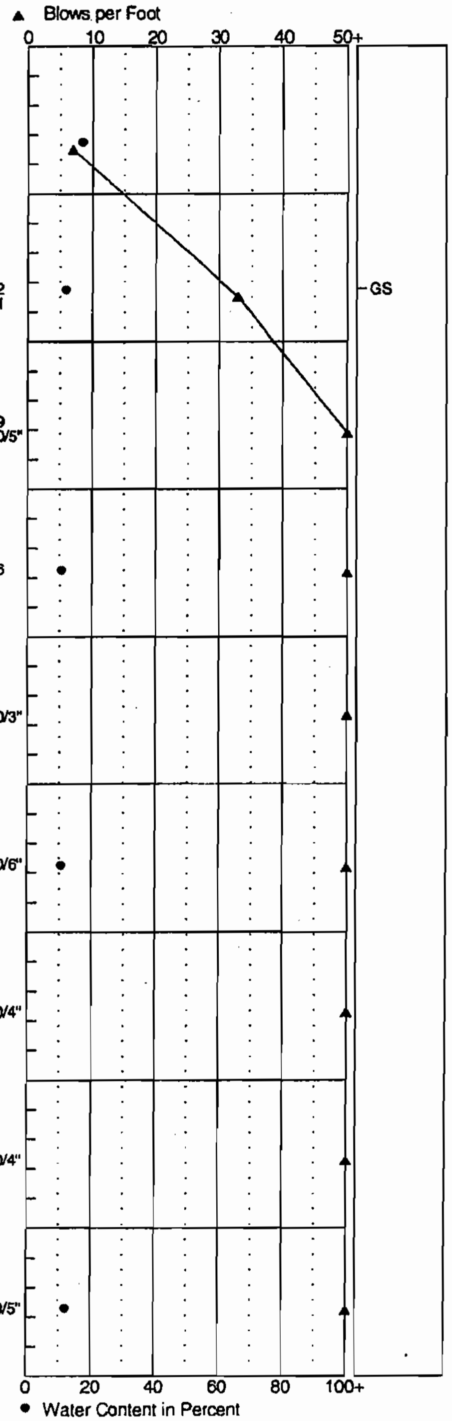
Depth in Feet: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Construction: Flush mount monument; Concrete; Bentonite chips

Sample	Blows
S-1	3 3 4
S-2	8 12 21
S-3	19 50/5"
S-4	46
S-5	50/3"
S-6	50/6"
S-7	50/4"
S-8	50/4"
S-9	50/5"

STANDARD PENETRATION RESISTANCE

LAB TESTS



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

HARTCROWSER

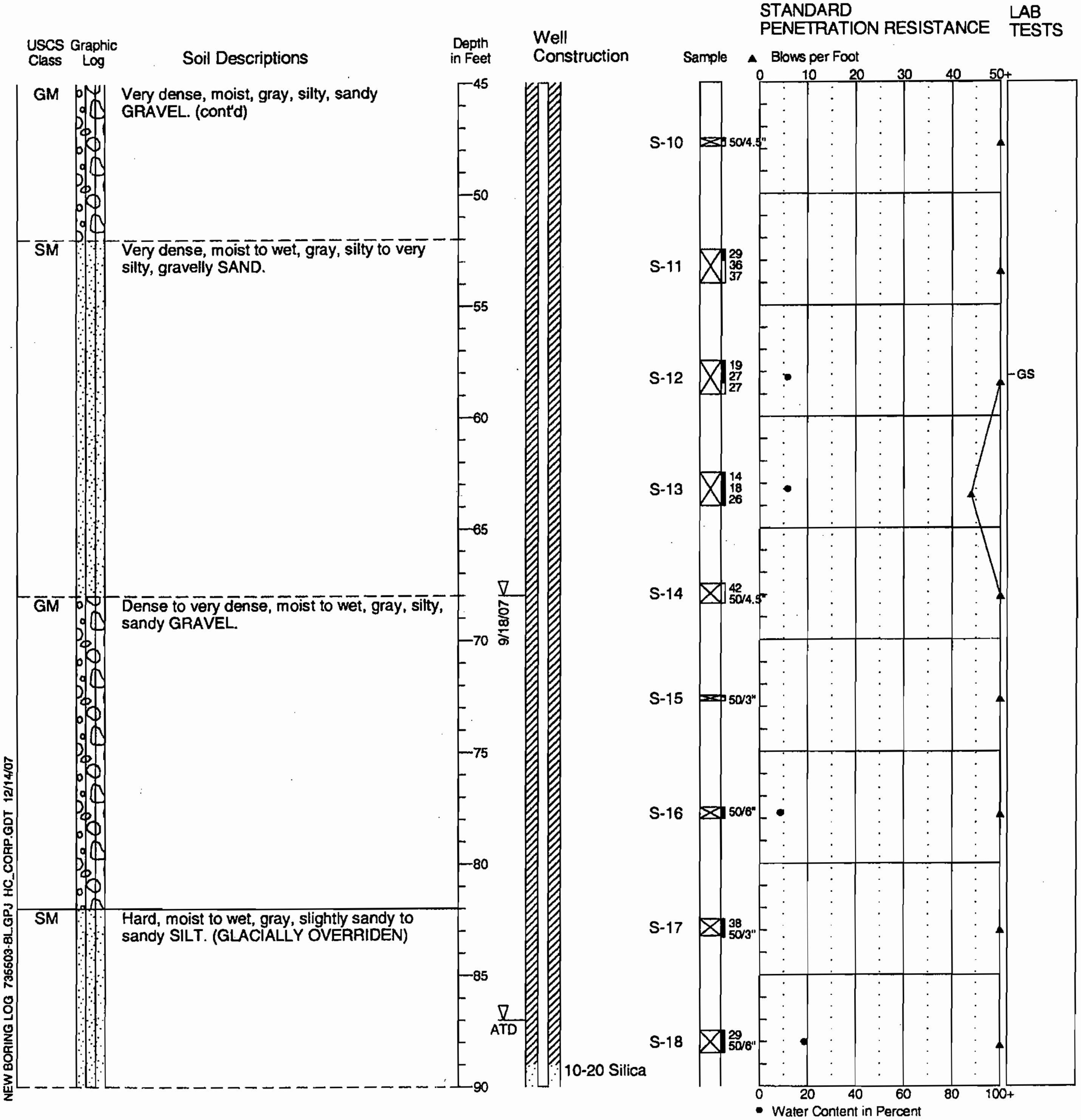
7355-03   8/07

Figure A-3   1/4

Boring Log & Construction Data for Monitoring Well HC-102

Location: N 360.6333 E -18.5435
Approximate Ground Surface Elevation: 145 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 5.5 inches
Logged By: P. Cordell Reviewed By: S. Upsall



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

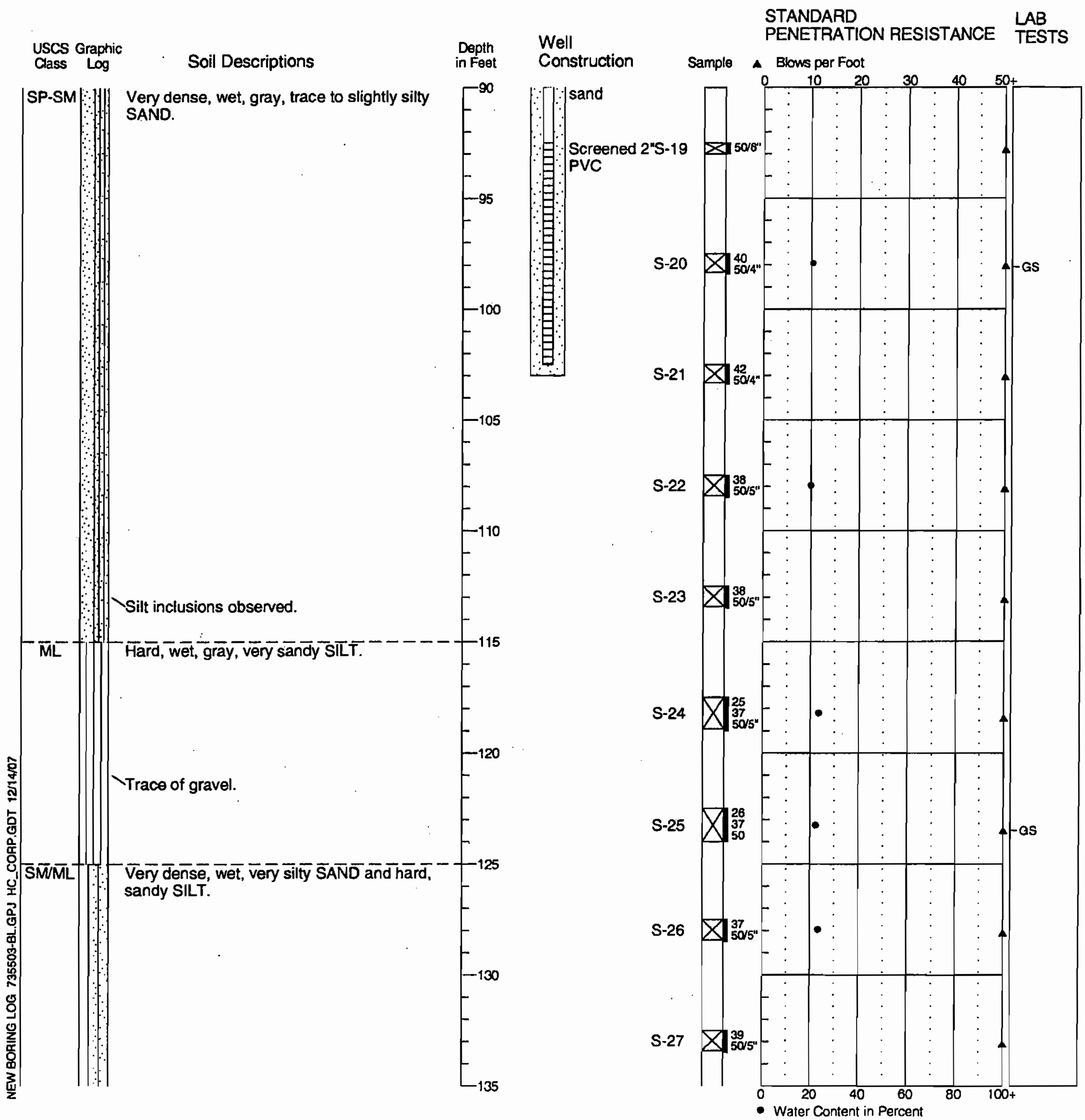
7355-03 8/07

Figure A-3 2/4

Boring Log & Construction Data for Monitoring Well HC-102

Location: N 360.6333 E -18.5435
Approximate Ground Surface Elevation: 145 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 5.5 inches
Logged By: P. Cordell Reviewed By: S. Upsall



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

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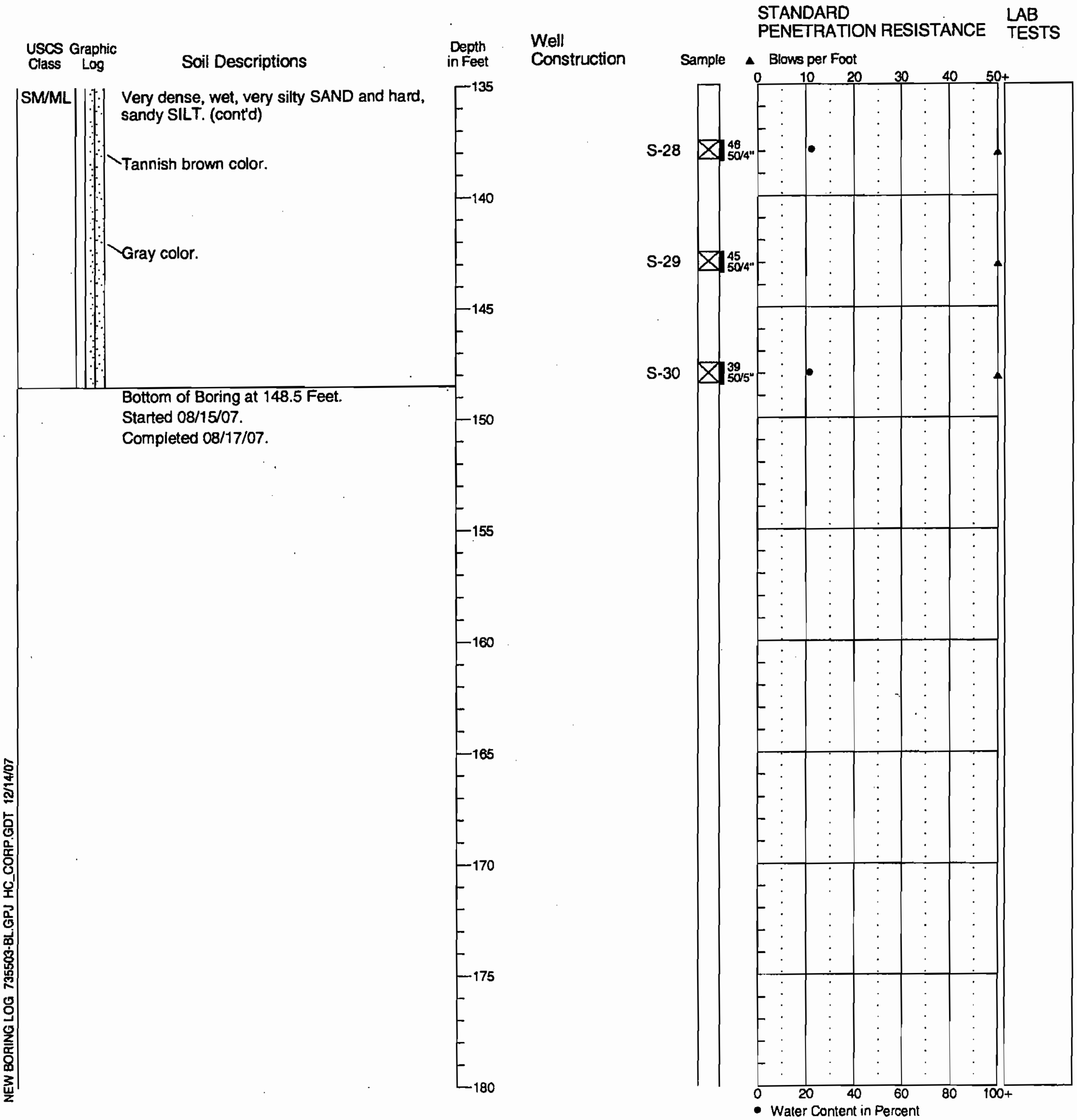
Figure A-3 3/4

Boring Log & Construction Data for Monitoring Well HC-102

Location: N 360.6333 E -18.5435
Approximate Ground Surface Elevation: 145 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 5.5 inches
Logged By: P. Cordell Reviewed By: S. Upsall



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
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HARTCROWSER

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Figure A-3 4/4

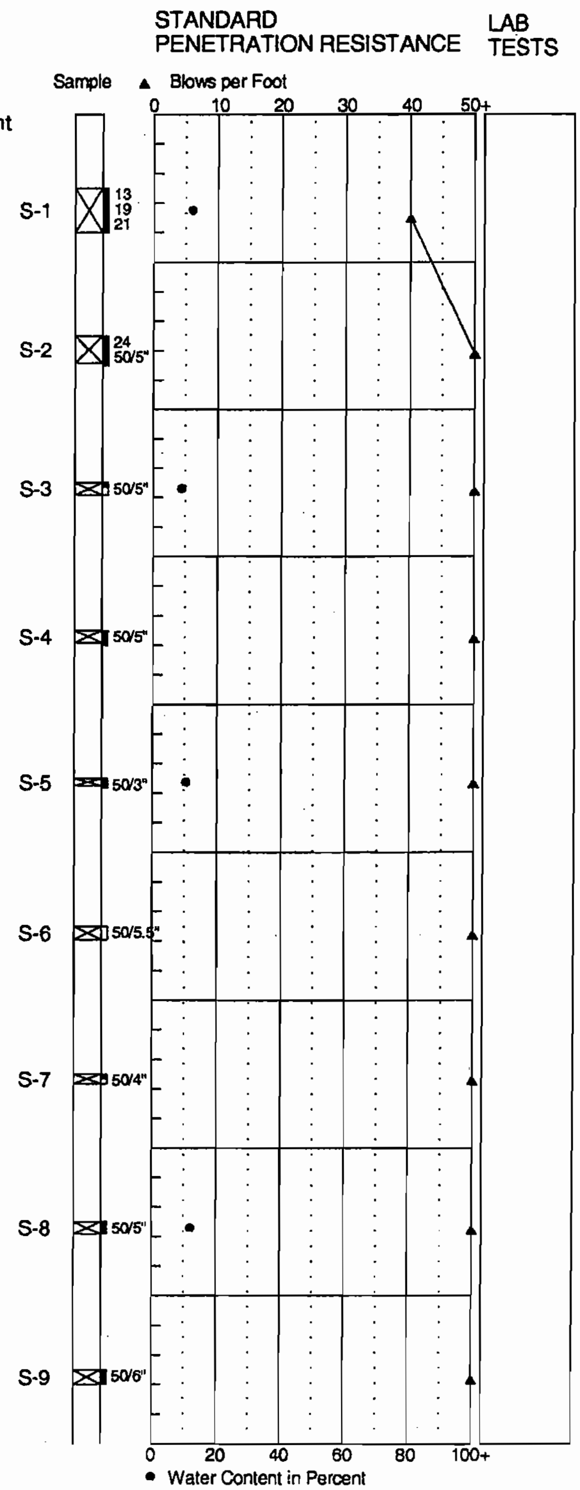
Boring Log & Construction Data for Monitoring Well HC-103

Location: N 491.2685 E 213.5255
Approximate Ground Surface Elevation: 139.5 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 5 inches
Logged By: P. Cordell   Reviewed By: S. Upsall

USCS Class	Soil Descriptions	Depth in Feet
SM	Dense to very dense, moist to wet, gray-brown, silty, gravelly SAND. (WEATHERED TILL)	0
	Cobbles encountered from 8 to 10 feet.	
SM	Very dense, moist to wet, gray-brown, silty, gravelly SAND. (GLACIAL TILL)	10
	Cobbles encountered from 18 to 20.5 feet.	
	Hard drilling with scattered cobbles from 24 to 35 feet.	
	Very gravelly.	
		45

Well Construction: Flush mount monument; Concrete; Bentonite chips



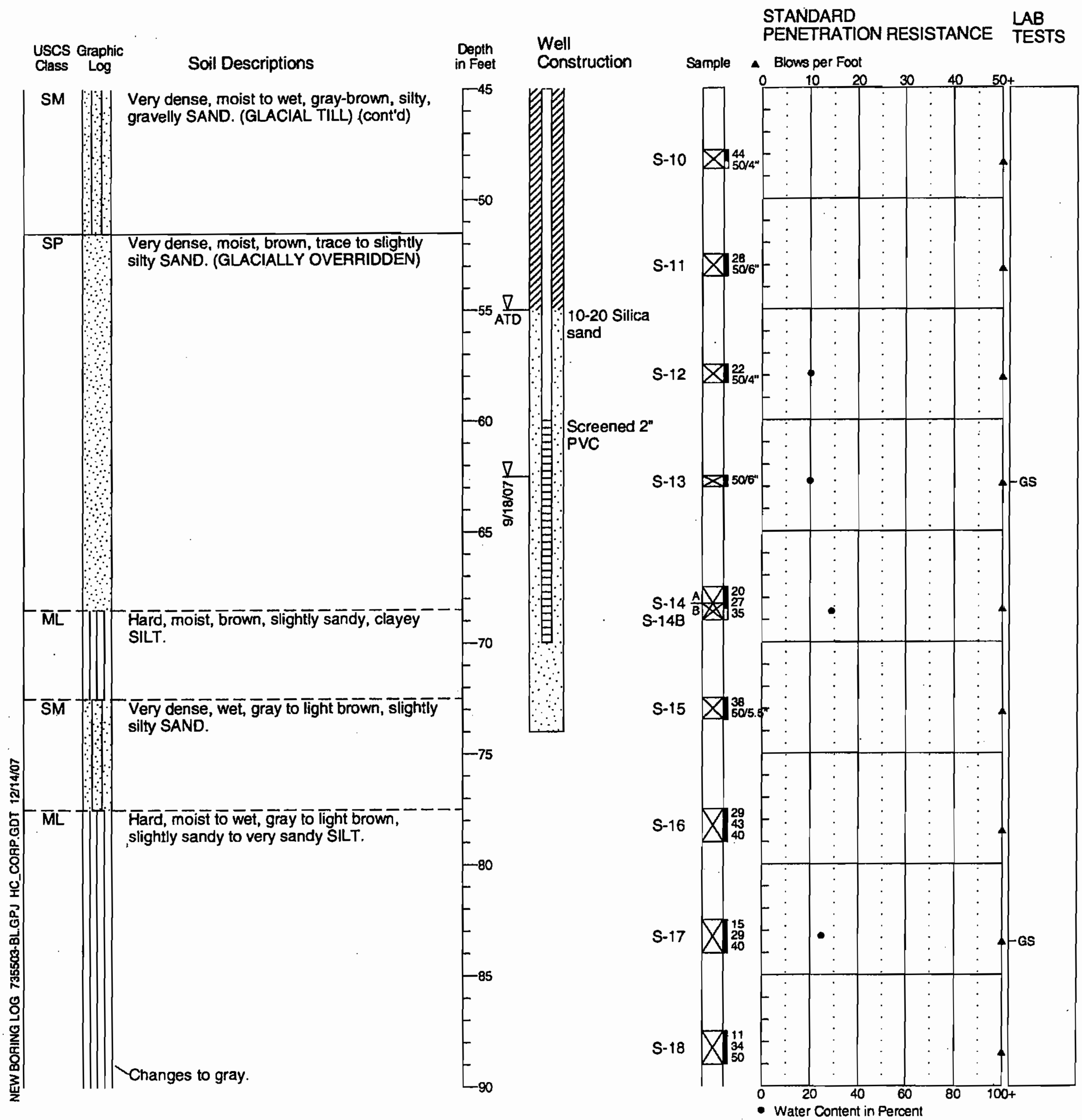
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
7355-03   8/07
Figure A-4   1/4

Boring Log & Construction Data for Monitoring Well HC-103

Location: N 491.2685 E 213.5255
Approximate Ground Surface Elevation: 139.5 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 5 inches
Logged By: P. Cordell Reviewed By: S. Upsall



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

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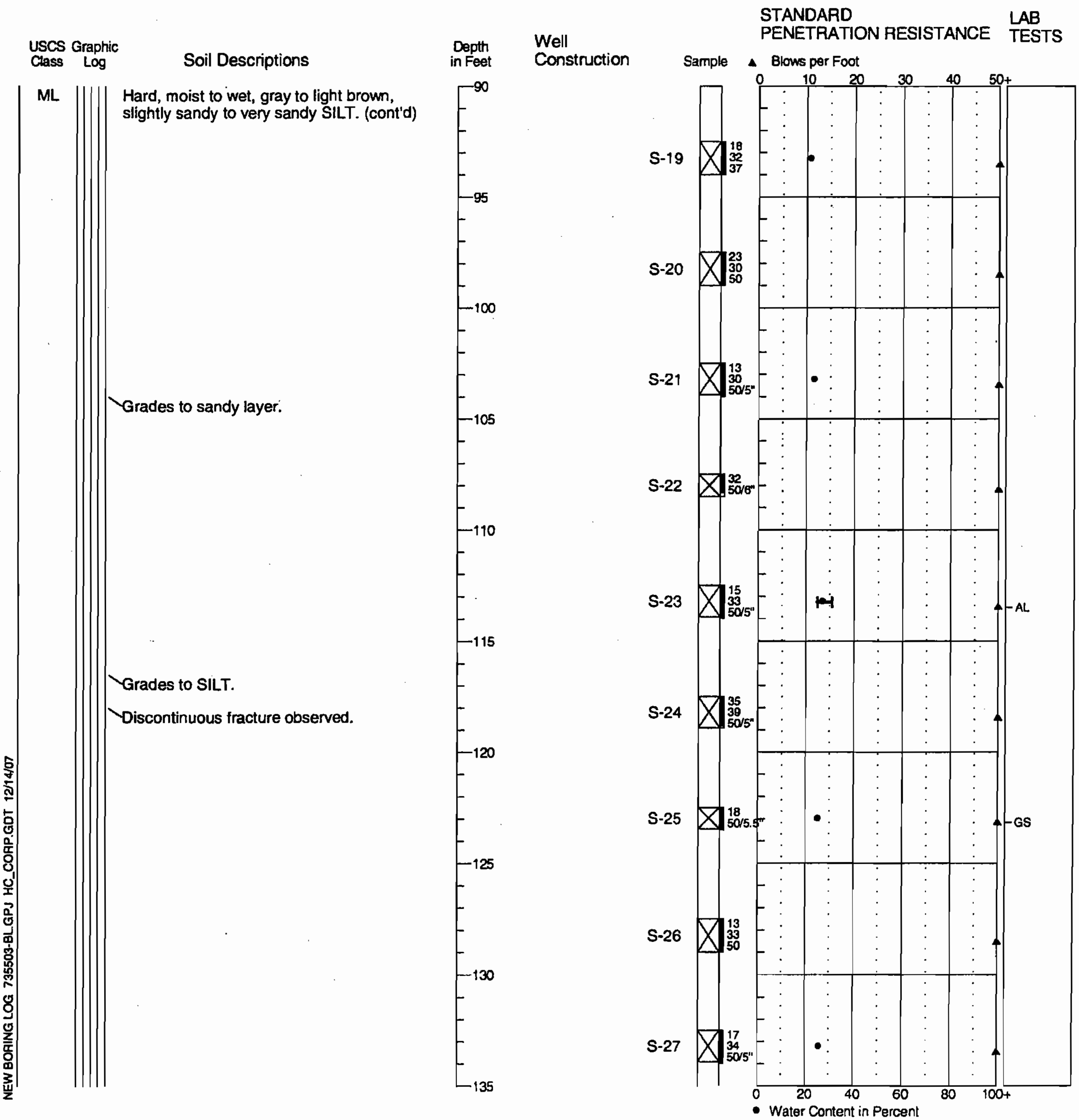
Figure A-4 2/4

Boring Log & Construction Data for Monitoring Well HC-103

Location: N 491.2685 E 213.5255
Approximate Ground Surface Elevation: 139.5 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 5 inches
Logged By: P. Cordell Reviewed By: S. Upsall



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

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2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
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4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7355-03 8/07

Figure A-4 3/4

Boring Log & Construction Data for Monitoring Well HC-103

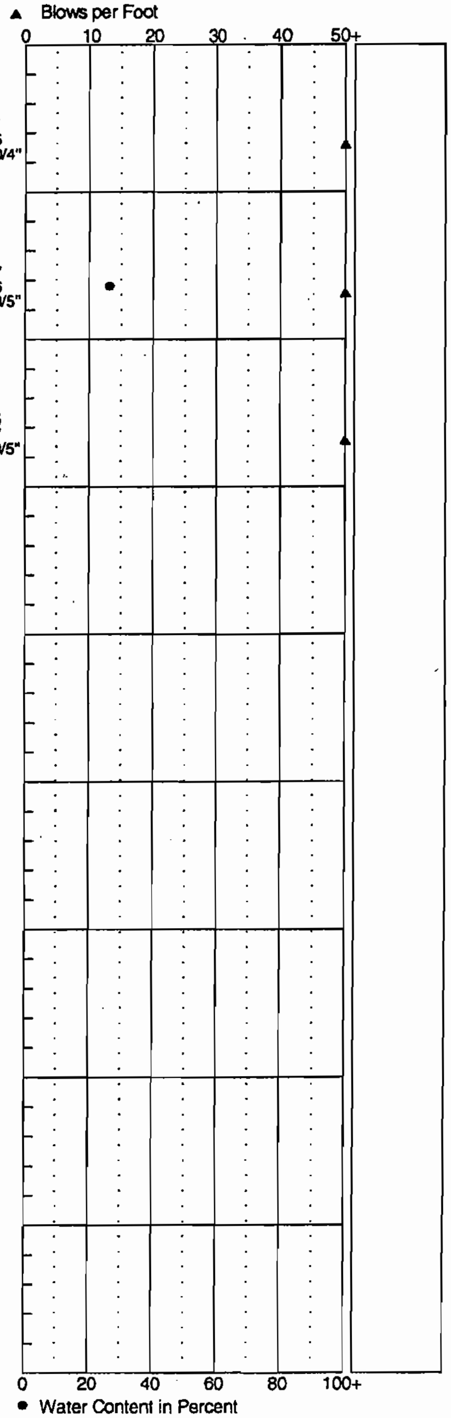
Location: N 491.2685 E 213.5255
Approximate Ground Surface Elevation: 139.5 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 5 inches
Logged By: P. Cordell Reviewed By: S. Upsall

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet	Well Construction	Sample
ML		Hard, moist to wet, gray to light brown, slightly sandy to very sandy SILT. (cont'd)	135		
					S-28 (11, 35, 50/4")
			140		
					S-29 (17, 36, 50/5")
			145		
					S-30 (25, 37, 50/5")
		Bottom of Boring at 149.0 Feet. Started 08/20/07. Completed 08/22/07.	150		
			155		
			160		
			165		
			170		
			175		
			180		

STANDARD PENETRATION RESISTANCE

LAB TESTS



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

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4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

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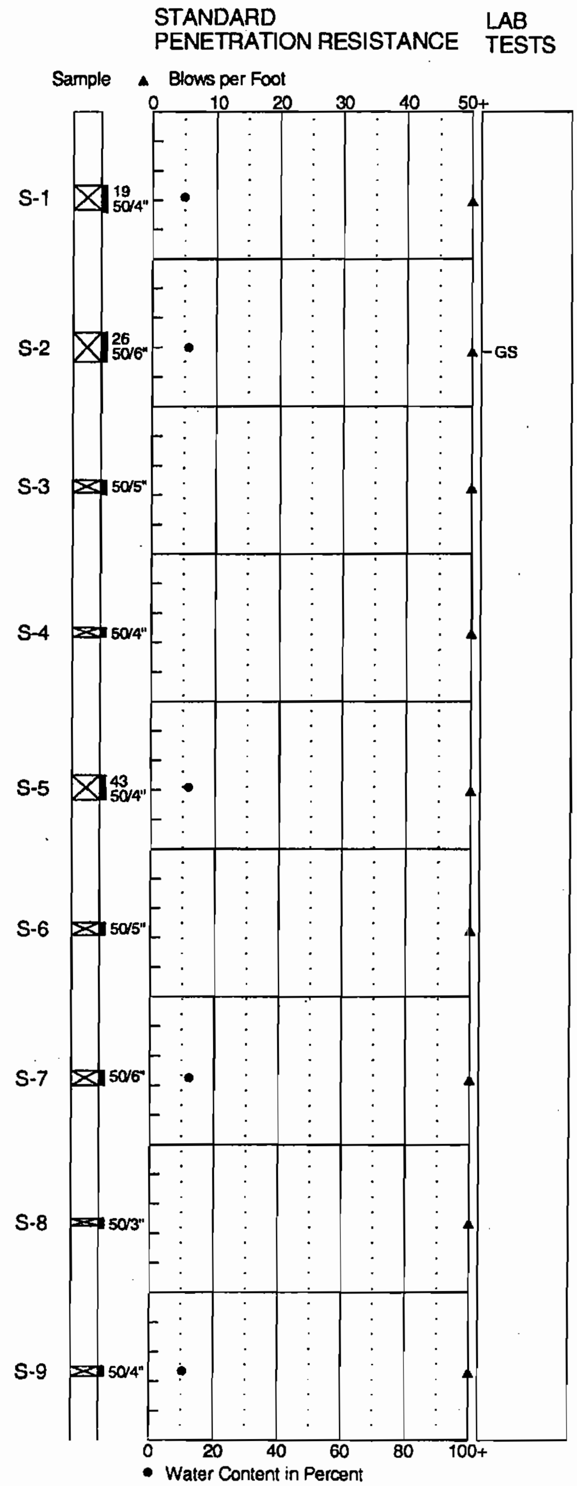
Figure A-4 4/4

Boring Log HC-104

Location: N 202.7852 E 84.6156
Approximate Ground Surface Elevation: 137 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell   Reviewed By: S. Upsall

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
SM		Very dense, moist, brown, silty, gravelly SAND. (FILL)	0–7
SM		Very dense, damp, gray-brown, slightly gravelly, silty to very silty SAND. (GLACIAL TILL)	7–45
		2-inch wet sand layer observed.	~24
		Wet conditions observed.	~28
		Grades to moist and gray.	~32
		Cobbles encountered from 30 to 50 feet.	~35
		Grades to gray.	~37.5



1. Refer to Figure A-1 for explanation of descriptions and symbols.
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4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

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Figure A-5   1/5

Boring Log HC-104

Location: N 202.7852 E 84.6156
Approximate Ground Surface Elevation: 137 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell Reviewed By: S. Upsall

USCS Class	Soil Descriptions	Depth in Feet
SM	Very dense, damp, gray-brown, slightly gravelly, silty to very silty SAND. (GLACIAL TILL) (cont'd)	45
	Zone of cobbles from 62.5 to 65 feet.	
ML	Hard, moist, light brown with dark brown mottling, slightly sandy SILT. (GLACIALLY OVERRIDDEN)	
	Grades to gray.	
SP-SM	Very dense, moist to wet, brown, slightly silty to very silty SAND.	ATD
	Grades to gray.	90

STANDARD PENETRATION RESISTANCE ▲ Blows per Foot (0, 10, 20, 30, 40, 50+)
● Water Content in Percent (0, 20, 40, 60, 80, 100+)

Sample	Blows	LAB TESTS
S-10	50/4.5"	
S-11	50/3"	
S-12	50/6"	
S-13	33 50/3"	
S-14	17 29 40	GS
S-15	38 40 42	
S-16	46 50/4"	
S-17	35 50/6"	GS
S-18	28 39 44	

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

HARTCROWSER

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Figure A-5 2/5

Boring Log HC-104

Location: N 202.7852 E 84.6156
Approximate Ground Surface Elevation: 137 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

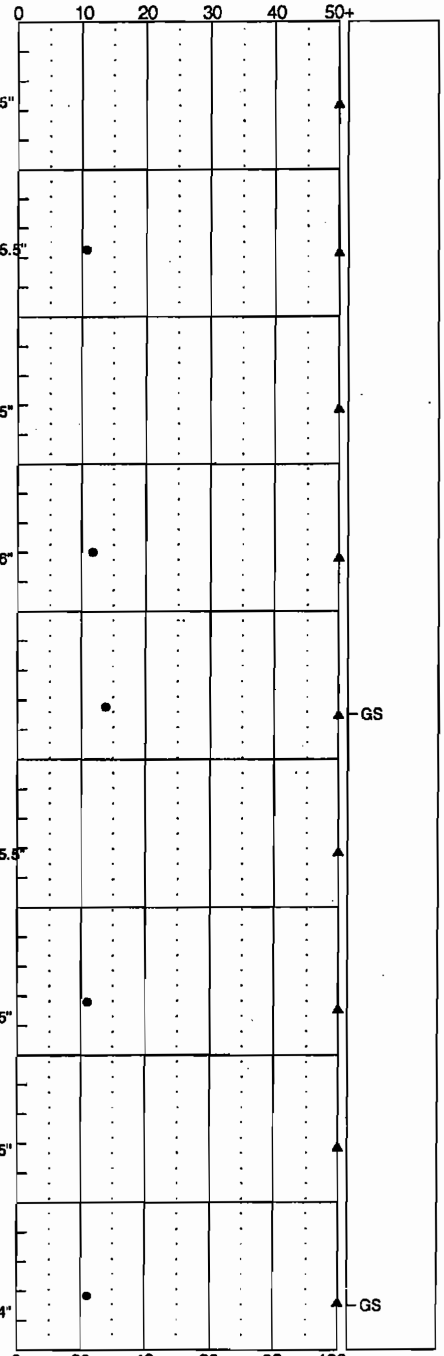
Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell Reviewed By: S. Upsall

USCS Class	Soil Descriptions	Depth in Feet
SP-SM	Very dense, moist to wet, brown, slightly silty to very silty SAND. (cont'd)	90
	Grades to brown.	
	Grades to gray.	
ML	Hard, damp, gray SILT.	
SM	Very dense, moist to wet, gray, silty SAND.	
ML	Hard, moist to wet, gray, very sandy SILT.	135

STANDARD PENETRATION RESISTANCE

LAB TESTS

Sample	Blows per Foot	Lab Tests
S-19	50/5"	
S-20	50/5.5"	
S-21	45 50/5"	
S-22	37 50/6"	
S-23	24 45 50	GS
S-24	35 50/5.5"	
S-25	23 45 50/5"	
S-26	33 50/5"	
S-27	29 33 50/4"	GS



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
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4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

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Figure A-5 3/5

Boring Log HC-104

Location: N 202.7852 E 84.6156
Approximate Ground Surface Elevation: 137 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell   Reviewed By: S. Upsall

USCS Class	Soil Descriptions	Depth in Feet
ML	Hard, moist to wet, gray, very sandy SILT. (cont'd)	135
ML	Grades to very sandy SILT.	
SM	Very dense, moist to wet, gray, slightly silty to silty SAND.	
SM	Grades to slightly silty to silty SAND.	140
SM/ML	Very dense, moist, gray, very silty SAND to slightly sandy to sandy SILT (intermixed layers).	~166.5

Depth scale: 135, 140, 145, 150, 155, 160, 165, 170, 175, 180

STANDARD PENETRATION RESISTANCE / LAB TESTS

Sample ▲ Blows per Foot (0, 10, 20, 30, 40, 50+)
● Water Content in Percent (0, 20, 40, 60, 80, 100+)

Sample	Blows	Lab Tests
S-28	50/6"	
S-29	25 50/6"	
S-30	50/6"	
S-31	50/5"	GS
S-32	50/6"	
S-33	50/5"	
S-34	16 33 50/5"	
S-35	22 33 50/5"	
S-36	23 37 50/4"	

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

HARTCROWSER

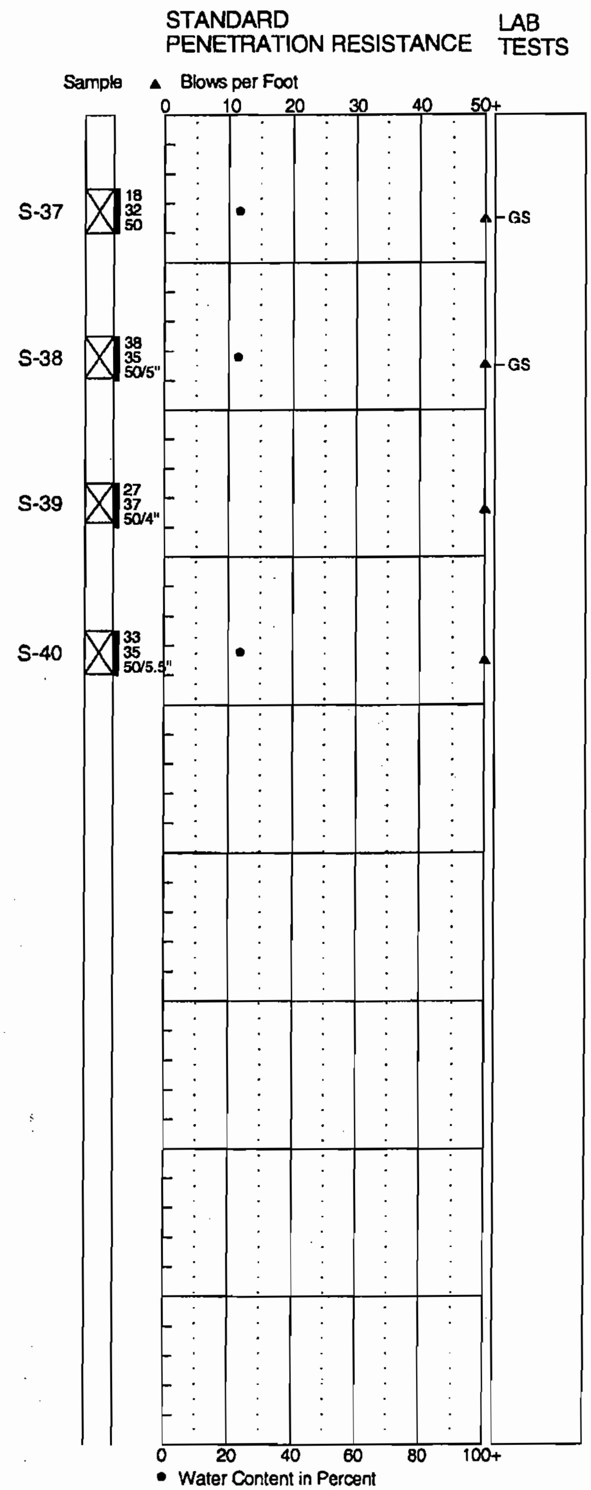
7355-03   8/07

Boring Log HC-104

Location: N 202.7852 E 84.6156
Approximate Ground Surface Elevation: 137 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell Reviewed By: S. Upsall

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
SM/ML		Very dense, moist, gray, very silty SAND to slightly sandy to sandy SILT (intermixed layers). (cont'd)	180–199
		Bottom of Boring at 199.0 Feet. Started 08/23/07. Completed 08/27/07.	199–225



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

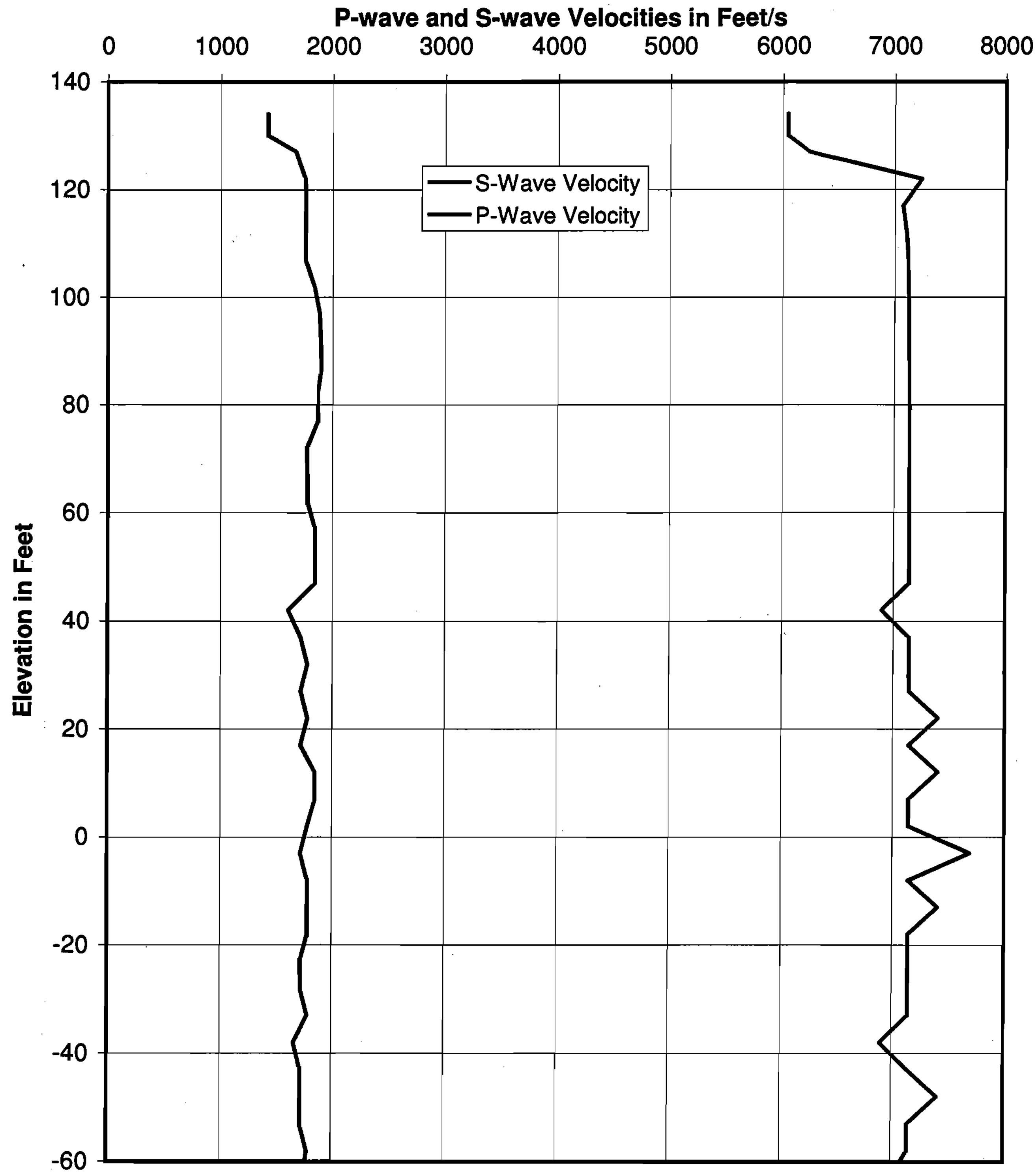
NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

HARTCROWSER

7355-03 8/07

Figure A-5 5/5

Downhole Compression and Shear Wave Velocity Measurement in Boring HC-104



Lincoln Square Expansion
Bellevue, Washington

P- and S-Wave Velocity Profiles Based on Downhole Seismic Survey in HC-104

7355-04 11-12

HARTCROWSER

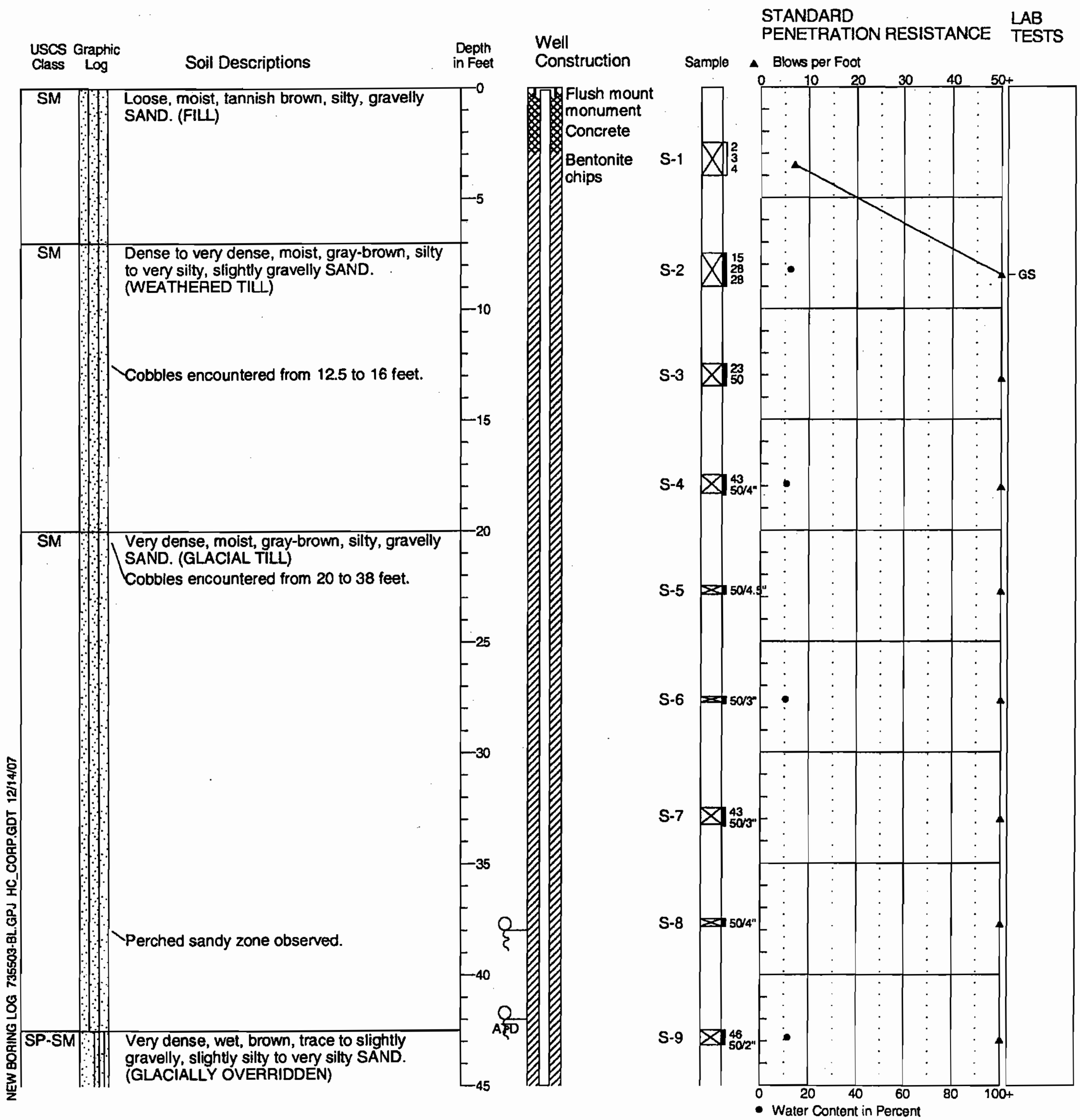
Figure

A-5A

Boring Log & Construction Data for Monitoring Well HC-105

Location: N 367.9773 E 246.8058
Approximate Ground Surface Elevation: 139 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell Reviewed By: S. Upsall



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-6 1/4

Boring Log & Construction Data for Monitoring Well HC-105

Location: N 367.9773 E 246.8058
Approximate Ground Surface Elevation: 139 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell Reviewed By: S. Upsall

USCS Class	Soil Descriptions	Depth in Feet
SP-SM	Very dense, wet, brown, trace to slightly gravelly, slightly silty to very silty SAND. (GLACIALLY OVERRIDDEN) (cont'd)	45
	Fissured seams and layers of sandy silty observed.	
ML	Hard, wet, brown with black and orange mottling, slightly sandy SILT.	
SM	Very dense, wet, brown, silty to very silty SAND.	
	Silt inclusions observed.	
ML	Hard, wet, brown, slightly clayey, very sandy SILT.	
	Cobbles encountered from 85 to 86 feet.	90

Well Construction: 9/18/07 (groundwater level); 10-20 Silica sand; Screened 2" PVC

STANDARD PENETRATION RESISTANCE ▲ Blows per Foot (0, 10, 20, 30, 40, 50+) · LAB TESTS

Sample	Blows	Lab Tests
S-10	29 50/5.5"	
S-11	39 50/5.5"	
S-12	28 44 48	GS
S-13	44 50/5"	
S-14 (A) / S-14B (B)	33 39 38	GS
S-15	24 50/6"	
S-16	28 38 40	
S-17	23 37 38	GS
S-18	24 40 34	

● Water Content in Percent (0, 20, 40, 60, 80, 100+)

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
7355-03 9/07
Figure A-6 2/4

Boring Log & Construction Data for Monitoring Well HC-105

Location: N 367.9773 E 246.8058
Approximate Ground Surface Elevation: 139 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

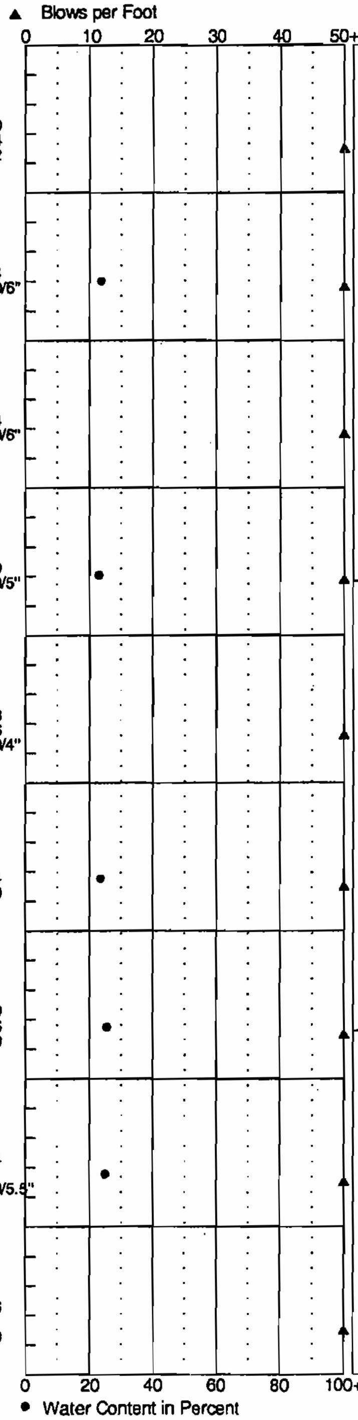
Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell Reviewed By: S. Upsall

USCS Class	Soil Descriptions	Depth in Feet
ML	Hard, wet, brown, slightly sandy to very sandy SILT.	90
	Grades to gray.	
SM	Very dense, wet, gray, silty SAND.	
ML	Hard, moist to wet, gray, sandy SILT.	

Depth in Feet: 90, 95, 100, 105, 110, 115, 120, 125, 130, 135

Sample	Blows	Lab Tests
S-19	30 34 42	
S-20	24 50/6"	
S-21	34 50/6"	
S-22	40 50/5"	AL
S-23	33 36 50/4"	
S-24	24 34 50	
S-25	19 36 50	GS
S-26	14 31 50/5.5"	
S-27	16 31 50	

STANDARD PENETRATION RESISTANCE



LAB TESTS

NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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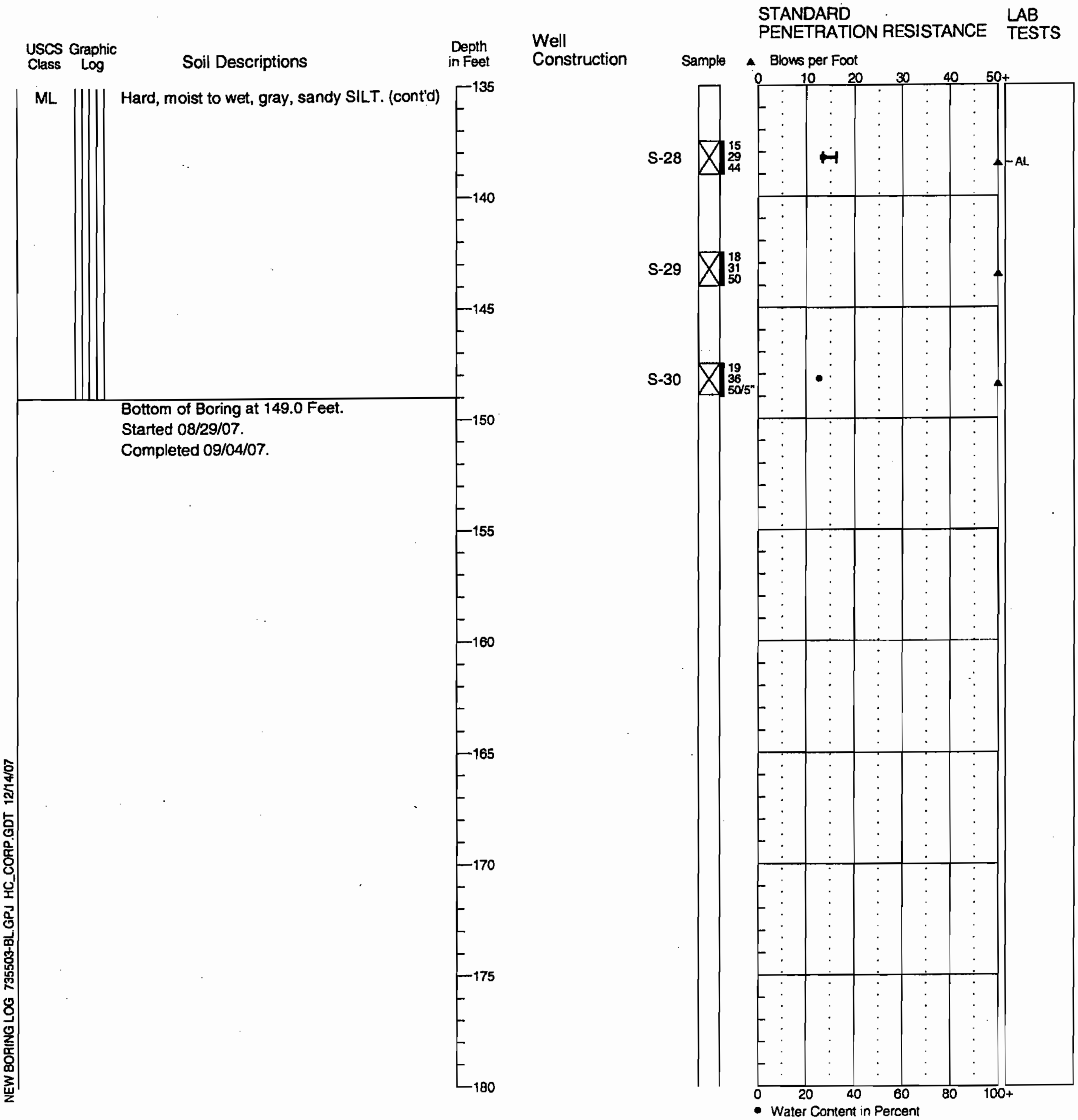
Figure A-6 3/4

Boring Log & Construction Data for Monitoring Well HC-105

Location: N 367.9773 E 246.8058
Approximate Ground Surface Elevation: 139 Feet
Horizontal Datum: Based on B-1
Vertical Datum: NAVD 88

Drill Equipment: Dietrich D-120 Mud Rotary
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: 6 inches
Logged By: P. Cordell   Reviewed By: S. Upsall



NEW BORING LOG 735503-BL.GPJ HC_CORP.GDT 12/14/07

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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Figure A-6 4/4

Boring Log & Construction Data for Monitoring Well HC08-6

Location: See Figure 2.
Approximate Ground Surface Elevation: 146 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

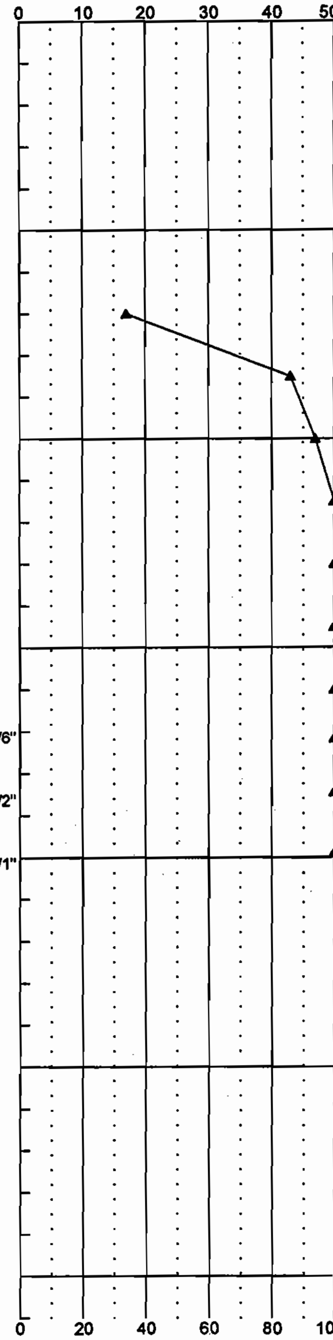
Drill Equipment: Mobile B-59
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Cordell Reviewed By: G. Both

USCS Class	Soil Descriptions	Depth in Feet
SM	Vacuumed soil to depth of 5 feet and drilled hole to 6 feet before starting sample collection.	0
SM	Medium dense, moist, light brown with orange mottling, silty SAND.	
SM	Very dense, moist, light gray, gravelly, silty SAND.	10
	Grading slightly gravelly.	15
	Grading very silty.	
SM/ML	Very dense to hard, moist, gray, gravelly, very silty SAND to very sandy SILT.	20
	Drilled unsampled from 20.1 to 50.0 feet.	25
		30

Well Construction: Flush mount monument; Concrete; Bentonite chips

Sample	Blows	LAB TESTS & (PID)
S-1	4, 7, 10	(<0.1)
	8, 17, 26	
S-2	13, 18, 29	(<0.1) CA
	22, 42, 50	(<0.1) CA
S-3	29, 42, 50	(<0.1)
	30, 45, 50	(<0.1)
S-4	22, 43, 50	(<0.1)
	34, 50/6"	(<0.1)
S-5	45, 50/2"	CA
	33, 50/1"	CA

STANDARD PENETRATION RESISTANCE



NEW BORING LOG 735504BL.GPJ HC_CORP.GDT 12/26/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER
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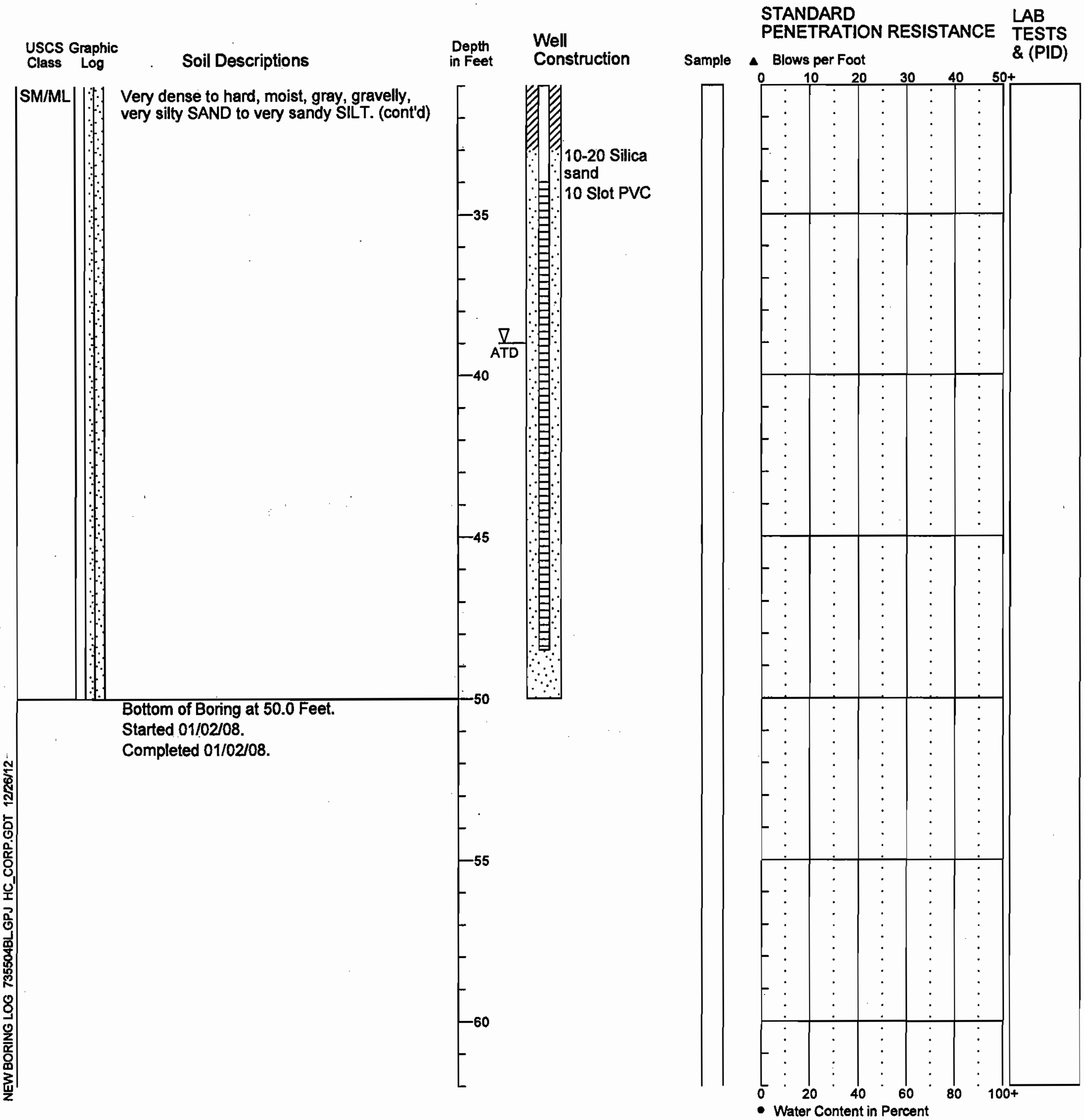
Figure A-10 1/2

Boring Log & Construction Data for Monitoring Well HC08-6

Location: See Figure 2.
Approximate Ground Surface Elevation: 146 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Mobile B-59
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Cordell Reviewed By: G. Both



NEWBORING LOG 735504BL.GPJ HC_CORP.GDT 12/26/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
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HARTCROWSER

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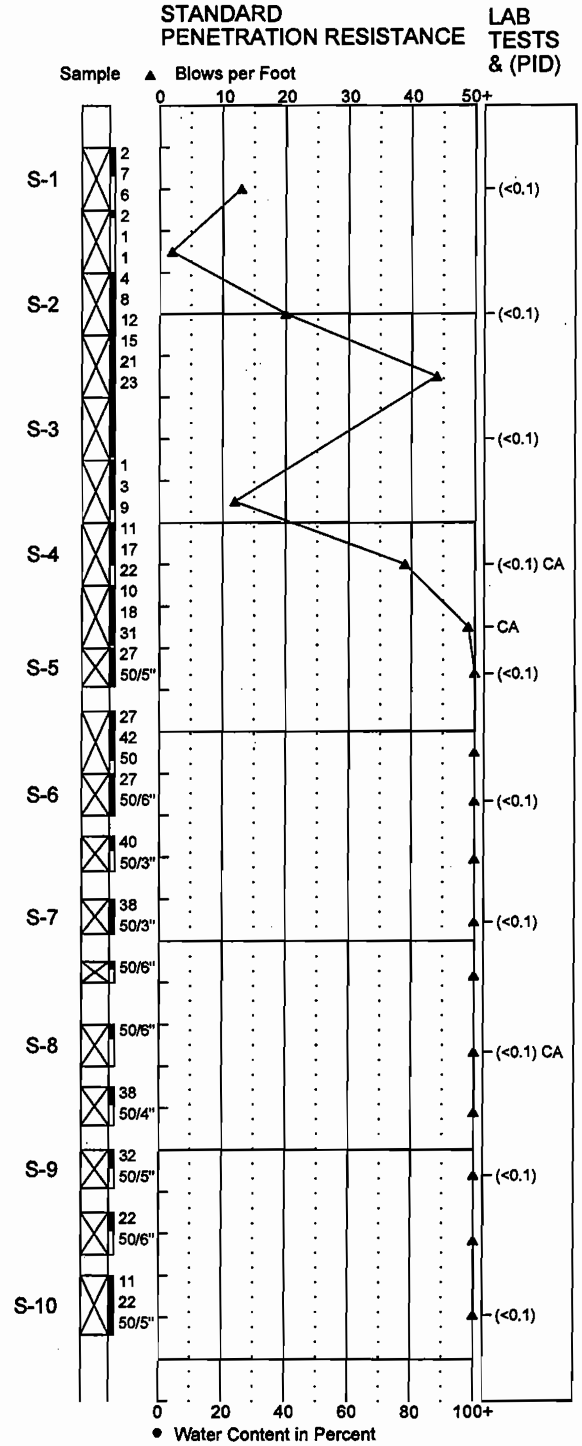
Figure A-10 2/2

Boring Log SB-1

Location: See Figure 2.
Approximate Ground Surface Elevation: 142 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Hollow Stem Auger
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Reed   Reviewed By: G. Both

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
SM		Loose, moist, reddish brown, gravelly, very silty SAND with charcoal and roots. (FILL)	0
SM		Loose, damp, olive gray, slightly gravelly, very silty SAND with slight oxidation.	5
SM		Very dense, moist, olive gray, gravelly, silty SAND.	10
		Grades less silty.	
		Grades slightly gravelly.	15
		Rough drilling indicative of gravel.	20
		2-inch-thick, wet, silty SAND interbed.	25
SM/ML		Very dense to hard, wet, olive gray, interbedded, very silty SAND to very sandy SILT.	
		Bottom of Boring at 29.4 Feet. Started 12/12/07. Completed 12/12/07.	30



NEW BORING LOG 735504BL.GPJ HC_CORP.GDT 12/26/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

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Figure A-2

Boring Log SB-2

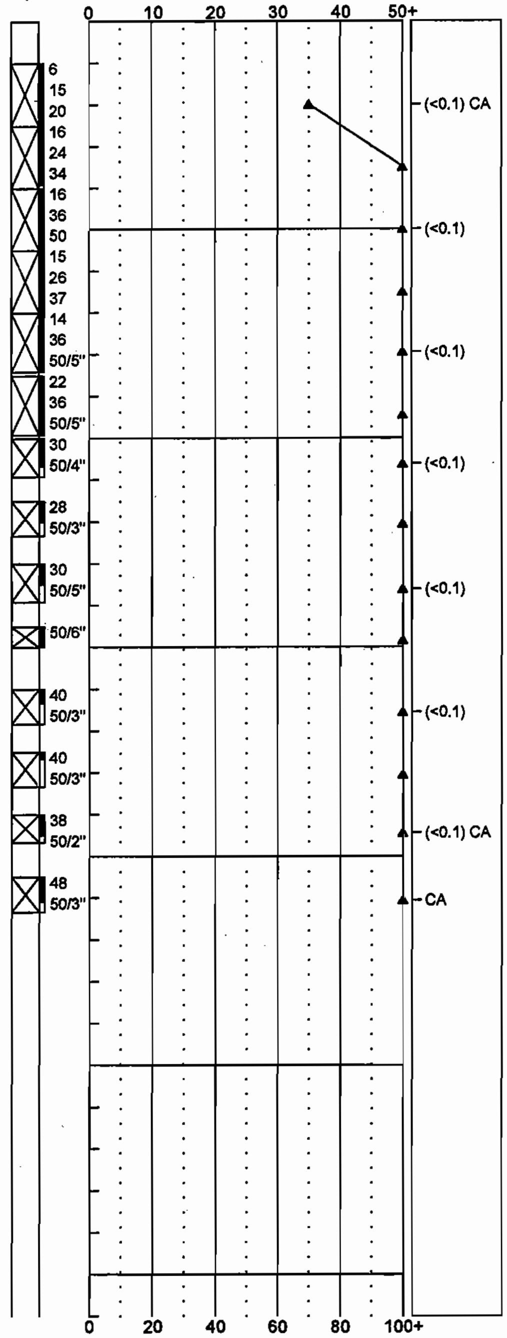
Location: See Figure 2.
Approximate Ground Surface Elevation: 138 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Hollow Stem Auger
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Reed   Reviewed By: G. Both

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
SM		2 inches of Asphalt over dense, moist to dry, brownish gray, gravelly, very silty SAND.	0
SM		Dense to very dense, moist, olive gray, gravelly, silty SAND.	
		2-inch-thick gravelly SAND layer.	5
		Grades very gravelly.	10
			15
			20
		Bottom of Boring at 21.3 Feet. Started 12/13/07. Completed 12/13/07.	
			25
			30

STANDARD PENETRATION RESISTANCE

Sample	Blows per Foot	LAB TESTS & (PID)
S-1	6, 15, 20	(<0.1) CA
	16, 24, 34	
S-2	16, 36, 50	(<0.1)
	15, 26, 37	
S-3	14, 36, 50/5"	(<0.1)
	22, 36, 50/5"	
S-4	30, 50/4"	(<0.1)
	28, 50/3"	
S-5	30, 50/5"	(<0.1)
	50/6"	
S-6	40, 50/3"	(<0.1)
	40, 50/3"	
S-7	38, 50/2"	(<0.1) CA
	48, 50/3"	CA



NEWBORING LOG 735504BL.GPJ HC_CORP.GDT 12/26/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

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Figure A-3

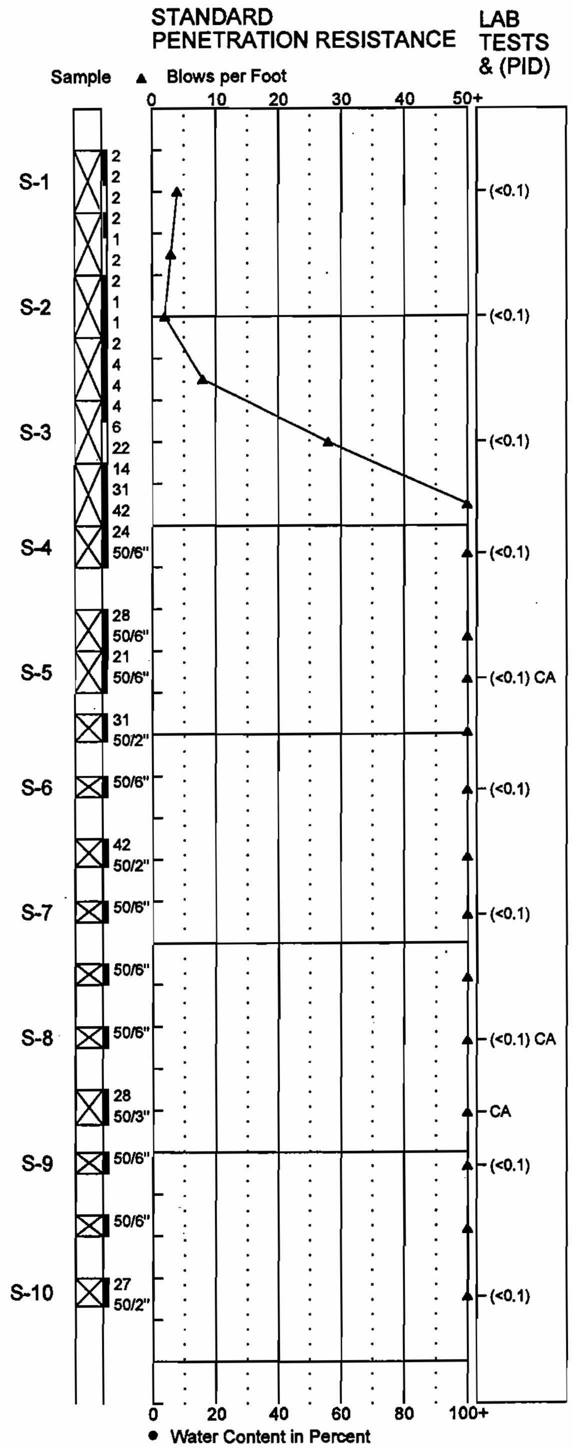
Boring Log SB-3

Location: See Figure 2.
Approximate Ground Surface Elevation: 137 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Hollow Stem Auger
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Reed Reviewed By: G. Both

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
SM		2 inches of Asphalt over loose, moist, reddish brown, gravelly, silty SAND with charcoal. (FILL)	0
SM		Very dense, moist, olive gray, gravelly, very silty SAND.	
		6-inch silty SAND layer.	
		6-inch silty SAND layer.	
		Rough drilling indicative of gravel.	
		Bottom of Boring at 28.7 Feet. Started 12/12/07. Completed 12/12/07.	

Depth scale: 0, 5, 10, 15, 20, 25, 30



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

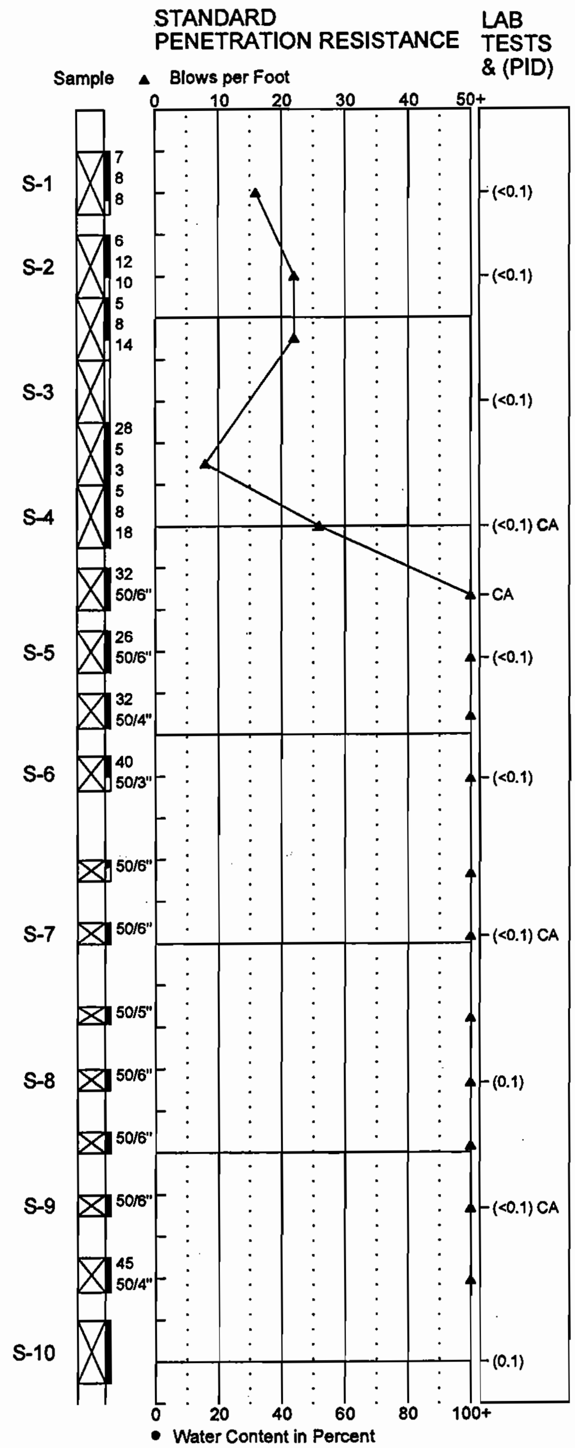
HARTCROWSER
7355-04 12/07
Figure A-4

Boring Log SB-4

Location: See Figure 2.
Approximate Ground Surface Elevation: 138 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Hollow Stem Auger
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Reed Reviewed By: G. Both

USCS Class	Soil Descriptions	Depth in Feet
SM	2 inches of Asphalt over medium dense, moist, gravelly, silty SAND with charcoal. (FILL)	0
	Concrete floor (former Safeway?)	
	Concrete floor.	
SM	Loose, moist to dry, lighlt brown, silty SAND.	
	Grading slightly gravelly.	
SM	Very dense, dry, light brown, gravelly, very silty SAND.	
	2-inch-thick, wet SAND interbed.	
	Bottom of Boring at 30.5 Feet. Started 12/11/07. Completed 12/11/07.	30



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

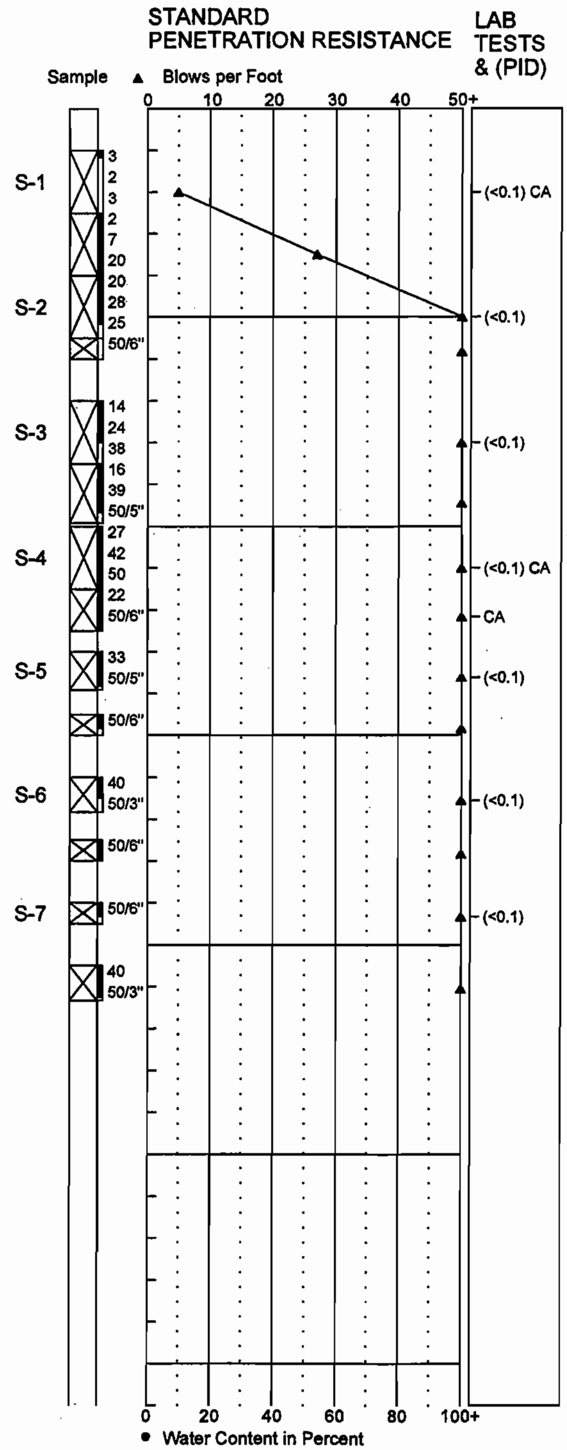
HARTCROWSER
7355-04 12/07
Figure A-5

Boring Log SB-5

Location: See Figure 2.
Approximate Ground Surface Elevation: 134 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Hollow Stem Auger
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Reed Reviewed By: G. Both

USCS Class	Graphic Log	Soil Descriptions	Depth in Feet
SM		2 inches of Asphalt over loose, damp, brown, very silty SAND.	0
SM		Medium dense to very dense, gray-brown, gravelly, very silty SAND.	
		Bottom of Boring at 21.3 Feet. Started 12/14/07. Completed 12/14/07.	



NEW BORING LOG 735504BL.GPJ HC_CORP.GDT 12/26/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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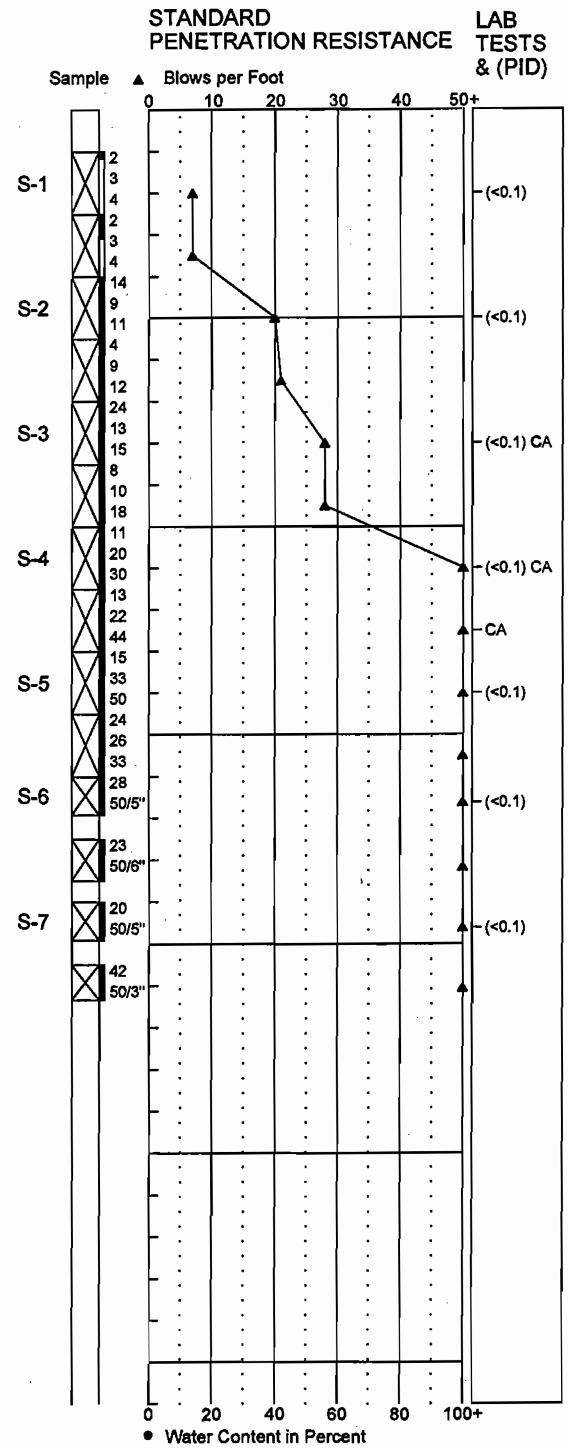
Figure A-6

Boring Log SB-6

Location: See Figure 2.
Approximate Ground Surface Elevation: 135 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Hollow Stem Auger
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Reed Reviewed By: G. Both

USCS Class	Soil Descriptions	Depth in Feet
SM	3 inches of Asphalt over loose, damp, brownish gray, gravelly, very silty SAND.	0
SM	Loose, damp, yellowish gray, slightly gravelly, very silty SAND, stratified with slight oxidation.	5
SM	Stiff, damp, yellowish brown, slightly gravelly, very sandy SILT. 8-inch SAND layer.	
SM	Dense to very dense, damp, olive gray, gravelly, silty SAND.	10
	Bottom of Boring at 21.3 Feet. Started 12/13/07. Completed 12/13/07.	15, 20, 25, 30



NEW BORING LOG 735504BL.GPJ HC_CORP.GDT 12/26/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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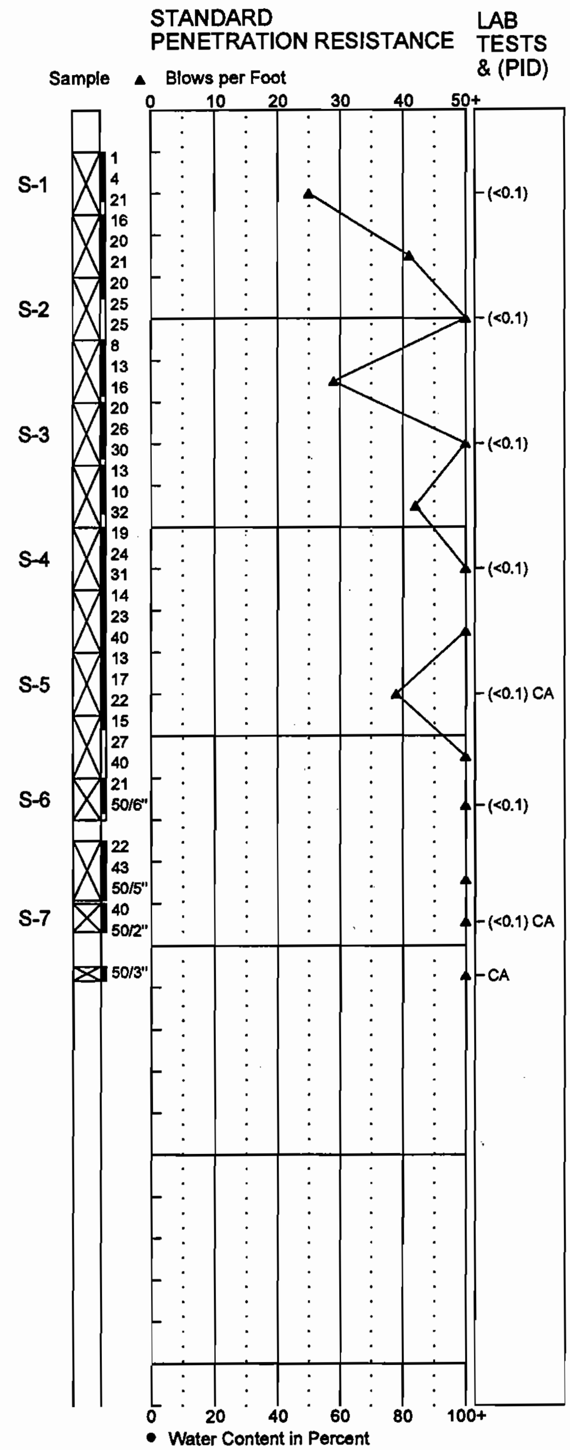
Figure A-7

Boring Log SB-7

Location: See Figure 2.
Approximate Ground Surface Elevation: 130 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Hollow Stem Auger
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Reed Reviewed By: G. Both

USCS Class	Soil Descriptions	Depth in Feet
SM	3 inches of Asphalt over (medium dense), light brown, slightly silty SAND.	0
SM	Medium dense to very dense, moist, gray-brown, slightly gravelly, very silty SAND.	
	Cobbles	5
SM	Very dense, damp to moist, gray-brown, slightly gravelly, silty SAND.	10
SM	Dense, wet, gray-brown, slightly gravelly, slightly silty SAND.	
	Grading very dense, moist to wet, silty.	15
SM	Very dense, wet, brown, slightly gravelly SAND.	20 ATD
	Bottom of Boring at 20.8 Feet. Started 12/17/07. Completed 12/17/07. Note: Grab groundwater sample collected for chemical analysis.	25 30



NEW BORING LOG 735504BL.GPJ HC_CORP.GDT 12/26/12

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

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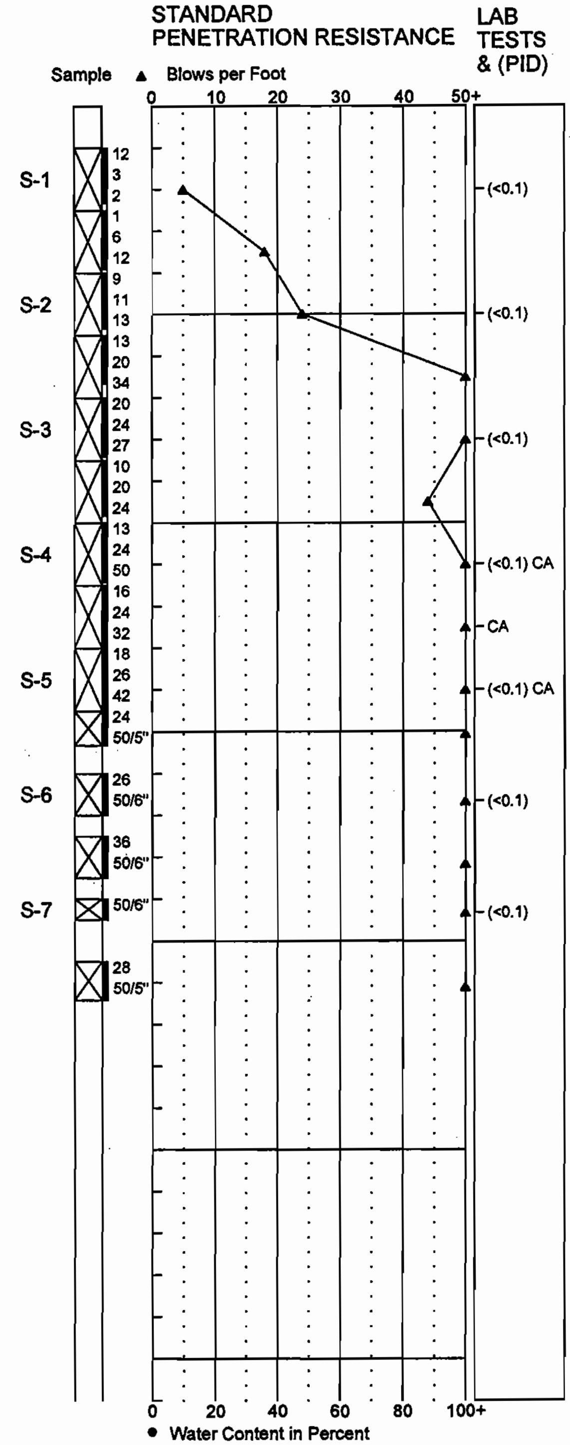
Figure A-8

Boring Log SB-8

Location: See Figure 2.
Approximate Ground Surface Elevation: 133 Feet
Horizontal Datum: NAD83, Washington State, North
Vertical Datum: NAVD88

Drill Equipment: Hollow Stem Auger
Hammer Type: SPT w/140 lb. Auto Hammer
Hole Diameter: inches
Logged By: P. Reed   Reviewed By: G. Both

USCS Class	Soil Descriptions	Depth in Feet
SM	2.5 inches of Asphalt over loose, damp, dark brown, silty SAND.	0
SM	Loose, damp, yellowish brown, gravelly, very silty SAND.	
SM	Loose, moist, olive-gray, gravelly, very silty SAND.	5
	Grading dense to very dense.	10
	Wetter layer.	15
	Bottom of Boring at 21.4 Feet. Started 12/14/07. Completed 12/14/07.	20
		25
		30



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. USCS designations are based on visual manual classification (ASTM D 2488) unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

HARTCROWSER

7355-04   12/07

Figure A-9

APPENDIX B
LABORATORY TESTING PROGRAM (2007)

APPENDIX B
LABORATORY TESTING PROGRAM (2007)

A laboratory testing program was performed for this study to evaluate the basic index and geotechnical engineering properties of the site soils. The tests performed and the procedures followed are outlined below.

Soil Classification

Field Observation and Laboratory Analysis. Soil samples from the explorations were visually classified in the field and then taken to our laboratory where the classifications were verified in a relatively controlled laboratory environment. Field and laboratory observations include density/consistency, moisture condition, and grain size and plasticity estimates.

The classifications of selected samples were checked by grain size analyses. Classifications were made in general accordance with the Unified Soil Classification (USC) System, ASTM D 2487, as presented on Figure B-1.

Water Content Determinations

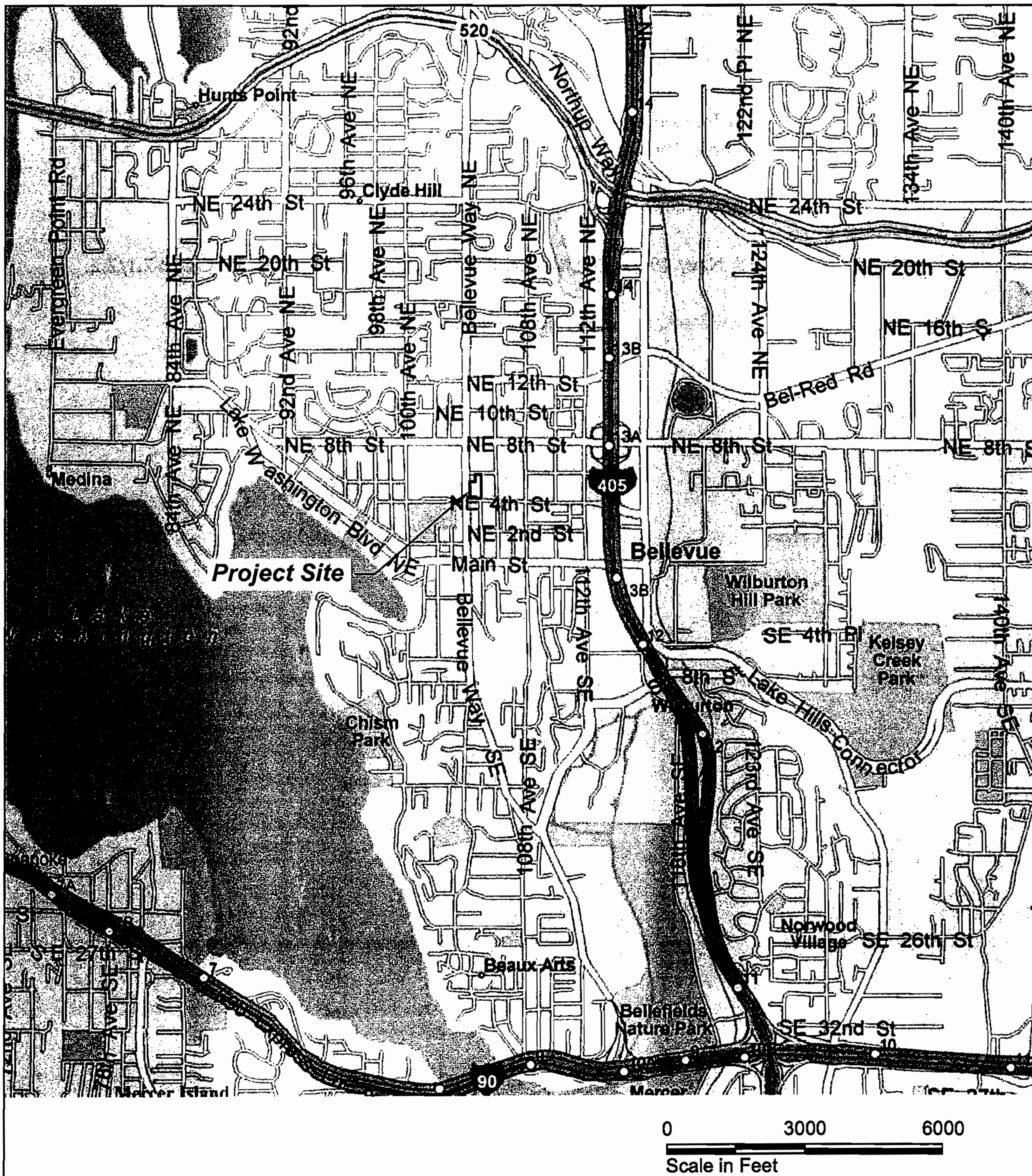
Water contents were determined for approximately half of the samples recovered in the explorations in general accordance with ASTM D 2216, as soon as possible following their arrival in our laboratory. The results of these tests are plotted at the respective sample depth on the exploration logs. In addition, water contents are routinely determined for samples subjected to other testing. These are also plotted on the exploration logs.

Atterberg Limits (AL)

We determined Atterberg limits for selected fine-grained soil samples. The liquid limit and plastic limit were determined in general accordance with ASTM D 4318-84. The results of the Atterberg limits analyses and the plasticity characteristics are summarized in the Liquid and Plastic Limits Test Report, Figure B-2. This relates the plasticity index (liquid limit minus the plastic limit) to the liquid limit. The results of the Atterberg limits tests are shown graphically on the boring logs as well as where applicable on figures presenting various other test results.

Grain Size Analysis (GS)

Grain size distribution was analyzed on representative samples in general accordance with ASTM D 422. Wet sieve analysis was used to determine the



WASHINGTON

N

Lincoln Square Expansion
Bellevue, Washington

Vicinity Map

7355-05

12/12

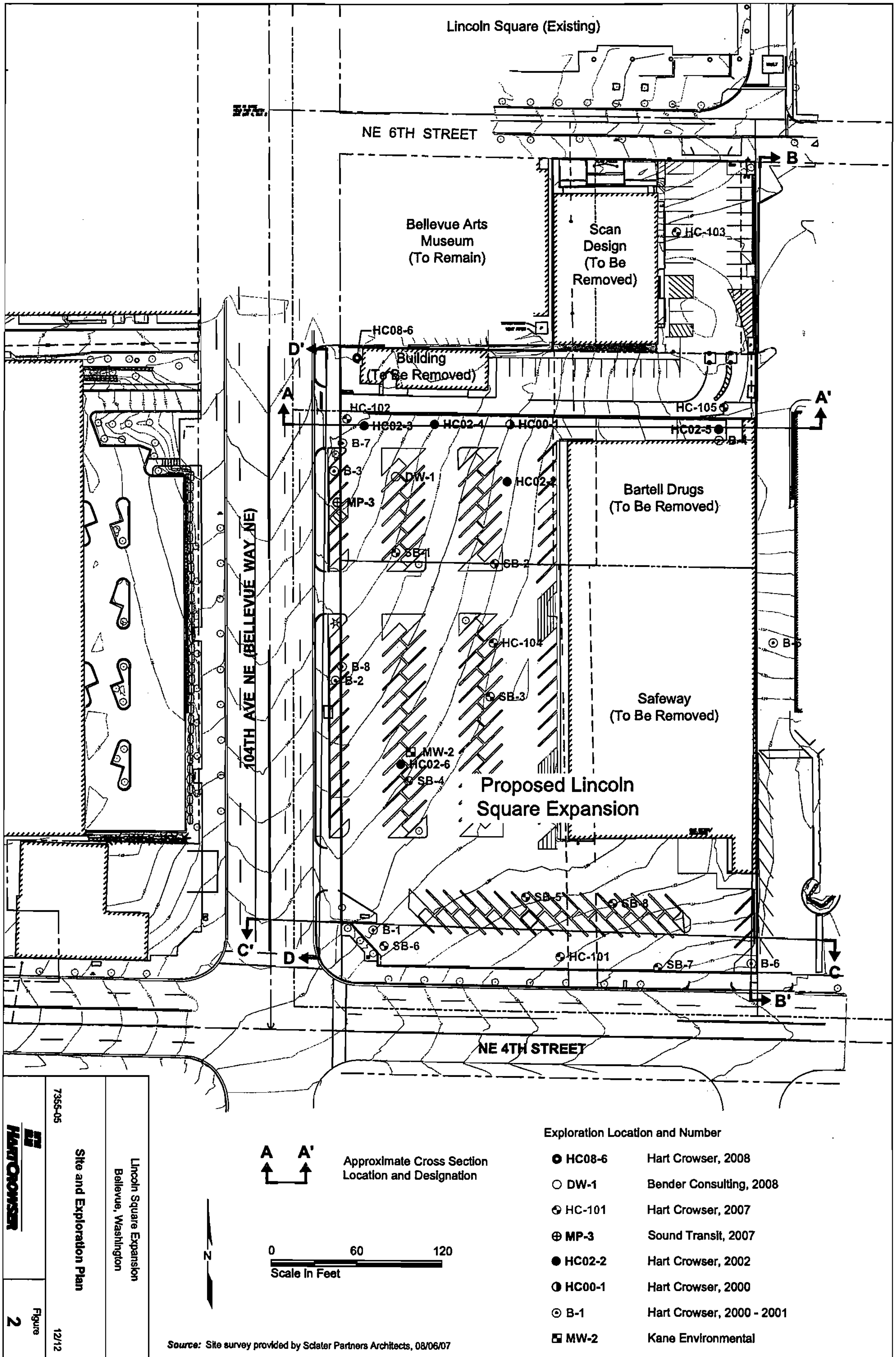
HARTCROWSER

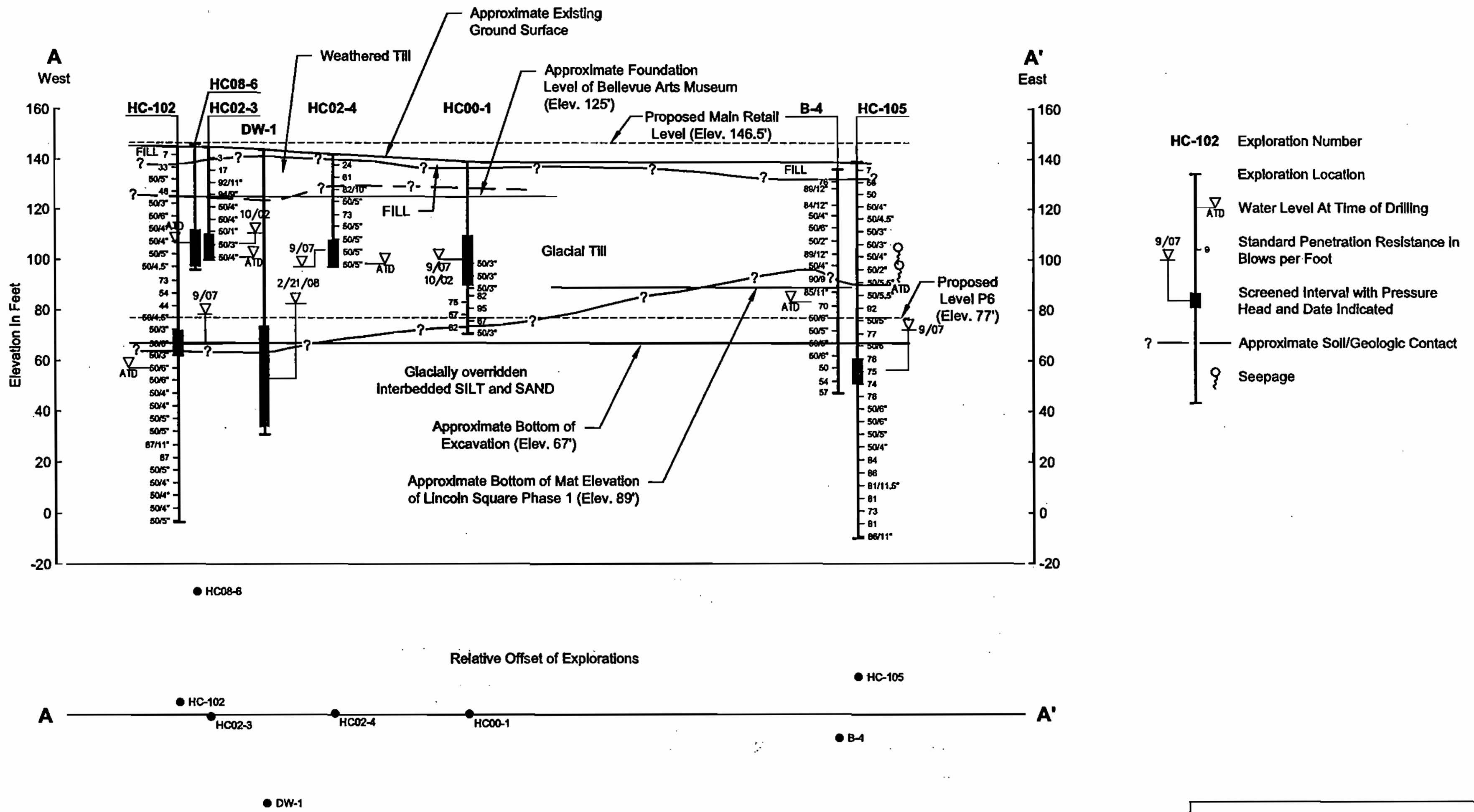
Figure

1

JAB 12/26/12 735505-001 (Vicinity Map).dwg

JAB 12/26/12 735505-002 (Exploration Plan).dwg





0 40 80
Scale in Feet

Note:
Contact between soil units is based upon interpolation between explorations and represents our interpretation of subsurfaca conditions based on available data.
See borings for detailed soil descriptions.

Lincoln Square Expansion
Bellevue, Washington

Generalized Subsurface Cross Section A-A'

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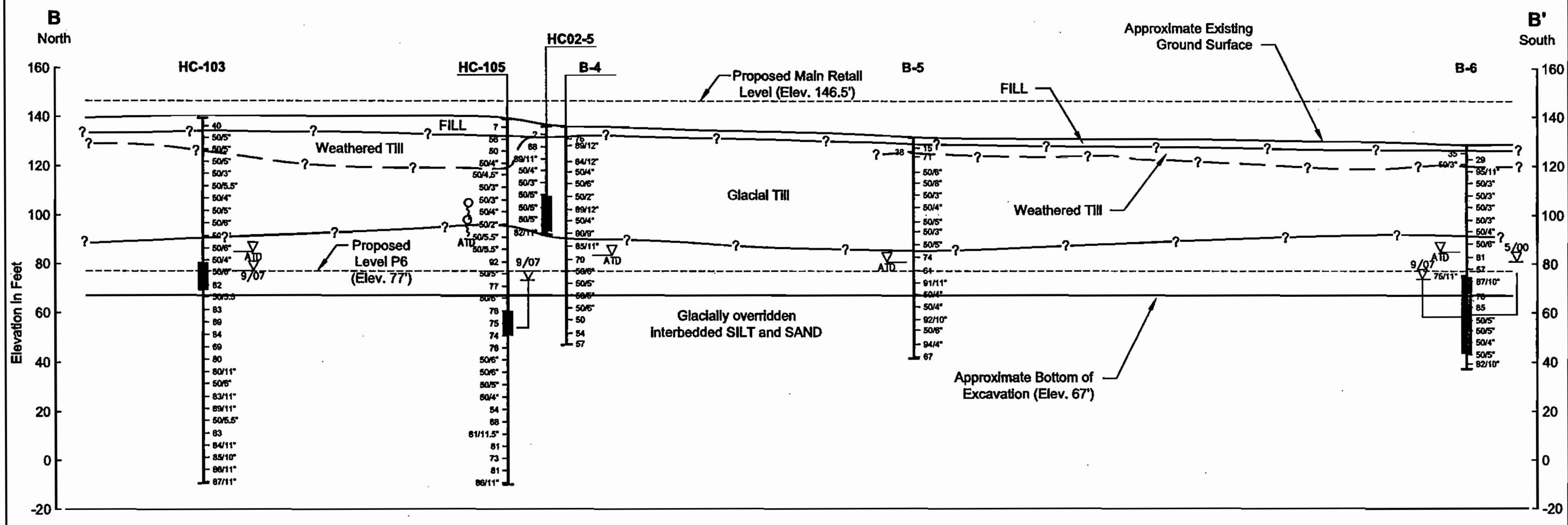
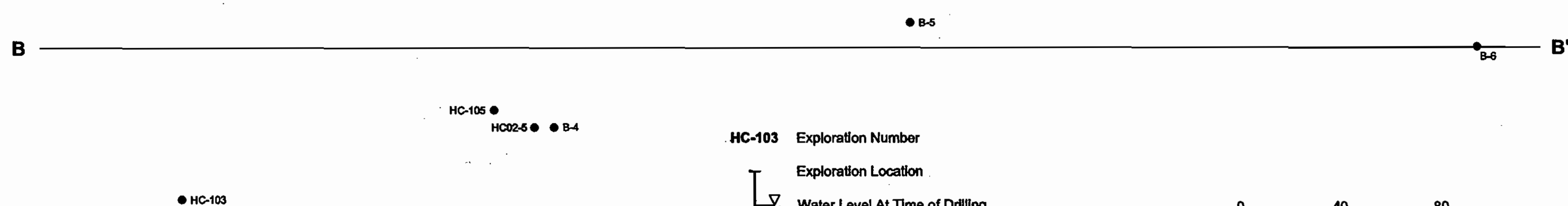
Figure
3

JAB 12/28/12 735505-003 (X-Sect A-A').dwg



Relative Offset of Explorations



HC-103 Exploration Number

Exploration Location

Water Level At Time of Drilling

Standard Penetration Resistance in Blows per Foot

Screened Interval with Pressure Head and Date Indicated

Approximate Soil/Geologic Contact

Seepage

0 40 80

Scale in Feet

Note:
Contact between soil units is based upon interpolation between explorations and represents our interpretation of subsurface conditions based on available data.
See borings for detailed soil descriptions.

Lincoln Square Expansion
Bellevue, Washington

Generalized Subsurface Cross Section B-B'

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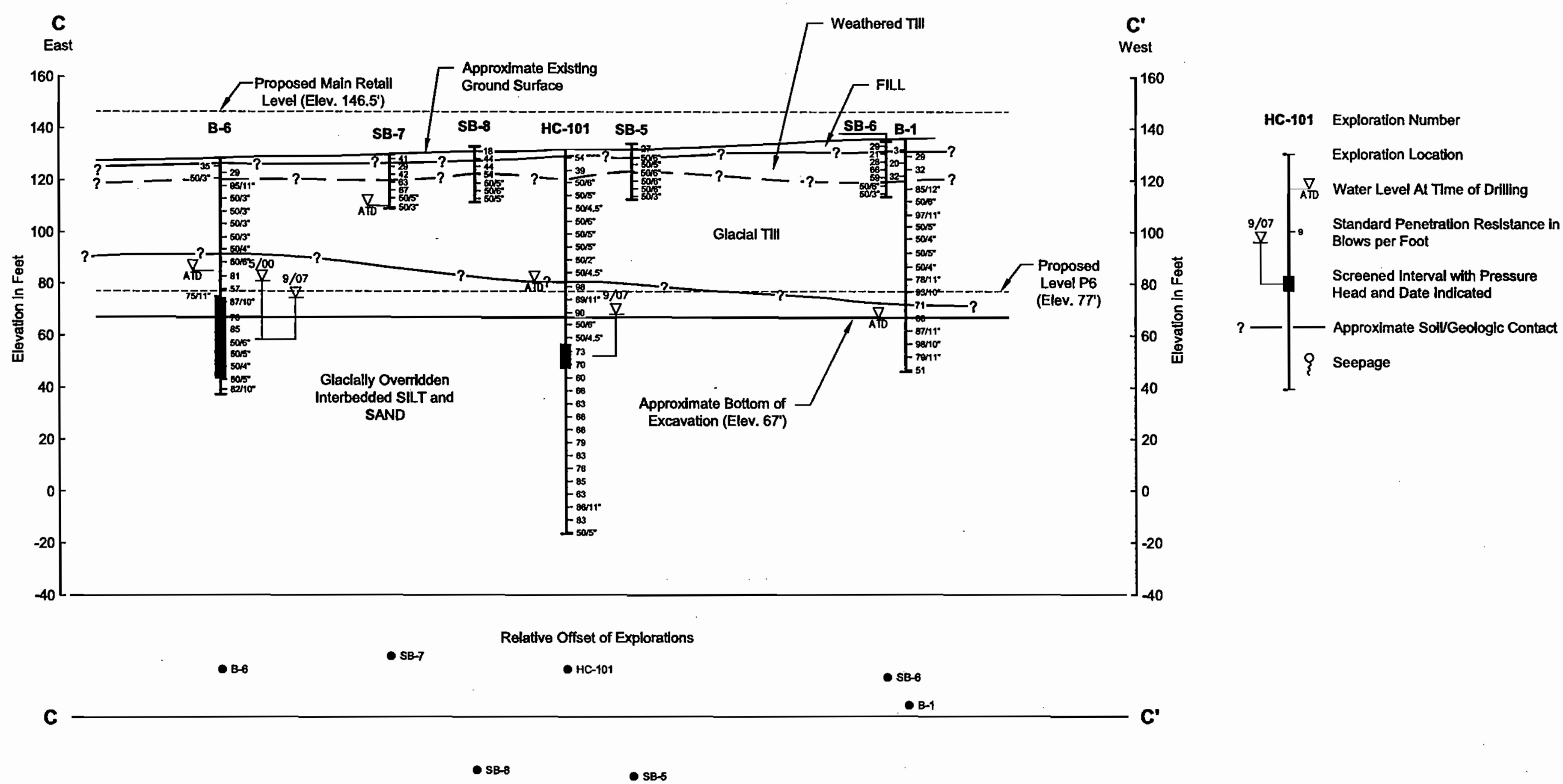
Figure
4

JAB 12/28/12 735505-004 (X-Sect B-B').dwg



Note:
Contact between soil units is based upon interpolation between explorations and represents our interpretation of subsurface conditions based on available data.
See borings for detailed soil descriptions.

Lincoln Square Expansion
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Generalized Subsurface Cross Section C-C'

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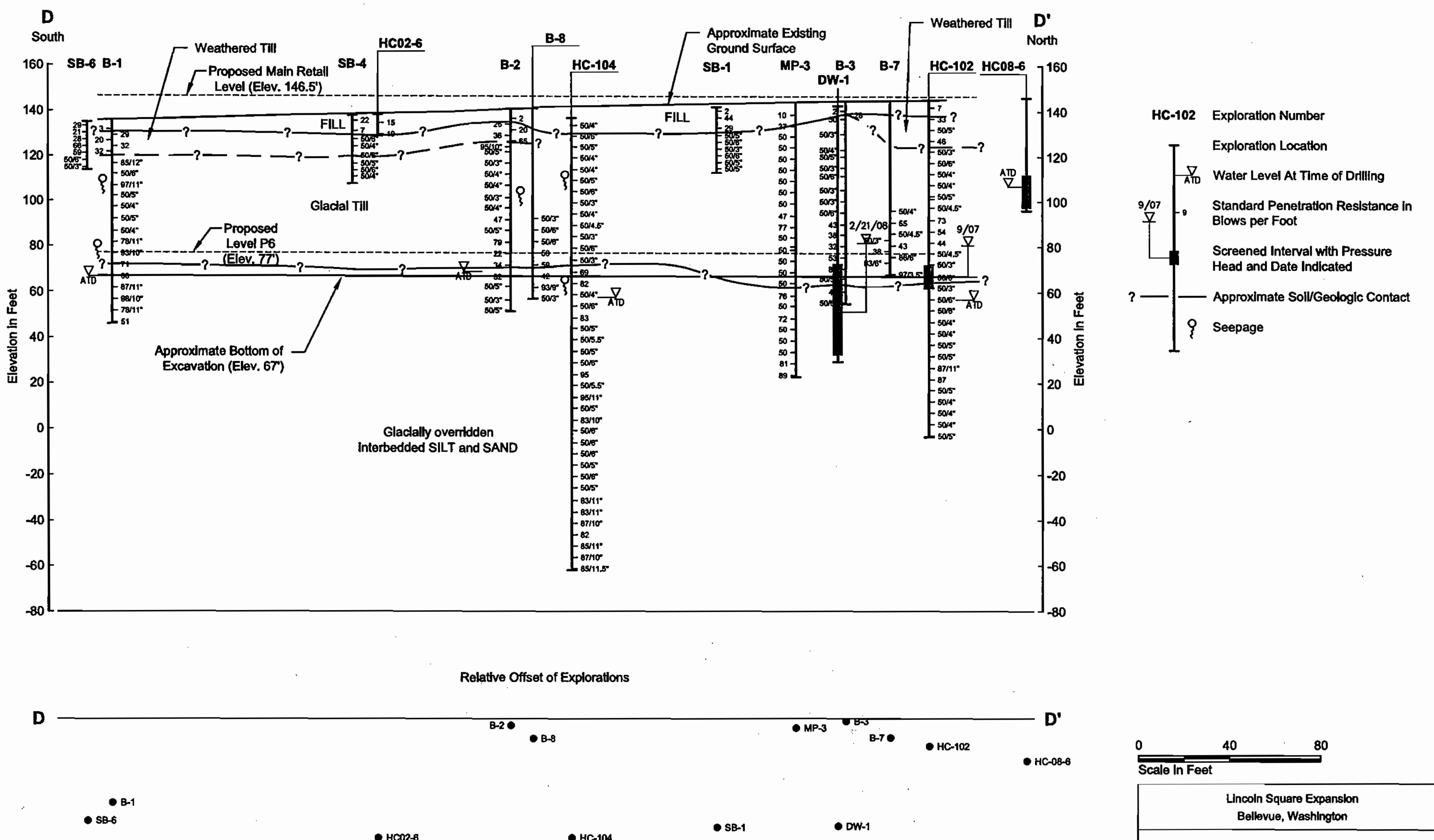
Figure
5

JAB 12/26/12 735505-005 (X-Sect C-C').dwg



Note:
Contact between soil units is based upon interpolation between explorations and represents our interpretation of subsurface conditions based on available data.
See borings for detailed soil descriptions.

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Generalized Subsurface Cross Section D-D'

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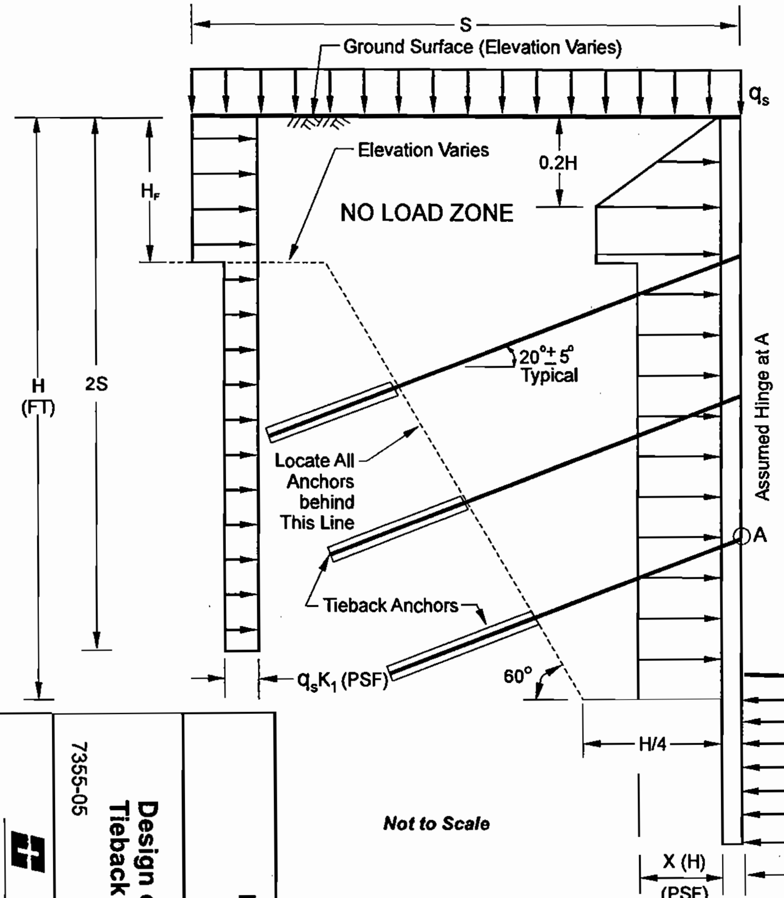
Figure
6

JAB 12/26/12 735505-006 (X-Sect D-D').dwg

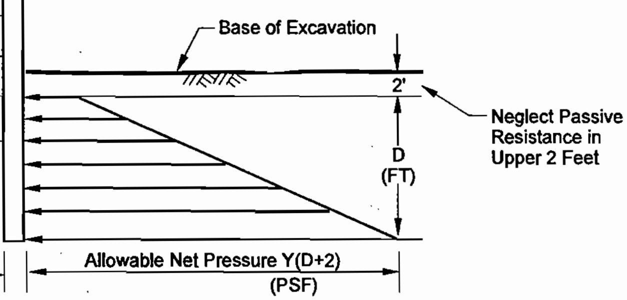
EAL 12/03/12 735505-AA.cdr

A. Lateral Soil Pressures for Soldier Pile Wall with Multiple Levels of Tiebacks



Notes:

1. Determine depth of embedment (D) by moment equilibrium of lateral soil pressures at about point A. Neglect moment resistance of soldier pile member at point A. D must also be sufficient to provide necessary vertical capacity.
2. Assume active or at-rest lateral pressures to act over pile spacing.
3. Assume passive pressures to act over three times the grouted soldier pile diameter or the pile spacing, whichever is smaller. Passive Pressures include a Factor of Safety of about 1.5.
4. It is assumed that the site is drained during construction so that hydrostatic pressures do not act on the walls.
5. All dimensions are given in feet.
6. Do not use these design criteria for design of any other type of shoring wall.
7. See Figure 8 to evaluate additional surcharge pressures.
8. Estimate depth of fill and weathered till (H_F) from Figure 3 through 6.

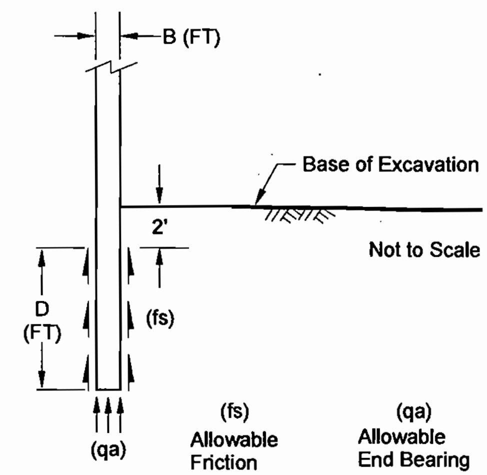


Recommended Values for K		
Soil Units	Active Conditions	At-Rest Conditions
Fill and Weathered Till	0.31	0.50
Native Glacial Till and Glacially Overridden Sand/Silt	0.24	0.40

Recommended Values of X in PCF		
Soil Units	Active Conditions	At-Rest Conditions
Fill and Weathered Till	23	35
Native Glacial Till and Glacially Overridden Sand/Silt	20	31

q_S = 250 psf (Traffic and Temporary Loads) + Additional Surcharge Loads

B. Vertical Capacity of Soldier Pile



	(fs) Allowable Friction	(qa) Allowable End Bearing
Overridden Silt/Sand	1.0 KSF	$\frac{8D}{B} \leq 40$KSF

Recommended Minimum Embedment Depth (D) = 10 Feet

C. Tentative Anchor Pullout Resistance

For design purposed, use allowable load transfer (adhesion) as follows for cased, pressure grouted, at least 6-inch-diameter boreholes in:

Native Glacial Till	3.5 KLF
Glacially Overridden Sand/Silt	2.0 KLF

KLF: Kips per lineal foot.

A minimum anchor load length (bonded zone) of 15 feet is recommended.

Verify with Load Test to 200% of Design Stress Level. See Text.

Recommended Values of Y in PCF	
For Native Glacial Till and Glacially Overridden Sand/Silt	
Above GWT	370
Below GWT	185

Assume GWT Elevation = 80 ft

Lincoln Square Expansion
Bellevue, Washington

Design of Temporary Soldier Pile and Tieback Shoring for Mass Excavation

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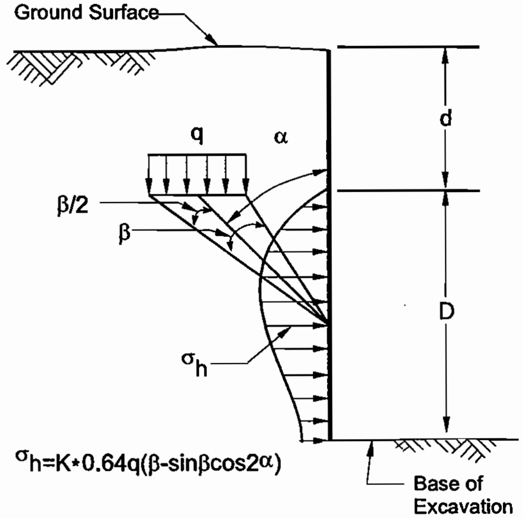
Figure 7

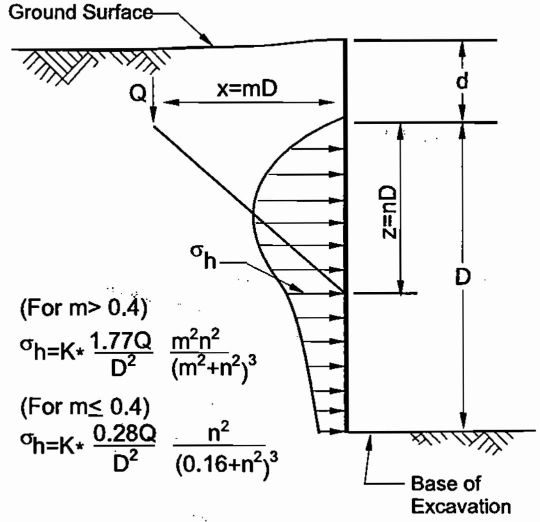
EAL 04/10/13 735505-AC.cdr

A. Strip Footing Cross Section View



$\sigma_h = K * 0.64q(\beta - \sin\beta \cos 2\alpha)$

B. Small Isolated Footing Cross Section View



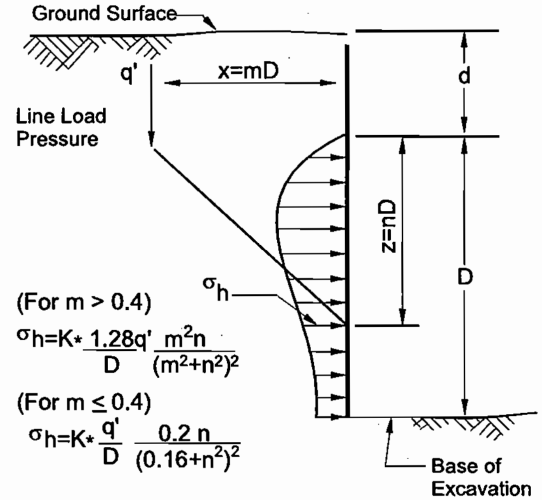
(For m> 0.4)

$\sigma_h = K * \frac{1.77Q}{D^2} \frac{m^2 n^2}{(m^2+n^2)^3}$

(For m≤ 0.4)

$\sigma_h = K * \frac{0.28Q}{D^2} \frac{n^2}{(0.16+n^2)^3}$

C. Continuous Wall Footing Parallel to Excavation Cross Section View



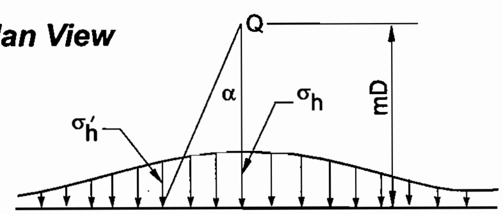
(For m > 0.4)

$\sigma_h = K * \frac{1.28q'}{D} \frac{m^2 n}{(m^2+n^2)^2}$

(For m ≤ 0.4)

$\sigma_h = K * \frac{q'}{D} \frac{0.2\,n}{(0.16+n^2)^2}$

D. Plan View



$\sigma'_h = \sigma_h \cos^2(1.1\alpha)$

Definition and Units

Q	Footing Load in Pounds
D	Excavation Depth below Footing in Feet
d	Depth to Base of Footing in Feet
σ_h	Lateral Soil Pressure in PSF
q	Unit Loading Pressure in PSF
q'	Footing Load in Pounds per Foot
α, β	Angles in Radians

K	Conditions
0.35	Active earth pressures on a flexible wall (e.g., shoring)
0.5	At-rest conditions, where surcharge loads exist prior to excavation
1.0	At-rest conditions, where surcharge loads are applied after construction of permanent wall

Notes:
1. Lateral pressures due to adjacent structures should be added to lateral pressures on Figures 5 and 6.
2. Wall footings acting other than parallel to the excavation can be treated as series of discrete point loads, using approach B.
3. Contact Hart Crowser for surcharge recommendations if necessary.

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Surcharge Pressures
Determination of Lateral Pressure
Acting on Adjacent Shoring

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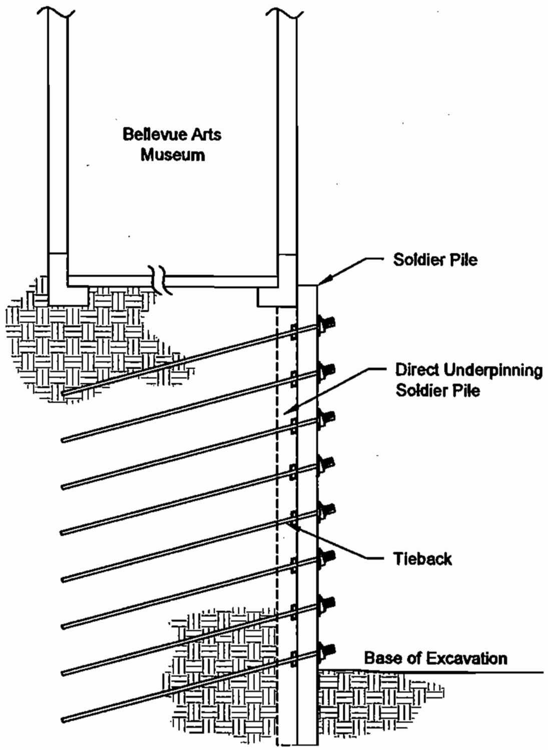
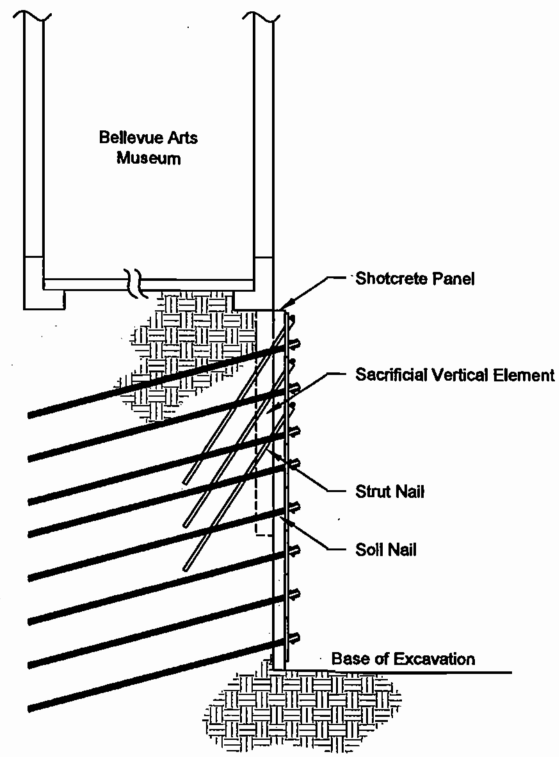
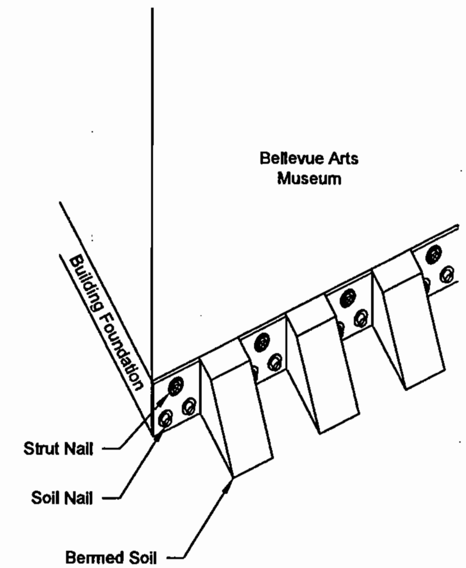
Figure 8



A. Soldier Pile Tieback System



B. Soil Nails



C. Example of Slot Cutting Construction

Not to Scale

Lincoln Square Expansion Bellevue, Washington	
Schematic Underpinning Concepts	
7355-05	4/13
HARTCROWSER	Figure 9

EAL 04/10/13 735505-011.dwg

ATTACHMENT 1
SOIL NAIL/ANCHOR TESTING PROGRAMS

ATTACHMENT 1
SOIL NAIL/ANCHOR TESTING PROGRAMS

SOIL NAIL TESTING PROGRAM

Sacrificial nail verification tests shall be performed at locations selected by the Contractor as indicated in the Drawings, and approved by the Owner's Representative. Proof tests shall be performed at locations selected by the Owner's Representative. All test data shall be recorded by the Owner's Representative, unless the Geotechnical Engineer approves otherwise. Pullout testing of soil nails shall not be performed until the nail grout and shotcrete facing have attained at least 50 percent of their specified 28-day compressive strengths.

Performance Tests

A minimum of two performance tests per soil type should be completed before installation of production soil nails. The unbonded length of the test soil nail should be at least 3 feet unless approved otherwise by the Geotechnical Engineer. Each performance test should be conducted according to the following procedure:

1. The geotechnical engineer will select the testing locations with input from the shoring subcontractor.

2. The maximum stress in the soil nail should not exceed 80 percent of the ultimate tensile strength for grade 150 ksi steel, or 90 percent of the yield strength for grade 60 or 75 ksi steel during performance testing (based on Post Tensioning Institute [PTI] manual). These conditions may require thicker soil nail bars than those used for production soil nails in order to successfully permit stressing to 200 percent of design load as required for the performance tests.

   The performance test will measure soil nail stress and displacement incrementally to values of unit skin friction equal to 200 percent of the design load (DL). The alignment load (AL) is the minimum load required to align the testing apparatus and should not exceed about 0.05DL. For performance test, the test nails should be incrementally loaded and unloaded, and deflections measured, in accordance with the schedule presented in Table 1-1.

Table 1-1 - Performance Test – Temporary Shoring

Load Level	Hold Time	Load Level	Hold Time
AL	Until Stable	1.75DL	Until Stable
0.25DL	10 min	1.50DL	Until Stable
0.50DL	10 min	1.25DL	Until Stable
0.75DL	10 min	1.00DL	Until Stable
1.00DL	10 min	0.75DL	Until Stable
1.25DL	10 min	0.50DL	Until Stable
1.50DL	60 min (Creep)	0.25DL	Until Stable
1.75DL	10 min	AL	Until Stable
2.00DL	10 min		

3. For 10-minute hold times, obtain and record deflection measurements during loading at intervals of 30 seconds, 1 minute, 2 minutes, 3 minutes, 5 minutes, 7 minutes, and 10 minutes. Measurements shall be made to an accuracy of 0.01 inch.

4. Perform a creep test at the 150 percent of design load, holding the load constant to within 50 psi, and recording readings at 30 seconds, 1 minute, 2 minutes, 3 minutes, 5 minutes, 7 minutes, 10 minutes, 20 minutes, 30 minutes, 50 minutes, and 60 minutes.

5. A successful test is one that does not experience pullout failure, holds the maximum test unit stress without considerable creep movement, satisfies apparent free length criteria, and satisfies creep rate criteria.

   - Pullout failure occurs when test measurements no longer exhibit a linear or near-linear relationship between unit stress and movement over the entire 200 percent stress range.

   - Noticeable creep is defined as a movement of not more than 0.04 inch between the 1- and 10-minute readings, or not more than 0.08 inch between the 6- and 60-minute readings. If the reading does not stabilize to 0.08 inch or less per log cycle, the test shall be considered to fail the creep movement criteria.

   - To meet apparent free length criteria, the total measured movement at the maximum test load minus the measured residual movement at the ending alignment load should be greater than 80 percent of the theoretical elastic elongation of the design unbonded length.

- Creep rate criteria is satisfied if the creep rate is linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.

6. Perform tests without backfill ahead of the anchor, if the hole will remain open, to avoid any contributory resistance by the backfill. If the hole will not remain open during testing, provide a bond breaker on the tie rods and backfill the no-load zone with a non-cohesive mixture.

Proof Tests

Proof testing shall be performed on approximately 5 percent of the production soil nails in each shotcrete lift for each soil nail shoring wall as determined by the Owner's Representative. The unbonded length of the test soil nail should be at least 3 feet unless approved otherwise by the Geotechnical Engineer. For each production soil nail to be proof tested, follow the procedures outlined below:

1. Load the test soil nail incrementally to 130 percent of the design load in increments of approximately 25 percent of the design load (i.e., 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, and 1.30 DL). The maximum stress in the soil nail rod should not exceed 80 percent of the ultimate tensile strength during proof testing.

2. Hold each incremental load for a period long enough to obtain a stable deflection measurement while recording deflections at each load increment. All load increments should be maintained to within 5 percent of the intended load. Hold the 130 percent load for a minimum of 10 minutes, recording the movement at times of 30 seconds, 1 minute, 2 minutes, 5 minutes, 7 minutes, and 10 minutes.

3. A successful test is one that meets the same acceptance criteria as performance test soil nails, except that the creep portion of the test need not exceed 10 minutes if a creep rate less then 0.04 inches per log cycle of time is observed between 1 and 10 minute readings.

4. Proof tested soil nails considered suitable for use as production soil nails should be completed by satisfactorily grouting the unbonded length prepared for the test.