SUBMITTED TO:
King County Department of
Natural Resources and Parks
Water and Land Resources
Division
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Seattle, WA 98104

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GEOTECHNICAL DATA REPORT

Levee Breach Analysis Mapping and Risk Assessment, Lower Raging River

KING COUNTY, WASHINGTON

SHANNON & WILSON

November 9, 2021

Shannon & Wilson No: 103692-303

Submitted To: King County Department of Natural Resources and Parks
Water and Land Resources Division
201 South Jackson Street
Seattle, WA 98104
Attn: Ms. Judi Radloff

Subject: GEOTECHNICAL DATA REPORT, LEVEE BREACH ANALYSIS MAPPING AND RISK ASSESSMENT, LOWER RAGING RIVER, KING COUNTY, WASHINGTON

We prepared this report to present the geotechnical data obtained for the Lower Raging River component of the King County Levee Breach Analysis Mapping and Risk Assessment project. This report presents the results of our geotechnical historical records research, subsurface explorations, and laboratory testing for the project. Our scope of services was specified in our Personal Services Agreement with King County, Number E00670E20, dated February 2, 2021.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON

Date: 2021.11.10
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Oliver Hoopes, PE
Associate

GVP:OTH:SRB/gvp

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1 INTRODUCTION

The King County Levee Breach Analysis Mapping and Risk Assessment (Project) is intended to identify the areas along portions of several river corridors within King County where containment levee systems may be vulnerable to breaching placing people, property, and infrastructure at risk. The Lower Raging River is one of the river systems included in the Project study.

Work for this Project involves data collection to physically characterize the levee systems, conducting seepage and levee failure analyses, hydrologic and hydraulic modeling, developing inundation mapping, and conducting economic risk analysis. Mapping and risk assessment results will be presented in subsequent reports.

This report presents the results of our geotechnical subsurface explorations and laboratory testing for the Lower Raging River corridor study, as well as available historical subsurface information. Subsurface explorations were performed to collect soil and groundwater data to support future geotechnical analyses of levee stability. The purpose of this report is to present the factual data collected during our geotechnical historical records research, subsurface explorations, and laboratory testing for the Lower Raging River study.

2 SITE DESCRIPTION

The Raging River is located in the central part of King County and flows into the Snoqualmie River at Fall City (see Figure 1). The Raging River basin has a watershed area of 33 square miles. Basin elevations range from 79 feet at the mouth of the Raging River to 3,517 feet on Rattlesnake Mountain. Except for the central valley floor and lower 8 miles of the river, the basin is generally steeply sloping and forested. The Upper Raging River flows in a narrow, V-shaped valley with an average gradient of about 3%. Between Upper Preston and Fall City, the Lower Raging River channel gradients range from 0.9% to 1.6%. Canyon Creek, Deep Creek, and Lake Creek are major tributaries of the Upper Raging River, and Icy Creek feeds into the Lower Raging River. From the Deep Creek confluence to Preston, the Upper Raging River flows northwest in a gently-sloping, 1,800-foot-wide valley. At Preston, the river turns abruptly to the northeast and flows through a steeper, narrower valley toward the Snoqualmie River at Fall City. In both the upper and lower valleys, the active floodplain is generally only a few hundred feet wide and lies between higher terraces. In its last mile, the river gradient flattens as it flows across an alluvial fan built by the Lower Raging River across the Snoqualmie River valley floor (Shannon & Wilson, 1991).

Large areas of the Upper Raging River basin were logged from about 1900 to 1932, from the vicinity of Preston southeast to the Canyon Creek and Deep Creek drainages. Logging along the Upper Raging River revived sometime in the 1970s but was most intensive in the late 1980s and involved almost the entire watershed upstream from Highway 18, on the order of 25% of the total area of the Raging River basin. The hillsides of the Lower Raging River between Preston and Fall City were logged mainly by 1960. The Lower Raging River is also crossed by five bridges between Fall City and Preston. The Preston bridge washed out in a large 1932 flood and was later rebuilt. Minor erosion problems associated with some of these bridges have been controlled by riprap (Shannon & Wilson, 1991). Land use along the river is primarily residential with some commercial activity such as quarries and lumberyards.

The Lower Raging River containment levee system consists of four levees that are approximately 1.5 miles long on both banks of the river, totaling about 2.85 miles of levee on the river. These levees protect residences, businesses, commercial property, and infrastructure from flood hazards within the unincorporated town of Fall City.

3 GEOLOGY

3.1 General Geologic Setting

The Raging River is located near the eastern edge of the Puget Lowland, a north-trending basin filled with the deposits of multiple Quaternary glaciations. The river flows through floodplains of gravelly alluvium derived primarily from reworked glacial sediment. Glacial sediments form or mantle the valley walls or the Raging River; most of these sediments were deposited 13,000 to 15,000 years ago during the Vashon stage of Fraser glaciation, the latest glaciation in which ice covered the Snoqualmie Valley area. Exposures of glacial sediments in the riverbank is common throughout the Raging River. Tributary streams and landslides from the steep valley walls deliver sediment ranging in size from clay to boulders to the river. In the headwaters of the river basin, Tertiary bedrock of the Cascade Range is exposed on the hillsides and in places in the river channel (Booth, 1990; Dragovich and others, 2007).

Along the Lower Raging River, the river gradient averages 0.94% as it crosses its alluvial fan into the Snoqualmie River. This reach of river is confined between levees spaced 100 to 150 feet apart. Prior to construction of the levees, the active channel was wider and multiple channels existed across the fan. Figure 3 presents the current Lower Raging River right bank and left bank levee alignments overlain onto 1936 aerial photographs taken prior to levee construction. As indicated in Figure 3, the levees were constructed atop channel

meanders at several locations. Since levee construction, alternate gravel bars have been deposited within the levees and are stabilized by vegetation in many cases.

3.2 Site Subsurface Conditions

Based on our historical information review the soils we sampled in our subsurface explorations, the following groups of materials are present in the upper 50 feet along the Lower Raging River system:

- **Levee Fill** – Levee fill represents the material primarily used to construct the levees. Levee fill generally consists of poorly graded gravel with silt, sand and cobbles. Explorations encountered levee fill to a depth of 5 to 6 feet below ground surface (bgs) in all four borings.
- **Native Gravel** – Gravel is present below the levee fill. The thickness of the native gravel ranges from 14 to 24 feet, with the layers ending 20 to 30 feet bgs in each boring. Native gravel primarily consists of poorly to well-graded gravel with silt, sand, and/or cobbles. In most borings, the contact between levee fill and native gravel is difficult to distinguish.
- **Native Sand** – Native sand consists of silty sand to poorly graded sand with silt, with the sand particles being primarily fine- to medium-grained. Native sand underlies the native gravel in B-RR-1 and B-RR-3. In B-RR-1, the native sand layer encountered was 5 feet thick; in B-RR-3 the layer was 18 feet thick. Native sand ranged from brown to gray with iron oxide staining locally.
- **Native Silt** – Silt was encountered in B-RR-1, B-RR-2, and B-RR-4, with the layer beginning between 22 and 30 feet bgs and extending to the bottom of each boring, to a depth of 51.5 feet bgs. In B-RR-2, the silt layer was directly beneath the native gravel layer. In B-RR-1, silt was encountered below the native sand layer, and in B-RR-4 silt was encountered beneath very soft silt. Native silt is primarily nonplastic to low plasticity silt or silt with sand ranging in color from brown to gray. Cohesionless native silt ranged from very loose to medium dense and cohesive native silt ranged from stiff to very stiff.
- **Native Very Soft Silt** – Native very soft silt was encountered in B-RR-4 between 22 and 30 feet bgs, and in B-RR-3 from 25 to 26 feet bgs. This silt is brown and low to medium plasticity. In B-RR-3, some wood fragments and other organic materials were encountered in this unit.

4 LEVEE CONSTRUCTION HISTORY

The Lower Raging River is confined by levees armored with riprap where it crosses the Snoqualmie River floodplain and Lower Raging River alluvial fan built across the

Snoqualmie River valley floor. These levees were built between 1939 and 1941, at which time the river was also straightened and channelized (Shannon & Wilson, 1991 and King County, 1940). The levees were raised and reinforced in the early 1960s. Supplementary bank protection structures, primarily riprap, are widespread throughout the Lower Raging River but most are limited in length to one or two pieces of private property. Records for the County-maintained revetments on both rivers do not quantify historic expenditures but show that most of the revetments have required repairs or maintenance at least once (Shannon & Wilson, 1991).

Approximately 125,000 cubic yards of gravel was removed from the river during levee construction in the 1930s (King County, 1940). As part of the King County flood control program, gravel was also removed from the Lower Raging River during the 1960s. Sequential photographs show that deposition of gravel bars at the river mouth and within levees has occurred on the river since the cessation of gravel removal, and that many of the gravel bars have become stabilized by vegetation. Logs were regularly removed along the inhabited section of the river during the 1960s, and log removal by King County continued to a lesser extent through the 1970s. Log removal was eventually discontinued due to budget constraints, concerns about fish habitat and air pollution from burning, and growing evidence that woody debris reduced flow velocities and can in some cases contribute to channel stability. In the 1980s, sawing of large logs into smaller pieces and removal of log jams was done on a limited basis by local residents and King County (Shannon & Wilson, 1991).

5 PROJECT SUBSURFACE EXPLORATIONS

We performed four borings and eight test pits to characterize the subsurface conditions along the Lower Raging River study area. We subcontracted with Holt Services, Inc. of Edgewood, Washington, to drill the four borings and install four vibrating wire piezometers (VWPs). We subcontracted with Agostino Construction, Inc. of Maple Valley, Washington, to excavate the eight test pits.

We used the following general goals to guide our selection of the exploration locations:

- Locations near inside river bends because scour risk at those locations is greater.
- Areas where no historic subsurface data is present.
- Target a relatively even distribution or spread of explorations along the river within the study area.

- Locations where, based on the historic aerial photographs (see Figure 3), the levees were constructed atop old river channels.

We designated our explorations using the exploration method (i.e., "B-RR" for Raging River borings and "TP-RR" for Raging River test pit) and a number (i.e., "B-RR-1" and "TP-RR-01"). 1 Alliance Geomatics surveyed the boring and test pit locations and elevations after completion. The locations of the Lower Raging River subsurface explorations are shown in Figure 2.

5.1 Soil Borings

Holt drilled and sampled the four borings using sonic core drilling techniques between June 21 and 24, 2021. The borings were designated B-RR-1 through B-RR-4. Each boring reached a depth of approximately 51.5 feet bgs. A Shannon & Wilson representative observed, logged, and collected the soil samples retrieved from the borings.

5.1.1 Sonic Core Drilling Procedures

Holt performed sonic core drilling using a Terra Sonic TSI 150CC track-mounted sonic drill. The sonic core drilling method uses high-frequency vibratory motion applied to the top of the drill column, along with down-pressure and rotation, to obtain nearly continuous core samples in the soil. Soil samples were obtained using a 6-inch-outside-diameter (OD) core barrel. The core barrel was advanced into the ground a specific distance (termed a core "run") and then retrieved for extraction of the sample core. The amount of sample retrieved, expressed as a percentage of the length of the recovered sample to the total length of the core run, is presented in the boring logs in Appendix A. Following retrieval of the core barrel, a temporary casing was advanced to the bottom of the sampled interval. The casing was then cleared of slough and the next core sample was collected, starting at the bottom of the temporary casing.

Core samples were stored in plastic bags to preserve moisture and placed into 5-foot-long wooden boxes to preserve structure during transport. The wooden boxes were returned to our laboratory in Seattle, Washington, for further review.

5.1.2 Split-Spoon Sampling

We collected disturbed soil samples with a split-spoon sampler in conjunction with Standard Penetration Testing (SPT) in accordance with ASTM Designation D1586, Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils (ASTM, 2020). The SPT consists of a 2-inch-OD, 1.375-inch-inside-diameter split-spoon sampler driven 18 inches into the bottom of the borehole with a 140-pound hammer free falling 30 inches.

The number of blows required to penetrate the final 12 inches is termed the Standard Penetration Resistance (N-value). The field N-values are plotted on the boring logs presented in Appendix A. These values provide an empirical means for evaluating the relative density of granular soil and the relative consistency (stiffness) of cohesive soil. Figure A-1 in Appendix A shows the relative density or consistency as it relates to the SPT N-value.

The presence of gravel and cobbles may impact measured penetration resistances and result in high SPT N-values. This can be especially pronounced when a geologic unit is known to be deposited in an environment where it is not overconsolidated, such as alluvium. Where gravelly/cobbly material is encountered in our explorations, our boring logs include a note that the blow counts recorded may not be indicative of the soil density due to the presence of gravel and cobbles.

SPT N-values can be affected by other factors, including the efficiency of the hammer used. N-values presented in this report are reported in blows per foot as counted in the field. No corrections have been applied. N-values of zero indicate that the sampler advanced the last 12 inches of the 18-inch sampling interval without a single hammer strike. That is, the weight of the drilling rods plus the weight of the hammer (not in motion), reported as "WOH", was sufficient to advance the sampler. An SPT was considered to have met refusal where more than 50 blows were required to drive the sampler 6 inches. If refusal was encountered, the test was terminated and the number of blows, along with the penetration distance recorded (i.e., 50/3").

We described each sample retrieved in the field and sealed the samples in labelled plastic jars to preserve moisture. We stored the sample jars in boxes and returned them to our laboratory in Seattle, Washington, for further review.

5.1.3 Vibrating Wire Piezometer Installation

Holt installed Geokon Model 4500S VWPs with a 350-kilopascal (50 pounds per square inch) pressure range in all boreholes in accordance with applicable Washington State Department of Ecology regulations. The VWP consists of a vibrating wire pressure transducer contained in stainless steel housing. The transducer is connected to a signal cable that is routed up the borehole to a datalogger at ground surface. Holt grouted the VWPs into place at depths ranging from 18 to 25 feet bgs by attaching it to a tremie pipe and pumping grout into the bottom of the borehole. A 12-inch-diameter steel monument was installed at the borehole to house and protect the datalogger.

5.1.4 Material Descriptions and Boring Logs

In the field, our field representative visually classified the soil samples in general accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 2020). Consistency, color, relative moisture, degree of plasticity, and other distinguishing characteristics of the samples were noted. Once returned to our offices, we performed an in-depth review of the sonic cores and SPT samples, took photographs of the cores, and assigned laboratory tests to select samples. Based on this review and the results of the laboratory tests, we modified the sample descriptions and classifications as necessary using elements of the Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487 (ASTM, 2020). However, ASTM 2487 was not followed in full because we did not perform both grain-size distribution analyses and Atterberg Limits determinations on each sample tested. Terminology used in our soil classifications is defined in the Soil Description and Log Key, Figure A-1.

Logs of the borings and photographs of the retrieved core runs are presented in Appendix A as Figures A-2 through A-9. The soil descriptions and interfaces on the logs are interpretive and the actual changes may be gradual. The left-hand portion of the boring logs provides our interpretation of the soil encountered in the boring. The right-hand portion of the boring logs show a graphic log, sample locations and designations, percent sample recovered, groundwater information, a graphical representation of N-values, and select laboratory test results.

In our material descriptions, we use density terms (loose, dense, etc.) versus consistency terms (soft, stiff, hard, etc.) based on their plasticity and soil behavior. We use density terms materials such as nonplastic silts, sands, and gravels. We use consistency terms for low to medium plasticity silts, elastic silts, and all clays.

5.2 Test Pit Excavations

Geotechnical test pits TP-RR-01 through TP-RR-08 were excavated by Agostino between June 21 and 22, 2021, using a Bobcat E45 Mini Excavator. Test pit depths ranged from approximately 2 to 8 feet bgs, and either a 2- or 4-foot-wide bucket was used for excavation. Agostino backfilled the test pits with the excavated materials (spoils). Agostino compacted the backfill in 12- to 16-inch lifts with a ho-pack plate compactor.

A Shannon & Wilson representative was present throughout the test pit excavation to collect samples, visually classify the soil, and prepare an exploration log for each test pit. We collected representative disturbed soil samples (grab samples) from the backhoe bucket or

spoil pile. After soil classification, we sealed the samples in 1-gallon bags to retain moisture and returned to our laboratory in Seattle, Washington, for further review.

The intervals over which the samples were collected are shown on the test pit logs presented in Appendix A as Figures A-10 through A-17.

6 HISTORIC SUBSURFACE EXPLORATIONS

We reviewed historical information available for the Lower Raging River study area and compiled nearby historic subsurface exploration logs in Appendix B. The historical explorations are from previous projects by Shannon & Wilson and King County Department of Transportation (DOT).

The historic Shannon & Wilson explorations along Lower Raging River consist of borings and test pits associated with the Raging River Bridge Replacement Project (Shannon & Wilson, 1997). The approximate boring locations are shown in Figure 2. The Shannon & Wilson boring logs, test pit logs, and associated lab testing records are provided in Appendix B as Figures B-1 through B-19.

The historic King County DOT boring and test pit logs are associated with the Smith-Parker Bridge Replacement Geotechnical Engineering Report (GeoEngineers, 1996). The approximate boring locations are shown in Figure 2. The legend for the GeoEngineers exploration location is provided in Appendix B, Figure B-20. The boring logs, test pit logs, and lab testing records are provided in Appendix B as Figures B-21 through B-35.

The historic explorations included in this report are from other projects and, except for the 1997 borings by Shannon & Wilson, conducted by other parties. The information associated with and location of historical exploration logs cannot be confirmed and is provided for reference only. We provide this data on an "as-is" basis.

7 GEOTECHNICAL LABORATORY TESTING

We subcontracted HWA GeoSciences, Inc. to perform geotechnical laboratory testing on select soil samples retrieved from the Lower Raging River study explorations. HWA performed visual classification on each of the retrieved samples. The laboratory testing program included water content determinations, grain-size distribution analyses, and Atterberg Limits determinations. A description of each laboratory test and the test results are provided in HWA's report (HWA, 2021), which is enclosed in Appendix C.

8 HYDROGEOLOGY

We collected hourly groundwater pressure data from the VWPs installed in the borings from June 21 to July 9, 2021. Over the course of our monitoring period, groundwater levels measured about 11 feet bgs in boring B-RR-1, 22 feet bgs in boring B-R-2, 18 feet bgs in boring B-RR-3, and 13 feet bgs in B-RR-4. The groundwater data and precipitation reported at Seatac Airport during the monitoring period are presented as Figures D-1 through D-4 in Appendix D. Additional groundwater data will be collected over the winter to aid in geotechnical stability analyses and risk assessment. An addendum to this report will be issued to present the additional data once it is available.

9 USE OF REPORT

This Geotechnical Data Report (GDR) was prepared for the exclusive use of King County and the Project team to present data for inclusion in the analyses to be performed for the Lower Raging River area. This GDR was prepared under a scope of services and level of effort determined by King County to be suitable for its purposes. This GDR presents the data from field explorations and field and laboratory testing of subsurface conditions at the specific locations and depths indicated using the means and methods described in this report. No other representation is made. Subsurface conditions, such as those that may be interpreted from exploration logs and test results included in this report, should not be construed as a guarantee or warranty of any subsurface conditions. Depending upon the analysis approach, additional geotechnical data may be necessary.

Natural processes or human activity may alter subsurface conditions. Because a geotechnical report is based on conditions that existed at the time of subsurface explorations, decisions on additional actions at the site should not be based on a report whose adequacy may have been affected by time, unless verified.

10 CLOSURE

Within the limitations of the scope, schedule, and budget, the interpretations and conclusions presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principals and practice in this area at the time this report was prepared. We make no other warranty, either express or implied.

Shannon & Wilson has prepared the enclosed, "Important Information About Your Geotechnical Report," to assist you and others in understanding the use and limitations of our report. This enclosure is presented at the end of this report.

11 REFERENCES

ASTM International, 2020, Annual book of standards, construction, v. 4.08, soil and rock (I): D420 - D5876: West Conshohocken, Penn., ASTM International, 1 v.

Booth, D.B., 1990, Surficial geology of the Skykomish and Snoqualmie Rivers area, Snohomish and King Counties, Washington: U.S. Geological Survey Misc. Inv. Map I-1745.

Dragovich, J.D., Anderson, M.L., Walsh, T.J., and others, 2007, Geologic map of the Fall City 7.5-minute quadrangle, King County, Washington: Washington State Division of Geology and Earth Resources Geologic Map GV-67, 16 p., 1 sheet, scale 1:24,000.

GeoEngineers, 1996, Geotechnical Engineering Report: Smith Parker Bridge Replacement, King County, Washington: Report prepared by GeoEngineers, Seattle, Wash., for King County Department of Transportation, Project No. August 16.

HWA Geosciences, Inc., 2021, Materials laboratory report, Lower Raging River – King County Levee Project: Report prepared by HWA Geosciences, Inc., Bothell, Wash., client project no. 103692-303, for Shannon & Wilson, Inc., Seattle, Wash., July 20.

King County, 1940, Fifth Annual Report of the County Road Engineer: Report prepared by H. Laufer under direction of H. H. Sisler for the King County Board of Commissioners, May.

Shannon & Wilson, 1991, Tolt and Raging Rivers Channel Migration Study, King County, Washington: Report prepared by Shannon & Wilson, Seattle, Wash., for King County Surface Water Management Division, Project No. W-5666-01, April.

Shannon & Wilson, 1997, Geotechnical Report, Raging River Bridge 234A Replacement, Fall City, Washington: Report prepared by Shannon & Wilson, Seattle, Wash., for King County Department of Transportation, Project No. W-6819-02, June.

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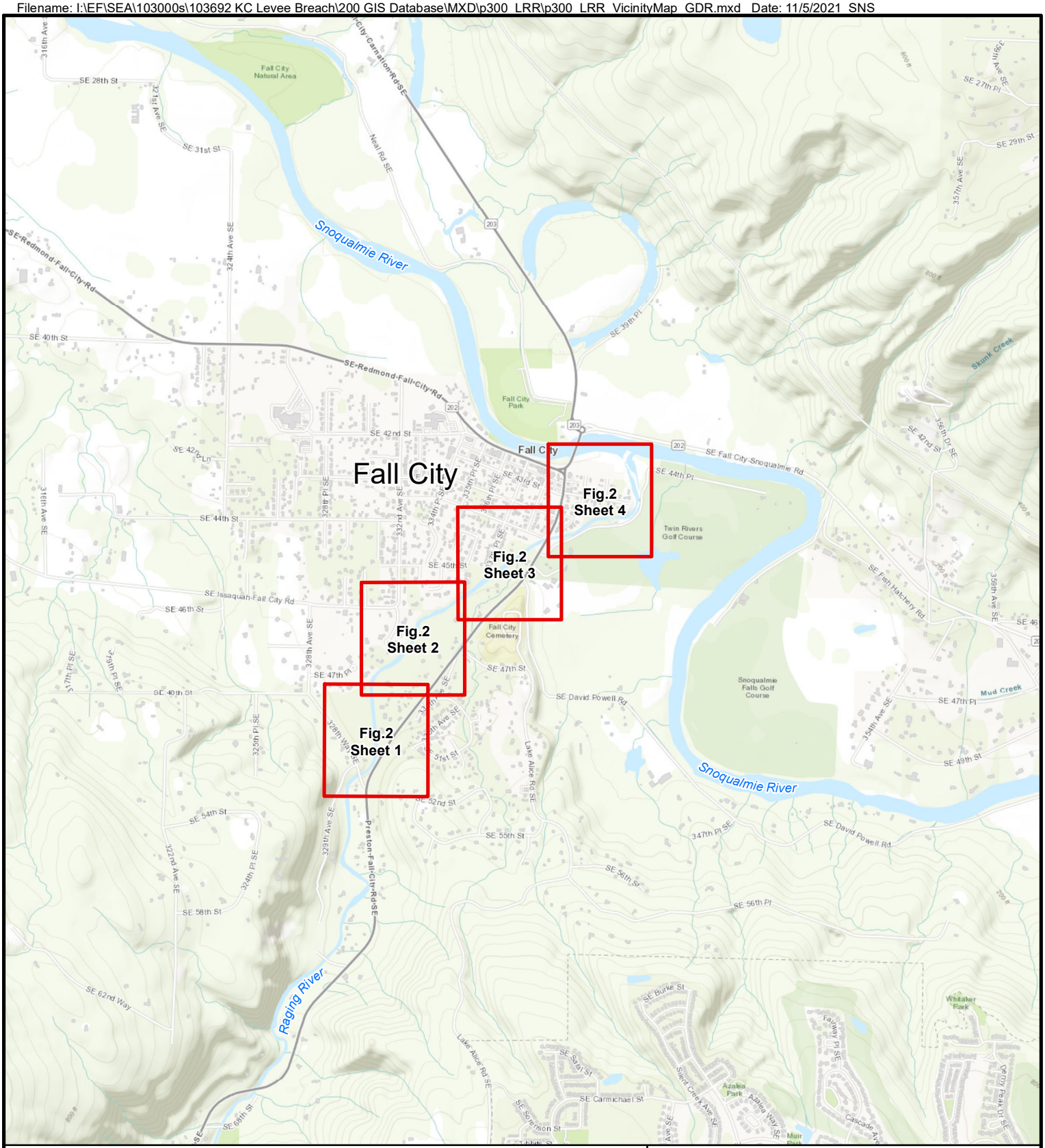

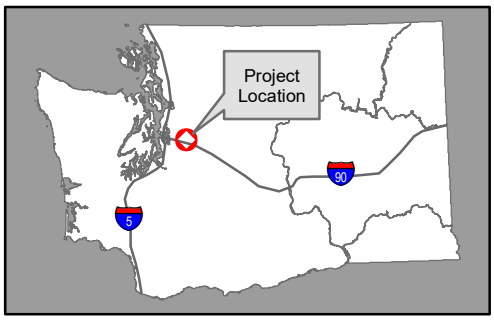

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LOWER RAGING RIVER VICINITY MAP

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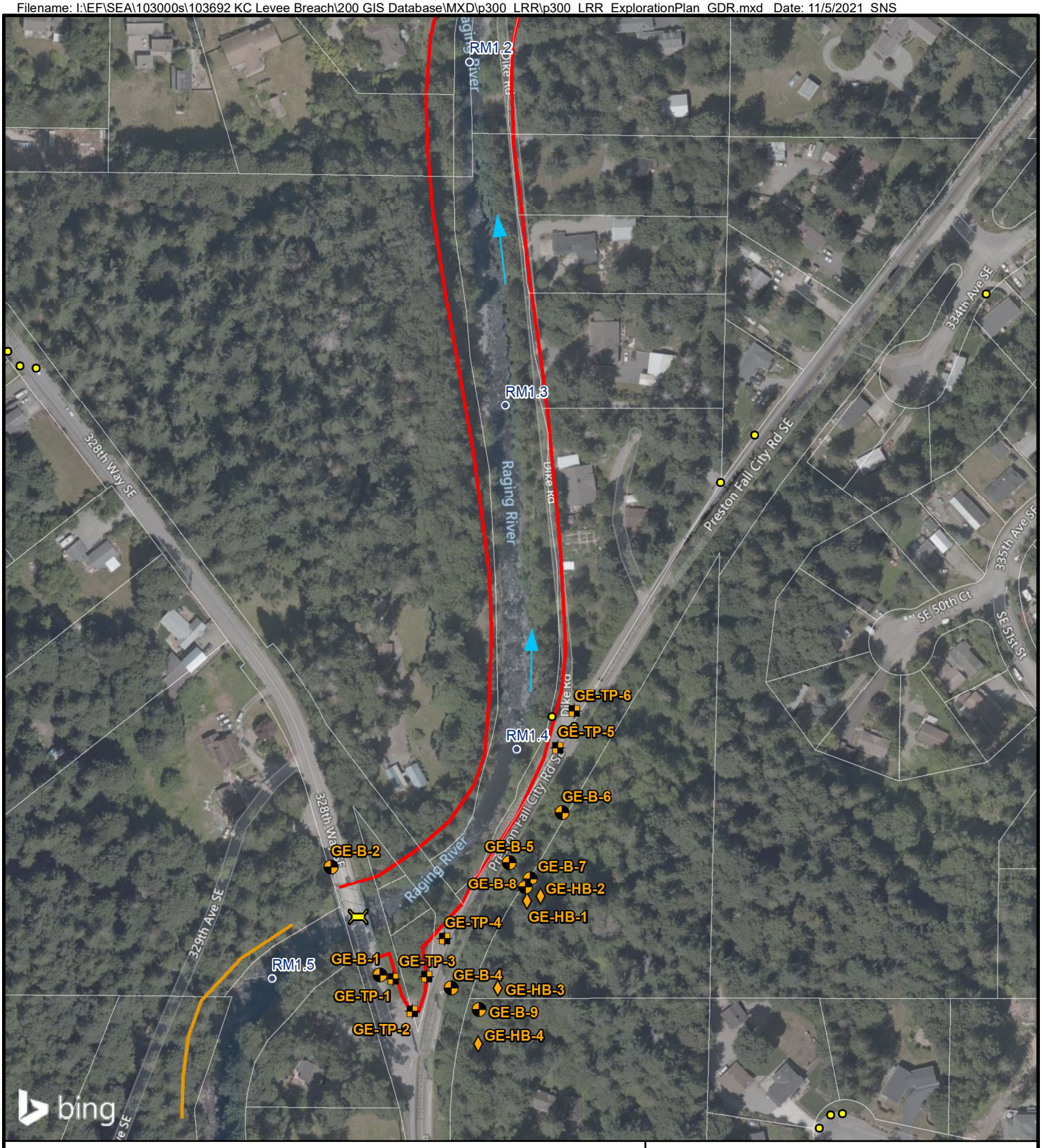

LEGEND

- King County Bridge
- Culverts
- Levees
- Revetments
- Levee Area of Interest

Project Explorations
- Project Boring
- Project Test Pit

Other Explorations
- Boring (Shannon & Wilson, 1997)
- Boring (GeoEngineers, 1997)
- Test Pit (GeoEngineers, 1997)
- Hand Boring (GeoEngineers, 1997)

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LOWER RAGING RIVER SITE AND EXPLORATION PLAN

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FIG. 2
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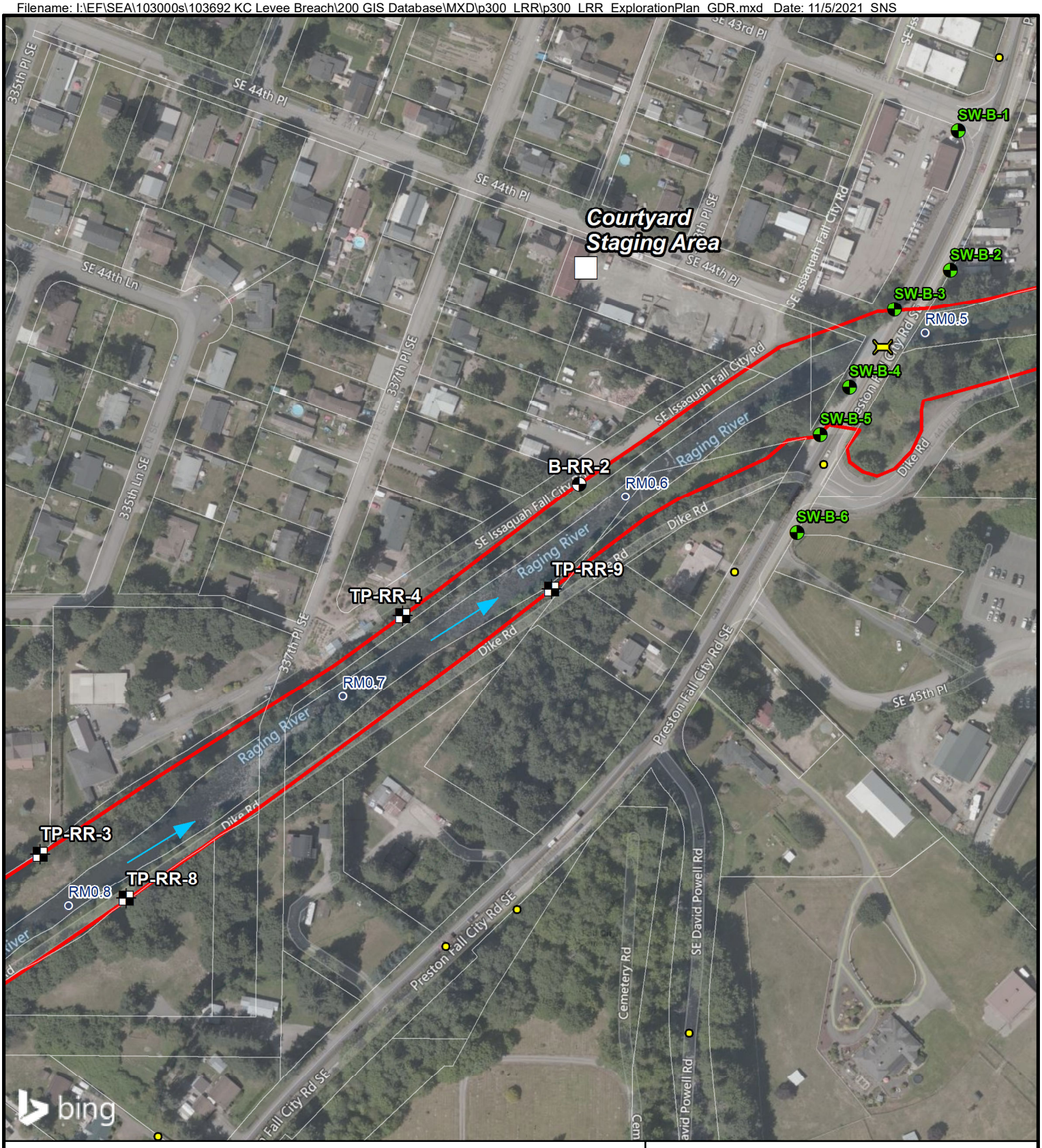

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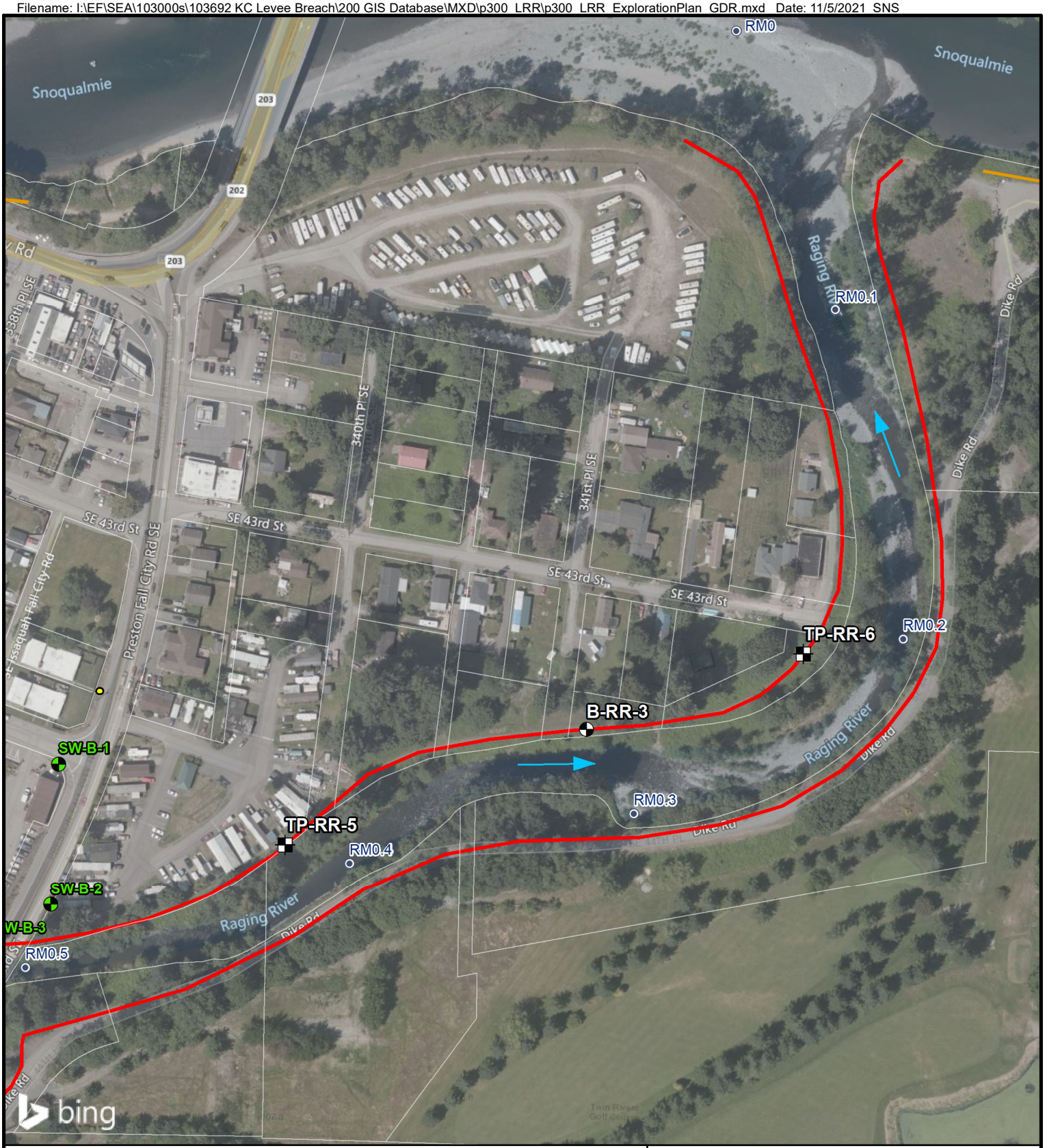

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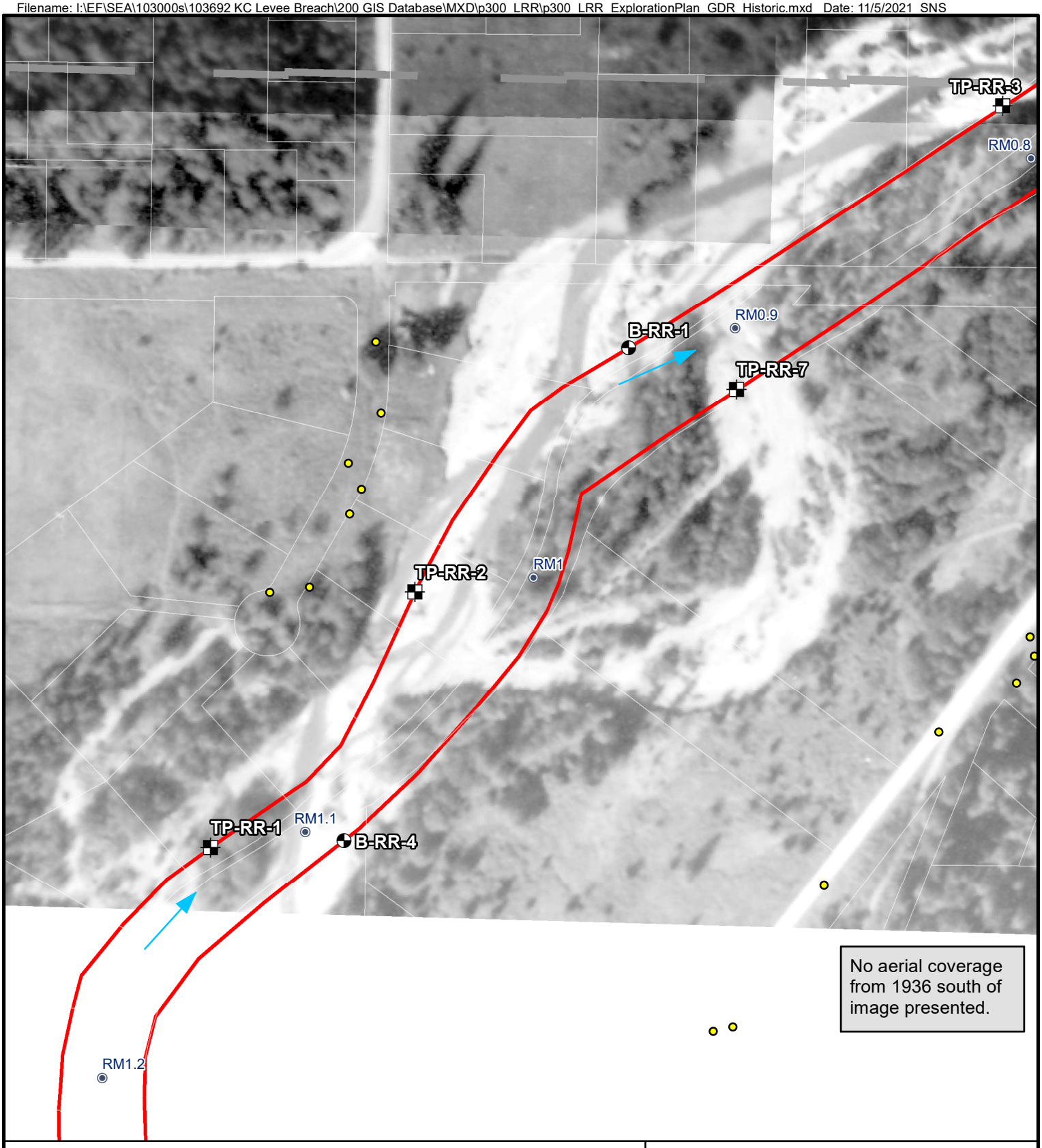

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King County, WA

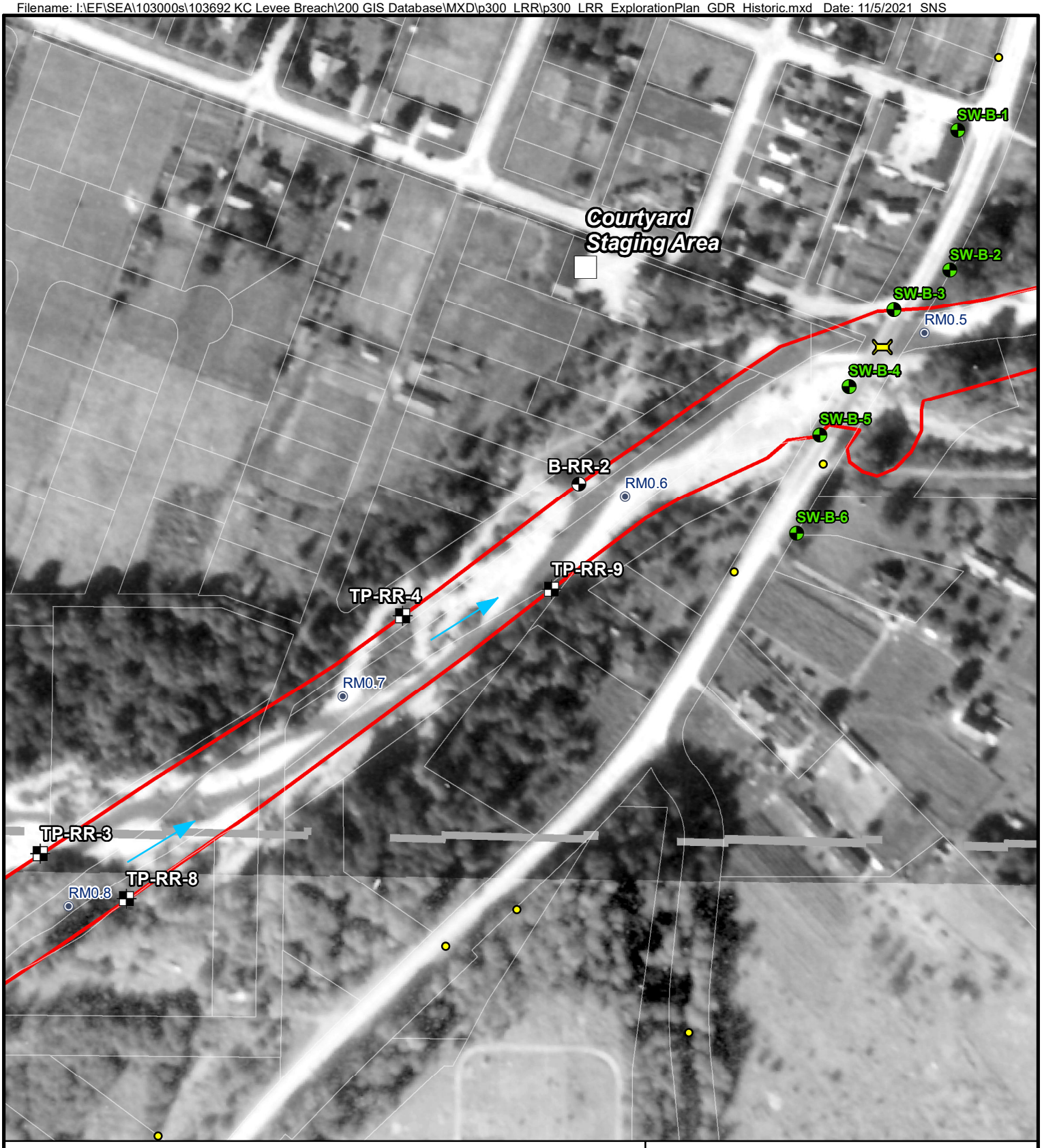
LOWER RAGING RIVER
1936 PRE-LEVEE AERIALS

November 2021 103692-303

SHANNON & WILSON

FIG. 3
Sheet 1 of 3

Filename: I:\EF\SEA\103000s\103692 KC Levee Breach\200 GIS Database\MXD\p300_LRR\p300_LRR_ExplorationPlan_GDR_Historic.mxd Date: 11/5/2021 SNS



LEGEND

- King County Bridge
- Culverts
- Levees
- Revetments
- Levee Area of Interest

Project Explorations
- Project Boring
- Project Test Pit

Other Explorations
- Boring (Shannon & Wilson, 1997)
- Boring (GeoEngineers, 1997)
- Test Pit (GeoEngineers, 1997)
- Hand Boring (GeoEngineers, 1997)

N W E S

0 200
Feet

Levee Breach Analysis Mapping and Risk Assessment
Geotechnical Data Report
King County, WA

LOWER RAGING RIVER
1936 PRE-LEVEE AERIALS

November 2021 103692-303

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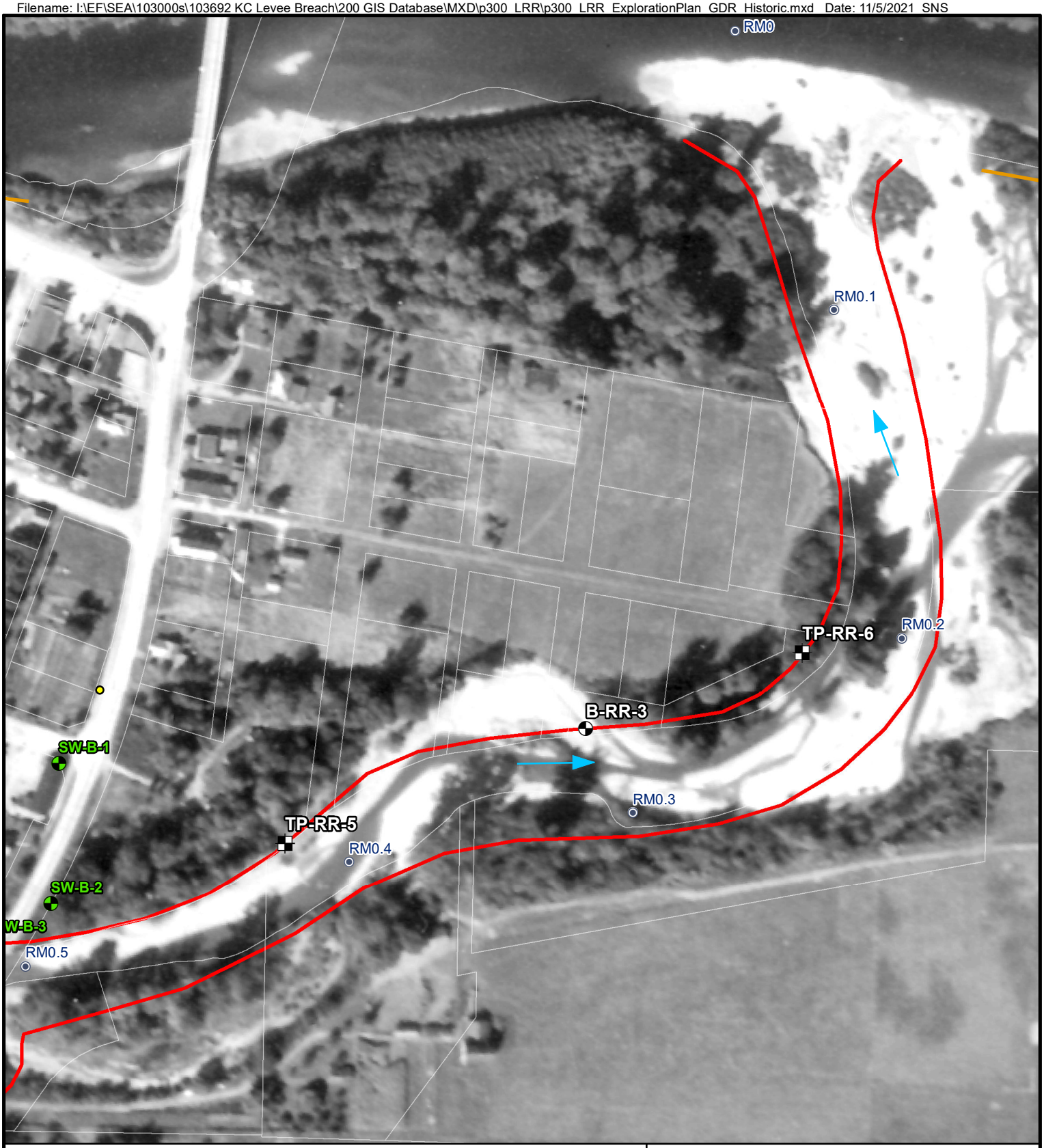
FIG. 3
Sheet 2 of 3

Filename: I:\EF\SEA\103000s\103692 KC Levee Breach\200 GIS Database\MXD\p300_LRR\p300_LRR_ExplorationPlan_GDR_Historic.mxd Date: 11/5/2021 SNS



LEGEND

- King County Bridge
- Culverts
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Project Explorations
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N W E S

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Feet

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Geotechnical Data Report
King County, WA

LOWER RAGING RIVER
1936 PRE-LEVEE AERIALS

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FIG. 3
Sheet 3 of 3

APPENDIX A: PROJECT SUBSURFACE EXPLORATION LOGS

Appendix A

Project Subsurface Exploration Logs

CONTENTS

SHANNON & WILSON

SOIL DESCRIPTION AND LOG KEY

Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report
King County, Washington

Shannon & Wilson uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following page. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

Structure[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch-thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch-thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

Angularity and Shape[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

Standard Penetration Test (SPT)[3]

Hammer	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diameter cathead 2-1/4 rope turns, > 100 rpm. If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less or 10 blows for 0 inch.

Moisture Content

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

Gradation

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

Cementation[1]

Weak	Crumbles/breaks with handling or slight finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

Plasticity[2]

Nonplastic	Cannot roll a 1/8-in. thread at any water content.	PI < 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 < PI < 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 < PI < 20
High	It takes considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	PI > 21

Additional Terms

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

Notes:

[1]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

[2]Adapted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

[3]Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

SHANNON & WILSON

SOIL DESCRIPTION AND LOG KEY

Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report
King County, Washington

Unified Soil Classification System (USCS)
Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488

Major Divisions			Symbol	Typical Identifications
Coarse-Grained Soils (more than 50% retained on No. 200 sieve)	Gravels (more than 50% of coarse fraction retained on No. 4 sieve)	Gravel (less than 5% fines)	GW	Well-graded Gravel; Well-graded Gravel with Sand
			GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel (more than 12% fines)	GM	Silty Gravel; Silty Gravel with Sand
			GC	Clayey Gravel; Clayey Gravel with Sand
	Sands (50% or more of coarse fraction passes the No. 4 sieve)	Sand (less than 5% fines)	SW	Well-graded Sand; Well-graded Sand with Gravel
			SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand (more than 12% fines)	SM	Silty Sand; Silty Sand with Gravel
			SC	Clayey Sand; Clayey Sand with Gravel
Fine-Grained Soils (50% or more passes the No. 200 sieve)	Silts and Clays (liquid limit less than 50)	Inorganic	ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays (liquid limit 50 or more)	Inorganic	MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		PT	Peat or other highly organic soils (see ASTM D4427)

Acronyms and Abbreviations

ATD	At Time of Drilling	MgO	Magnesium Oxide	psi	Pounds per Square Inch
Diam.	Diameter	mm	Millimeter	PVC	Polyvinyl Chloride
Elev.	Elevation	MnO	Manganese Oxide	rpm	Rotations per Minute
ft	Feet	NA	Not Applicable or Not Available	SPT	Standard Penetration Test
FeO	Iron Oxide	NP	Nonplastic	USCS	Unified Soil Classification System
gal	Gallons	O.D.	Outside Diameter	q_u	Unconfined Compressive Strength
Horiz.	Horizontal	OW	Observation Well	VWP	Vibrating Wire Piezometer
HSA	Hollow-Stem Auger	pcf	Pounds per Cubic Foot	Vert.	Vertical
I.D.	Inside Diameter	PID	Photoionization Detector	WOH	Weight of Hammer
in	Inches	PMT	Pressuremeter Test	WOR	Weight of Rods
lbs	Pounds	ppm	Parts per Million	Wt	Weight

Relative Density
Cohesionless Soils

N, SPT, Blows/ft	Relative Density
< 4	Very loose
4 - 10	Loose
10 - 30	Medium dense
30 - 50	Dense
> 50	Very dense

Relative Consistency
Cohesive Soils

N, SPT, Blows/ft	Relative Consistency
< 2	Very soft
2 - 4	Soft
4 - 8	Medium stiff
8 - 15	Stiff
15 - 30	Very stiff
> 30	Hard

Percentages[1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

Well and Backfill Symbols

- Bentonite Cement Grout
- Bentonite Grout
- Bentonite Chips
- Silica Sand
- Perforated or Screened Casing
- Surface Cement Seal
- Asphalt or Cap
- Slough
- Inclinometer or Non-perforated Casing
- Instrumentation Riser or Electrical Lead
- Vibrating Wire Piezometer with Designation

Notes:

Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

Total Depth:	*51.5 ft.*	Northing:	*206,580 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*131.6 ft.*	Easting:	*1,377,911 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

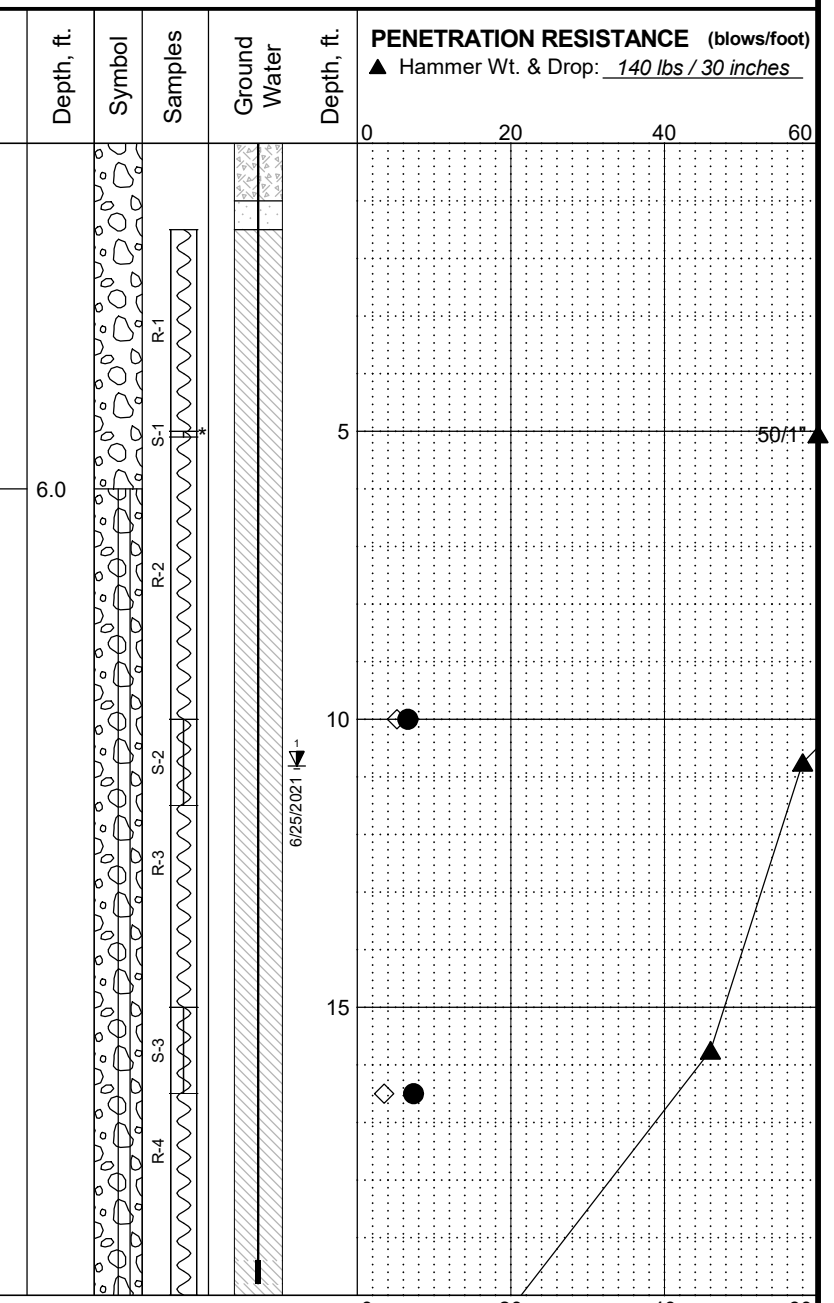
SOIL DESCRIPTION

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

Medium dense, brown to gray-brown, *Poorly Graded Gravel with Sand and Cobbles (GP)*; moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; trace nonplastic fines.

6.0

Medium dense, brown to brown-gray, *Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM)* to *Poorly Graded Gravel with Sand and Cobbles (GP)*; moist, wet below about 11 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic fines.



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

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

NOTES

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

Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report
King County, Washington

LOG OF BORING B-RR-1
LOWER RAGING RIVER

November 2021 103692-303

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 1 of 3

REV 1.0 - FINAL

Log: DPO Rev: SAW Typ: DPO
MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/5/21

Total Depth:	*51.5 ft.*	Northing:	*206,580 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*131.6 ft.*	Easting:	*1,377,911 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

SOIL DESCRIPTION

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

- Sandy layer from about 20 to 21 feet.

- Red-brown and iron-oxide staining at 18 and 24 feet.

24.5

Medium dense, brown to gray, *Silty Sand (SM)*; wet; fine sand; nonplastic fines; few low plasticity silt zones below about 28 feet.

- Strong iron-oxide staining at about 29 feet.

29.5

Medium stiff to very stiff, gray, interbedded, *Silt (ML)*, *Silt with Sand (ML),* and *Sandy Silt (ML)* and medium dense, gray, *Silty Sand (SM)*; wet; trace fine, subangular gravel; fine to medium sand; nonplastic to low plasticity.
- Strong iron-oxide staining at about 31 feet.

36.0

Stiff to very stiff, gray, *Silt (ML)* and *Silt with Sand (ML)*; moist to wet; trace fine to coarse, subrounded gravel; fine to medium sand; low to medium plasticity; few lean clay seams and nonplastic silty sand layers.

- Coarse, subrounded gravel at about 39 feet.

CONTINUED NEXT SHEET

Depth, ft. | Symbol | Samples (S-4, R-5, S-5, R-6, S-6, R-7, S-7, R-8) | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

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

0 20 40 60

25 30 35

◇ 80

0 20 40 60

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered

Soil Core (as in Sonic Core Borings)

2.0" O.D. Split Spoon Sample

Well Screen and Sand Filter

Bentonite-Cement Grout

Bentonite Chips/Pellets

Bentonite Grout

Ground Water Level in VWP

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
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LOG OF BORING B-RR-1
LOWER RAGING RIVER

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FIG. A-2
Sheet 2 of 3

REV 1.0 - FINAL

Log: DPO Rev: SAW Typ: DPO

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/5/21

Total Depth:	*51.5 ft.*	Northing:	*206,580 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*131.6 ft.*	Easting:	*1,377,911 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

SOIL DESCRIPTION

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

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

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

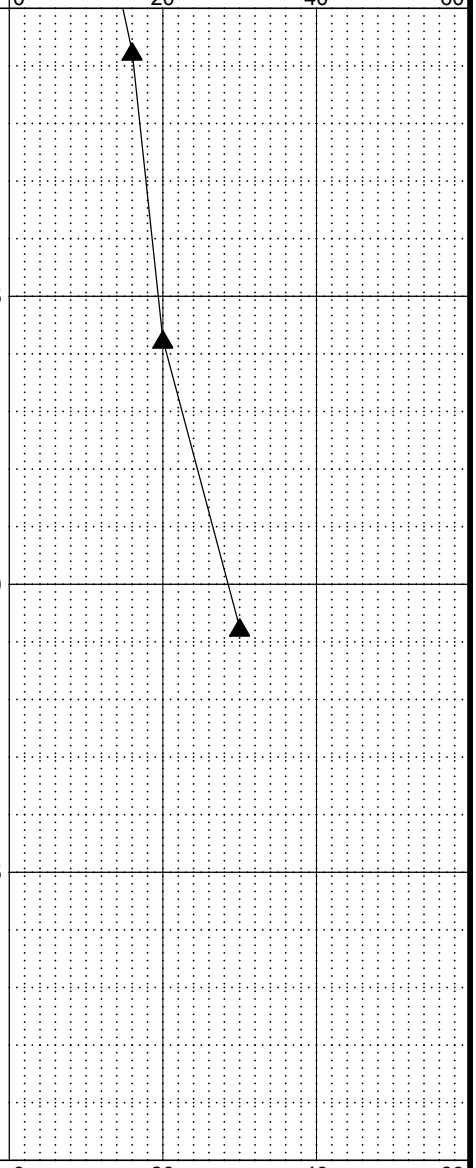
- Laminated to interbedded low plasticity silt with fine sand seams from 42 to 45 feet.

S-8, R-9, S-9, R-10, S-10

51.5

BOTTOM OF BORING
COMPLETED 6/21/2021

NOTE: Where gravels exceeding ½ the inside diameter of the split spoon sampler, cobbles, or boulders are present the SPT blow counts are not reliable indicators of soil density or stiffness. The interpreted density and stiffness of these soil zones presented in the boring log is based on density of other soil zones encountered and interpretation of the geologic depositional environment instead of the blow count versus relative density relationship presented in Figure A-1.



LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

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

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
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LOG OF BORING B-RR-1
LOWER RAGING RIVER

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FIG. A-2
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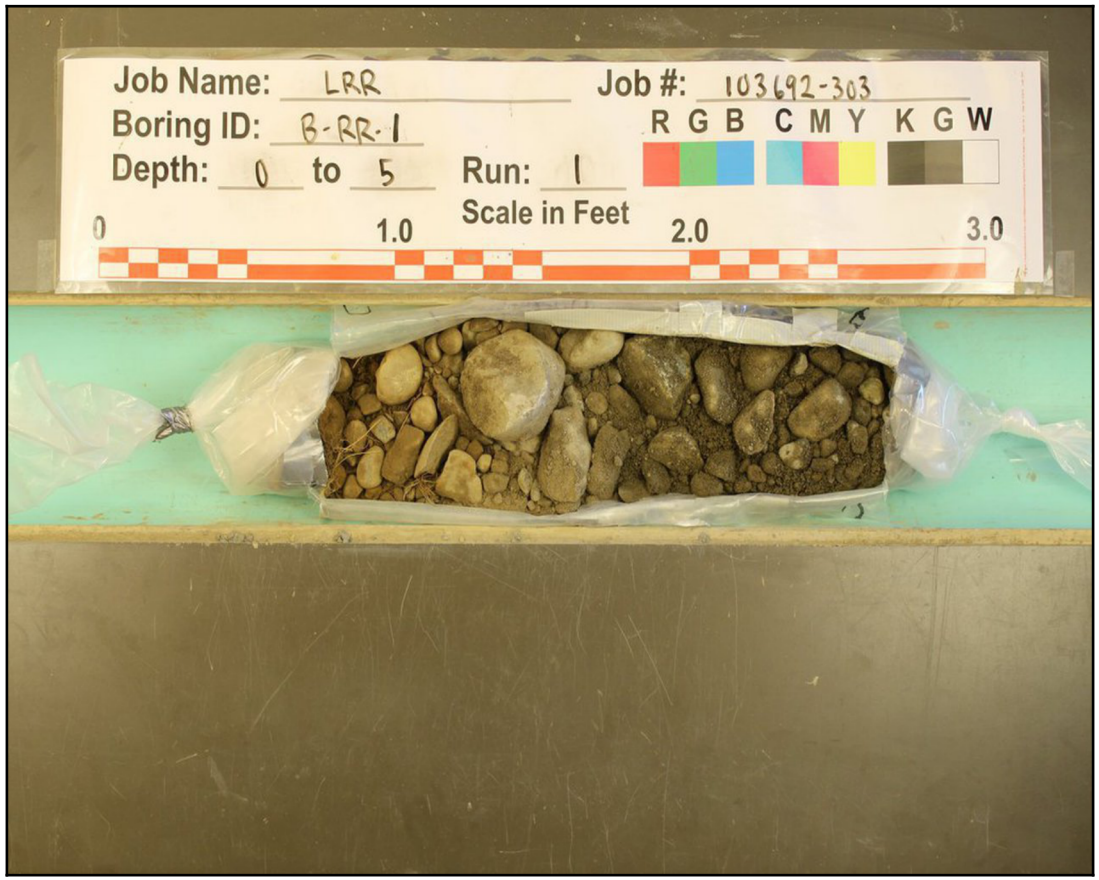
REV 1.0 - FINAL

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/5/21 Log: DPO Rev: SAW Typ: DPO



Notes:

1. Material Descriptions:

   0.0 to 5.0:

   Medium dense, brown to gray-brown, Poorly Graded Gravel with Sand and Cobbles (GP); moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; trace nonplastic fines.

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BORING B-RR-1
SONIC CORE PHOTOGRAPHS

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FIG. A-3
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FIG. A-3
Sheet 1 of 15

Notes:

1. Material Descriptions:

   5.0 to 6.0:

   Medium dense, brown to gray-brown, Poorly Graded Gravel with Sand and Cobbles (GP); moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; trace nonplastic fines.

   6.0 to 10.0:

   Medium dense, brown to brown-gray, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist, wet below about 11 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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King County, Washington

BORING B-RR-1
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FIG. A-3
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FIG. A-3
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Notes:
1. Material Descriptions:
   10.0 to 15.0:
   Medium dense, brown to brown-gray, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist, wet below about 11 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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FIG. A-3
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FIG. A-3
Sheet 3 of 15

Notes:

1. Material Descriptions:

   15.0 to 16.5:

   Medium dense, brown to brown-gray, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist, wet below about 11 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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BORING B-RR-1
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FIG. A-3
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FIG. A-3
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Notes:

1. Material Descriptions:

16.5 to 20.0:

Medium dense, brown to brown-gray, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist, wet below about 11 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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SONIC CORE PHOTOGRAPHS

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FIG. A-3
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FIG. A-3
Sheet 5 of 15

Notes:

1. Material Descriptions:

   20.0 to 21.5:

   Medium dense, brown to brown-gray, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist, wet below about 11 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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SONIC CORE PHOTOGRAPHS

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FIG. A-3
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FIG. A-3
Sheet 6 of 15

Notes:

1. Material Descriptions:

   21.5 to 24.5:

   Medium dense, brown to brown-gray, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist, wet below about 11 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

   24.5 to 25.0:

   Medium dense, brown to gray, Silty Sand (SM); wet; fine sand; nonplastic; few low plasticity silt zones below about 28 feet.

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SONIC CORE PHOTOGRAPHS

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FIG. A-3
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Notes:
1. Material Descriptions:
   25.0 to 28.0:
   Medium dense, brown to gray, Silty Sand (SM); wet; fine sand; nonplastic; few low plasticity silt zones below about 28 feet.

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FIG. A-3
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FIG. A-3
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Notes:

1. Material Descriptions:

   28.0 to 29.5:

   Medium dense, brown to gray, Silty Sand (SM); wet; fine sand; nonplastic; few low plasticity silt zones below about 28 feet.

   29.5 to 30.0:

   Medium dense, gray, interbedded, Silty Sand (SM) and medium stiff to very stiff, gray, Silt (ML), Silt with Sand (ML), and Sandy Silt (ML); wet; trace fine, subangular gravel; fine to medium sand; nonplastic to low plasticity.

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FIG. A-3
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FIG. A-3
Sheet 9 of 15

Notes:
1. Material Descriptions:
   30.0 to 35.0:
   Medium dense, gray, interbedded, Silty Sand (SM) and medium stiff to very stiff, gray, Silt (ML), Silt with Sand (ML), and Sandy Silt (ML); wet; trace fine, subangular gravel; fine to medium sand; nonplastic to low plasticity.

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BORING B-RR-1
SONIC CORE PHOTOGRAPHS

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FIG. A-3
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FIG. A-3
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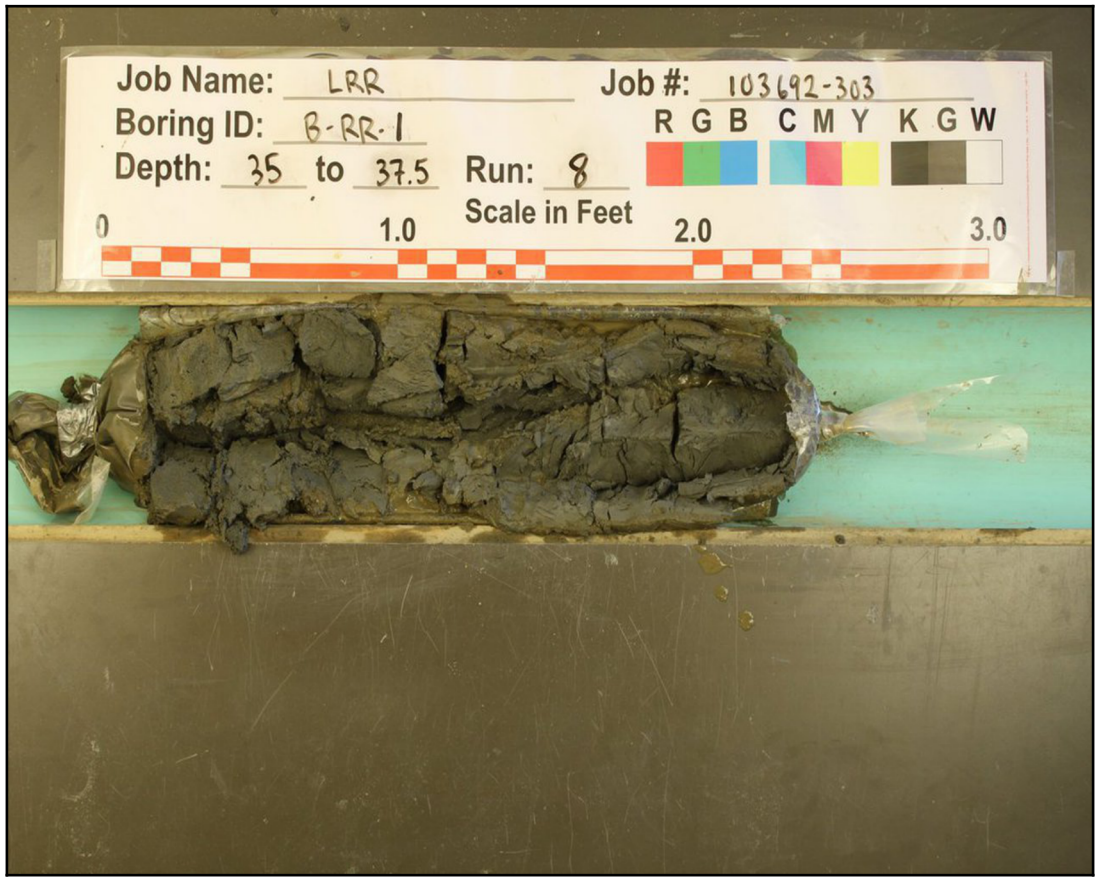

Notes:

1. Material Descriptions:

35.0 to 36.0:

Medium dense, gray, interbedded, Silty Sand (SM) and medium stiff to very stiff, gray, Silt (ML), Silt with Sand (ML), and Sandy Silt (ML); wet; trace fine, subangular gravel; fine to medium sand; nonplastic to low plasticity.

36.0 to 37.5:

Stiff to very stiff, gray, Silt (ML) and Silt with Sand (ML); moist to wet; trace fine to coarse, subrounded gravel; fine to medium sand; low to medium plasticity; few lean clay seams and nonplastic silty sand layers.

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FIG. A-3
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FIG. A-3
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Notes:

1. Material Descriptions:

   37.5 to 40.0:

   Stiff to very stiff, gray, Silt (ML) and Silt with Sand (ML); moist to wet; trace fine to coarse, subrounded gravel; fine to medium sand; low to medium plasticity; few lean clay seams and nonplastic silty sand layers.

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FIG. A-3
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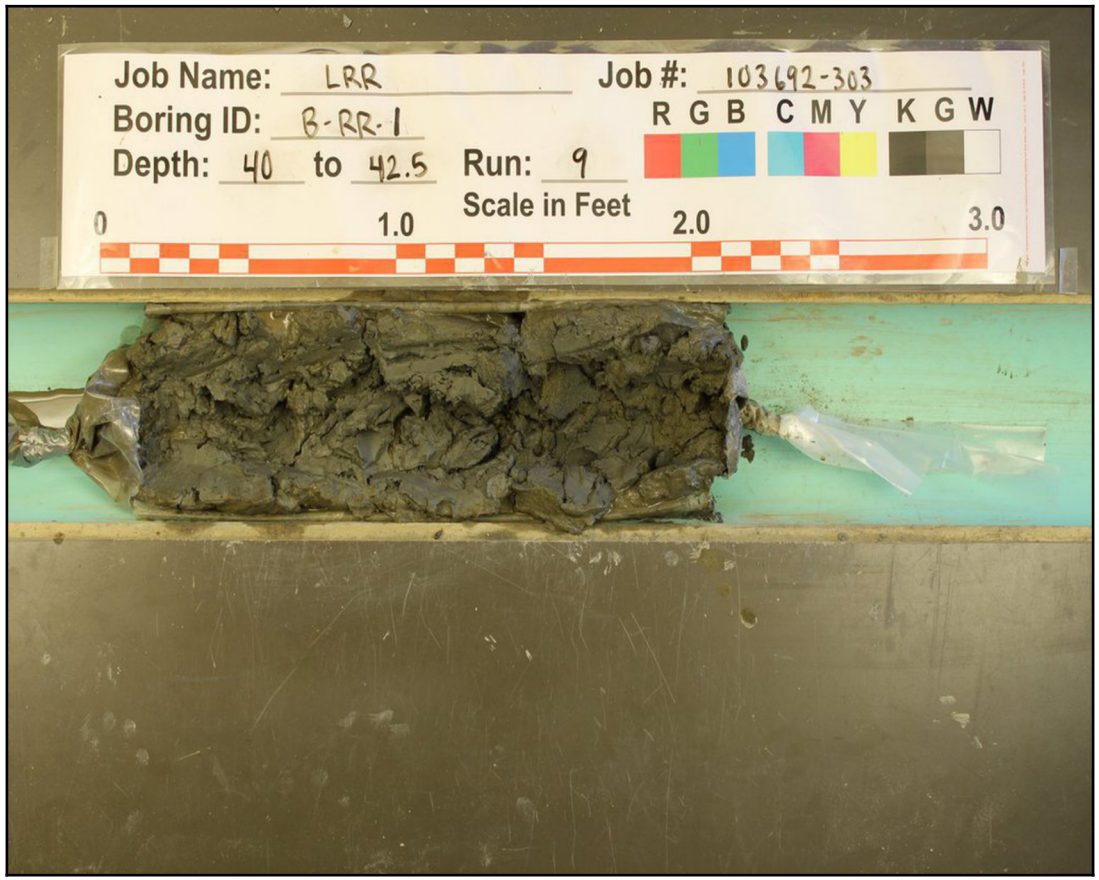

Notes:
1. Material Descriptions:
   40.0 to 42.5:
   Stiff to very stiff, gray, Silt (ML) and Silt with Sand (ML); moist to wet; trace fine to coarse, subrounded gravel; fine to medium sand; low to medium plasticity; few lean clay seams and nonplastic silty sand layers.

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FIG. A-3
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Notes:
1. Material Descriptions:
   42.5 to 45.0:
   Stiff to very stiff, gray, Silt (ML) and Silt with Sand (ML); moist to wet; trace fine to coarse, subrounded gravel; fine to medium sand; low to medium plasticity; few lean clay seams and nonplastic silty sand layers.

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Notes:
1. Material Descriptions:
   45.0 to 50.0:
   Stiff to very stiff, gray, Silt (ML) and Silt with Sand (ML); moist to wet; trace fine to coarse, subrounded gravel; fine to medium sand; low to medium plasticity; few lean clay seams and nonplastic silty sand layers.

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FIG. A-3
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Total Depth:	*51.5 ft.*	Northing:	*207,530 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*118.0 ft.*	Easting:	*1,379,335 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

SOIL DESCRIPTION

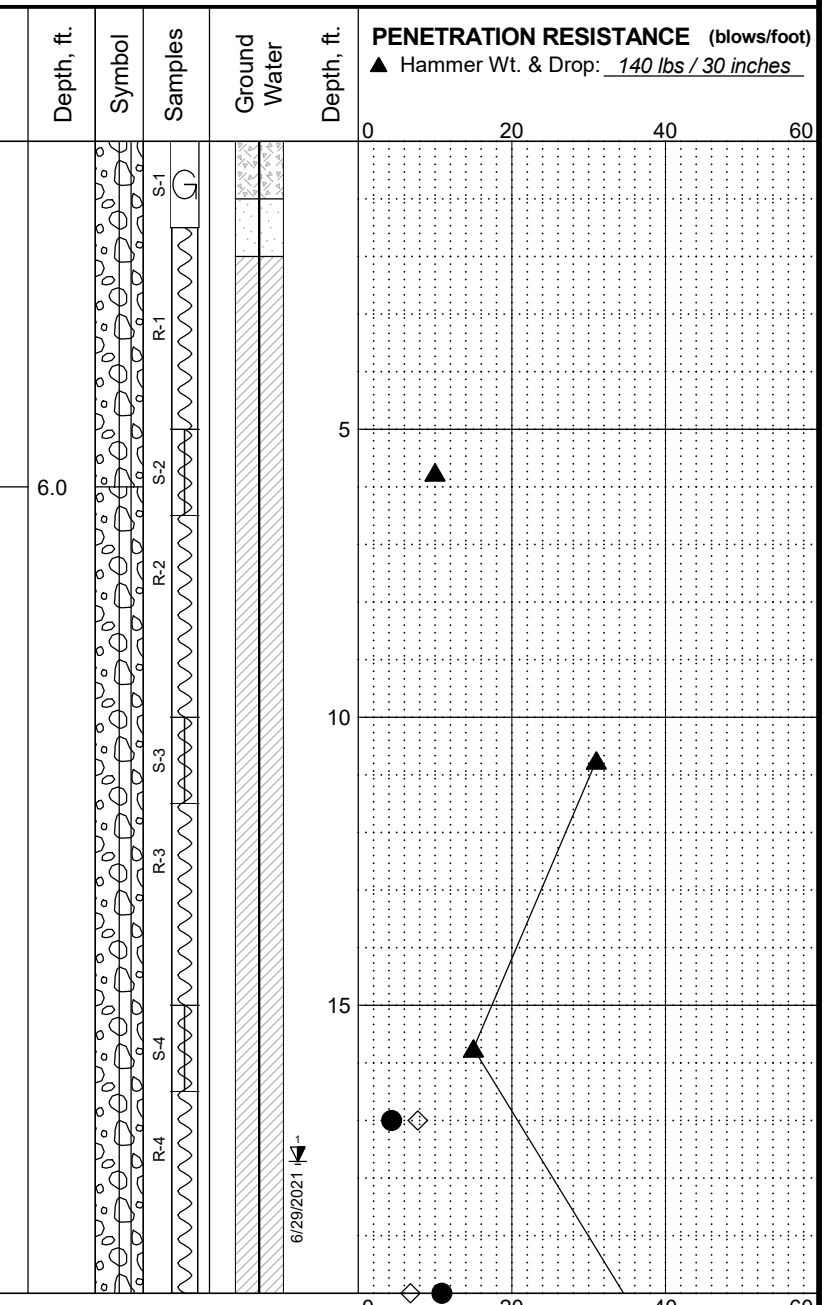
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Medium dense, brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; moist; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic fines; few cobbles below 5 feet.

6.0

Medium dense, brown to gray-brown, *Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM)*; moist, wet below about 17 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic fines; few silty gravel and sandy zones.

CONTINUED NEXT SHEET



LEGEND

- * Sample Not Recovered
- Grab Sample
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

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

NOTES

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

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LOG OF BORING B-RR-2
LOWER RAGING RIVER

November 2021 103692-303

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FIG. A-4
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REV 1.0 - FINAL

Log: DPO Rev: SAW Typ: DPO

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/3/21

Total Depth:	51.5 ft.	Northing:	207,530 ft.	Drilling Method:	Sonic Core	Hole Diam.:	6 in.
Top Elevation:	118.0 ft.	Easting:	1,379,335 ft.	Drilling Company:	Holt Services	Rod Diam.:	1.75"
Vert. Datum:		Station:	-	Drill Rig Equipment:	TerraSonic 150	Hammer Type:	Automatic
Horiz. Datum:		Offset:	-	Other Comments:	4" core/6" casing		

SOIL DESCRIPTION

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

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

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

0 20 40 60

22.0

Medium dense, red-brown turning gray-brown below 25 feet, *Well-Graded Gravel with Sand and Cobbles (GW)* to *Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM)*; wet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic fines; stratified gravel with sandy zones; cobble layer below 28 feet.

29.5

Loose to medium dense, gray-brown, *Silt with Sand (ML)*; wet; trace fine to coarse, subrounded gravel; fine sand; nonplastic to low plasticity; few silty sand and sandy silt layers interbedded.

S-5 R-5 S-6 R-6 S-7 R-7 S-8 R-8

25 30 35

0 20 40 60

CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Grab Sample
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

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

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LOG OF BORING B-RR-2
LOWER RAGING RIVER

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FIG. A-4
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REV 1.0 - FINAL

Log: DPO Rev: SAW Typ: DPO

MASTER LOG E 103692.GPJ SHAN WIL.GDT 11/3/21

Total Depth:	*51.5 ft.*	Northing:	*207,530 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*118.0 ft.*	Easting:	*1,379,335 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

SOIL DESCRIPTION

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

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

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

- Becomes gray at about 42 feet.

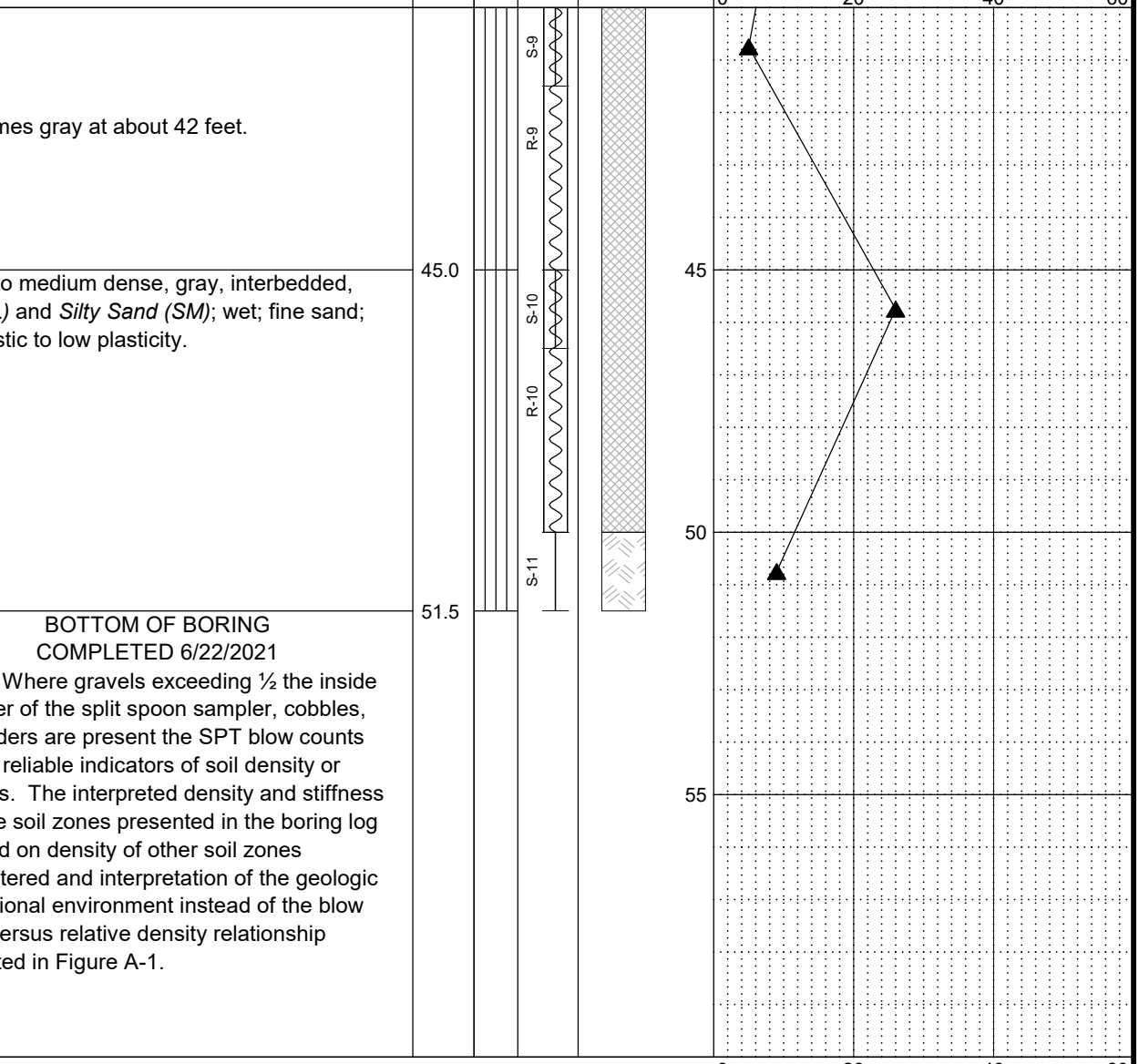
45.0

Loose to medium dense, gray, interbedded, *Silt (ML)* and *Silty Sand (SM)*; wet; fine sand; nonplastic to low plasticity.

51.5

BOTTOM OF BORING
COMPLETED 6/22/2021

NOTE: Where gravels exceeding ½ the inside diameter of the split spoon sampler, cobbles, or boulders are present the SPT blow counts are not reliable indicators of soil density or stiffness. The interpreted density and stiffness of these soil zones presented in the boring log is based on density of other soil zones encountered and interpretation of the geologic depositional environment instead of the blow count versus relative density relationship presented in Figure A-1.



LEGEND

- * Sample Not Recovered
- Grab Sample
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

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

NOTES

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

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LOG OF BORING B-RR-2
LOWER RAGING RIVER

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FIG. A-4
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REV 1.0 - FINAL

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/3/21 Log: DPO Rev: SAW Typ: DPO

Notes:
1. Material Descriptions:
   1.5 to 5.0:
   Medium dense, brown, Poorly Graded Gravel with Silt and Sand (GP-GM); moist; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few cobbles below 5 feet.

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BORING B-RR-2
SONIC CORE PHOTOGRAPHS

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FIG. A-5
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Notes:

1. Material Descriptions:

   5.0 to 6.0:

   Medium dense, brown, Poorly Graded Gravel with Silt and Sand (GP-GM); moist; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few cobbles below 5 feet.

   6.0 to 7.0:

   Medium dense, brown to gray-brown, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM); moist, wet below about 17 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few silty gravel and sandy zones.

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Notes:

1. Material Descriptions:

   7.0 to 10.0:

   Medium dense, brown to gray-brown, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM); moist, wet below about 17 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few silty gravel and sandy zones.

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Notes:
1. Material Descriptions:
   10.0 to 15.0:
   Medium dense, brown to gray-brown, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM); moist, wet below about 17 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few silty gravel and sandy zones.

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Notes:

1. Material Descriptions:

   15.0 to 20.0:

   Medium dense, brown to gray-brown, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM); moist, wet below about 17 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few silty gravel and sandy zones.

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FIG. A-5
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FIG. A-5
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Notes:

1. Material Descriptions:

   20.0 to 22.0:

   Medium dense, brown to gray-brown, Poorly to Well-Graded Gravel with Silt and Sand and Cobbles (GP-GM/GW-GM); moist, wet below about 17 feet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few silty gravel and sandy zones.

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FIG. A-5
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FIG. A-5
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Notes:
1. Material Descriptions:
   22.0 to 25.0:
   Medium dense, red-brown turning gray-brown below 25 feet, Well-Graded Gravel with Sand and Cobbles (GW) to Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM); wet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; stratified gravel with sandy zones; cobble layer below 28 feet.

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FIG. A-5
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Notes:

1. Material Descriptions:

   25.0 to 27.0:

   Medium dense, red-brown turning gray-brown below 25 feet, Well-Graded Gravel with Sand and Cobbles (GW) to Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM); wet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; stratified gravel with sandy zones; cobble layer below 28 feet.

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FIG. A-5
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Notes:

1. Material Descriptions:

29.5 to 30.0:

Loose to medium dense, gray-brown, Silt with Sand (ML); wet; trace fine to coarse, subrounded gravel; fine sand; nonplastic to low plasticity; few silty sand and sandy silt layers interbedded.

27.0 to 29.5:

Medium dense, red-brown turning gray-brown below 25 feet, Well-Graded Gravel with Sand and Cobbles (GW) to Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM); wet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; stratified gravel with sandy zones; cobble layer below 28 feet.

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FIG. A-5
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Notes:
1. Material Descriptions:
   30.0 to 35.0:
   Loose to medium dense, gray-brown, Silt with Sand (ML); wet; trace fine to coarse, subrounded gravel; fine sand; nonplastic to low plasticity; few silty sand and sandy silt layers interbedded.

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FIG. A-5
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Notes:

1. Material Descriptions:

   35.0 to 37.5:

   Loose to medium dense, gray-brown, Silt with Sand (ML); wet; trace fine to coarse, subrounded gravel; fine sand; nonplastic to low plasticity; few silty sand and sandy silt layers interbedded.

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FIG. A-5
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FIG. A-5
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Notes:
1. Material Descriptions:
   37.5 to 40.0:
   Loose to medium dense, gray-brown, Silt with Sand (ML); wet; trace fine to coarse, subrounded gravel; fine sand; nonplastic to low plasticity; few silty sand and sandy silt layers interbedded.

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Notes:
1. Material Descriptions:
   40.0 to 41.5:
   Loose to medium dense, gray-brown, Silt with Sand (ML); wet; trace fine to coarse, subrounded gravel; fine sand; nonplastic to low plasticity; few silty sand and sandy silt layers interbedded.

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FIG. A-5
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Notes:
1. Material Descriptions:
   41.5 to 45.0:
   Loose to medium dense, gray-brown, Silt with Sand (ML); wet; trace fine to coarse, subrounded gravel; fine sand; nonplastic to low plasticity; few silty sand and sandy silt layers interbedded.

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Notes:
1. Material Descriptions:
   45.0 to 47.5:
   Loose to medium dense, gray, interbedded, Silt (ML) and Silty Sand (SM); wet; fine sand; nonplastic to low plasticity.

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Notes:
1. Material Descriptions:
   47.5 to 50.0:
   Loose to medium dense, gray, interbedded, Silt (ML) and Silty Sand (SM); wet; fine sand; nonplastic to low plasticity.

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BORING B-RR-2
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FIG. A-5
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FIG. A-5
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Total Depth:	51.5 ft.	Northing:	208,109 ft.	Drilling Method:	Sonic Core	Hole Diam.:	6 in.
Top Elevation:	106.8 ft.	Easting:	1,380,701 ft.	Drilling Company:	Holt Services	Rod Diam.:	1.75"
Vert. Datum:		Station:	-	Drill Rig Equipment:	TerraSonic 150	Hammer Type:	Automatic
Horiz. Datum:		Offset:	-	Other Comments:	4" core/6" casing		

SOIL DESCRIPTION

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

Brown to gray-brown, *Poorly Graded Gravel with Sand and Cobbles (GP)* to *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)*; moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic fines.

5.0

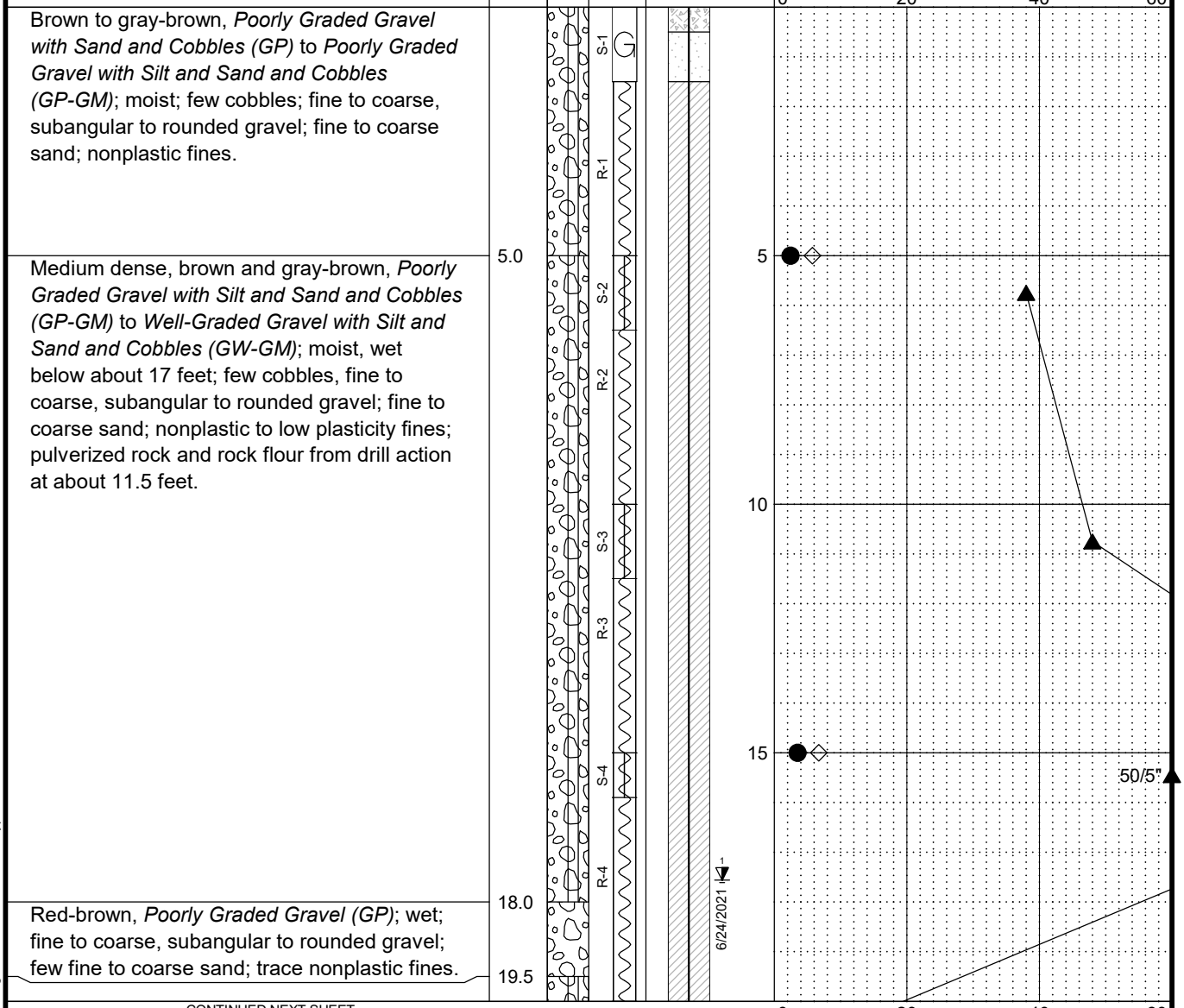
Medium dense, brown and gray-brown, *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)* to *Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM)*; moist, wet below about 17 feet; few cobbles, fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic to low plasticity fines; pulverized rock and rock flour from drill action at about 11.5 feet.

18.0

Red-brown, *Poorly Graded Gravel (GP)*; wet; fine to coarse, subangular to rounded gravel; few fine to coarse sand; trace nonplastic fines.

19.5

CONTINUED NEXT SHEET



LEGEND

- * Sample Not Recovered
- Grab Sample
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

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

NOTES

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

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LOG OF BORING B-RR-3
LOWER RAGING RIVER

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FIG. A-6
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REV 1.0 - FINAL

Log: DPO Rev: SAW Typ: DPO

MASTER LOG E 103692.GPJ SHAN WIL.GDT 11/3/21

Total Depth:	51.5 ft.	Northing:	208,109 ft.	Drilling Method:	Sonic Core	Hole Diam.:	6 in.
Top Elevation:	106.8 ft.	Easting:	1,380,701 ft.	Drilling Company:	Holt Services	Rod Diam.:	1.75"
Vert. Datum:		Station:	-	Drill Rig Equipment:	TerraSonic 150	Hammer Type:	Automatic
Horiz. Datum:		Offset:	-	Other Comments:	4" core/6" casing		

SOIL DESCRIPTION

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

Loose, gray-brown, *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)*; wet; trace cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic fines; few silty seams; few wood fragments.

24.0

Loose, gray, *Poorly Graded Sand (SP)* to *Poorly Graded Sand with Silt (SP-SM)*; wet; fine to medium sand; nonplastic fines; few wood fragments.

25.0

Very soft, dark brown, *Organic Silt with Sand (OL)* and *Silt (ML)*; wet; low to medium plasticity; few wood fragments.

26.0

Medium dense, brown to gray, interbedded, *Poorly Graded Sand with Silt (SP-SM)*, *Poorly Graded Sand (SP)*, and *Silty Sand (SM)*; wet; trace to few fine gravel; fine to medium sand; nonplastic fines; iron-oxide staining around 27 feet; few wood fragments.

30.0

Medium dense, gray, *Silty Sand (SM)*; wet; trace fine gravel; fine to medium sand; nonplastic fines.

34.0

Brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)* to *Silty Gravel (GM)*; wet; fine to coarse gravel and sand; nonplastic fines.

35.0

Very loose, gray, *Silty Sand (SM)* to *Poorly Graded Sand with Silt (SP-SM)* and *Poorly Graded Sand (SP)*; wet; fine to medium sand, grading to coarse sand with depth; nonplastic fines.

39.0

Brown, *Silty Gravel with Sand (GM)*; wet; fine to coarse gravel and sand; nonplastic fines.

CONTINUED NEXT SHEET

Depth, ft.

Symbol

Samples: S-5, R-5, S-6, R-6, S-7, R-7, S-8, R-8

Ground Water

Depth, ft.

PENETRATION RESISTANCE (blows/foot)

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

0 20 40 60

25

WC=61

WOH

30

35

0 20 40 60

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered	Well Screen and Sand Filter
Grab Sample	Bentonite-Cement Grout
Soil Core (as in Sonic Core Borings)	Bentonite Chips/Pellets
2.0" O.D. Split Spoon Sample	Bentonite Grout
	Ground Water Level in VWP

NOTES

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

Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report
King County, Washington

LOG OF BORING B-RR-3
LOWER RAGING RIVER

November 2021 103692-303

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-6
Sheet 2 of 3

REV 1.0 - FINAL

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/3/21 Log: DPO Rev: SAW Typ: DPO

Total Depth:	*51.5 ft.*	Northing:	*208,109 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*106.8 ft.*	Easting:	*1,380,701 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

SOIL DESCRIPTION

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

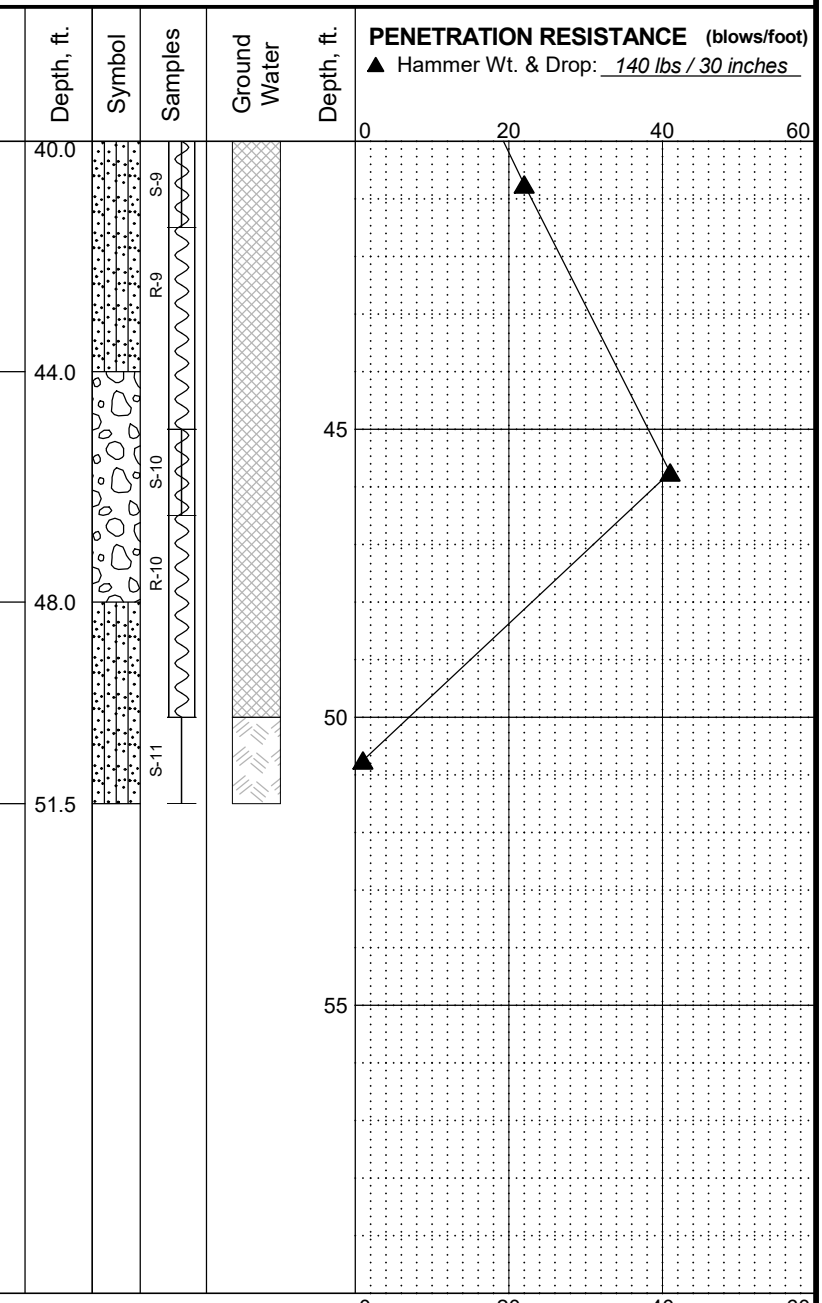
Medium dense, gray, *Silty Sand (SM)* to *Poorly Graded Sand with Silt (SP-SM)*; wet; fine to medium sand, grading to coarse sand with depth; nonplastic fines.

Medium dense, brown and gray, interbedded, *Poorly Graded Gravel with Silt and Sand (GP-GM)* and *Poorly Graded Gravel with Sand (GP)*; wet; fine to coarse, subangular to subrounded gravel; fine to coarse sand; nonplastic fines.
- Strong iron-oxide staining at about 46 feet.

Very loose, gray-brown, *Silty Sand (SM)* grading to *Poorly Graded Sand with Silt (SP-SM)*; wet; trace fine gravel; fine to medium sand, grading to coarse sand; nonplastic fines.

BOTTOM OF BORING
COMPLETED 6/23/2021

NOTE: Where gravels exceeding ½ the inside diameter of the split spoon sampler, cobbles, or boulders are present the SPT blow counts are not reliable indicators of soil density or stiffness. The interpreted density and stiffness of these soil zones presented in the boring log is based on density of other soil zones encountered and interpretation of the geologic depositional environment instead of the blow count versus relative density relationship presented in Figure A-1.



LEGEND

* Sample Not Recovered	Well Screen and Sand Filter
Grab Sample	Bentonite-Cement Grout
Soil Core (as in Sonic Core Borings)	Bentonite Chips/Pellets
2.0" O.D. Split Spoon Sample	Bentonite Grout
	Ground Water Level in VWP

NOTES

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

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LOG OF BORING B-RR-3
LOWER RAGING RIVER

November 2021 103692-303

SHANNON & WILSON, INC.
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FIG. A-6
Sheet 3 of 3

REV 1.0 - FINAL

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/3/21 Log: DPO Rev: SAW Typ: DPO

Notes:
1. Material Descriptions:
   1.5 to 5.0:
   Brown to gray-brown, Poorly Graded Gravel with Sand and Cobbles (GP) to Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM); moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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BORING B-RR-3
SONIC CORE PHOTOGRAPHS

October 2021 103692-303

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FIG. A-7
Sheet 1 of 14

FIG. A-7
Sheet 1 of 14

Notes:
1. Material Descriptions:
   5.0 to 10.0:
   Medium dense, brown and gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM) to Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM); moist, wet below about 17 feet; few cobbles, fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic to low plasticity; pulverized rock and rock flour from drill action at about 11.5 feet.

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SONIC CORE PHOTOGRAPHS

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FIG. A-7
Sheet 2 of 14

FIG. A-7
Sheet 2 of 14

Notes:

1. Material Descriptions:

   10.0 to 15.0:

   Medium dense, brown and gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM) to Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM); moist, wet below about 17 feet; few cobbles, fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic to low plasticity; pulverized rock and rock flour from drill action at about 11.5 feet.

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BORING B-RR-3
SONIC CORE PHOTOGRAPHS

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FIG. A-7
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FIG. A-7
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Notes:

1. Material Descriptions:

   15.0 to 17.5:

   Medium dense, brown and gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM) to Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM); moist, wet below about 17 feet; few cobbles, fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic to low plasticity; pulverized rock and rock flour from drill action at about 11.5 feet.

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FIG. A-7
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FIG. A-7
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Notes:

1. Material Descriptions:

17.5 to 18.0:

Medium dense, brown and gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM) to Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM); moist, wet below about 17 feet; few cobbles, fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic to low plasticity; pulverized rock and rock flour from drill action at about 11.5 feet.

19.5 to 20.0:

Loose, gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM); wet; trace cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few silty seams; few wood fragments.

18.0 to 19.5:

Red-brown, Poorly Graded Gravel (GP); wet; fine to coarse, subangular to rounded gravel; few fine to coarse sand; nonplastic.

FIG. A-7
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FIG. A-7
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Notes:

1. Material Descriptions:

   20.0 to 24.0:

   Loose, gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM); wet; trace cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic; few silty seams; few wood fragments.

   24.0 to 25.0:

   Loose, gray, Poorly Graded Sand (SP) to Poorly Graded Sand with Silt (SP-SM); wet; fine to medium sand; nonplastic; few wood fragments.

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FIG. A-7
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FIG. A-7
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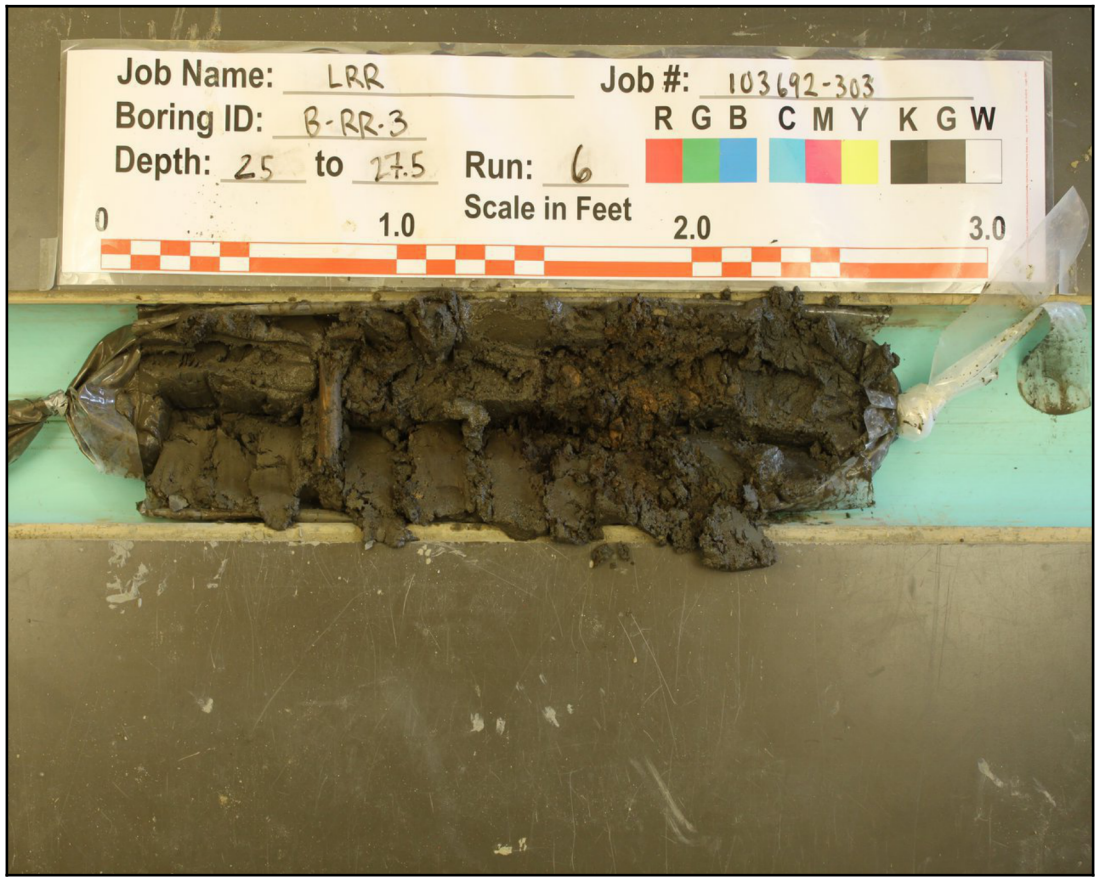

Notes:

1. Material Descriptions:

   25.0 to 26.0:

   Very soft, dark brown, Organic Silt with Sand (OL) and Silt (ML); wet; low to medium plasticity; few wood fragments.

   26.0 to 27.5:

   Medium dense, brown to gray, interbedded, Poorly Graded Sand with Silt (SP-SM), Poorly Graded Sand (SP), and Silty Sand (SM); wet; trace to few fine gravel; fine to medium sand; nonplastic; iron-oxide staining around 27 feet; few wood fragments.

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FIG. A-7
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FIG. A-7
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Notes:
1. Material Descriptions:
   27.5 to 30.0:
   Medium dense, brown to gray, interbedded, Poorly Graded Sand with Silt (SP-SM), Poorly Graded Sand (SP), and Silty Sand (SM); wet; trace to few fine gravel; fine to medium sand; nonplastic; iron-oxide staining around 27 feet; few wood fragments.

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FIG. A-7
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FIG. A-7
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Notes:
1. Material Descriptions:
   30.0 to 32.5:
   Medium dense, gray, Silty Sand (SM); wet; trace fine gravel; fine to medium sand; nonplastic.

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FIG. A-7
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FIG. A-7
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Notes:
1. Material Descriptions:
   32.5 to 34.0:
   Medium dense, gray, Silty Sand (SM); wet; trace fine gravel; fine to medium sand; nonplastic.
   34.0 to 35.0:
   Brown, Poorly Graded Gravel with Silt and Sand (GP-GM) to Silty Gravel (GM); wet; fine to coarse gravel and sand; nonplastic.

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FIG. A-7
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FIG. A-7
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Notes:
1. Material Descriptions:
   35.0 to 39.0:
   Very loose, gray, Silty Sand (SM) to Poorly Graded Sand with Silt (SP-SM) and Poorly Graded Sand (SP); wet; fine to medium sand, grading to coarse sand with depth; nonplastic.
   39.0 to 40.0:
   Brown, Silty Gravel with Sand (GM); wet; fine to coarse gravel and sand; nonplastic.

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FIG. A-7
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FIG. A-7
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Notes:

1. Material Descriptions:

   40.0 to 44.0:

   Medium dense, gray, Silty Sand (SM) to Poorly Graded Sand with Silt (SP-SM); wet; fine to medium sand, grading to coarse sand with depth; nonplastic.

   44.0 to 45.0:

   Medium dense, brown and gray, interbedded, Poorly Graded Gravel with Silt and Sand (GP-GM) and Poorly Graded Gravel with Sand (GP); wet; fine to coarse, subangular to subrounded gravel; fine to coarse sand; nonplastic.

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FIG. A-7
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FIG. A-7
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Notes:

1. Material Descriptions:

   45.0 to 47.0:

   Medium dense, brown and gray, interbedded, Poorly Graded Gravel with Silt and Sand (GP-GM) and Poorly Graded Gravel with Sand (GP); wet; fine to coarse, subangular to subrounded gravel; fine to coarse sand; nonplastic.

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FIG. A-7
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FIG. A-7
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Notes:

1. Material Descriptions:

   48.0 to 50.0:

   Very loose, gray-brown, Silty Sand (SM) grading to Poorly Graded Sand with Silt (SP-SM); wet; trace fine gravel; fine to medium sand, grading to coarse sand; nonplastic.

   47.0 to 48.0:

   Medium dense, brown and gray, interbedded, Poorly Graded Gravel with Silt and Sand (GP-GM) and Poorly Graded Gravel with Sand (GP); wet; fine to coarse, subangular to subrounded gravel; fine to coarse sand; nonplastic.

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FIG. A-7
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FIG. A-7
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Total Depth:	*51.5 ft.*	Northing:	*205,826 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*141.4 ft.*	Easting:	*1,377,482 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

SOIL DESCRIPTION

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

Brown, *Poorly Graded Gravel with Sand and Cobbles (GP)*; moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; trace nonplastic fines.

5.0

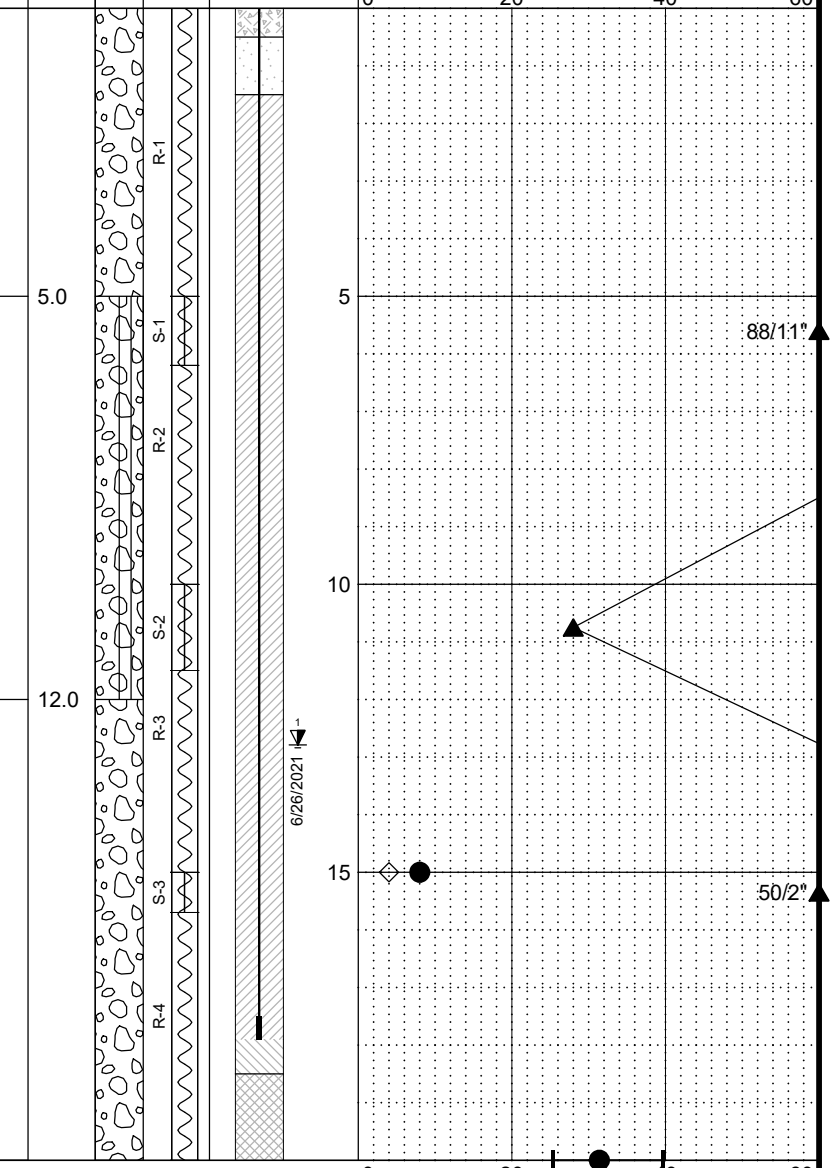
Medium dense, brown to gray-brown, *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)* to *Poorly Graded Gravel with Sand and Cobbles (GP)*; moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic fines.

12.0

Medium dense, brown to red-brown, *Poorly Graded Gravel with Sand and Cobbles (GP)*; moist to wet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; trace nonplastic fines.

- Red-brown below about 18 feet.

CONTINUED NEXT SHEET



LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

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

NOTES

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

Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report
King County, Washington

LOG OF BORING B-RR-4
LOWER RAGING RIVER

November 2021 103692-303

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-8
Sheet 1 of 3

REV 1.0 - FINAL

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/3/21 Log: DPO Rev: SAW Typ: DPO

Total Depth:	*51.5 ft.*	Northing:	*205,826 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*141.4 ft.*	Easting:	*1,377,482 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

SOIL DESCRIPTION

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

Soft, brown, *Lean Clay (CL)*; moist to wet; few cobbles and gravel above about 22 feet; low plasticity to medium plasticity.

- N-values for Sample S-4 may be overstated due to driving on gravel slough in drill casing.

Brown, *Sandy Silt (ML)*; wet; fine to medium sand; nonplastic; few iron-oxide stained seams.

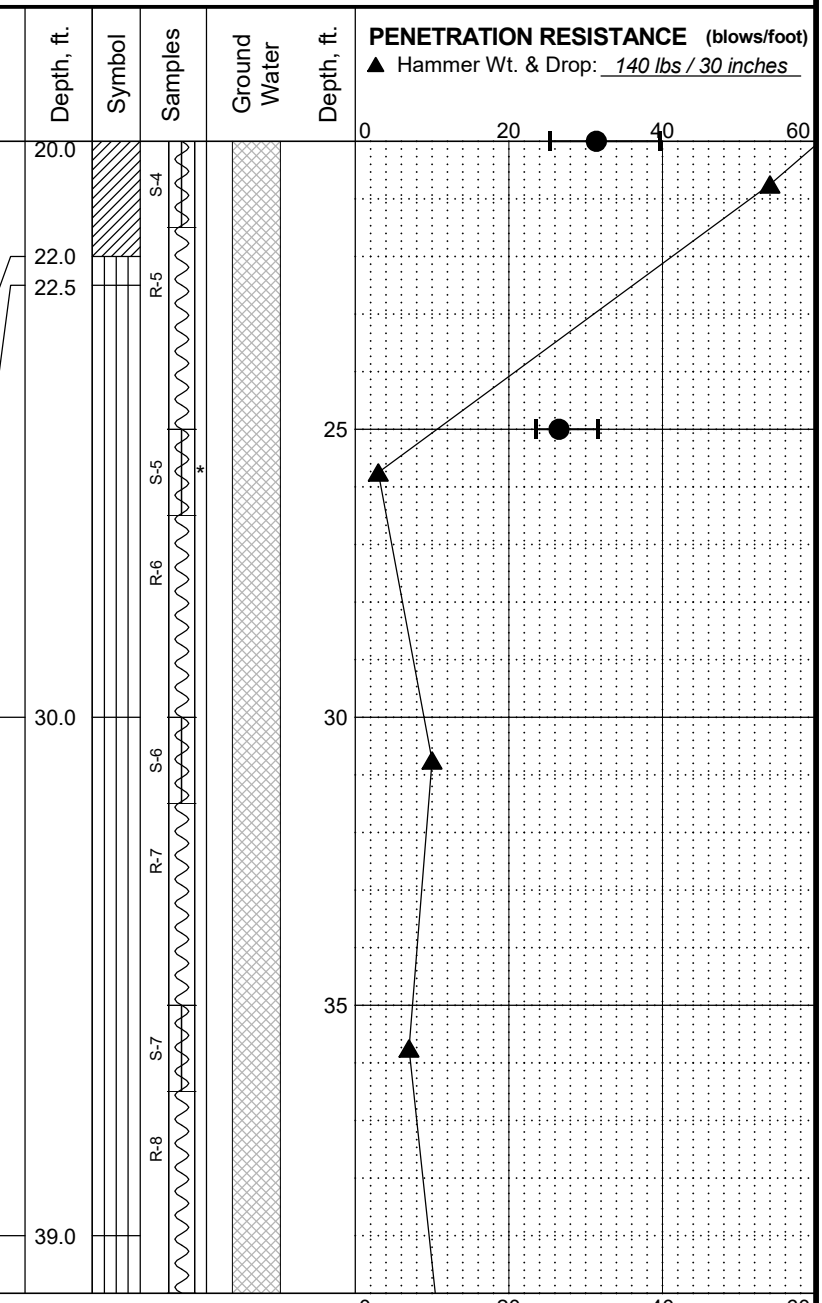
Very loose, brown, *Silt (ML)*; moist to wet; few fine sand; low plasticity.

- Gray at about 28 feet overlying sandy silt layer with strong iron-oxide staining.

Loose to medium dense, brown, turning gray below 33 feet, *Silt (ML)* and *Sandy Silt (ML)*; wet; fine sand; grades low plasticity to nonplastic with depth; few sand seams.

Loose to medium dense, gray, interbedded, *Silt (ML)*, *Sandy Silt (ML)*, and *Silty Sand*

CONTINUED NEXT SHEET



LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

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

NOTES

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

Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report
King County, Washington

LOG OF BORING B-RR-4
LOWER RAGING RIVER

November 2021 103692-303

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-8
Sheet 2 of 3

REV 1.0 - FINAL

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/3/21 Log: DPO Rev: SAW Typ: DPO

Total Depth:	*51.5 ft.*	Northing:	*205,826 ft.*	Drilling Method:	*Sonic Core*	Hole Diam.:	*6 in.*
Top Elevation:	*141.4 ft.*	Easting:	*1,377,482 ft.*	Drilling Company:	*Holt Services*	Rod Diam.:	*1.75"*
Vert. Datum:		Station:	-	Drill Rig Equipment:	*TerraSonic 150*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	-	Other Comments:	*4" core/6" casing*		

SOIL DESCRIPTION

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

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

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

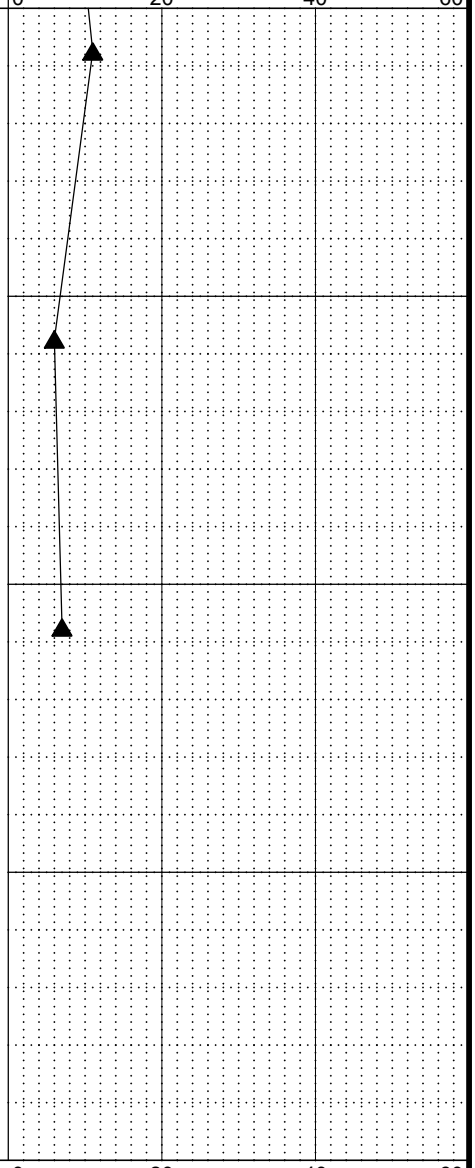
(SM); wet; fine sand; nonplastic to low plasticity.

S-8, R-9, S-9, R-10, S-10

51.5

BOTTOM OF BORING
COMPLETED 6/24/2021

NOTE: Where gravels exceeding ½ the inside diameter of the split spoon sampler, cobbles, or boulders are present the SPT blow counts are not reliable indicators of soil density or stiffness. The interpreted density and stiffness of these soil zones presented in the boring log is based on density of other soil zones encountered and interpretation of the geologic depositional environment instead of the blow count versus relative density relationship presented in Figure A-1.



LEGEND

- * Sample Not Recovered
- Soil Core (as in Sonic Core Borings)
- 2.0" O.D. Split Spoon Sample
- Well Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in VWP

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

NOTES

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

Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report
King County, Washington

LOG OF BORING B-RR-4
LOWER RAGING RIVER

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FIG. A-8
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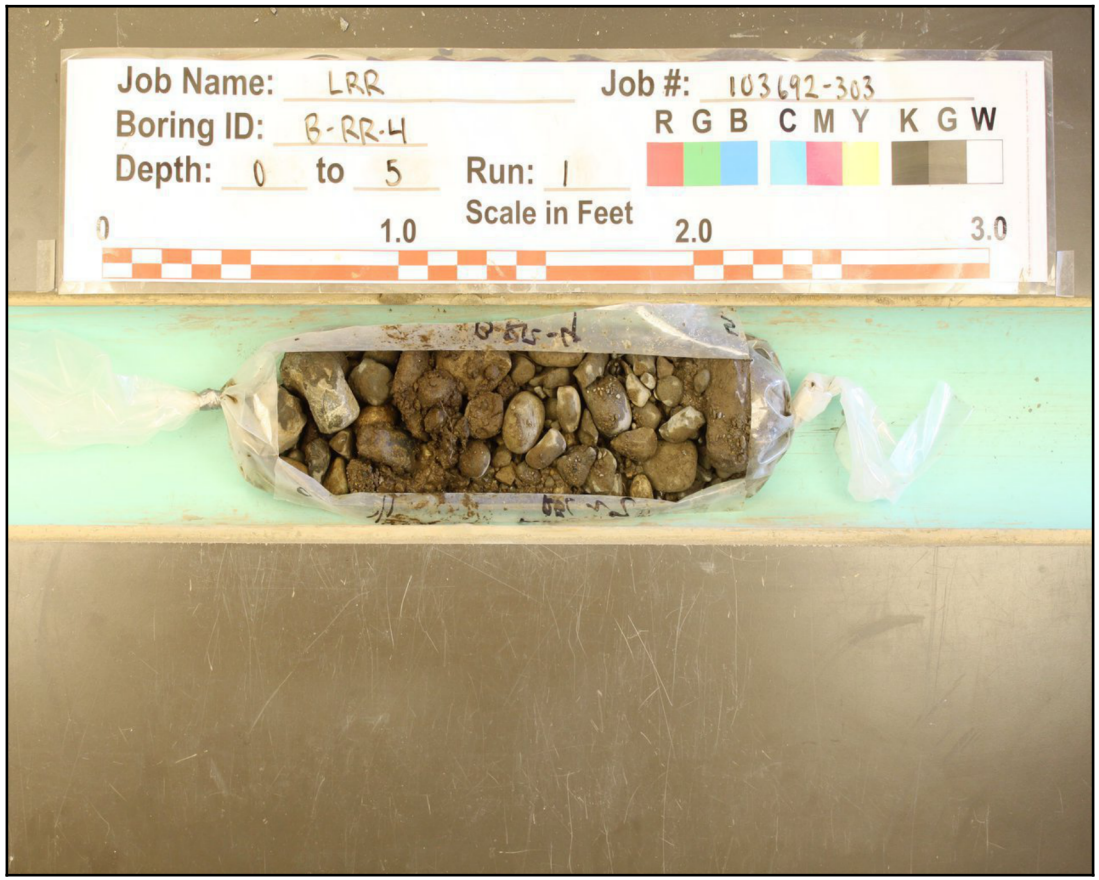
REV 1.0 - FINAL

Log: DPO Rev: SAW Typ: DPO

MASTER LOG E 103692.GPJ SHAN_WIL.GDT 11/3/21



Notes:
1. Material Descriptions:
   0.0 to 5.0:
   Brown, Poorly Graded Gravel with Sand and Cobbles (GP); moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

Levee Breach Analysis Mapping and Risk Assessment
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BORING B-RR-4
SONIC CORE PHOTOGRAPHS

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FIG. A-9
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Notes:
1. Material Descriptions:
   5.0 to 6.5:
   Medium dense, brown to gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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Geotechnical Data Report
King County, Washington

BORING B-RR-4
SONIC CORE PHOTOGRAPHS

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FIG. A-9
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FIG. A-9
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Notes:
1. Material Descriptions:
   6.5 to 10.0:
   Medium dense, brown to gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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FIG. A-9
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FIG. A-9
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Notes:

1. Material Descriptions:

   10.0 to 12.0:

   Medium dense, brown to gray-brown, Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM) to Poorly Graded Gravel with Sand and Cobbles (GP); moist; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

   12.0 to 15.0:

   Medium dense, brown to red-brown, Poorly Graded Gravel with Sand and Cobbles (GP); moist to wet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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FIG. A-9
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Notes:

1. Material Descriptions:

   15.0 to 20.0:

   Medium dense, brown to red-brown, Poorly Graded Gravel with Sand and Cobbles (GP); moist to wet; few cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; nonplastic.

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FIG. A-9
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Notes:
1. Material Descriptions:
   20.0 to 22.0:
   Soft, brown, Lean Clay (CL); moist to wet; few cobbles and gravel above about 22 feet; low plasticity to medium plasticity.
   22.0 to 22.5:
   Brown, Sandy Silt (ML); wet; fine to medium sand; nonplastic; few iron-oxide stained seams.

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FIG. A-9
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FIG. A-9
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Notes:
1. Material Descriptions:
   22.5 to 25.0:
   Very loose, brown, Silt (ML); moist to wet; few fine sand; low plasticity.

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FIG. A-9
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FIG. A-9
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Notes:
1. Material Descriptions:
   25.0 to 27.5:
   Very loose, brown, Silt (ML); moist to wet; few fine sand; low plasticity.

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FIG. A-9
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FIG. A-9
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Notes:
1. Material Descriptions:
   27.5 to 30.0:
   Very loose, brown, Silt (ML); moist to wet; few fine sand; low plasticity.

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FIG. A-9
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FIG. A-9
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Notes:
1. Material Descriptions:
   30.0 to 35.0:
   Loose to medium dense, brown, turning gray below 33 feet, Silt (ML) and Sandy Silt (ML); wet; fine sand; grades low plasticity to nonplastic with depth; few sand seams.

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FIG. A-9
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Notes:
1. Material Descriptions:
   35.0 to 37.5:
   Loose to medium dense, brown, turning gray below 33 feet, Silt (ML) and Sandy Silt (ML); wet; fine sand; grades low plasticity to nonplastic with depth; few sand seams.

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FIG. A-9
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FIG. A-9
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Notes:

1. Material Descriptions:

   39.0 to 40.0:

   Loose to medium dense, gray, interbedded, Silt (ML), Sandy Silt (ML), and Silty Sand (SM); wet; fine sand; nonplastic to low plasticity.

   37.5 to 39.0:

   Loose to medium dense, brown, turning gray below 33 feet, Silt (ML) and Sandy Silt (ML); wet; fine sand; grades low plasticity to nonplastic with depth; few sand seams.

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FIG. A-9
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Notes:
1. Material Descriptions:
   40.0 to 42.5:
   Loose to medium dense, gray, interbedded, Silt (ML), Sandy Silt (ML), and Silty Sand (SM); wet; fine sand; nonplastic to low plasticity.

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Notes:
1. Material Descriptions:
   42.5 to 45.0:
   Loose to medium dense, gray, interbedded, Silt (ML), Sandy Silt (ML), and Silty Sand (SM); wet; fine sand; nonplastic to low plasticity.

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Notes:
1. Material Descriptions:
   45.0 to 50.0:
   Loose to medium dense, gray, interbedded, Silt (ML), Sandy Silt (ML), and Silty Sand (SM); wet; fine sand; nonplastic to low plasticity.

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-RR-1

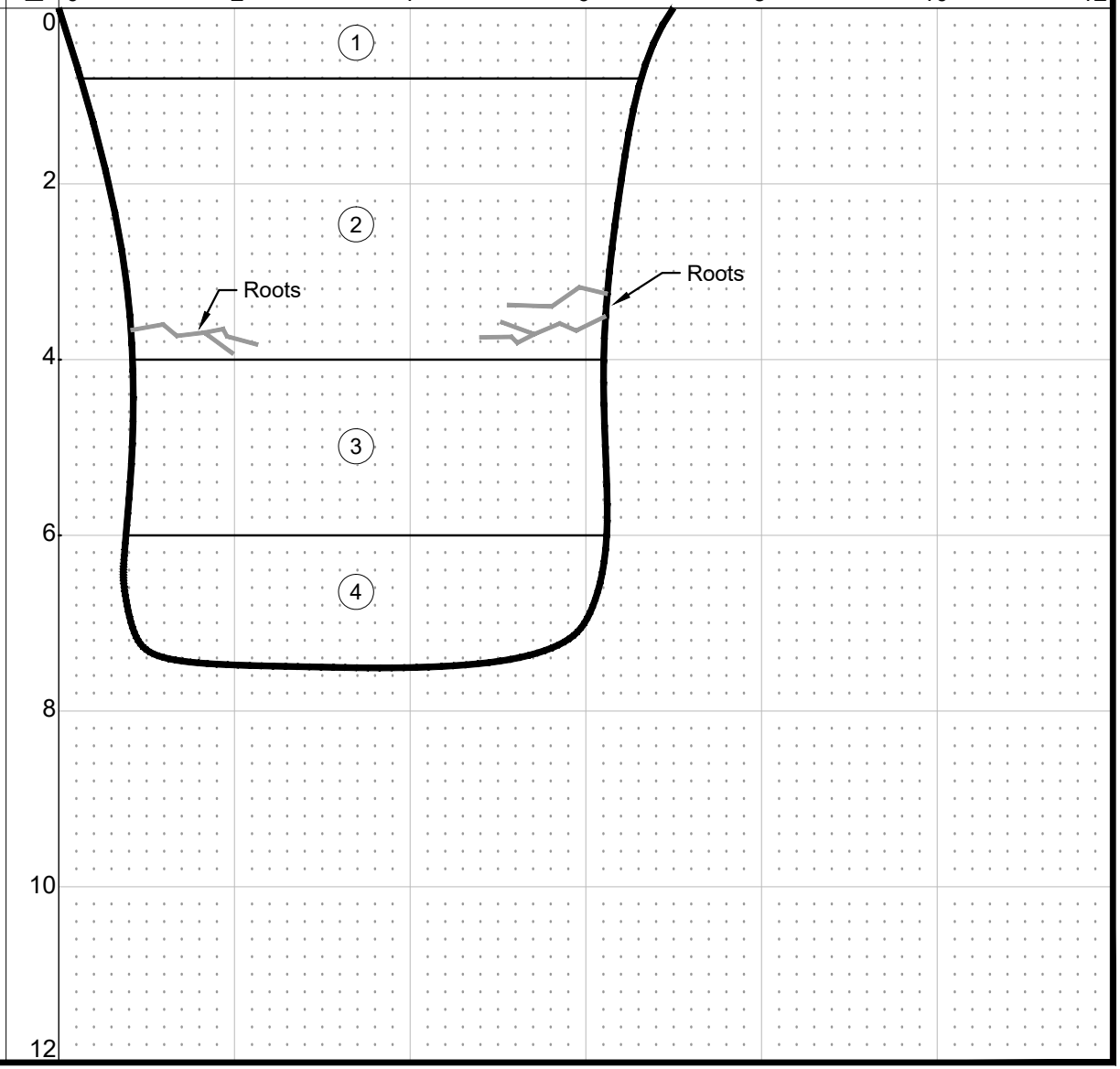
JOB NO: 103692-403 DATE: 7-28-2021 LOCATION: Lower Raging River Left Bank - Upstream (South)

PROJECT: Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report, King County, WA

SOIL DESCRIPTION	Ground Water	% Water Content	Samples
(1) Topsoil and grass.	None Observed		
(2) Brown, *Well-Graded Gravel with Silt and Sand and Cobbles (GW-GM)*; moist; subrounded to rounded cobbles; fine to coarse gravel; fine to coarse sand; nonplastic fines. - Few roots from about 3 to 4 feet.			S-1
(3) Brown, *Silty Sand (SM)* and *Sandy Silt (ML)*; moist; few fine to coarse, subrounded gravel; fine to coarse sand; low plasticity fines.		15.1	S-2
(4) Gray to brown, *Poorly Graded Sand with Gravel (SP)* to *Poorly Graded Gravel with Sand (GP)*; moist; fine to coarse, subrounded gravel; fine to coarse sand; trace nonplastic fines.		4.3	S-3

Sketch of Southeast Pit Side

Surface Elevation: Approx. 142 Ft.



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LOG OF TEST PIT TP-RR-2

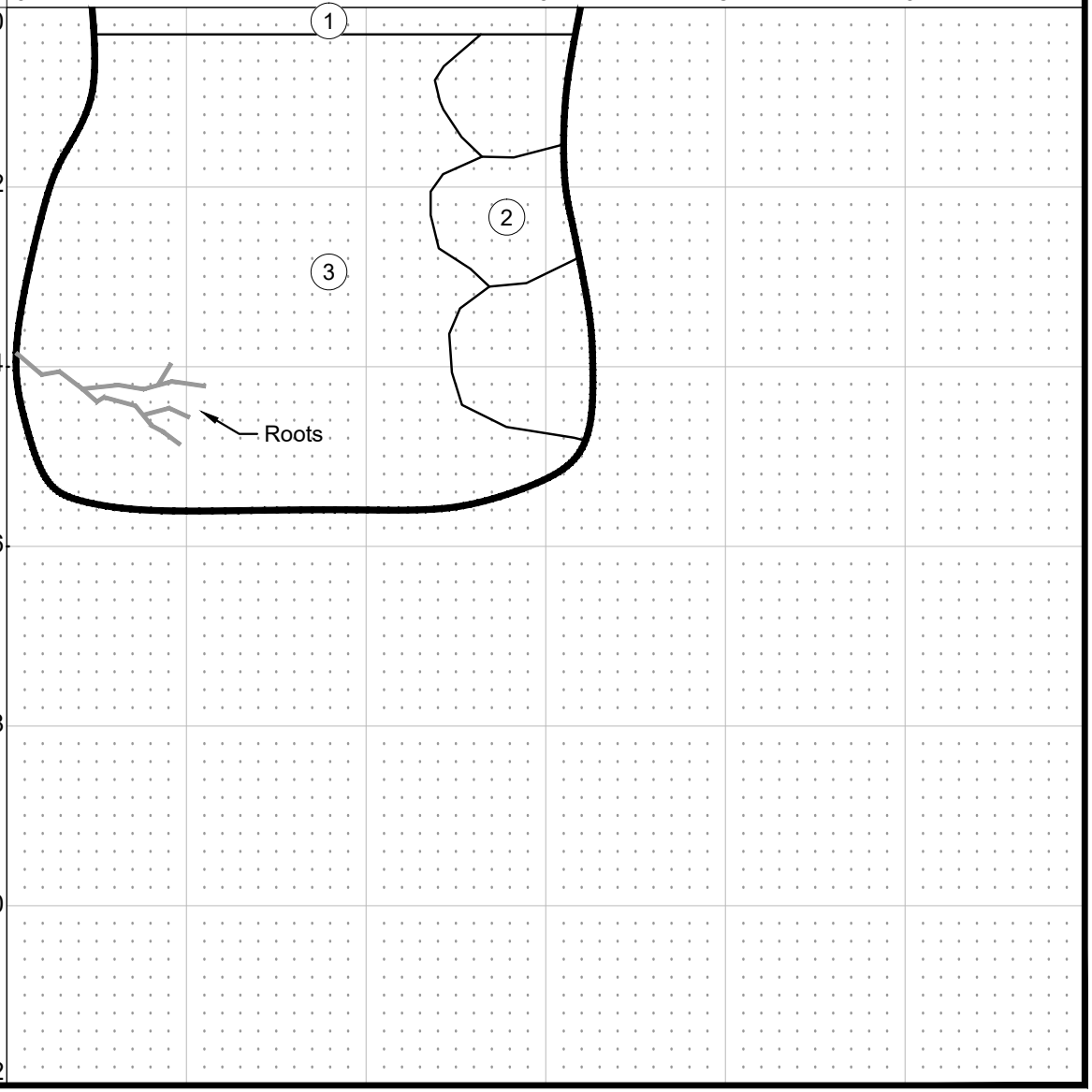
JOB NO: 103692-403 DATE: 7-28-2021 LOCATION: Lower Raging River Left Bank - Upstream (North)

PROJECT: Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report, King County, WA

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Topsoil and grass with crushed gravel. (2) Angular boulders observed on east edge of test pit to about 6 feet west of the eastern edge of the levee. (3) Brown, *Well-Graded Gravel with Sand and Cobbles (GW)*; moist; subrounded cobbles; fine to coarse, subrounded to rounded gravel; fine to coarse sand; trace nonplastic fines. - Few roots from about 3 to 4 feet.	None Observed		S-1	0

Sketch of East Pit Side

Surface Elevation: Approx. 136 Ft.



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LOG OF TEST PIT TP-RR-3

JOB NO: 103692-403 DATE: 7-28-2021 LOCATION: Lower Raging River Left Bank - Central (South)

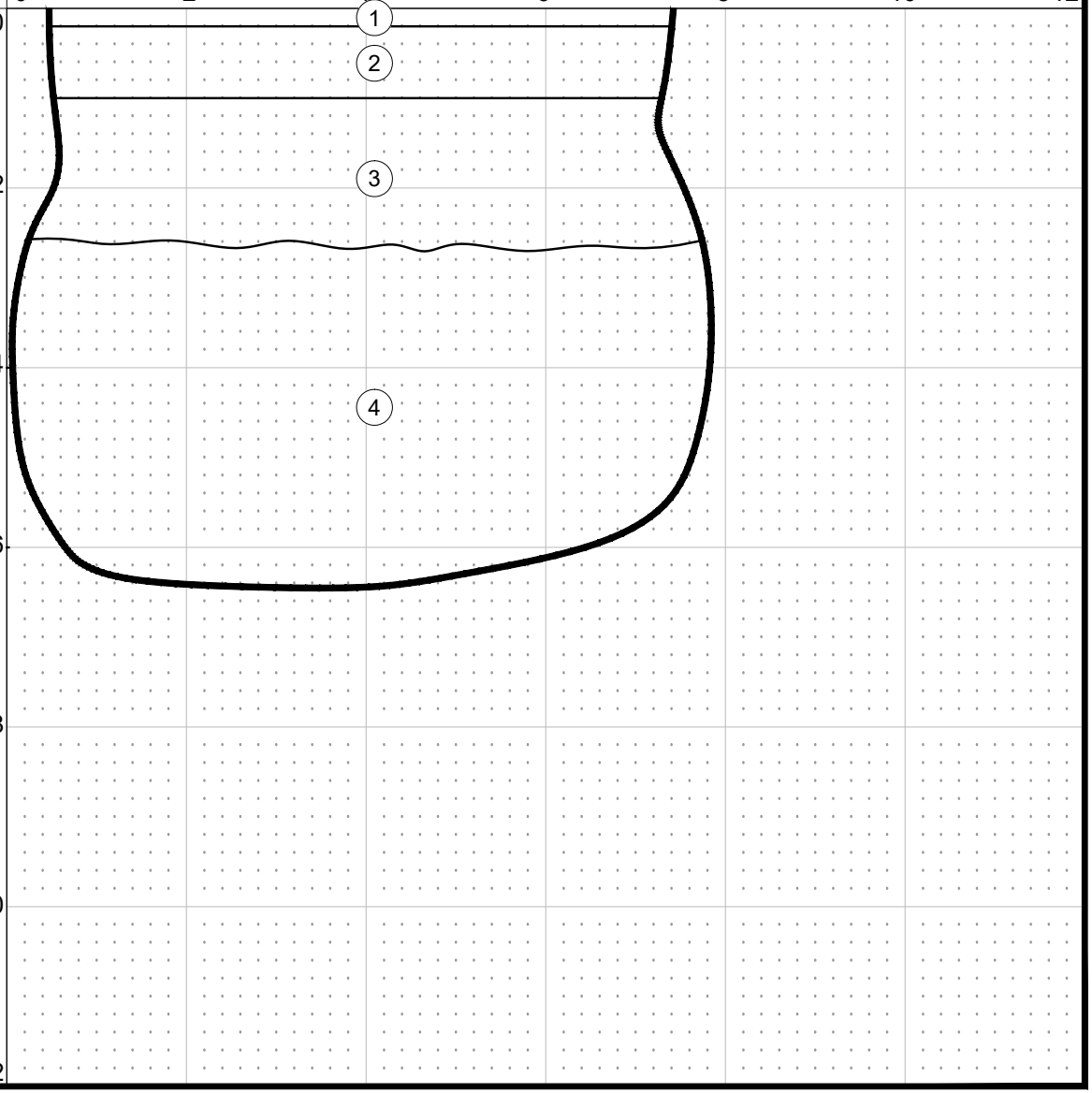
PROJECT: Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report, King County, WA

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Topsoil and grass. (2) Gray-brown crushed gravel mixed with topsoil. - Grass roots at about 1 foot. (3) Gray-brown, angular Boulders and Cobbles mixed with *Poorly Graded Gravel with Sand (GP)*; moist; angular boulders; subrounded gravel; fine to coarse sand; trace nonplastic fines. (4) Brown and gray, *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)*; moist; subrounded cobbles; fine to coarse, subrounded to rounded gravel; fine to coarse sand; nonplastic fines.	None Observed		S-1 S-2	0 2 4 6 8 10 12

Sketch of East Pit Side

Surface Elevation: Approx. 125 Ft.

Horizontal Distance in Feet



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LOG OF TEST PIT TP-RR-4

JOB NO: 103692-403 DATE: 7-28-2021 LOCATION: Lower Raging River Left Bank - Central (North)

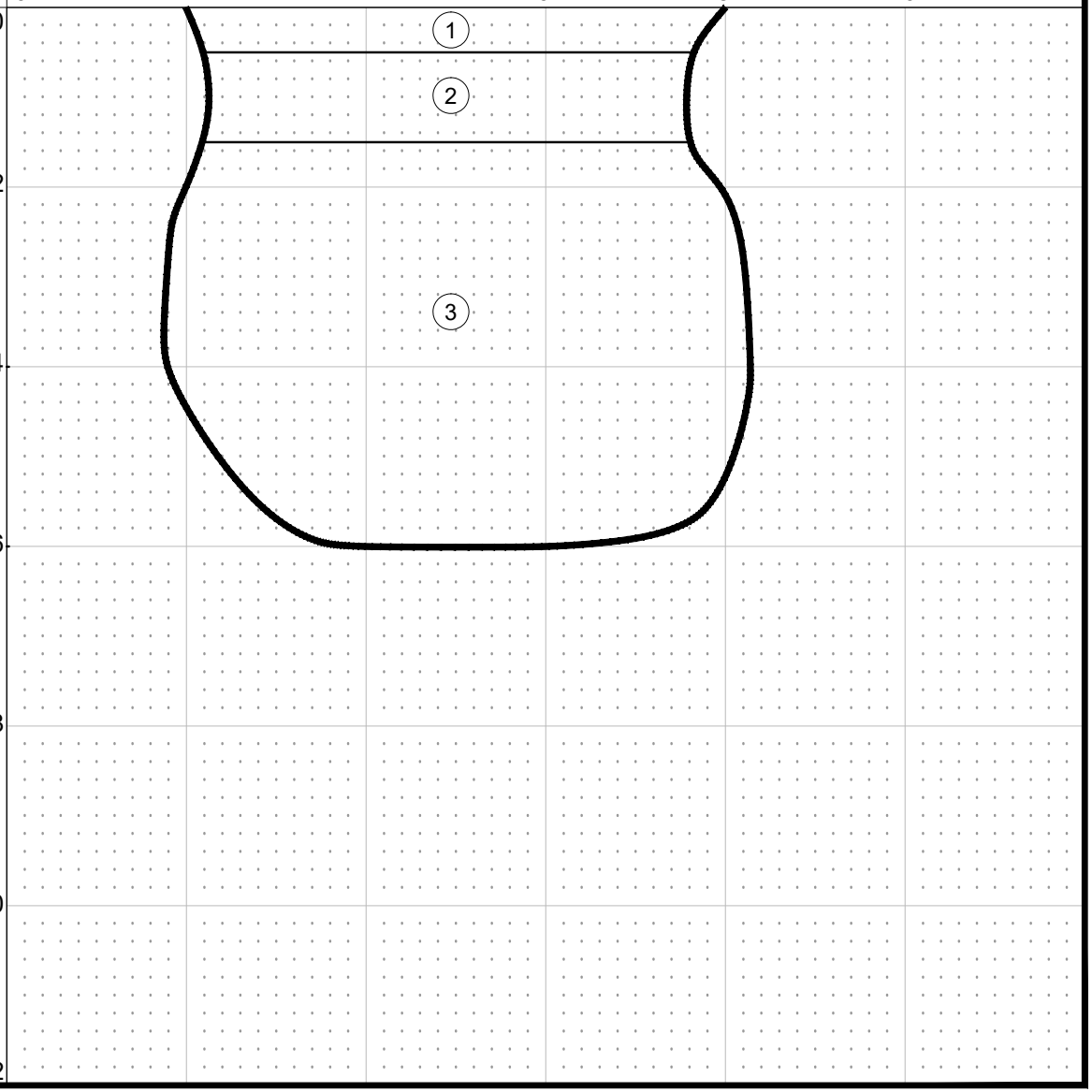
PROJECT: Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report, King County, WA

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Topsoil and grass.	None Observed		S-1	0
(2) Brown and gray crushed gravel.				2
(3) Brown, *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)*; moist; subrounded cobbles; fine to coarse gravel; fine to coarse sand; nonplastic fines. - roots from about 3 to 4 feet.				4
			S-2	6
				8
				10
				12

Sketch of East Pit Side

Surface Elevation: Approx. 121 Ft.

Horizontal Distance in Feet



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LOG OF TEST PIT TP-RR-5

JOB NO: 103692-403 DATE: 7-28-2021 LOCATION: Lower Raging River Left Bank - Downstream (South)

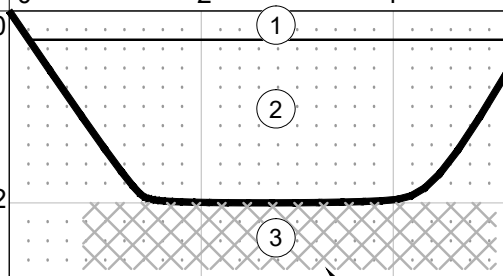
PROJECT: Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report, King County, WA

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Topsoil and grass. (2) Brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; trace subrounded cobbles; fine to coarse, subangular to rounded gravel; fine to coarse sand; low plasticity fines. - 3-inch chunk of asphalt. (3) Gabion basket encountered at 2 feet with overlapping grids filled with material similar to that described above, but with higher plasticity and less gravel. - Gabion baskets on water side of levee filled with coarse rounded gravel (see photo). - Gabion basket on land side of levee utilized fabric (see photo).	None Observed	12.3	S-1	0 2 4 6 8 10 12

Sketch of East Pit Side

Surface Elevation: Approx. 107 Ft.

Horizontal Distance in Feet



Gabion Basket - Water Side

Gabion Basket - Land Side

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LOG OF TEST PIT TP-RR-6

JOB NO: 103692-403 DATE: 7-28-2021 LOCATION: Lower Raging River Left Bank - Downstream (North)

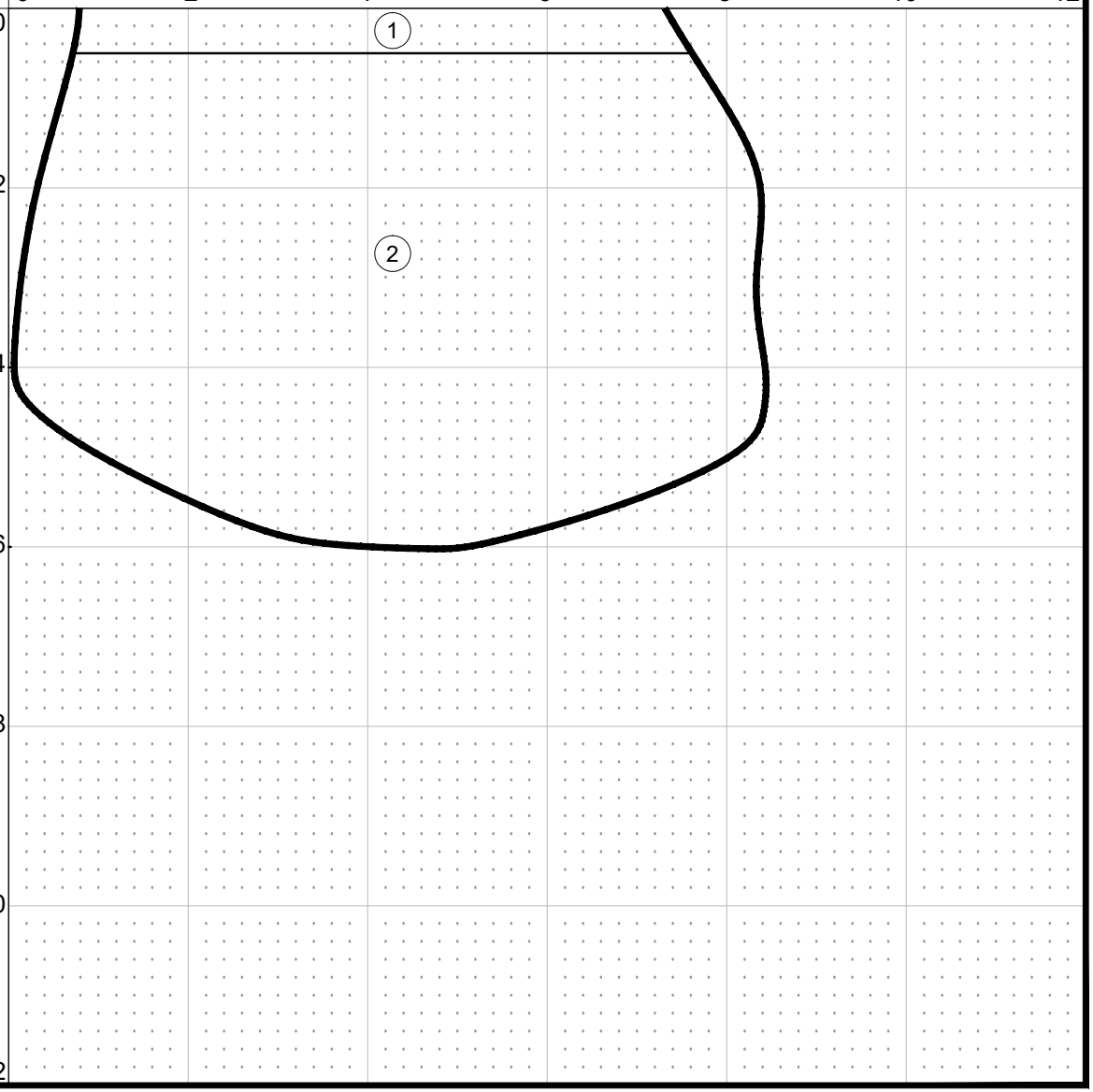
PROJECT: Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report, King County, WA

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Topsoil and grass over crushed gravel.	None Observed			0
(2) Brown, *Poorly Graded Gravel with Sand and Cobbles (GP)*; moist; subrounded cobbles; fine to coarse, subrounded to rounded gravel; fine to coarse sand; trace nonplastic fines.		4.0	S-1	4
				6
				8
				10
				12

Sketch of East Pit Side

Surface Elevation: Approx. 105 Ft.

Horizontal Distance in Feet



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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

LOG OF TEST PIT TP-RR-7

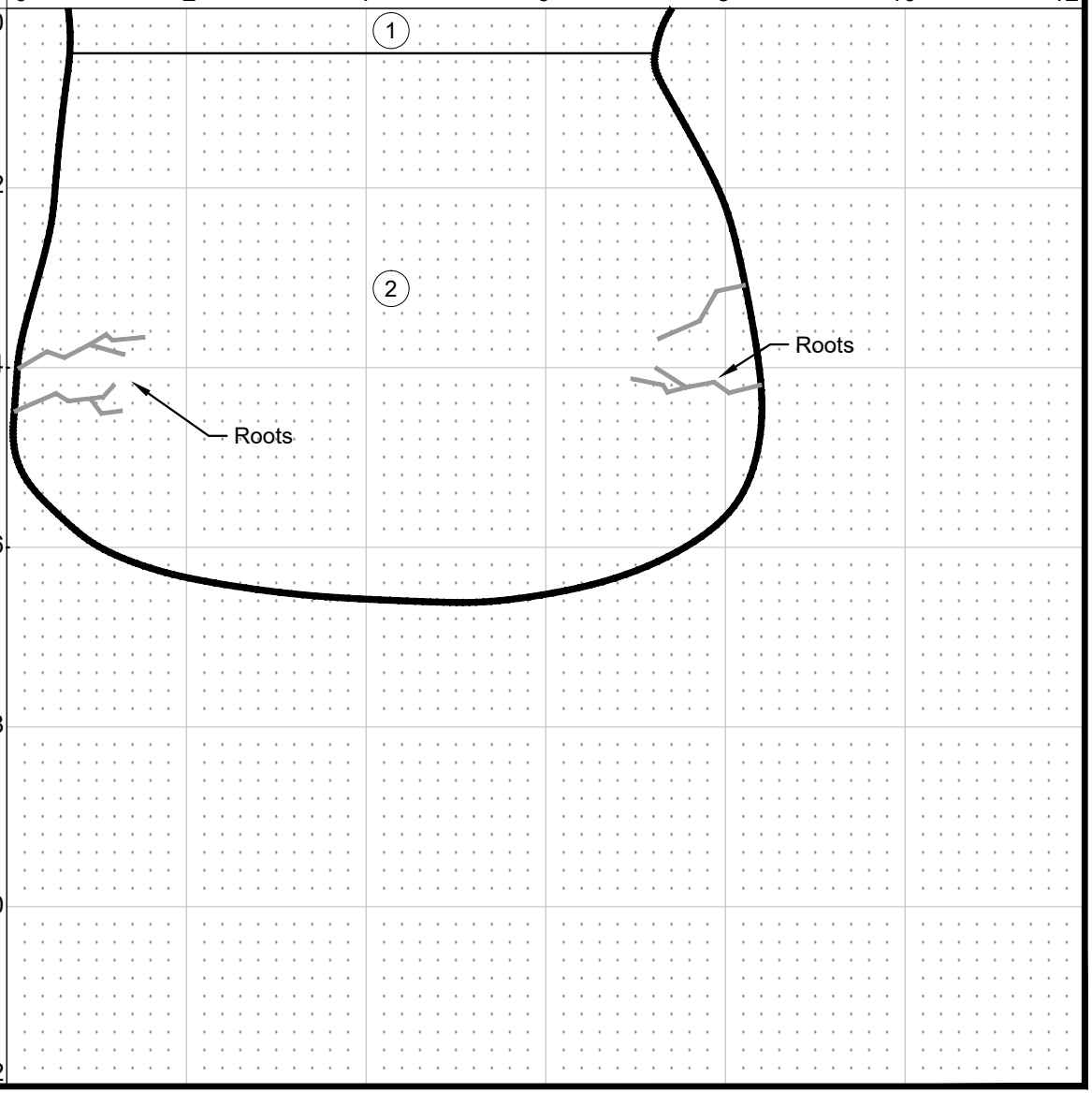
JOB NO: 103692-403 DATE: 7-28-2021 LOCATION: Lower Raging River Right Bank - South

PROJECT: Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report, King County, WA

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Gravel and patchy grass at the surface with topsoil. (2) Brown, *Poorly Graded Gravel with Sand and Cobbles (GP)*; moist; subrounded cobbles; fine to coarse, subrounded to rounded gravel; fine to coarse sand; trace nonplastic fines. - Roots from about 3 to 4 feet.	None Observed		S-1	0 2 4 6 8 10 12

Sketch of East Pit Side

Surface Elevation: Approx. 129 Ft.



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LOG OF TEST PIT TP-RR-8

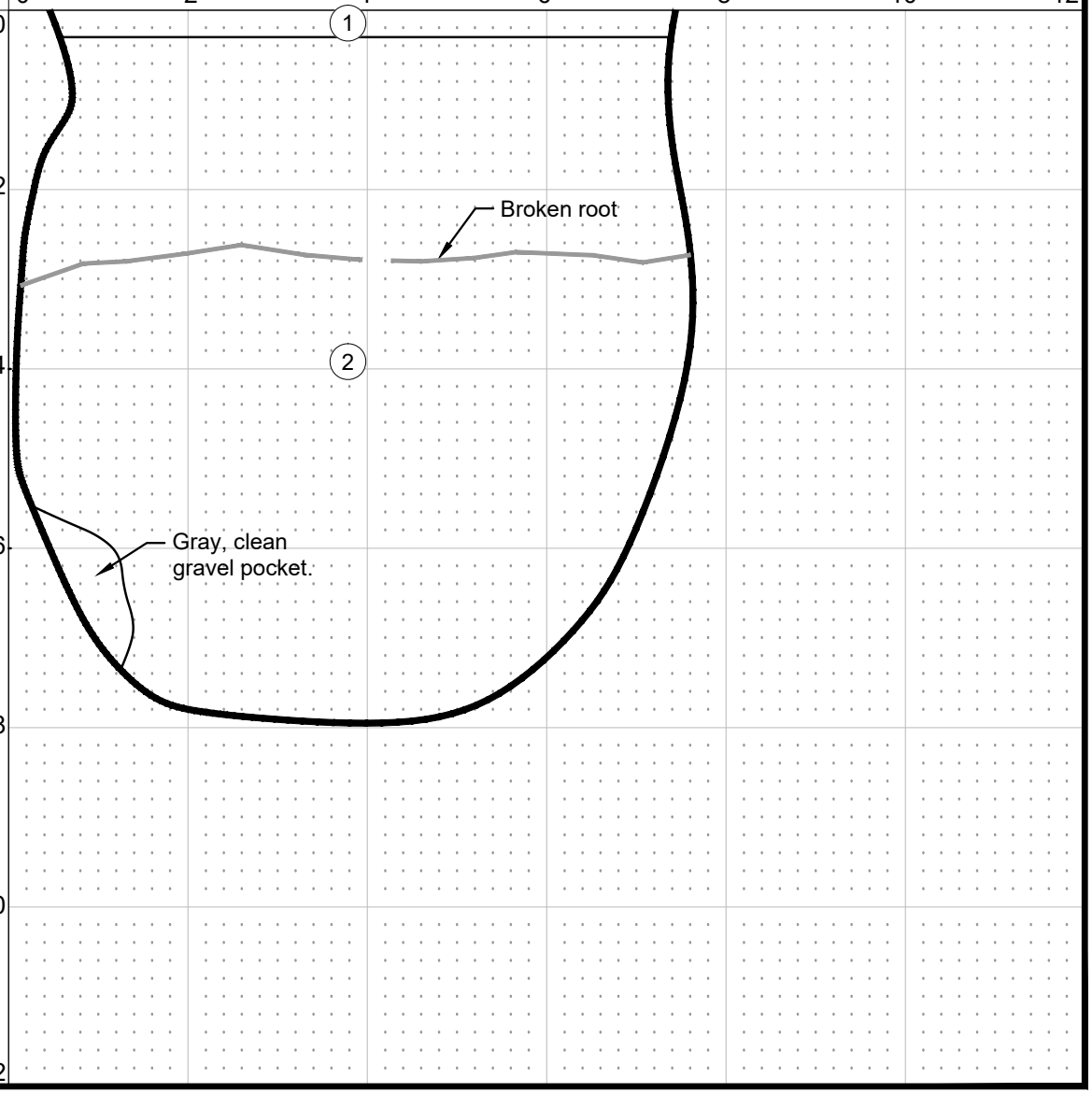
JOB NO: 103692-403 DATE: 7-28-2021 LOCATION: Lower Raging River Right Bank - North

PROJECT: Levee Breach Analysis Mapping and Risk Assessment, Geotechnical Data Report, King County, WA

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Topsoil and grass.	None Observed			0
(2) Brown, *Poorly Graded Gravel with Sand and Cobbles (GP)*; moist; subrounded cobbles; fine to coarse, subrounded to rounded gravel; fine to coarse sand; trace nonplastic fines. - Cobbles up to 10 inches encountered. - Possible boulders. - Fine roots above 2 feet and 1 inch roots from 3 to 4 feet. - Gray, clean gravel pocket at about 6 feet on the north side.		2.5	S-1	4
				12

Sketch of East Pit Side

Surface Elevation: Approx. 121 Ft.



APPENDIX B: HISTORICAL SITE EXPLORATION LOGS

Appendix B

Historical Site Exploration Logs

CONTENTS

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

S&W CLASSIFICATION OF SOIL CONSTITUENTS

- MAJOR constituents compose more than 50 percent, by weight, of the soil. Major constituents are capitalized (SAND).
- Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (slightly silty SAND).
- Trace constituents compose 0 to 5 percent of the soil (slightly silty SAND, trace of gravel).

MOISTURE CONTENT DEFINITIONS

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

ABBREVIATIONS

ATD	At Time of Drilling
Elev.	Elevation
ft	feet
HSA	Hollow Stem Auger
ID	Inside Diameter
in	inches
lbs	pounds
Mon.	Monument cover
N	Blows for last two 6-inch increments
NA	Not Applicable or Not Available
OD	Outside Diameter
OVA	Organic Vapor Analyzer
PID	Photoionization Detector
ppm	parts per million
PVC	Polyvinyl Chloride
SS	Split Spoon sampler
SPT	Standard Penetration Test
USC	Unified Soil Classification
WLI	Water Level Indicator

GRAIN SIZE DEFINITIONS

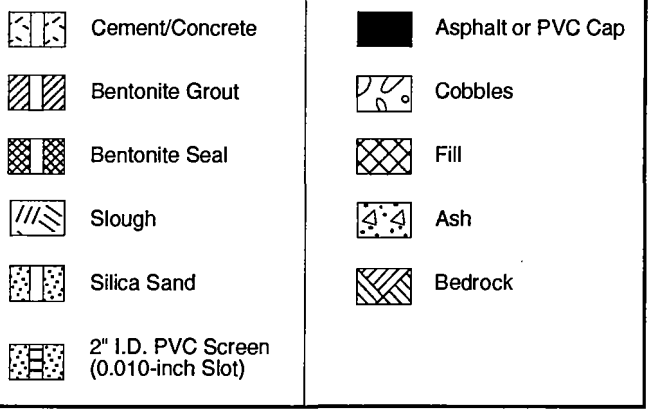
DESCRIPTION	SIEVE SIZE
FINES	< #200 (0.08 mm)
SAND*	
• Fine	• #200 - #40 (0.4 mm)
• Medium	• #40 - #10 (2 mm)
• Coarse	• #10 - #4 (5 mm)
GRAVEL*	
• Fine	• #4 - 3/4 inch
• Coarse	• 3/4 - 3 inches
COBBLES	3 - 12 inches
BOULDERS	> 12 inches

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

RELATIVE DENSITY / CONSISTENCY

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

WELL AND OTHER SYMBOLS



Raging River Bridge 234A
Fall City, Washington

SOIL CLASSIFICATION AND LOG KEY

January 1997 W-6819-02

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

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL②		TYPICAL DESCRIPTION
Coarse-Grained Soils *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Clean Gravels① *(less than 5% fines)*	GW		Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP		Poorly Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		Gravels with① Fines *(more than 12% fines)*	GM		Silty Gravels, Gravel-Sand-Silt Mixtures
			GC		Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Clean Sands① *(less than 5% fines)*	SW		Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP		Poorly Graded Sand, Gravelly Sands, Little or No Fines
*[Use Dual Symbols for 5 - 12% Fines (i.e. GP-GM)]*①		Sands with① Fines *(more than 12% fines)*	SM		Silty Sands, Sand-Silt Mixtures
			SC		Clayey Sands, Sand-Clay Mixtures
Fine-Grained Soils *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML		Inorganic Silts of Low to Medium Plasticity, Rock Flour, or Clayey Silts with Slight Plasticity
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		Organic	OL		Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	CH		Inorganic Clays of Medium to High Plasticity, Sandy Fat Clay, Gravelly Fat Clay
			MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sands or Silty Soils, Elastic Silt
		Organic	OH		Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		PT		Peat, Humus, Swamp Soils with High Organic Content (See D 4427-92)

NOTES

1. Dual symbols (symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND) are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

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

Raging River Bridge 234A
Fall City, Washington

SOIL CLASSIFICATION AND LOG KEY

January 1997 W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

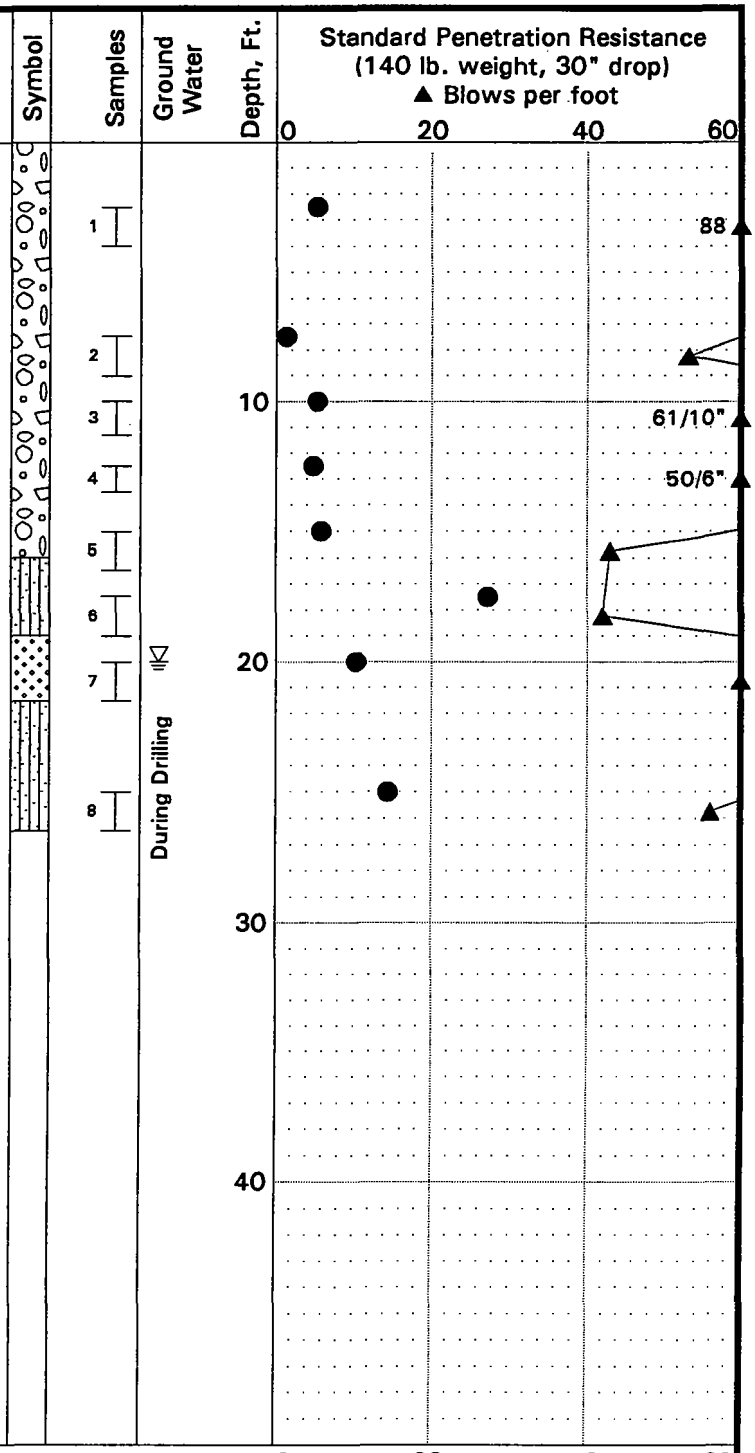
FIG. A-1
Sheet 2 of 2

MASTERLG 5/15/97

SOIL DESCRIPTION Surface Elev.: Approx. 103 Feet	Depth, Ft.
Very dense, brown, slightly sandy, fine to coarse GRAVEL; moist; cobbles and boulders inferred from drilling action; GW.	
Dense, gray, silty, fine SAND, trace of organics; wet; thinly laminated; SM/ML.	16.0
Very dense, gray-brown, gravelly SAND, trace of silt; wet; bedded with layers of fine to medium sand; SW.	19.0
Very dense, gray-brown, silty, fine to medium SAND, trace of coarse gravel; wet; scattered cobbles inferred from drilling action; SM.	21.5
BOTTOM OF BORING COMPLETED 11/15/96	26.5

NOTE

Pavement section consists of 2-inch-thick asphalt over 4-inch-thick base course.



LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Surface Seal
- Annular Sealant
- Piezometer Screen
- Grout
- Water Level
- Low Water Level

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USC letter symbol based on visual classification.

Raging River Bridge 234A
Fall City, Washington

LOG OF BORING B-1

December 1996 W-6819-02

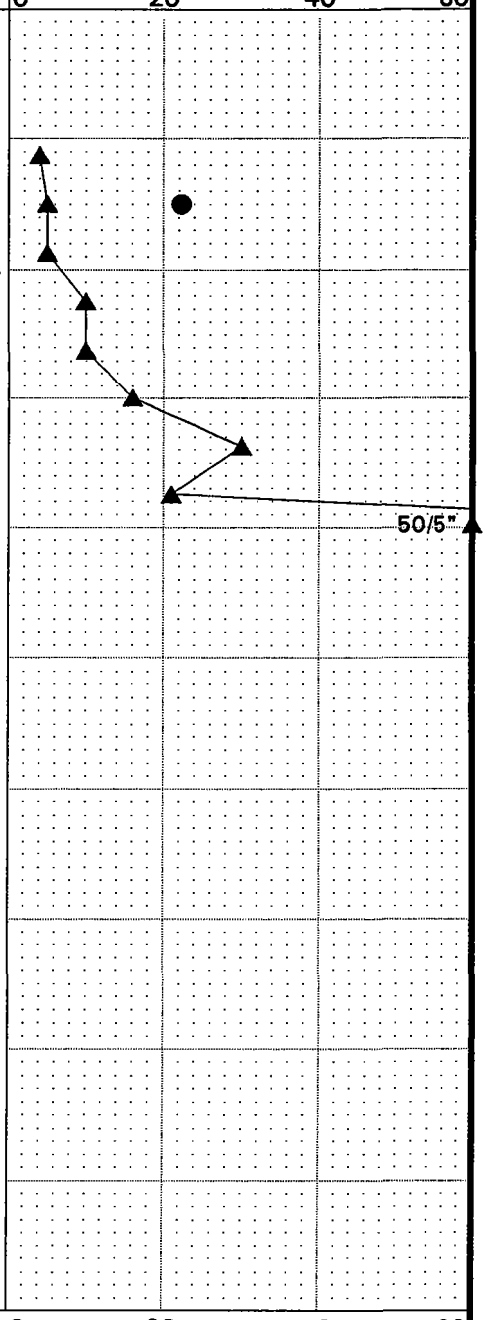
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2

MASTERLG 5/15/97

SOIL DESCRIPTION Surface Elev.: Approx. 104 Feet	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Loose, brown, fine sandy SILT; moist to dry; trace of gravel; scattered roots; (Fill); SM.			1	None Observed During Drilling	2
			2		4
	5.5		3		6
Medium dense to very dense, light brown, silty, fine sandy GRAVEL; moist to dry; GW.			4		8
	8.5		5		10
BOTTOM OF BORING COMPLETED 12/11/96					12
					14
					16
					18

Porter Penetration Resistance
(40 lb. weight, 18" drop)
▲ Blows per 6"



● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Surface Seal
- Annular Sealant
- Piezometer Screen
- Grout
- Water Level
- Low Water Level

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USC letter symbol based on visual classification.

Raging River Bridge 234A
Fall City, Washington

LOG OF BORING B-2

December 1996 W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3

MASTERLG 5/15/97

SOIL DESCRIPTION Surface Elev.: Approx. 112 Feet	Depth, Ft.
Loose, brown, silty, fine SAND, trace of gravel; moist; (Fill); SM.	6.0
Medium dense to very dense, brown, gravelly, silty SAND; scattered cobbles inferred from drilling action; moist; (Fill); SM.	12.0
Medium dense, slightly silty, sandy GRAVEL; moist; GW.	15.0
Very dense, gray-brown, silty, sandy GRAVEL; wet; cobbles and boulders inferred from drilling action; GW.	
Medium dense, brown, clean to slightly silty, fine to medium SAND; wet; scattered laminations of organic silt; SM.	39.0 43.0
Dense to very dense, gray, silty, gravelly SAND; wet; SP-SM.	
Very dense, gray, silty, fine SAND, scattered gravel; wet; SM.	56.0 61.0
Very dense, yellow-brown, sandy GRAVEL, trace of silt; wet; GW.	
Dense, gray, slightly sandy, slightly clayey SILT; wet; scattered pockets of peat; ML.	67.0
Very dense, yellow-brown, gravelly, fine to coarse SAND, trace of silt; wet; SW. - cobbles inferred from drilling action between 76 and 78 feet.	73.0 80.5
BOTTOM OF BORING COMPLETED 11/20/96	

Symbol

Samples: 1, 2, 3, 4, 5, 6*, 7, 8, 9, 10, 11, 12*, 13, 14, 15, 16, 17, 18

Ground Water Depth, Ft.: During Drilling

Standard Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot

Depth, Ft.	Blows per foot
10	73
	50/4"
20	62
	84/8"
30	50/4"
40	86
50	76
60	77
	50/6"
70	62/6"
80	74
90	

0 20 40 60

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Surface Seal
- Annular Sealant
- Piezometer Screen
- Grout
- Water Level
- Low Water Level

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USC letter symbol based on visual classification.

Raging River Bridge 234A
Fall City, Washington

LOG OF BORING B-3

December 1996 W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-4

MASTERLG 5/15/97

SOIL DESCRIPTION Surface Elev.: Approx. 102 Feet	Depth, Ft.
Medium dense, gray-brown, silty, fine SAND; moist; SM.	
Very dense, gray-brown, silty, sandy GRAVEL; wet; cobbles inferred from drilling action; GW. - layers of silty, fine sand inferred from drill cuttings between 17 and 19 feet.	7.0
Large cobbles and boulders inferred from drilling action; GW.	28.0
Dense, gray, silty, fine SAND; wet; scattered pockets of organic, clayey silt; SM.	33.0 38.0
Very dense, gray-brown, gravelly, fine to coarse SAND and sandy GRAVEL, trace of silt; wet; SW/GW.	58.0
Very dense, gray-brown, silty, fine SAND; wet; laminated with sandy silt; trace of fine gravel; SM.	61.5
BOTTOM OF BORING COMPLETED 12/11/96	

Symbol

Samples: 1, 2*, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

Ground Water: During Drilling

Depth, Ft.: 10, 20, 30, 40, 50, 60, 70, 80, 90

Standard Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot

0 20 40 60

50/6"
50/6"
50/2"
50/1"
50/4"
80/6"
91
50/6"
88

0 20 40 60

● % Water Content
Plastic Limit ⊢●⊣ Liquid Limit
Natural Water Content

LEGEND

- • Sample Not Recovered
- ⊥ 2" O.D. Split Spoon Sample
- ⊥ 3" O.D. Shelby Tube Sample
- Surface Seal
- Annular Sealant
- Piezometer Screen
- Grout
- ▽ Water Level
- ▼ Low Water Level

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USC letter symbol based on visual classification.

Raging River Bridge 234A
Fall City, Washington

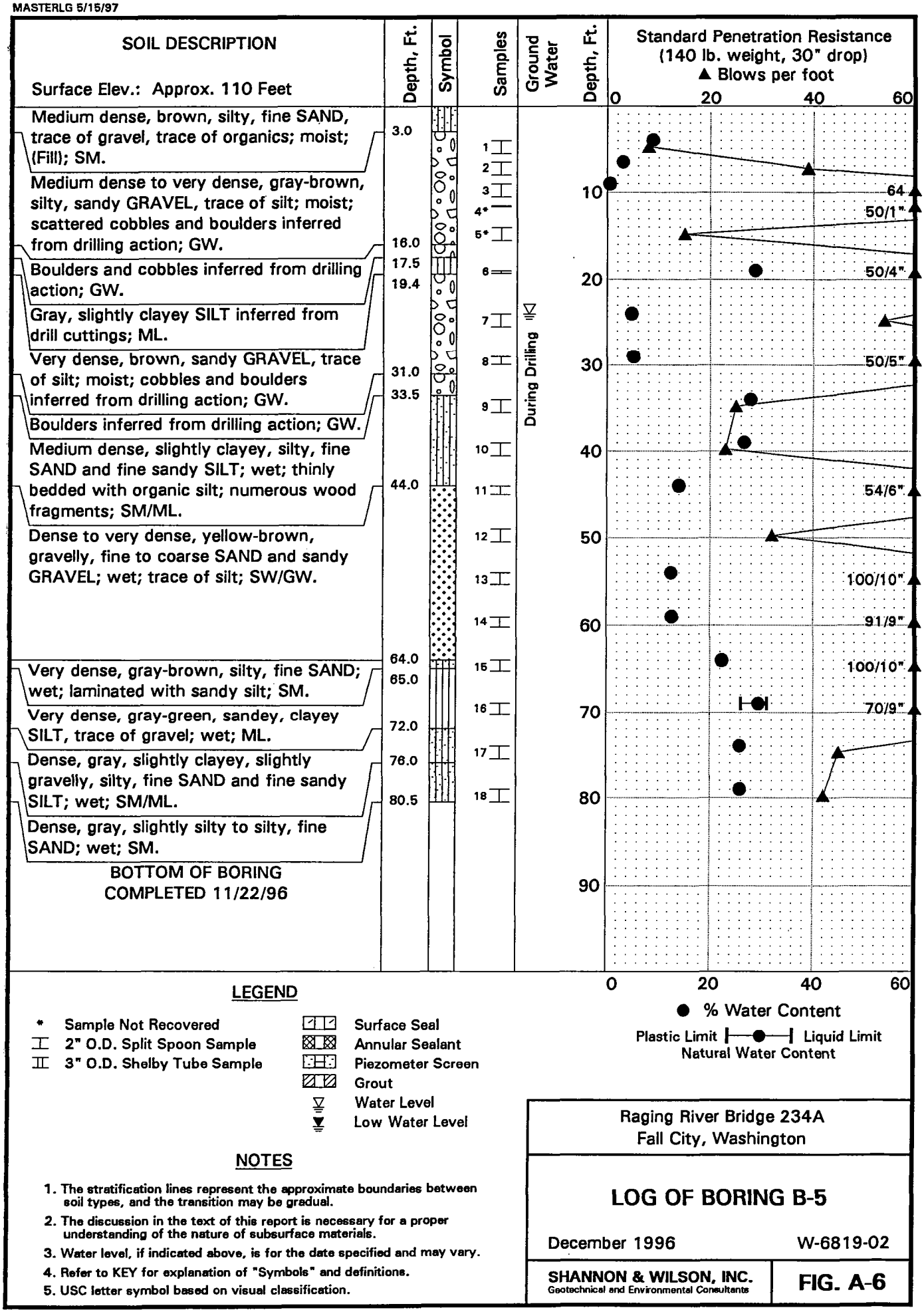
LOG OF BORING B-4

December 1996 W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-5

MASTERLG 5/15/97



LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- 3" O.D. Shelby Tube Sample
- Surface Seal
- Annular Sealant
- Piezometer Screen
- Grout
- Water Level
- Low Water Level

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USC letter symbol based on visual classification.

Raging River Bridge 234A
Fall City, Washington

LOG OF BORING B-5

December 1996 W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-6

MASTERLG 5/15/97

SOIL DESCRIPTION Surface Elev.: Approx. 108 Feet	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Medium dense, brown, gravelly, silty, fine to medium SAND; moist; (Fill); SM.					
	4.0		1 G		
Very dense, slightly sandy, fine to coarse GRAVEL; moist; cobbles and boulders inferred from drilling action; GW.			2	None Observed During Drilling	10
			3		
	14.6		4		20
BOTTOM OF BORING COMPLETED 11/25/96					30
					40

Standard Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot

0 20 40 60

50/6"
50/1"
50/6"

0 20 40 60

● % Water Content
Plastic Limit ⊢●⊣ Liquid Limit
Natural Water Content

NOTES

1. Upper 6 inches consists of crushed gravel.
2. Drilling refusal at bottom of boring.

LEGEND

*	Sample Not Recovered		Surface Seal
I	2" O.D. Split Spoon Sample		Annular Sealant
II	3" O.D. Shelby Tube Sample		Piezometer Screen
G	Grab Sample		Grout
		▽	Water Level
		▼	Low Water Level

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USC letter symbol based on visual classification.

Raging River Bridge 234A
Fall City, Washington

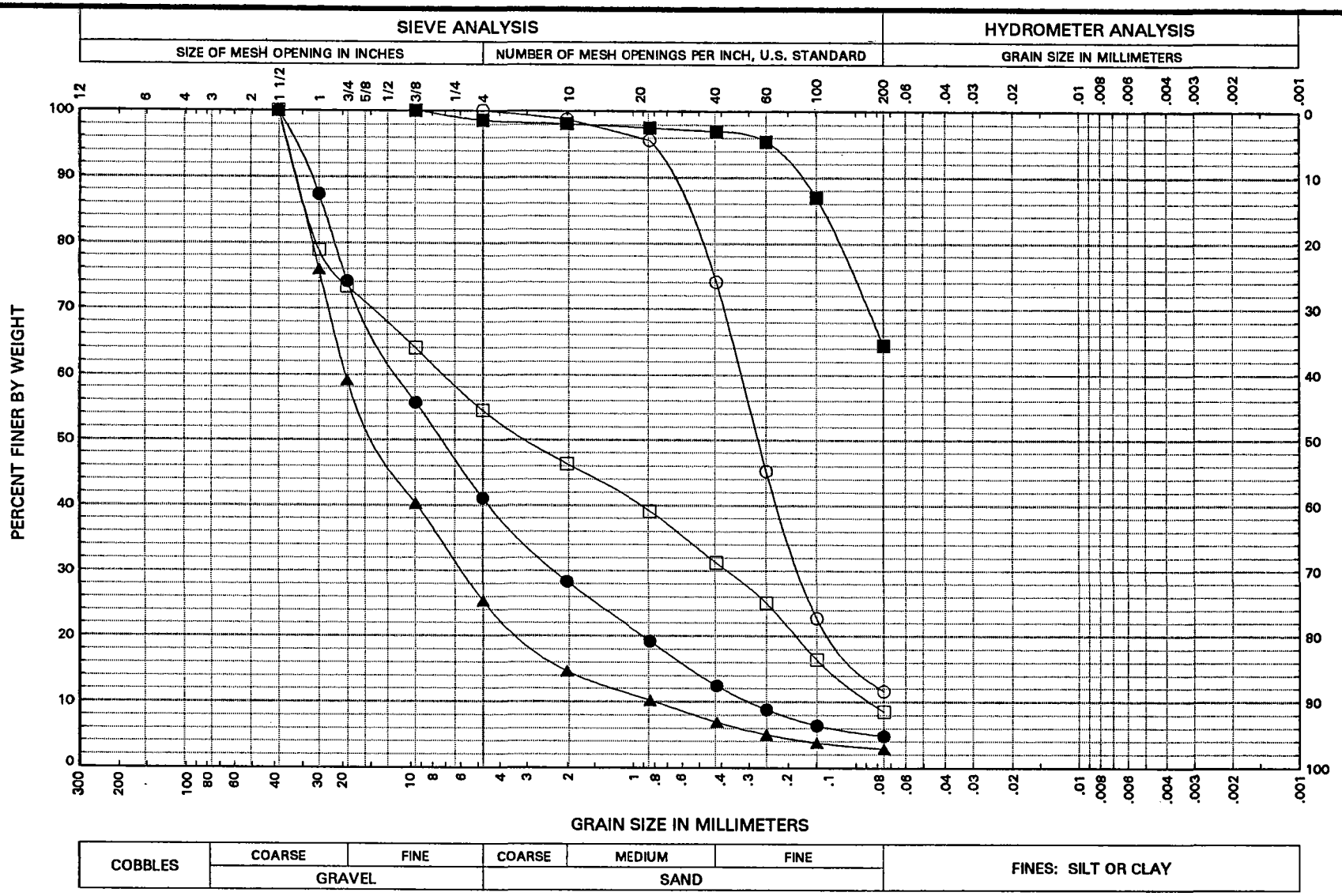
LOG OF BORING B-6

December 1996 W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-7

NCDGRAIN 6/30/97



BORING AND SAMPLE NO.	DEPTH, FT.	U.S.C.	CLASSIFICATION	% FINES	NAT. W.C. %	LL	PL	PI
● B-1, S-2	7.5	GW	Brown, sandy GRAVEL; trace of silt.	4.8	1.3			
■ B-2, S-2	3.0	ML	Brown, sandy SILT.	64.4	22.3			
▲ B-3, S-7	23.0	GW	Brown, sandy GRAVEL; trace of silt.	2.9	6.6			
○ B-3, S-10	39.0	SP-SM	Gray-brown, slightly silty SAND.	11.6	24.3			
□ B-3, S-11	44.0	SP-SM	Gray, slightly silty, gravelly SAND.	8.5	11.2			

Raging River Bridge 234A
Fall City, Washington

GRAIN SIZE DISTRIBUTION
BORINGS B-1 THROUGH B-3

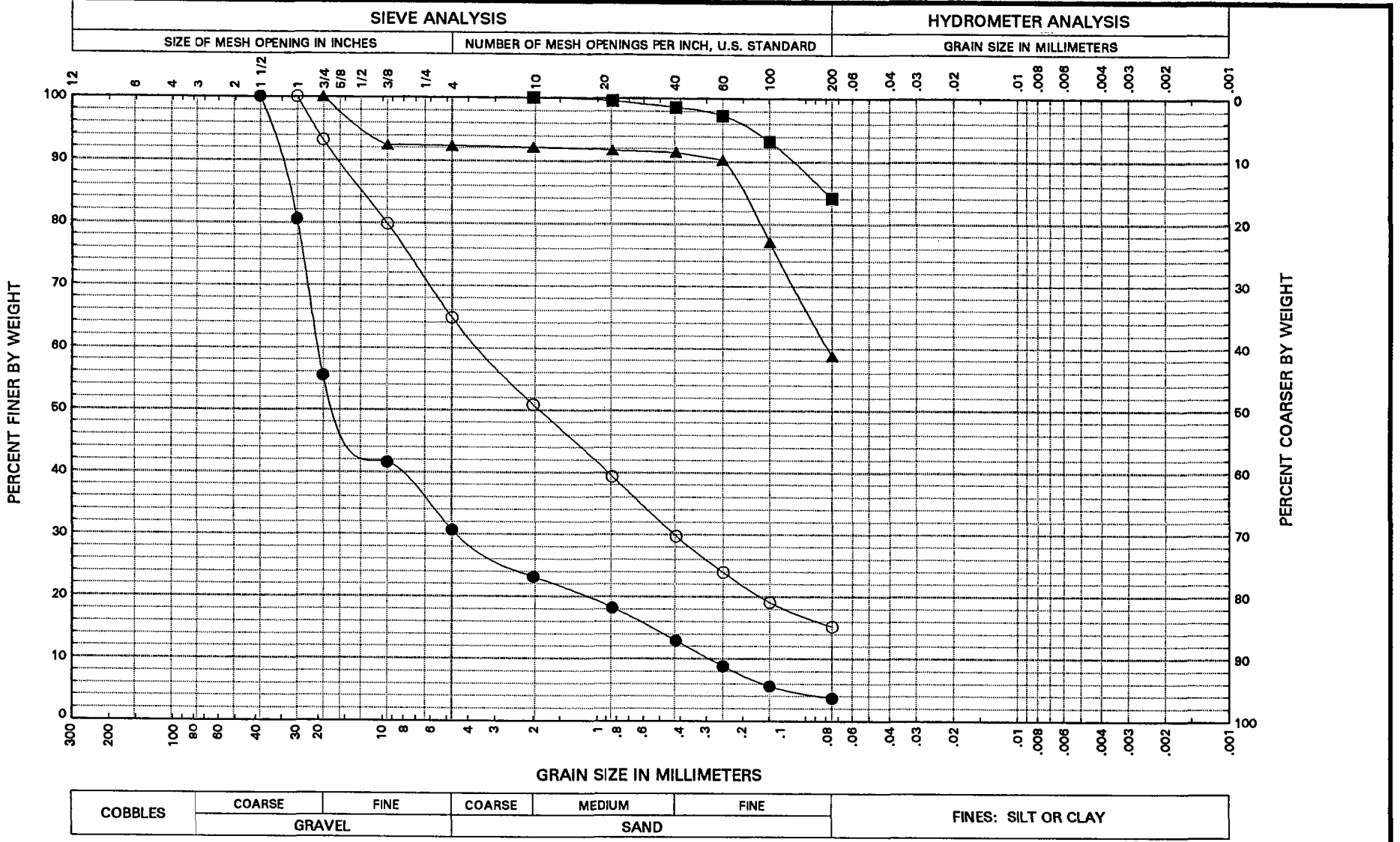
W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-8

FIG. A-8

NCDGRAIN 6/30/97



BORING AND SAMPLE NO.	DEPTH, FT.	U.S.C.	CLASSIFICATION	% FINES	NAT. W.C. %	LL	PL	PI
● B-4, S-4	20.0	GP	Brown, sandy GRAVEL; trace of silt.	3.7	6.7			
■ B-5, S-9	34.0	ML	Gray, slightly clayey, sandy SILT.	84.0	27.8			
▲ B-5, S-17	74.0	ML	Gray, slightly clayey, slightly gravelly, sandy SILT.	58.7	25.8			
○ B-6, S-1	2.5	SM	Brown, silty, gravelly SAND.	15.2	9.0			

Raging River Bridge 234A
Fall City, Washington

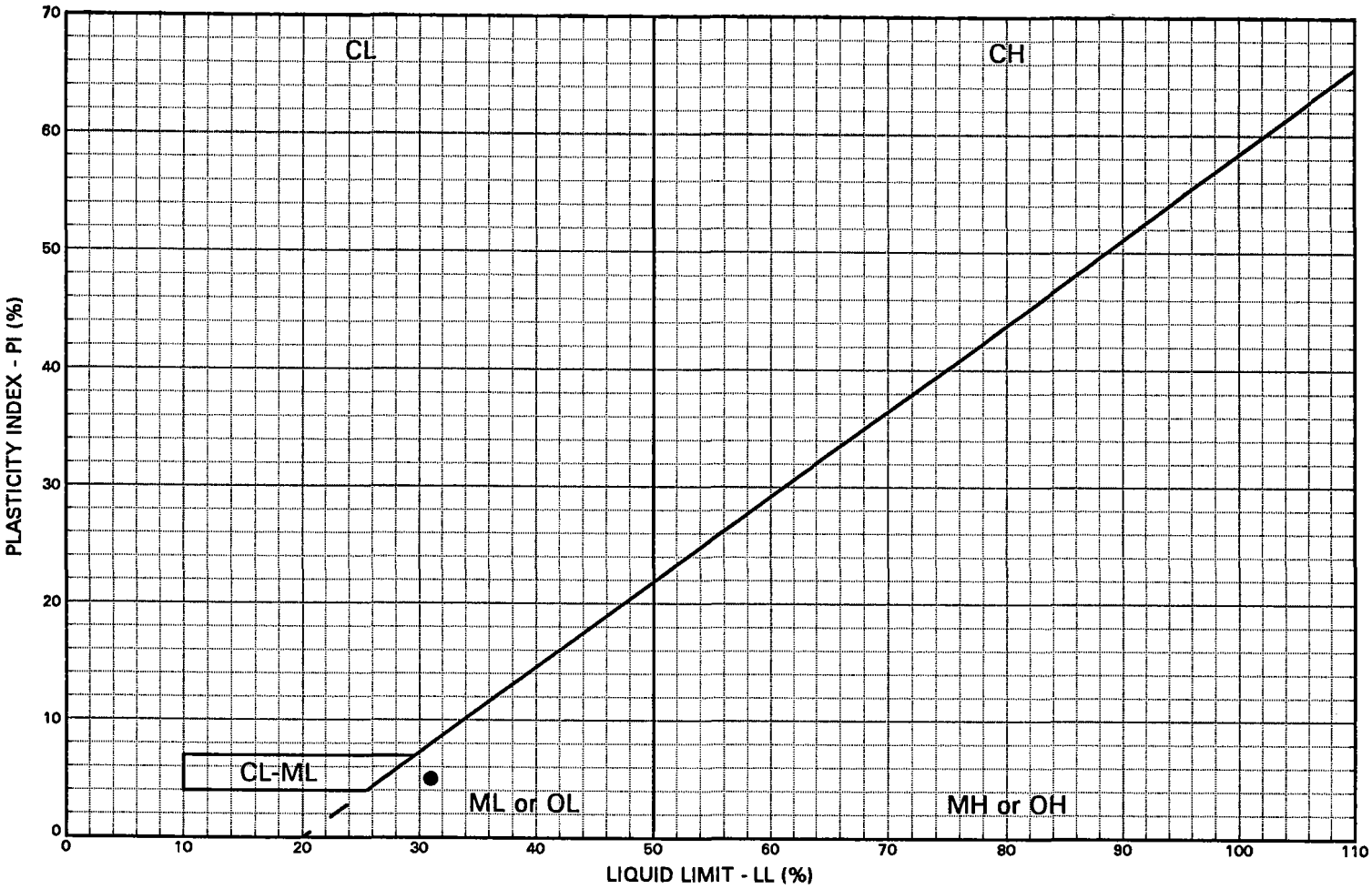
GRAIN SIZE DISTRIBUTION
BORINGS B-4 THROUGH B-6

W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-9

FIG. A-9



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

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

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

CL-ML: Silty clays and clayey silts

BORING AND SAMPLE NO.	DEPTH, FT.	U.S.C.	CLASSIFICATION	LL, %	PL, %	PI, %	NAT. W.C. %	PASS. #200, %
● B-5, S-16	69.0	ML	Gray, sandy, clayey SILT; trace of gravel.	31	26	5	29.4	

Raging River Bridge 234A
Fall City, Washington

PLASTICITY CHART

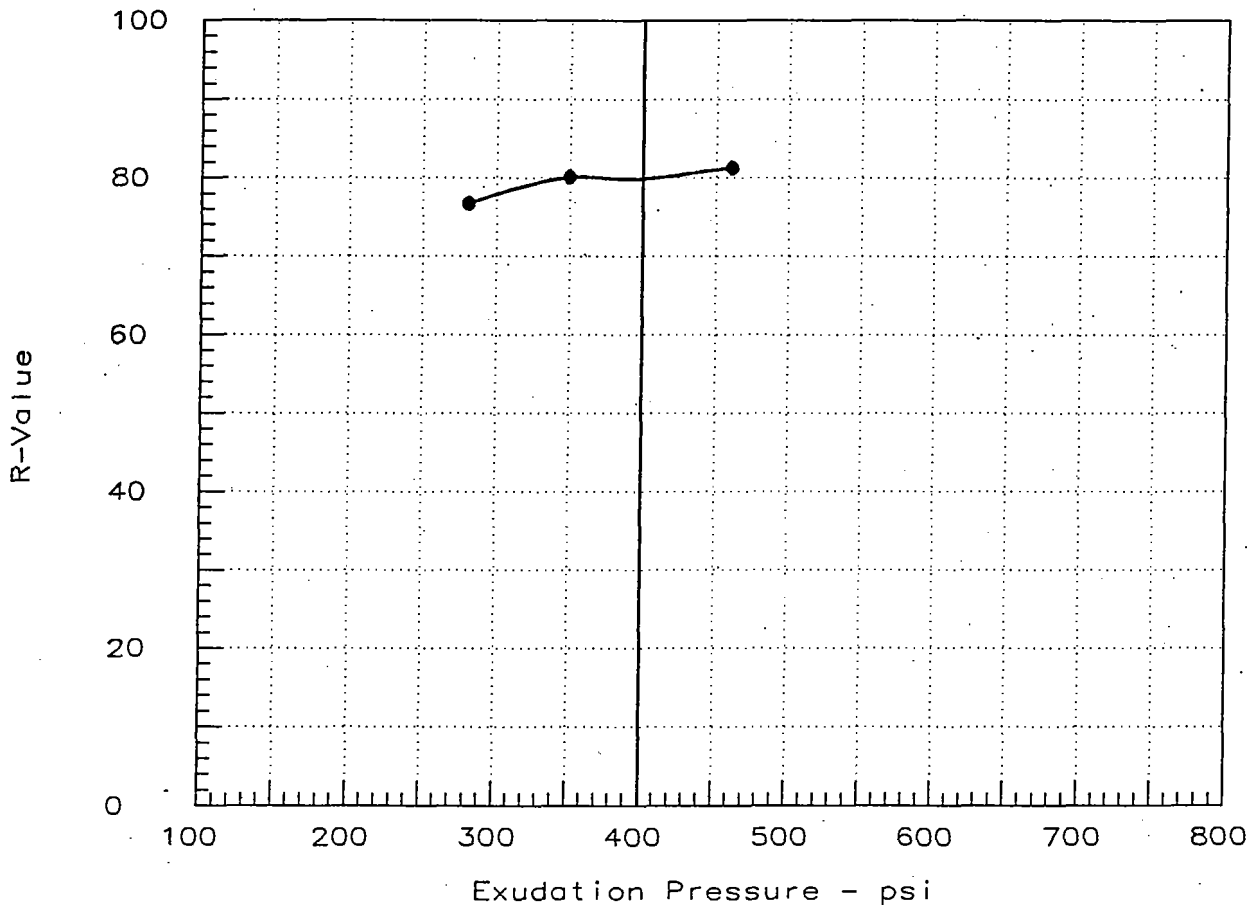
W-6819-02

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-10

FIG. A-10

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - ASTM - D 2844

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	100	133.8	7.4	0.06	19	2.43	461	81.9	81.3
2	100	133.5	7.6	0.06	23	2.44	282	77.5	76.7
3	100	134.4	7.5	0.06	19	2.42	350	80.9	80.1

TEST RESULTS	MATERIAL DESCRIPTION
R-Value @ 400 psi exudation pressure = 79.9	Poorly Graded Sand with Silt and Gravel

Project No.: ***
Project: Raging River Bridge
Location: B-3, S-1A, 0 - 3 Ft.

Date: 11-14-96

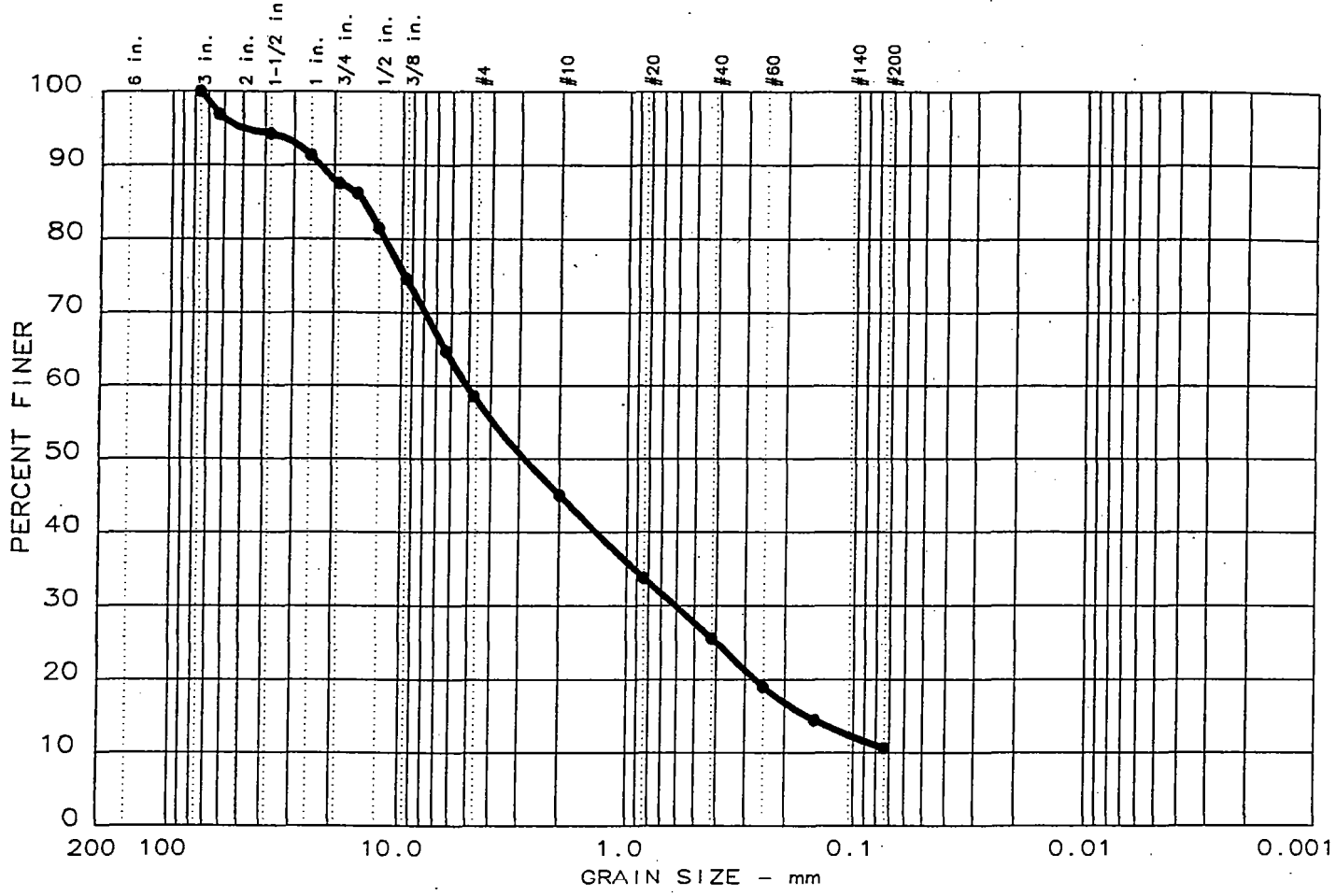
Tested by: VW
Checked by:
Remarks:
K96-1677
W6814-02

R-VALUE TEST REPORT

KING COUNTY MATERIALS LABORATORY

Fig. No.

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	41.4	48.0	10.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			14.77	5.06	2.85	0.602	0.1601			

MATERIAL DESCRIPTION	USCS	AASHTO
● Poorly Graded Sand with Silt and Gravel	SP-SM	

Project No.: ***
Project: Raging River Bridge
● Location: B-3, S-1A, 0 - 3 Ft.

Date: 11-14-96

Remarks:
K96-1677
W6814-02

GRAIN SIZE DISTRIBUTION TEST REPORT
KING COUNTY MATERIALS LABORATORY

Figure No. 11

KING COUNTY SOILS & MATERIALS LABORATORY
7725 LEARY WAY N.E.
REDMOND, WASHINGTON
TU 5-1211

'R' VALUE DATA

PROJECT Raging River Bridge PROJECT NO. _____ LAB TEST NO. K96-1677

FAS NO. _____ CONTRACT NO. _____ DATE TESTED 11-14-96

TYPE OF MATERIAL Poorly Graded Sand with Silt and Gravel TO BE USED FOR _____

SOURCE OF MATERIAL Native STATION _____

CONTRACTOR _____ SAMPLE DEPTH 0-3 ft TEST HOLE NO. B3

REMARKS _____

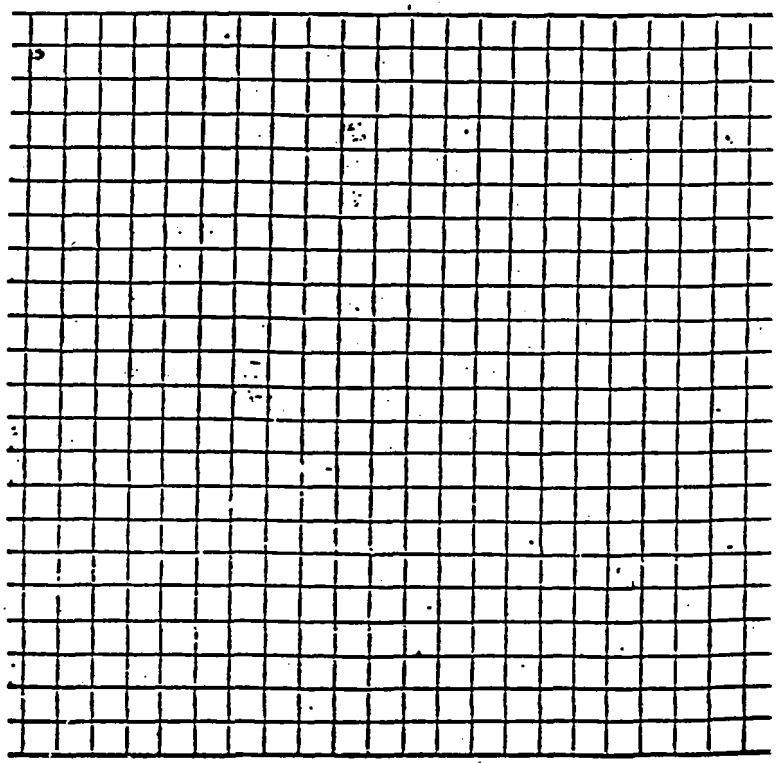
PAVEMENT DESIGN	
EXUDATION R VALUE	80
EXPANSION R VALUE	—
DESIGN R VALUE	80
MAX. SWELL PRESSURE	
TRAFFIC INDEX	
CRUSHED ROCK EQUIV.	

SOIL CLASSIFICATION	
SAND EQUIVALENT	
LIQUID LIMIT	
PLASTIC INDEX	
SPEC. GRAV. #4+	
SPEC. GRAV. #4-	
AASHO CLASSIF.	
UNIFIED CLASS.	SP-SM

GRADING ANALYSIS

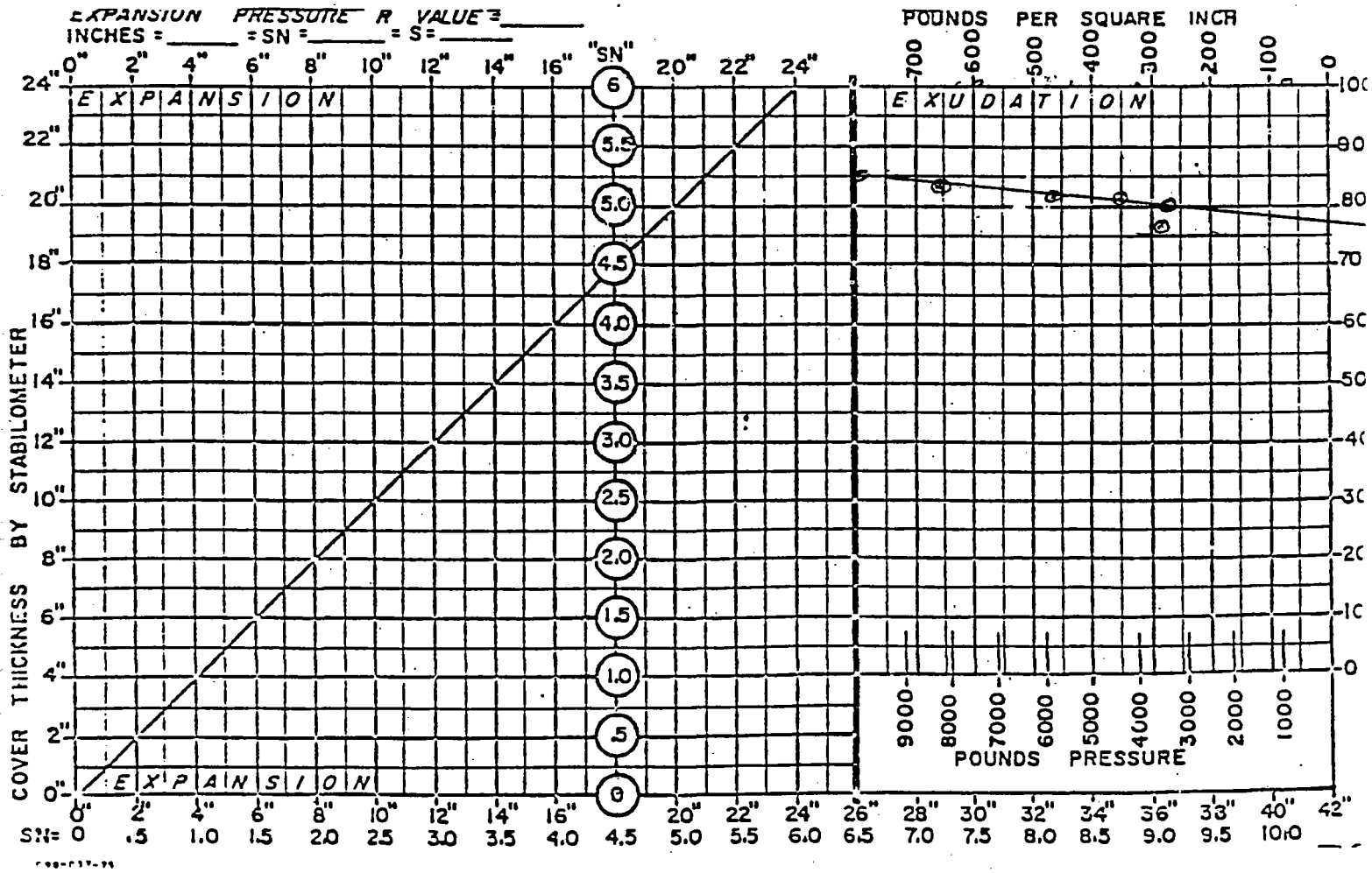
AS REC'D		AS USED		
SIEVE	%	SIZE	%	WT.
MAX. SIZE 2½				
1½"	95	1"-3/8"		
1"	91	3/4"-3/8"	15	162
3/4"	88			
1/2"	81	3/8"-#4	18	194
3/8"	75			
#4	59	#4 - 0	67	724
#10	45			
#40	26	TOTAL	100	1080
#200	11			

TESTED BY TW

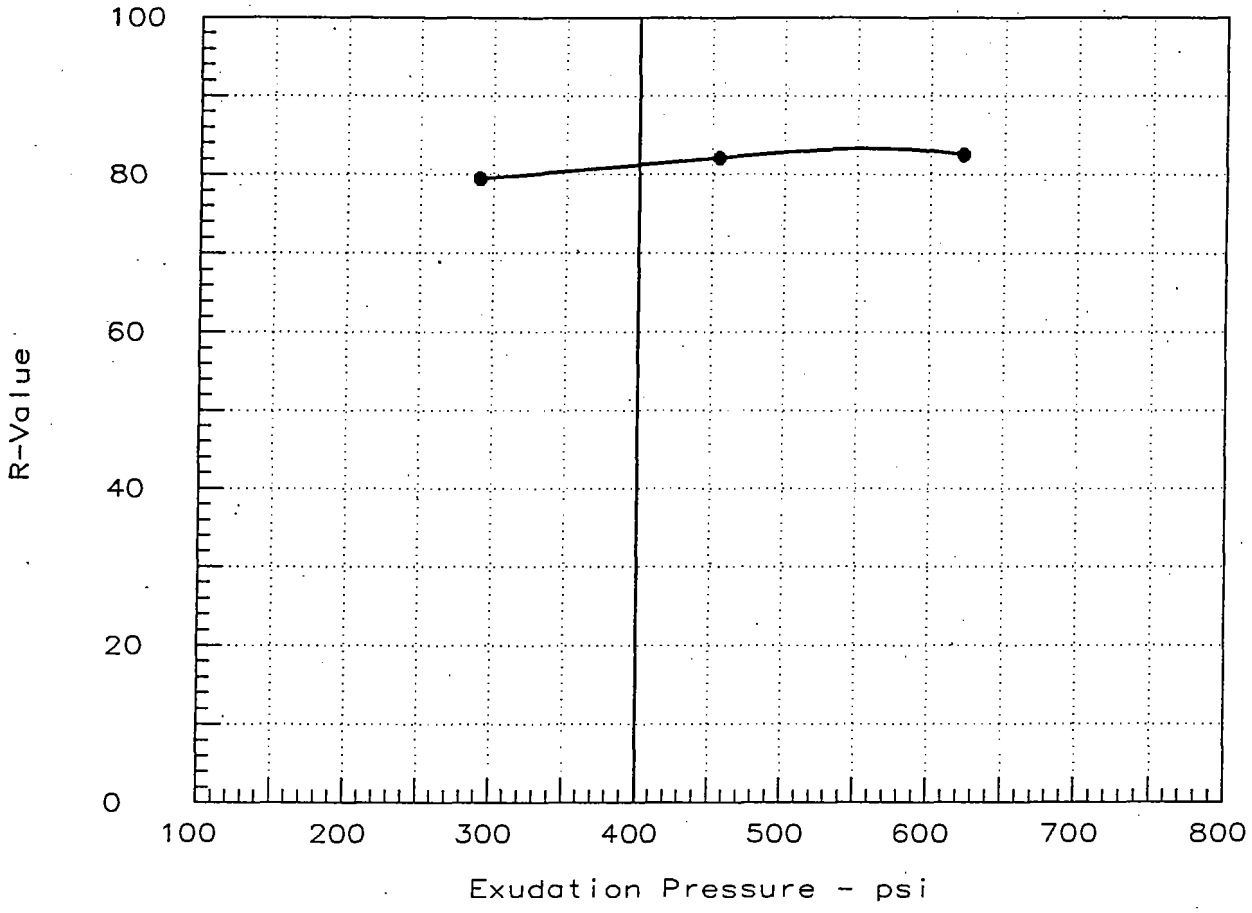


K96-1677

	MOLD NUMBER	HV-	HV-	HV-	HV-	HV-	HV-
SAMPLE PREPARATION	INITIAL MOISTURE CONTENT	0 %	0 %	0 %	0 %	0 %	0 %
	INITIAL SAMPLE WEIGHT DRY (GMS)	1080	1080	1080	1080	1080	1080
	INITIAL SAMPLE WEIGHT WET (GMS) (A)	1130					
	INITIAL WEIGHT OF WATER IN SAMPLE	50	50	50	50	50	50
	SECONDARY MOISTURE CONTENT	4.6			%		
	WEIGHT OF WATER ADDED (B)	00	30	35	32½	28	31
	TOTAL WEIGHT WATER IN SAMPLE (A+B)	20+50	80		82½		81
	WEIGHT WET SAMPLE USED						
	DESIRED MOISTURE CONTENT		7.4		7.6		7.5
KNEADING COMPACTION	COMPACTOR AIR PSI/NO. BLOWS	100/40					
	EXUDATION PRESSURE LBS	1000 32	5765	3430 32	3538 32	8250 32	4400 50
	EXUDATION PRESSURE PSI (A=12.57)	800	461	273	281	657	350
	SAMPLE HEIGHT (0.01")	2.46	2.43	2.41	2.44	2.41	2.42
	WEIGHT MOLD + WET SOIL (GMS)	3254	3272	3265	3261	3308	3272
	WEIGHT MOLD (GMS)	2106	2120	2105	2105	2157	2167
	WET WEIGHT SOIL (0.01 LB)						
	WET DENSITY (LBS/CU.FT.)						
	DRY DENSITY (LBS/CU.FT.)						
EXP. PRESS.	EXPANSION PRESSURE FRAME NUMBER	EP-	EP-	EP-	EP-	EP-	EP-
	EXPANSION PRESSURE RDG OR PSI	0,0001	0,0002	0,0002	0,0002	0,0001	0,0002
	EXPANSION PRESSURE THICKNESS (INCHES)	— IN.	1 IN.	— IN.	— IN.	½ IN.	1 IN.
HVEEM STABILOMETER	STABILOMETER PH, 500 LBS (40 PSI) PV	8	8	9	9	9	8
	STABILOMETER PH, 1000 LBS (80 PSI) PV	11	11	13	13	12	11
	STABILOMETER PH, 1500 LBS (120 PSI) PV	15	15	17	18	14	14
	STABILOMETER PH, 2000 LBS (160 PSI) PV	18	19	22	23	18	19
	DISPLACEMENT TURNS (D)	D= 3.73	D= 4.10	D= 4.22	D= 4.33	D= 4.00	D= 4.38
	RESISTANCE VALUE (R)	R= 84	R= 82	R= 80	R= 77	R= 83	R= 81
	RESISTANCE VALUE THICKNESS (INCHES)	IN.	IN.	IN.	IN.	IN.	IN.



R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - ASTM - D 2844

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	100	136.6	6.8	0.00	17	2.42	622	83.2	82.5
2	100	136.9	7	0.03	17	2.41	455	82.8	82.1
3	100	137.8	7.1	0.00	19	2.41	291	80.4	79.5

TEST RESULTS	MATERIAL DESCRIPTION
R-Value @ 400 psi exudation pressure = 81.2	Well Graded Gravel with Silt and Sand

Project No.: ***
Project: Raging River Bridge
Location: B-5, S-1A, 0 - 2 Ft.

Date: 11-14-96

Tested by: VW
Checked by:
Remarks:
K96-1678
W6814-02

R-VALUE TEST REPORT

KING COUNTY MATERIALS LABORATORY

Fig. No.

KING COUNTY SOILS & MATERIALS LABORATORY
7725 LEARY WAY N.E.
REDMOND, WASHINGTON
TU 5-1211

'H' VALUE DATA

PROJECT Raging River Bridge PROJECT NO. _____ LAB TEST NO. K96-1678

FAS NO. _____ CONTRACT NO. _____ DATE TESTED 11-14-96

TYPE OF MATERIAL Well Graded Gravel with Silt and Sand TO BE USED FOR _____

SOURCE OF MATERIAL _____ STATION _____

CONTRACTOR _____ SAMPLE DEPTH 0-2 ft. TEST HOLE NO. B5

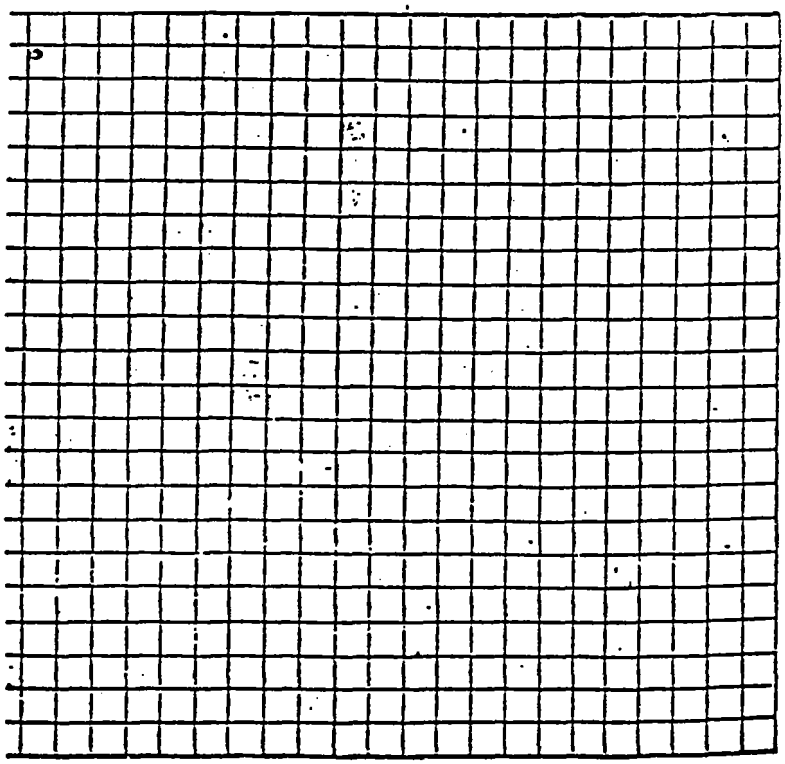
REMARKS _____

PAVEMENT DESIGN	
EXUDATION R VALUE	81
EXPANSION R VALUE	—
DESIGN R VALUE	81
MAX. SWELL PRESSURE	
TRAFFIC INDEX	
CRUSHED ROCK EQUIV.	

SOIL CLASSIFICATION	
SAND EQUIVALENT	
LIQUID LIMIT	
PLASTIC INDEX	
SPEC. GRAV. #4+	
SPEC. GRAV. #4-	
AASHO CLASSIF.	
UNIFIED CLASS.	GW-GM

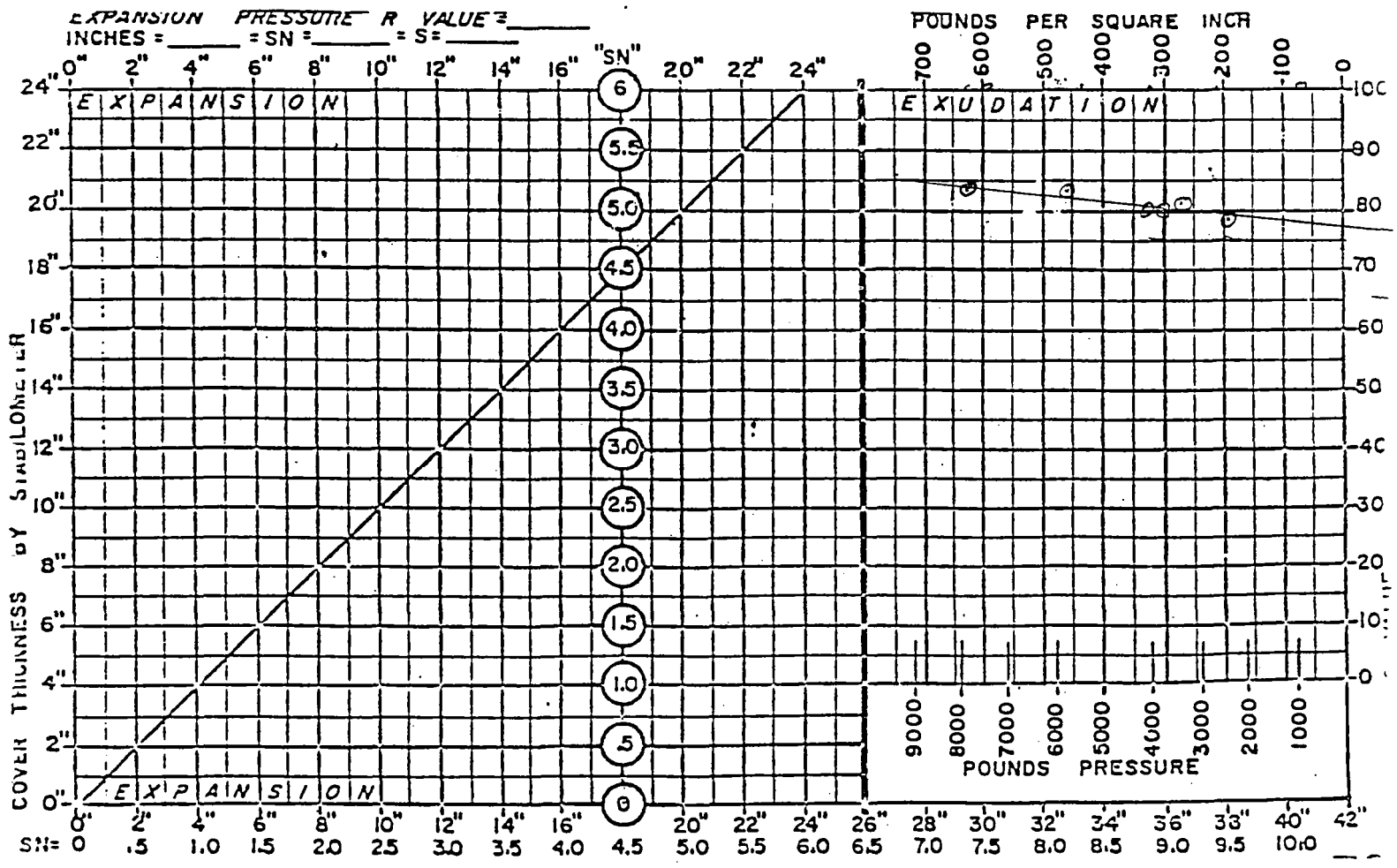
GRADING ANALYSIS				
AS REC'D		AS USED		
SIEVE	%	SIZE	%	WT.
MAX. SIZE 2"				
1½"	95	1"-3/8"		
1"	87	3/4"-3/8"	15	165
3/4"	78			
1/2"	73	3/8"-#4	20	220
3/8"	66			
#4	51	#4 - 0	65	715
#10	37			
#40	21	TOTAL	100	1100
#200	9			

TESTED BY VK

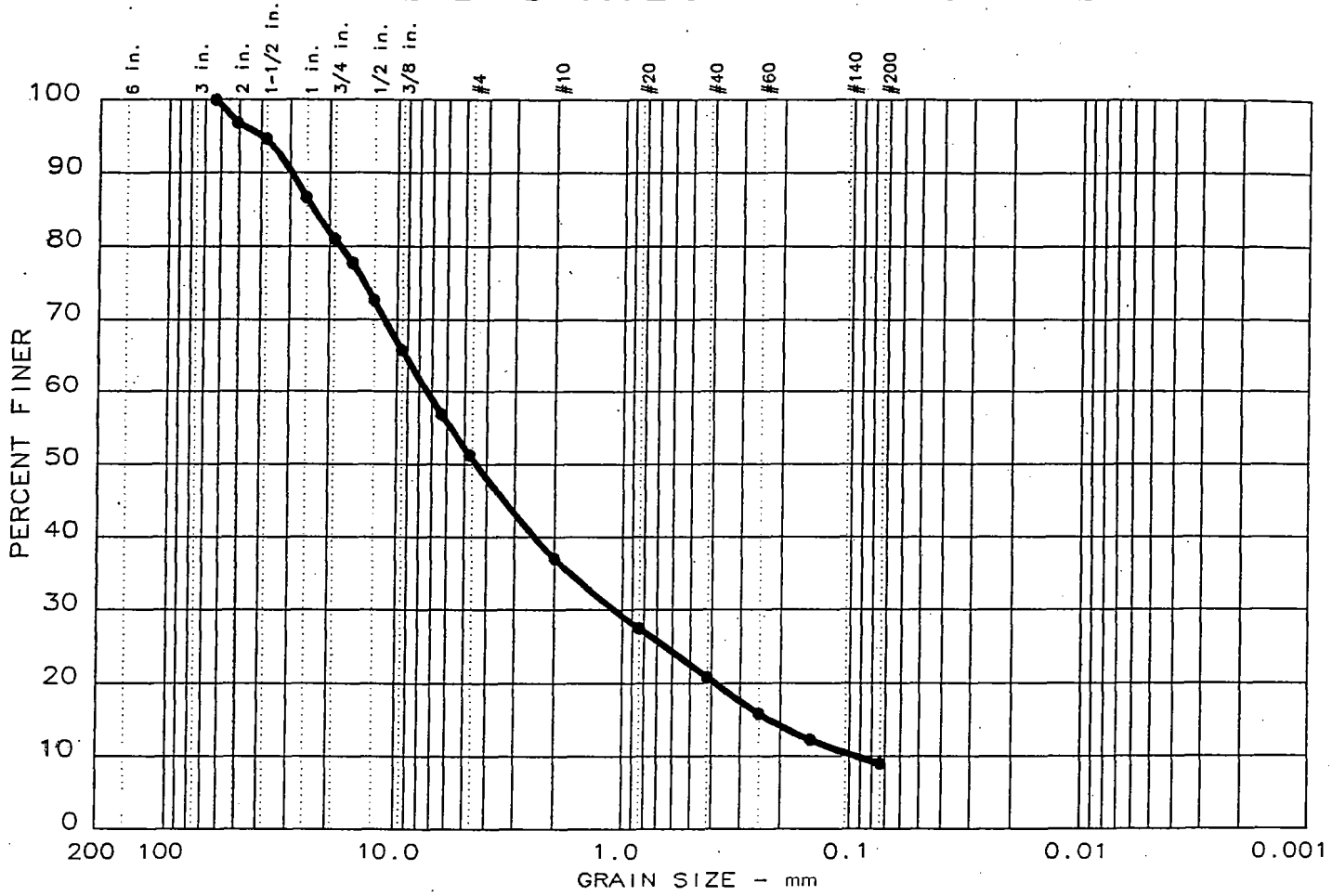


K96-1678

	MOLD NUMBER	HV-	HV-	HV-	HV-	HV-	HV-
PREPARATION	INITIAL MOISTURE CONTENT	0 %	0 %	9 %	0 %	0 %	0 %
	INITIAL SAMPLE WEIGHT DRY (GMS)	1100	1100	1100	1100	1100	1100
	INITIAL SAMPLE WEIGHT WET (GMS) (A)	1150	1150	1150	1150	1150	1150
	INITIAL WEIGHT OF WATER IN SAMPLE	50	50	50	50	50	50
	SECONDARY MOISTURE CONTENT				%		
	WEIGHT OF WATER ADDED (B)	25	30	27½	28½	31½	33½
	TOTAL WEIGHT WATER IN SAMPLE (A+B)	75	80	77½	78½	81½	83½
	WEIGHT WET SAMPLE USED						
	DESIRED MOISTURE CONTENT	6%		7%	7%		
COMPACTION	COMPACTOR AIR PSI/NO. BLOWS	100/40	100/40	100/40	100/40	100/40	100/40
	EXUDATION PRESSURE LBS	7821 LBS	3365 LBS	5723 LBS	3659 LBS	4231	2387 LBS
	EXUDATION PRESSURE PSI (A=12.57)	622	267	456	291	336	190
	SAMPLE HEIGHT (0.01")	2.42	2.42	2.41	2.41	2.41	2.41
	WEIGHT MOLD + WET SOIL (GMS)	3284	3287	3270	3274	3285	3284
	WEIGHT MOLD (GMS)	2120	2120	2106	2051	2105	2112
	WET WEIGHT SOIL (0.01 LB)						
	WET DENSITY (LBS/CU.FT.)						
	DRY DENSITY (LBS/CU.FT.)						
EXPANSION PRESS.	EXPANSION PRESSURE FRAME NUMBER	EP-	EP-	EP-	EP-	EP-	EP-
	EXPANSION PRESSURE RDG OR PSI	0	[illegible]	[illegible]	0	[illegible]	[illegible]
	EXPANSION PRESSURE THICKNESS (INCHES)	IN.	IN.	IN.	IN.	IN.	IN.
STABILOMETER	STABILOMETER PH, 500 LBS (40 PSI)PV	8	7	7	8	7	8
	STABILOMETER PH, 1000 LBS (80 PSI)PV	11	10	10	11	12	12
	STABILOMETER PH, 1500 LBS (120 PSI)PV	14	13	13	15	16	17
	STABILOMETER PH, 2000LBS (160 PSI)PV	17	19	17	19	20	22
	DISPLACEMENT TURNS (D)	D= 4.11	D= 4.41	D= 4.36	D= 4.53	D= 4.07	D= 4.21
	RESISTANCE VALUE (R)	R= 84	R= 81	R= 83	R= 80	R= 80	R= 79
	RESISTANCE VALUE THICKNESS (INCHES)	IN.	IN.	IN.	IN.	IN.	IN.



GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	48.7	42.3	9.0	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			23.44	7.33	4.42	1.084	0.2213	0.0933	1.72	78.5

MATERIAL DESCRIPTION	USCS	AASHTO
● Well Graded Gravel with Silt and Sand	GW-GM	

Project No.: ***
Project: Raging River Bridge
● Location: B-5, S-1A, 0 - 2 Ft.

Date: 11-14-96

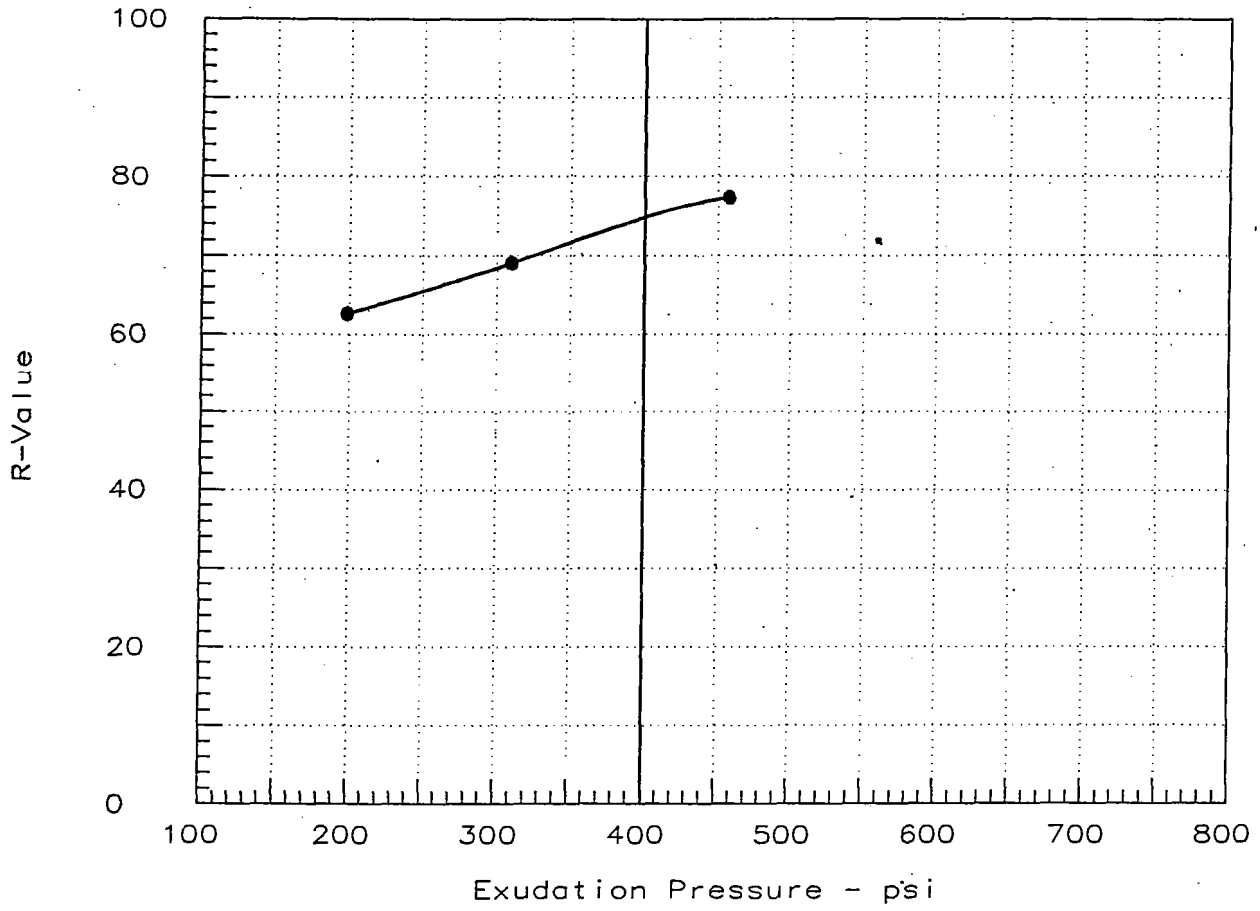
Remarks:
K96-1678
W6814-02

GRAIN SIZE DISTRIBUTION TEST REPORT

KING COUNTY MATERIALS LABORATORY

Figure No.

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - ASTM - D 2844

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	100	124.7	10.2	0.21	35	2.61	310	66.9	69.0
2	100	125.8	9.7	0.70	26	2.60	458	76.0	77.3
3	100	124.3	10.7	0.12	42	2.62	199	59.9	62.7

TEST RESULTS	MATERIAL DESCRIPTION
R-Value @ 400 psi exudation pressure = 74.9	Silty Sand with Gravel

Project No.: ***
Project: Raging River Bridge
Location: B-6, S-1A, 3 - 4 Ft.

Date: 11-14-96

Tested by: VW
Checked by:
Remarks:
K96-1679
W6814-02

R-VALUE TEST REPORT

KING COUNTY MATERIALS LABORATORY

Fig. No.

KING COUNTY SOILS & MATERIALS LABORATORY
7725 LEARY WAY N.E.
REDMOND, WASHINGTON
TU 5-1211

'H' VALUE DATA

PROJECT Raging River Bridge PROJECT NO. _____ LAB TEST NO. K96-1679

FAS NO. _____ CONTRACT NO. _____ DATE TESTED 11-14-96

TYPE OF MATERIAL Silty Sand w/Gravel TO BE USED FOR _____

SOURCE OF MATERIAL Native STATION _____

CONTRACTOR _____ SAMPLE DEPTH 3-4f TEST HOLE NO. B6

REMARKS _____

PAVEMENT DESIGN	
EXUDATION R VALUE	75
EXPANSION R VALUE	
DESIGN R VALUE	
MAX. SWELL PRESSURE	
TRAFFIC INDEX	
CRUSHED ROCK EQUIV.	

SOIL CLASSIFICATION	
SAND EQUIVALENT	
LIQUID LIMIT	
PLASTIC INDEX	
SPEC. GRAV. #4+	
SPEC. GRAV. #4-	
AASHO CLASSIF.	
UNIFIED CLASS.	SM

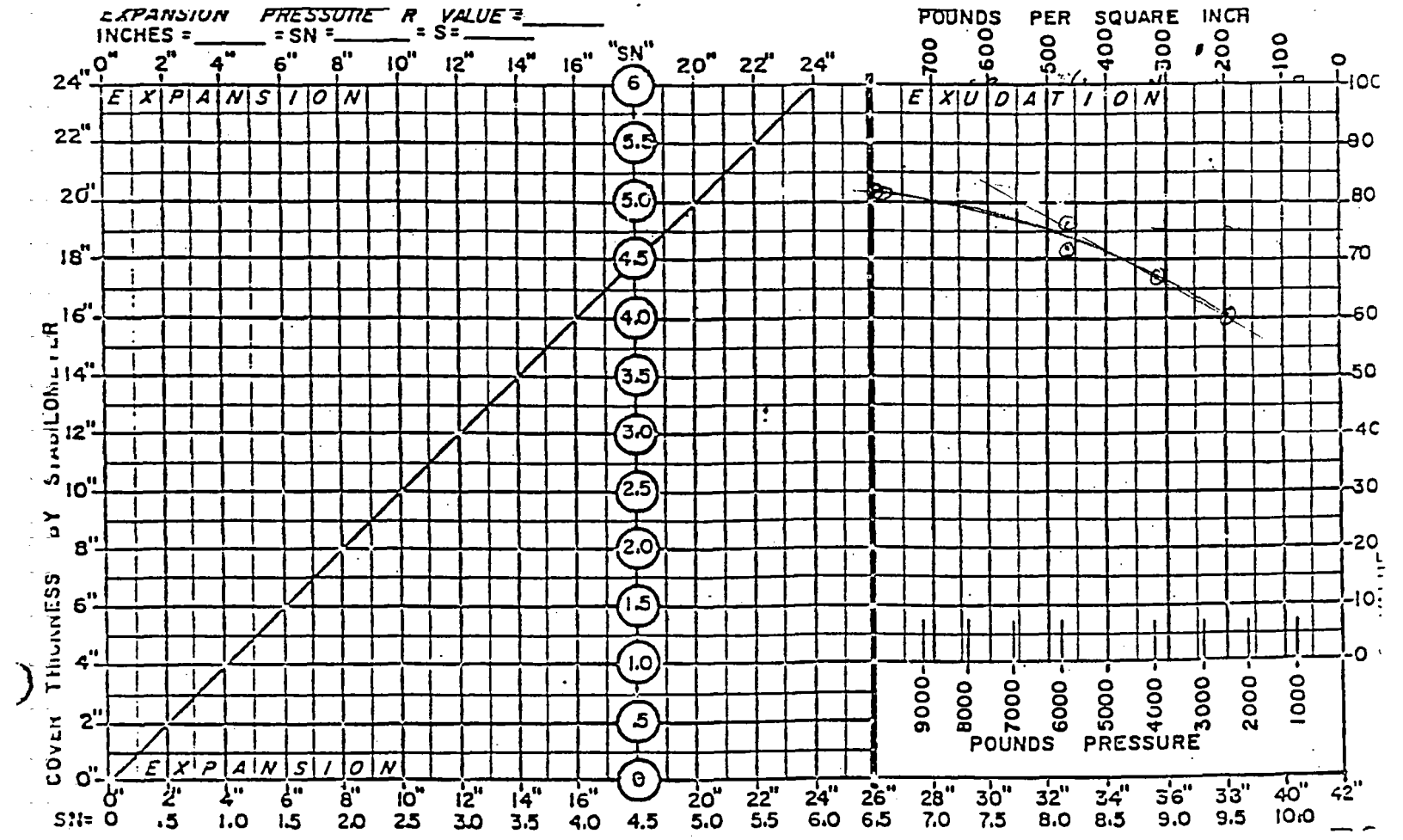
GRADING ANALYSIS

AS REC'D		AS USED		
SIEVE	%	SIZE	%	WT.
MAX. SIZE 1"				
1½"	99	1"-3/8"		
1"	97	3/4"-3/8"	12	130
3/4"	94			
1/2"	88	3/8"-#4	11	119
3/8"	83			
#4	72	#4 - 0	77	831
#10	63			
#40	48	TOTAL	100	1080
#200	30			

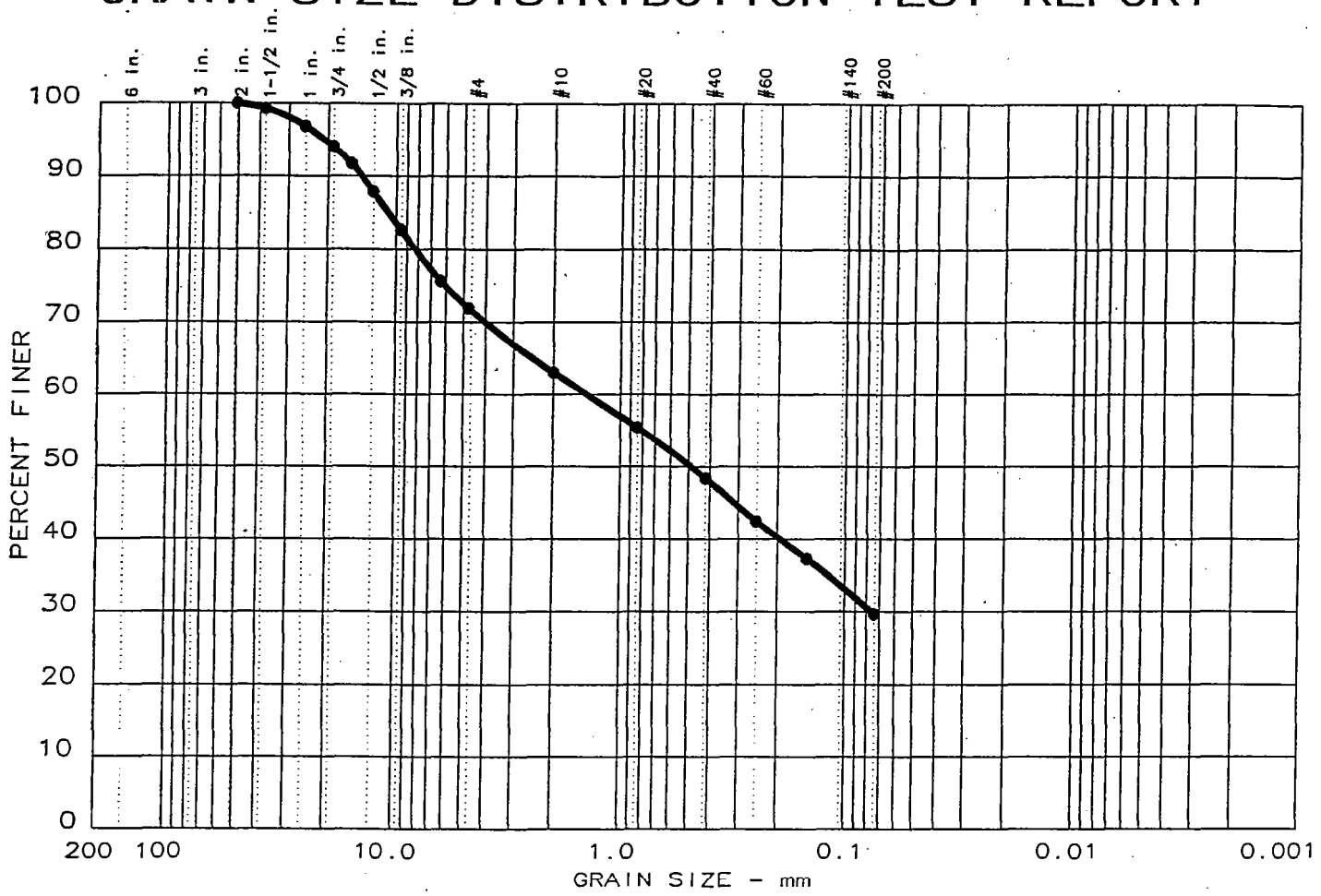
TESTED BY VV

K96-1679

	MOLD NUMBER	HV-	HV-	HV-	HV-	HV-	HV-
PREPARATION	INITIAL MOISTURE CONTENT	0 %	0 %	0 %	0 %	0 %	0 %
	INITIAL SAMPLE WEIGHT DRY (GMS)	1080	1080	1080	1080	1080	1080
	INITIAL SAMPLE WEIGHT WET (GMS) (A)						
	INITIAL WEIGHT OF WATER IN SAMPLE	90	90	90	90	90	90
	SECONDARY MOISTURE CONTENT	8.3			%		
	WEIGHT OF WATER ADDED (B)	20	15	10	13	18	25
	TOTAL WEIGHT WATER IN SAMPLE (A+B)	110	105	100	103	108	115
	WEIGHT WET SAMPLE USED	1185					
	DESIRED MOISTURE CONTENT	10.2	9.7				10.7
COMPACTION	COMPACTOR AIR PSI/NO. BLOWS	100/40	100/40	100/40	100/40	100/40	100/40
	EXUDATION PRESSURE LBS	3896 434	5756 434	10000 2L	10000 2L	5750 434	2500
	EXUDATION PRESSURE PSI (A=12.57)	310	458	796	796	457	199 434
	SAMPLE HEIGHT (0.01")	2.61	2.60	2.57	2.56	2.61	2.62
	WEIGHT MOLD + WET SOIL (GMS)	3288	3234	3283	3288	3304	3349 3334
	WEIGHT MOLD (GMS)	2105	2054	2105	2112	2124	2160
	WET WEIGHT SOIL (0.01 LB)						
	WET DENSITY (LBS/CU.FT.)						
	DRY DENSITY (LBS/CU.FT.)						
EXPANSION PRESS.	EXPANSION PRESSURE FRAME NUMBER	EP-	EP-	EP-	EP-	EP-	EP-
	EXPANSION PRESSURE RDG OR PSI	0.0007	0.0023	0.0026	0.0016	0.0020	0.0004
	EXPANSION PRESSURE THICKNESS (INCHES)	3.5 IN.	11.5 IN.	13 IN.	8 IN.	10 IN.	2 IN.
STABILOMETER	STABILOMETER PH, 500 LBS (40 PSI) PV	12	9	16	10	10	14
	STABILOMETER PH, 1000 LBS (80 PSI) PV	18	14	16	15	15	22
	STABILOMETER PH, 1500 LBS (120 PSI) PV	26	19	20	20	21	31
	STABILOMETER PH, 2000 LBS (160 PSI) PV	35	26	26	26	27	42
	DISPLACEMENT TURNS (D)	D= 4.42	D= 4.07	D= 3.82	D= 4.08	D= 4.20	D= 4.70
	RESISTANCE VALUE (R)	R= 67	R= 76	R= 77	R= 76	R= 73	R= 60
	RESISTANCE VALUE THICKNESS (INCHES)	IN.	IN.	IN.	IN.	IN.	IN.



GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	28.1	42.2	29.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			10.84	1.41	0.48	0.076				

MATERIAL DESCRIPTION	USCS	AASHTO
● Silty Sand with Gravel	SM	

Project No.: ***
Project: Raging River Bridge
● Location: B-6, S-1A, 3 - 4 Ft.

Date: 11-14-96

Remarks:
K96-1679
W6814-02

GRAIN SIZE DISTRIBUTION TEST REPORT

KING COUNTY MATERIALS LABORATORY

Figure No.

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More Than 50% Retained on No. 200 Sieve	GRAVEL More Than 50% of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More Than 50% of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More Than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less Than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or More	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Descriptions of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water

Wet - Visible free water or saturated, usually soil is obtained from below water table

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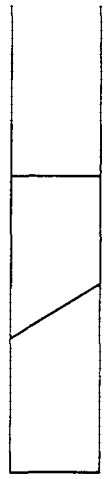
SOIL CLASSIFICATION SYSTEM

FIGURE A-1

LABORATORY TESTS:

AL	Atterberg limits
CP	Compaction
CS	Consolidation
DS	Direct shear
GS	Grain-size
%F	Percent fines
HA	Hydrometer analysis
SK	Permeability
SM	Moisture content
MD	Moisture and density
SP	Swelling pressure
TX	Triaxial compression
UC	Unconfined compression
CA	Chemical analysis

SOIL GRAPH:



SM Soil Group Symbol (See Note 2)

Distinct Contact Between Soil Strata

Gradual or Approximate Location of Change Between Soil Strata

Water Level

Bottom of Boring

BLOW COUNT/SAMPLE DATA:

Blows required to drive a 2.4-inch I.D. split-barrel sampler 12 inches or other indicated distances using a 300-pound hammer falling 30 inches.

22 Location of relatively undisturbed sample

12 Location of disturbed sample

17 Location of sampling attempt with no recovery

Blows required to drive a 1.5-inch I.D. (SPT) split-barrel sampler 12 inches or other indicated distances using a 140-pound hammer falling 30 inches.

10 Location of sample obtained in general accordance with Standard Penetration Test (ASTM D 1586) procedures

26 Location of SPT sampling attempt with no recovery

Location of grab sample

"P" indicates sampler pushed with weight of hammer or against weight of drill rig.

NOTES:

1. The reader must refer to the discussion in the report text, the Key to Boring Log Symbols and the exploration logs for a proper understanding of subsurface conditions.
2. Soil classification system is summarized in Figure A-1.

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KEY TO BORING LOG SYMBOLS

FIGURE A-2

TEST DATA

BORING B-1

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
						Surface Elevation (ft.): 170.0
					ASPHALT	6 inches asphalt concrete
					GP-GM	Brown fine to coarse gravel with silt and sand (medium dense, moist) (fill)
			23			
SM	3		9			Becomes loose
					SW-SM	Brown fine to coarse sand with silt and gravel (medium dense, moist) (fill?)
MD	6	95	19			
					GP	▽ Gray fine to coarse gravel with sand and cobbles (medium dense, wet)
			28			
MD	5	142	68			Becomes very dense
						Boulder encountered from 25 to 26 feet
					ML	Gray fine sandy silt (hard, wet)
MD	26	100	50			
					SM	Gray silty fine sand (very dense, wet)
MD	20	109	65			
					ML	Gray silt (hard, wet)
MD	25	94	44			

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0146-062-01-1130

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LOG OF BORING

FIGURE A-3

TEST DATA

BORING B-1
(Continued)

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
			45			Boring completed at 44.5 feet on 01/02/96 Ground water encountered at about 16 feet during drilling

DEPTH IN FEET

40
45
50
55
60
65
70
75
80

Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0146-062-01-1130

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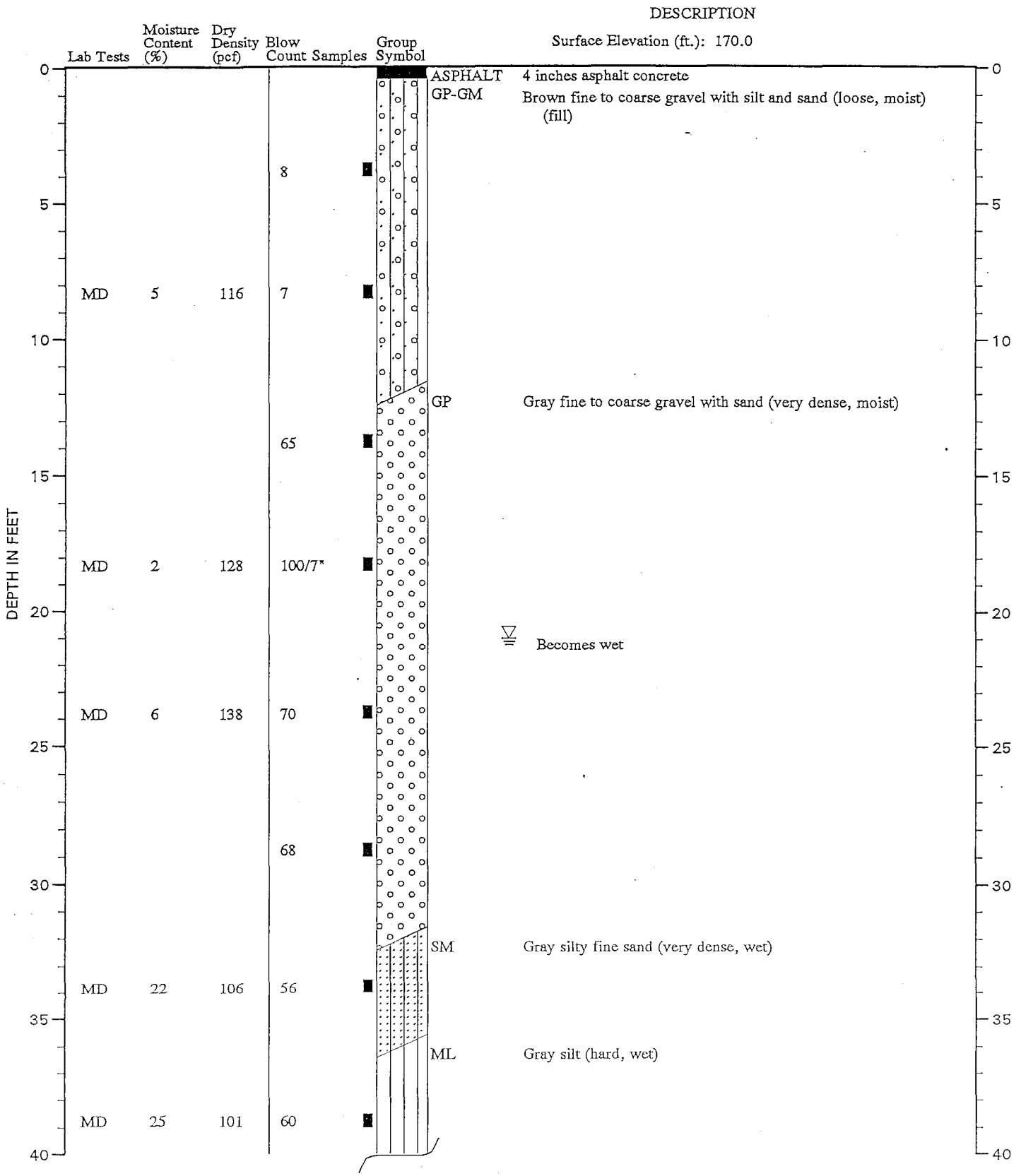
LOG OF BORING

FIGURE A-3

TEST DATA

BORING B-2



Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0146-062-01-1130

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LOG OF BORING

FIGURE A-4

TEST DATA

BORING B-2
(Continued)

DESCRIPTION

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol
			51		

Boring completed at 44.5 feet on 01/03/96
Ground water encountered at about 21.0 feet during drilling

DEPTH IN FEET

40
45
50
55
60
65
70
75
80

Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0146-062-01-1130

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LOG OF BORING

FIGURE A-4

TEST DATA

BORING B-4

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
						Surface Elevation (ft.): 161.0
					ASPHALT	6 inches asphalt concrete
					CONCRETE	8 inches portland cement concrete
R-Value					SM	Brown silty fine sand with medium to coarse sand (dense, moist)
			34			
MD	27	98	53		ML	Gray silt (very stiff to hard, moist)
MD	25	100	25			
AL	27		50			

DEPTH IN FEET

0, 5, 10, 15, 20, 25, 30, 35, 40

Boring completed at 21.5 feet on 02/26/96
Ground water encountered at approximately 15.4 feet during drilling

Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0146-062-01-1130

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LOG OF BORING

FIGURE A-6

TEST DATA

BORING B-5

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
						Surface Elevation (ft.): 160.0
					ASPHALT CONCRETE	6 inches asphalt concrete 8 inches portland cement concrete
			38		SM	Brown silty fine sand with occasional fine to coarse gravel (dense, moist)
						Boring completed at 7.5 feet on 02/26/96

DEPTH IN FEET

0, 5, 10, 15, 20, 25, 30, 35, 40

Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0146-062-01-1130

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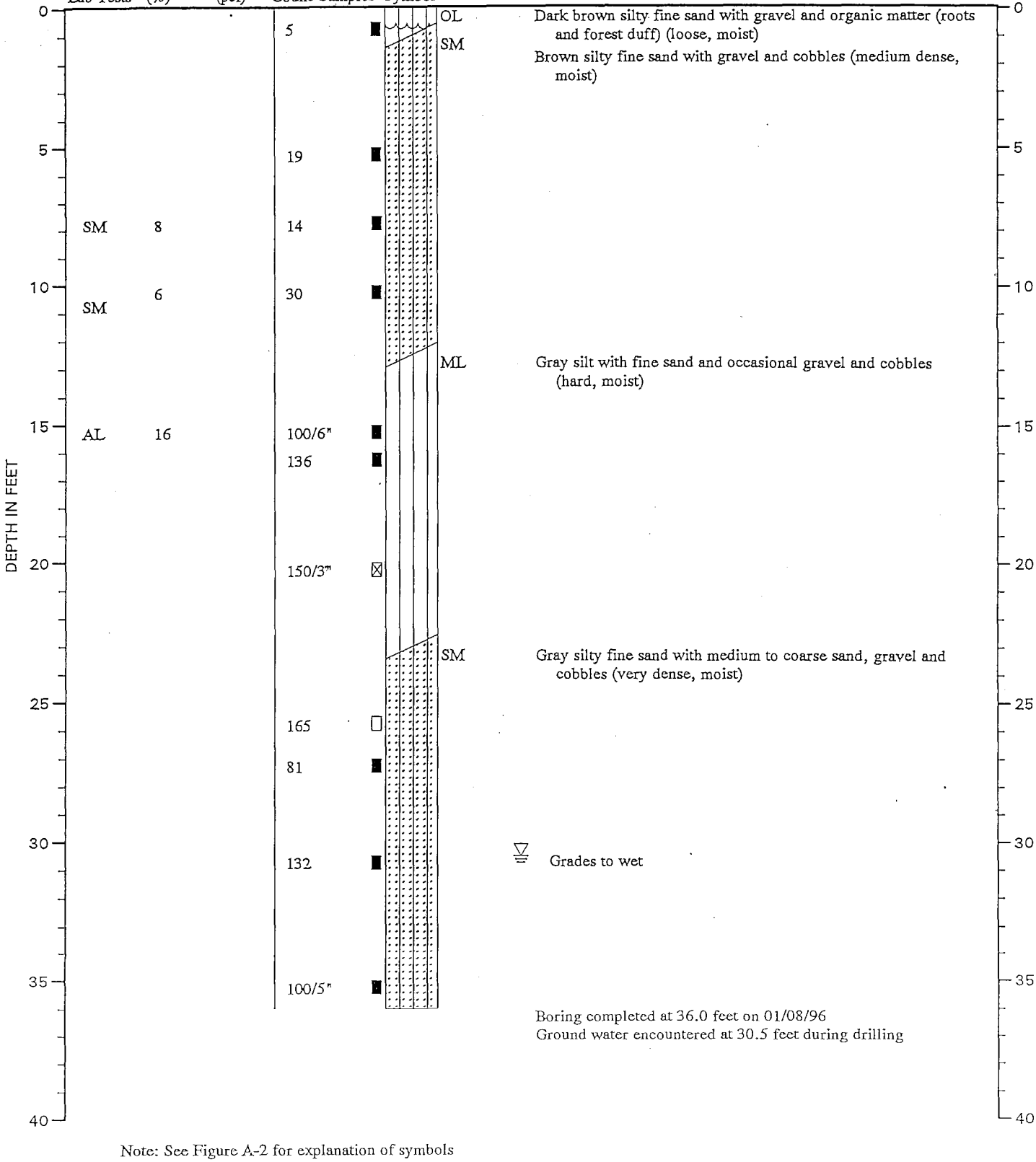
LOG OF BORING

FIGURE A-7

TEST DATA

BORING B-6



Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0146-062-01-1130

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LOG OF BORING

FIGURE A-8

TEST DATA

BORING B-7

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
						Surface Elevation (ft.): 174.0
					ML	Brown sandy silt with occasional gravel and cobbles (medium stiff, moist)
			23			
			50/0"			
						Boring completed at 5.0 feet on 03/02/96 due to refusal No ground water encountered during drilling

DEPTH IN FEET

0, 5, 10, 15, 20, 25, 30, 35, 40

Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0148-082-01-1130

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LOG OF BORING

FIGURE A-9

TEST DATA

BORING B-8

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
						Surface Elevation (ft.): 174.0
					OL	Forest duff
					ML	Brown sandy silt with occasional gravel and cobbles (medium stiff, moist)
SM	21		5			
			34			Grades to hard
MD	21	96	39			
						Boring completed at 10.5 feet on 03/02/96 due to refusal
						No ground water encountered during drilling

DEPTH IN FEET

0, 5, 10, 15, 20, 25, 30, 35, 40

Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/98

0146-062-01-1130

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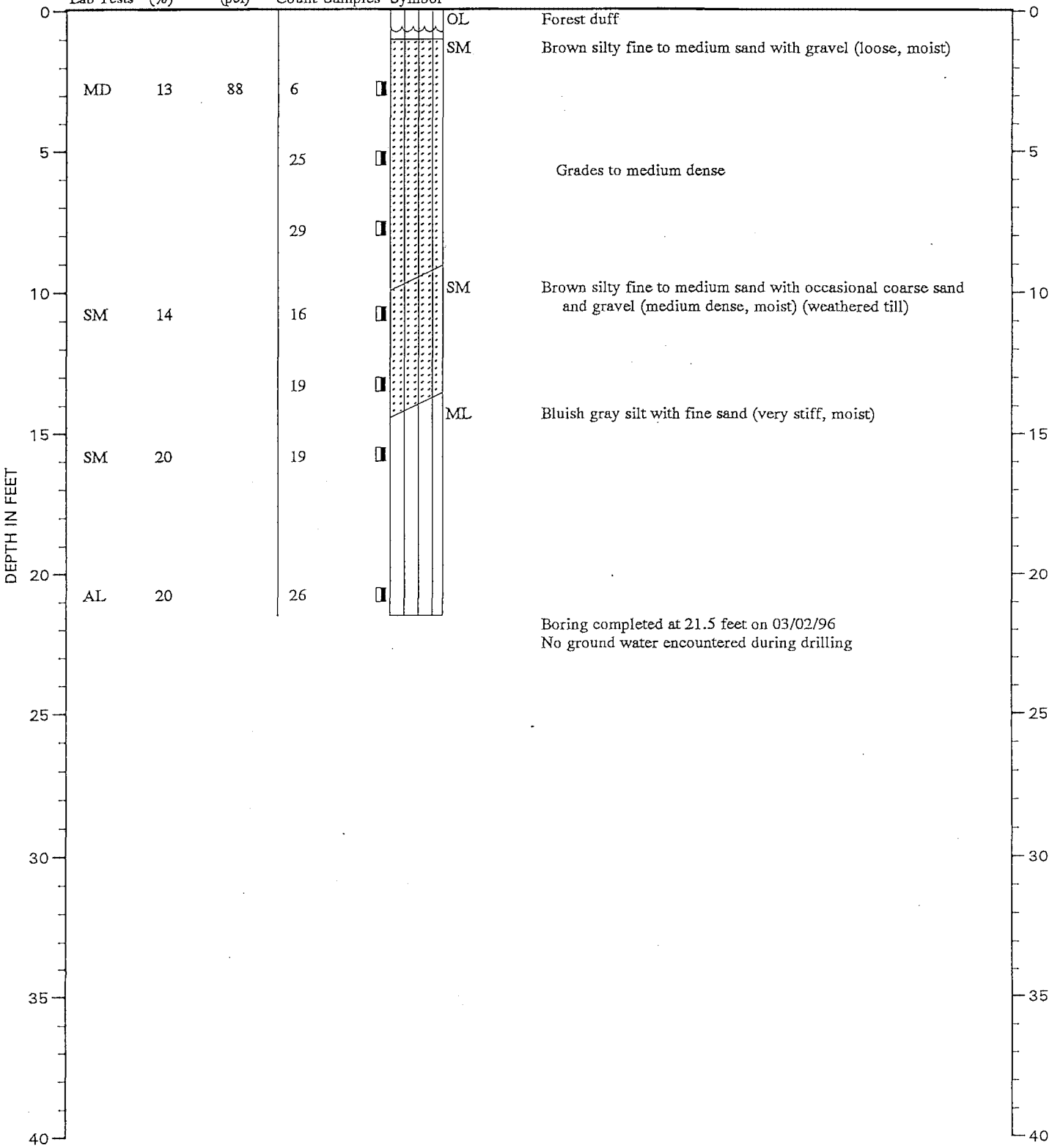
LOG OF BORING

FIGURE A-10

TEST DATA

BORING B-9



Note: See Figure A-2 for explanation of symbols

:DJM:SJT:CMS 8/16/96

0146-062-01-1130

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LOG OF BORING

FIGURE A-11

LOG OF HAND BORING

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		HAND BORING HB-1
0.0 - 6.0	ML	Brown sandy silt with gravel (soft to medium stiff, moist) (colluvium)
		Hand boring completed at 6.0 feet on 01/25/96 due to refusal
		No ground water seepage observed
		No caving observed
		Disturbed soil samples obtained at 1.0 and 3.0 feet
		HAND BORING HB-2
0.0 - 3.5	ML	Brown sandy silt with occasional roots (medium stiff, moist)
		Grades to with gravel at 3.0 feet
		Hand boring completed at 3.5 feet on 01/25/96
		No ground water seepage observed
		No caving observed
		Disturbed soil sample obtained at 1.0 foot
		HAND BORING HB-3
0.0 - 0.5	OL	Topsoil and forest duff
0.5 - 3.0	SM	Brown silty fine to medium sand with occasional fine gravel and cobbles (loose, moist) (colluvium)
3.0 - 4.5	SM	Brown silty fine to medium sand with coarse sand and fine gravel (medium dense, moist)
4.5 - 4.8	SM	Brown fine gravel with silt and fine to coarse sand (medium dense, moist)
		Hand boring completed at 4.8 feet on 01/25/96
		No ground water seepage observed
		No caving observed
		Disturbed soil samples obtained at 2.3 and 3.3 feet

THE DEPTHS ON THE HAND BORING LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE HAND BORING AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT.

LOG OF HAND BORING

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		HAND BORING HB-4
0.0 - 0.6		Topsoil and forest duff
0.6 - 3.6	SM	Brown silty fine to medium sand with coarse sand and occasional fine to coarse gravel (medium dense, moist)
3.6 - 5.6	SP	Brown fine to medium sand with occasional fine gravel and a trace of silt (dense, moist)
5.6 - 5.7		Brown fine to coarse sandy silt with gravel (stiff, moist)
		Hand boring completed at 5.7 feet on 01/25/96
		No ground water seepage observed
		No caving observed
		Disturbed soil samples obtained at 2.0, 4.5 and 5.6 feet

THE DEPTHS ON THE HAND BORING LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE HAND BORING AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT.

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT TP-1
0.0 - 1.5	SM	Dark brown silty fine to medium sand with coarse gravel, occasional cobbles and grass roots (medium dense, moist) (topsoil)
1.5 - 2.5	ML	Light yellow-brown with orange splotches blocky silt with penetrating grass roots (stiff, moist) (fill)
2.5 - 8.0	SM	Reddish brown silty fine to coarse sand with occasional fine to coarse gravel and shrub roots (medium dense, moist) (fill)
		Become dark brown at 4.0 feet
		Test pit completed at 8.0 feet on 02/23/96
		No ground water seepage observed
		No caving observed
		Disturbed soil sample obtained at 1.5 feet for R-Value Test
		TEST PIT TP-2
0.0 - 0.5	SM	Dark brown silty fine to medium sand with occasional fine to coarse gravel, occasional cobbles and shrub roots (loose to medium dense, moist) (topsoil)
0.5 - 7.0	ML	Light yellow-brown with orange splotches silt with penetrating shrub roots, occasional fine to coarse gravel and occasional cobbles (stiff, moist)
7.0 - 8.0	ML	Dark brown sandy silt (stiff, moist)
		Test pit completed at 8.0 feet on 02/23/96
		No ground water seepage observed
		No caving observed

THE DEPTHS ON THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT.

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT TP-3
0.0 - 1.0	GM	Dark brown silty fine to coarse gravel with fine sand, occasional cobbles and roots (medium dense, moist) (topsoil)
1.0 - 2.0	GM	Brown silty fine to coarse gravel with fine to coarse sand, cobbles, boulders, grass and shrub roots (loose to medium dense, moist) (weathered till)
2.0 - 6.0	GW-GM	Grayish brown fine to coarse gravel with silt, fine to coarse sand, cobbles and boulders (loose, moist) (fill)
		Test pit completed at 6.0 feet on 02/23/96
		No ground water seepage observed
		Severe caving observed between 0.0 and 6.0 feet
		Disturbed soil sample obtained at 3.0 feet
		TEST PIT TP-4
0.0 - 1.0	GM	Dark brown silty fine to coarse gravel with fine to coarse sand, occasional cobbles, grass and shrub roots (medium dense, moist) (topsoil)
1.0 - 8.5	GM	Light brown silty coarse gravel with fine gravel, fine to coarse sand, cobbles and occasional boulders (medium dense, moist)
8.5 - 9.5	ML	Orangish brown to gray silt (medium stiff, moist)
		Test pit completed at 9.5 feet on 02/23/96
		No ground water seepage observed
		Severe caving observed between 0.0 and 7.0 feet
		Disturbed soil samples obtained at 8.5 and 9.0 feet
		TEST PIT TP-5
0.0 - 0.3	GW	Fine to coarse gravel with sand (medium dense, moist) (fill)
0.3 - 1.5	RX	Boulders and cobbles with brown fine to medium sand (riprap) (fill)
		Test pit completed at 1.5 feet on 02/23/96 due to refusal on riprap boulders
		No ground water seepage observed
		No caving observed

THE DEPTHS ON THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT.

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT TP-6
0.0 - 0.3	GW	Fine to coarse gravel with sand (medium dense, moist) (fill)
0.3 - 2.0	RX	Cobbles and boulders with dark brown fine to medium sand (fill)
		Test pit completed at 2.0 feet on 02/23/96
		No ground water seepage observed
		No caving observed

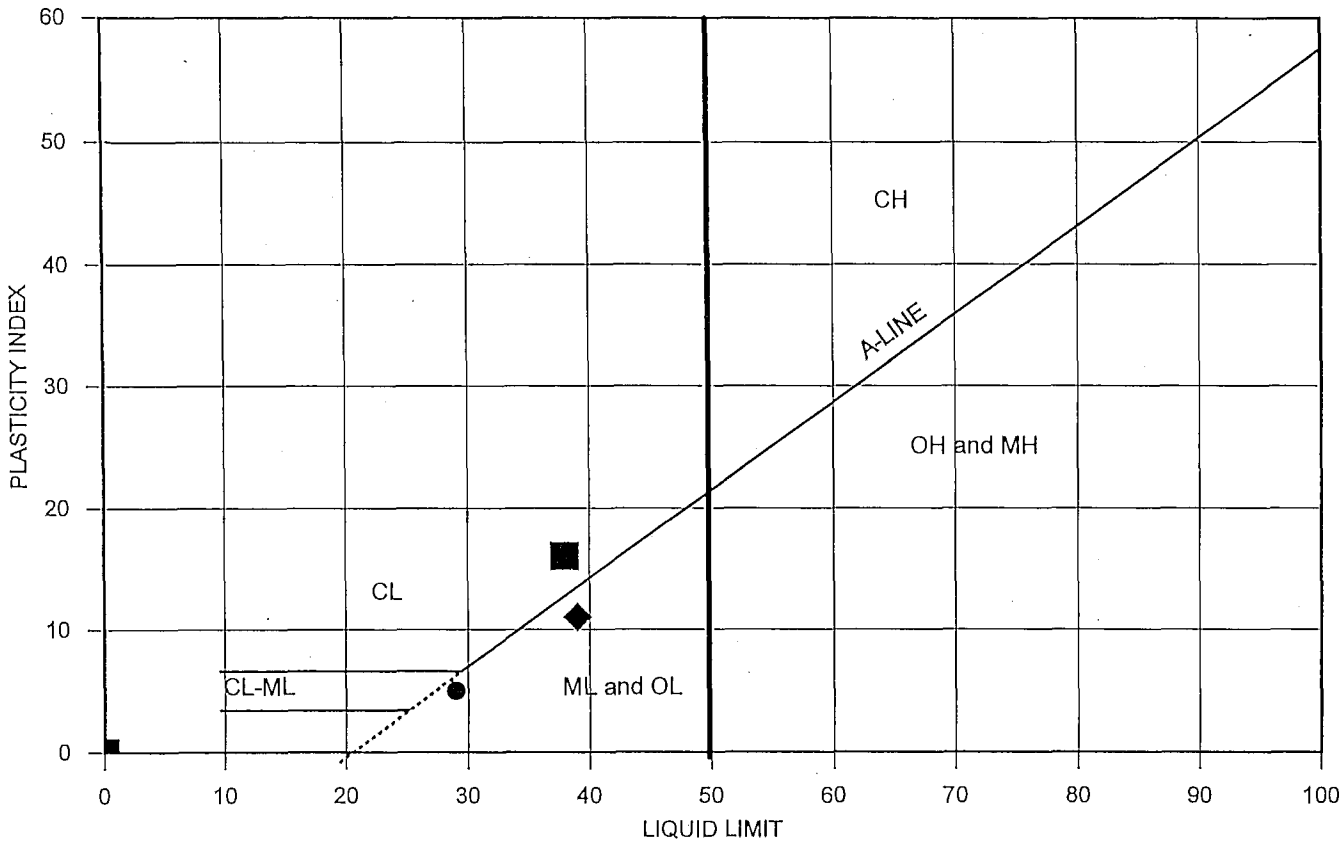
THE DEPTHS ON THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT.

Geo Engineers

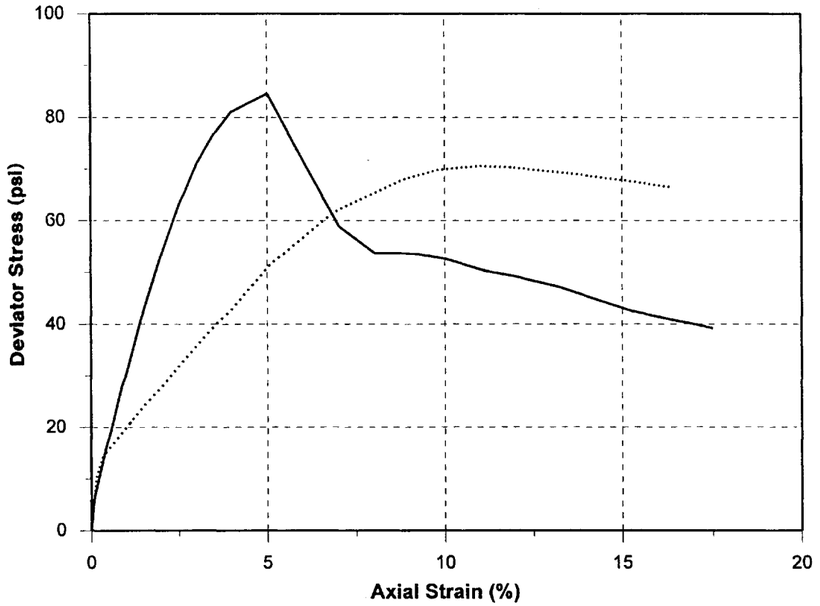
ATTERBERG LIMITS TEST RESULTS

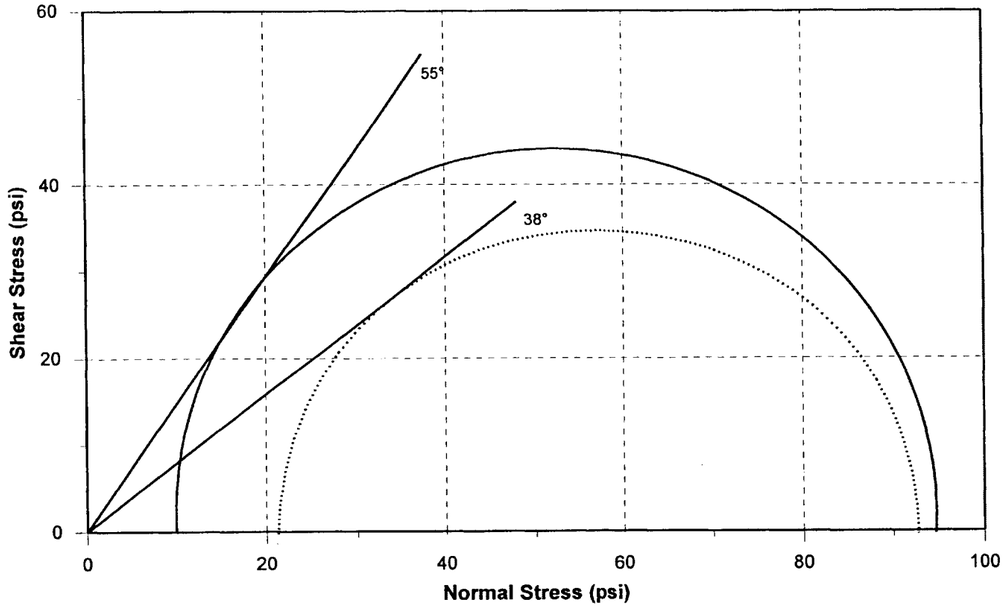
FIGURE A-17

PLASTICITY CHART



EXPLORATION NUMBER	SAMPLE DEPTH (feet)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SOIL DESCRIPTION
B-3	21.0	17	nonplastic	nonplastic	Gray fine sandy silt (ML)
B-4	21.0	27	39	11	Gray silt (ML)
B-6	15.0	16	29	5	Brown silt with fine to medium sand and fine to coarse gravel (ML)
B-9	20.5	20	38	16	Gray clay (CL)





SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION	MOISTURE CONTENT (%)	DRY DENSITY (PCF)
———	B-3	21	Gray silt (ML)	17	117
.....	B-4	16	Gray silt (ML)	25	100

Geo Engineers

CONSOLIDATED DRAINED TRIAXIAL TEST RESULT

FIGURE A–18

0146-062-01 JJM:KKJ 06/05/96

APPENDIX C: GEOTECHNICAL LABORATORY TET RESULTS

Appendix C

Geotechnical Laboratory Test Results

CONTENTS

HWA | GEOSCIENCES INC.
DBE/MWBE

July 20, 2021
HWA Project No. 2011-048-23 Task 900

Shannon & Wilson
400 North 34th Street, Suite 100
Seattle WA, 98103

Attn: Mr. Oliver Hoopes, P.E.

Subject: **MATERIALS LABORATORY REPORT**
Lower Raging River – King County Levee Project
Client Project No.: 103692-303

Dear Mr. Hoopes;

In accordance with your request, HWA GeoSciences Inc. (HWA) performed laboratory testing for the above referenced project. Herein we present the results of our laboratory analyses, which are summarized on the attached Figures. The laboratory testing program was performed in general accordance with your instructions and appropriate ASTM Standards as outlined below.

SAMPLE DESCRIPTION: The subject samples were delivered to our laboratory on July 6, 2021 by Shannon & Wilson personnel. The samples were delivered in large plastic bags and were designated with exploration ID, sample number, and depth of sampling. The soil samples were classified using visual-manual methods. The descriptions may be found on the attached Summary of Material Properties, Figures 1 through 2.

PERCENTAGE FINER THAN #200 SIEVE: The percentage of material finer than the #200 sieve was determined for each specified sample in general accordance with ASTM D1140. The soil was oven dried and washed over a #200 sieve to determine the percentage of fines. The results are plotted on the attached Particle Size Analysis of Soils Report, Figures 3 through 8, which also indicate the moisture content of the soil samples at the time of testing.

PARTICLE SIZE ANALYSIS OF SOILS: The particle size distribution of each specified sample was determined in general accordance with ASTM D6913 and ASTM D7928. The results are plotted on the attached Particle Size Analysis of Soils Report, Figures 3 through 8, which also indicate the moisture content of the soil samples at the time of testing.

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ATTERBERG LIMITS): The plasticity index of each specified sample was tested using method ASTM D4318, multi-point method. The results are reported on the attached Liquid Limit, Plastic Limit, and Plasticity Index Report, Figure 9.

CLOSURE: Experience has shown that test values on soil and other natural materials vary with each representative sample. As such, HWA has no knowledge as to the extent and quantity of material the tested samples may represent. HWA also makes no warranty as to how representative either the samples tested or the test results obtained are to actual field conditions. It is a well-established fact that sampling methods present varying degrees of disturbance that affect sample representativeness.

No copy should be made of this report except in its entirety.

We appreciate the opportunity to provide laboratory testing services on this project. Should you have any questions or comments, or if we may be of further service, please call.

Sincerely,

HWA GEOSCIENCES INC.

Kristin Nolan
Materials Laboratory Manager

Steven E. Greene, L.G., L.E.G.
Principal Engineering Geologist
Vice President

Attachments:

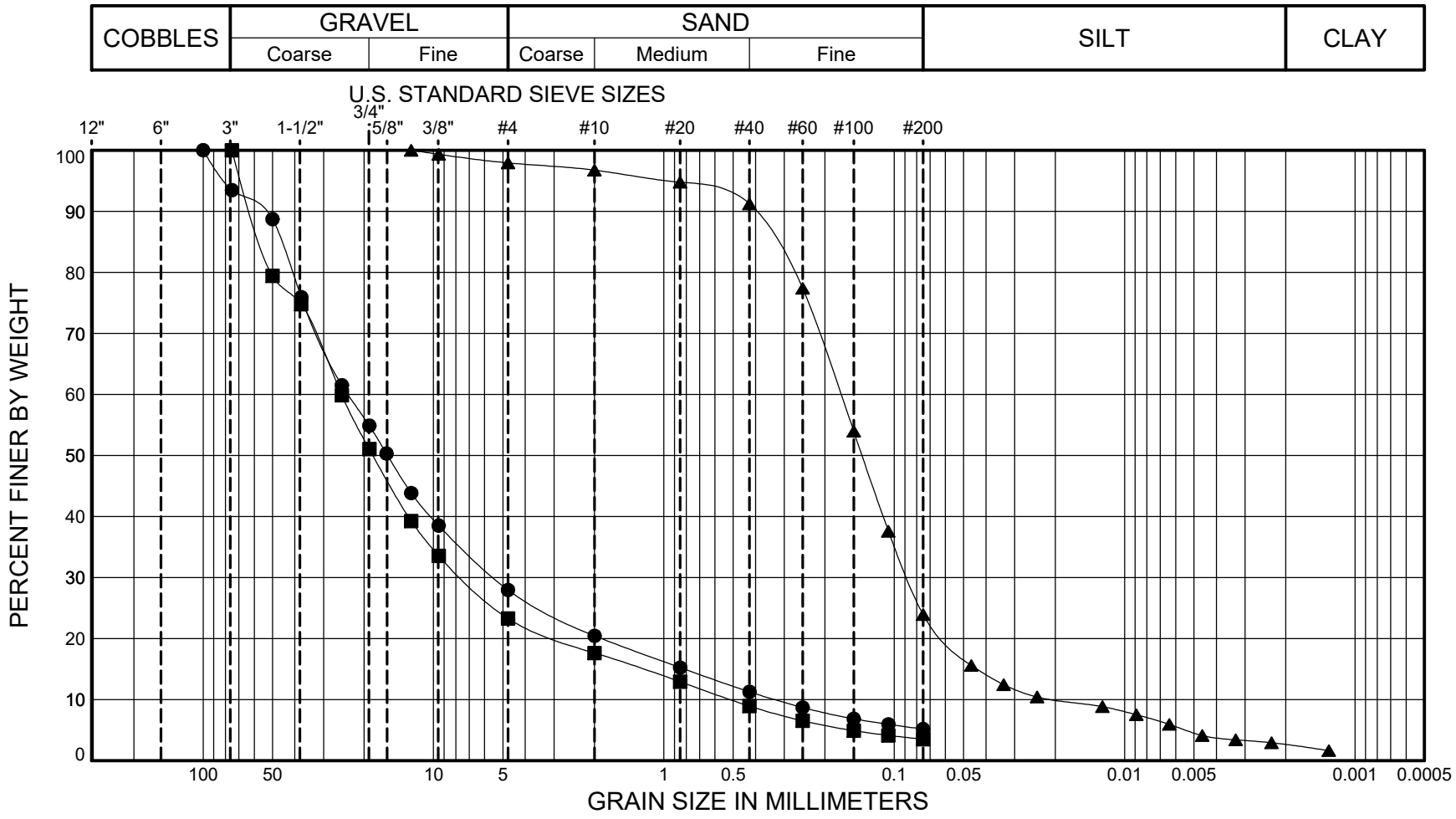
Figures 1-2	Summary of Material Properties
Figures 3-8	Particle Size Analysis of Soils Report
Figure 9	Liquid Limit, Plastic Limit and Plasticity Index of Soils

EXPLORATION DESIGNATION	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	SPECIFIC GRAVITY	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
						LL	PL	PI					
B-RR-1,R-3	10.0	15.0	6.6						65.5	22.8	5.2	GP-GM	Olive-brown, poorly graded GRAVEL with silt, sand, and cobbles
B-RR-1,R-4	16.5	20.0	7.3						76.7	19.8	3.5	GP	Olive-brown, poorly graded GRAVEL with sand
B-RR-1,R-6	25.0	26.5	24.4						2.1	74.0	23.9	SM	Olive-brown, silty SAND
B-RR-1,R-7	31.5	33.0	29.4			34	26	8		19.6	80.4	ML	Grayish-brown, SILT with sand
B-RR-2,R-4	17.0	20.0	4.3						59.1	33.2	7.7	GW-GM	Olive-brown, well-graded GRAVEL with silt and sand
B-RR-2,R-5	20.0	22.0	10.9						47.3	38.3	6.8	GP-GM	Olive-brown, poorly graded GRAVEL with silt, sand, and cobbles
B-RR-2,R-5	23.0	25.0	10.6						66.2	32.5	1.3	GW	Yellowish-brown, well-graded GRAVEL with sand
B-RR-2,R-6	25.0	27.0	10.4						48.0	44.9	7.1	GW-GM	Olive-brown, well-graded GRAVEL with silt and sand
B-RR-2,R-7	30.0	31.5	29.6			26	23	3				ML	Olive-brown, SILT with sand
B-RR-3,R-2	5.0	7.5	2.4						62.3	32.0	5.8	GW-GM	Grayish-brown, well-graded GRAVEL with silt and sand
B-RR-3,R-4	15.0	17.5	3.5						51.3	17.8	6.7	GP-GM	Grayish-brown, poorly graded GRAVEL with silt, sand, and cobbles
B-RR-3,R-6	25.0	27.0	60.8			50	37	13				OL	Dark brown, organic SILT with sand
B-RR-3,R-7	30.0	32.5	20.2						0.8	79.2	19.9	SM	Dark gray, silty SAND
B-RR-3,R-8	35.0	36.5	22.8								3.9	SP	Grayish-brown, poorly graded SAND
B-RR-4,R-4	15.0	20.0	8.0						73.7	22.3	4.0	GP	Olive, poorly graded GRAVEL with sand
B-RR-4,R-5	20.0	21.5	31.4			40	25	15				CL	Dark grayish-brown, lean CLAY
B-RR-4,R-6	25.0	26.0	26.5			32	24	8				ML	Olive-brown, SILT
TP-RR-1,S-2	4.0	6.0	15.1						10.4	59.4	30.2	SM	Olive-brown, silty SAND
TP-RR-1,S-3	6.0	7.0	4.3						47.0	49.0	4.0	SP	Olive-brown, poorly graded SAND with gravel
TP-RR-5,S-2	1.0	2.0	12.3						48.7	23.1	28.1	GM	Olive-brown, silty GRAVEL with sand

Notes: 1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report test, other graphs and tables, and the exploration logs.
2. The soil classifications in this table are based on ASTM D2487 and D2488 as applicable.

EXPLORATION DESIGNATION	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	SPECIFIC GRAVITY	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
						LL	PL	PI					
TP-RR-6,S-1	4.0	6.0	4.0						59.6	36.2	4.2	GP	Olive-brown, poorly graded GRAVEL with sand
TP-RR-8,S-1	4.0	6.0	2.5						47.8	18.8	2.0	GP	Olive-brown, poorly graded GRAVEL with sand and cobbles

Notes: 1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report test, other graphs and tables, and the exploration logs.
2. The soil classifications in this table are based on ASTM D2487 and D2488 as applicable.



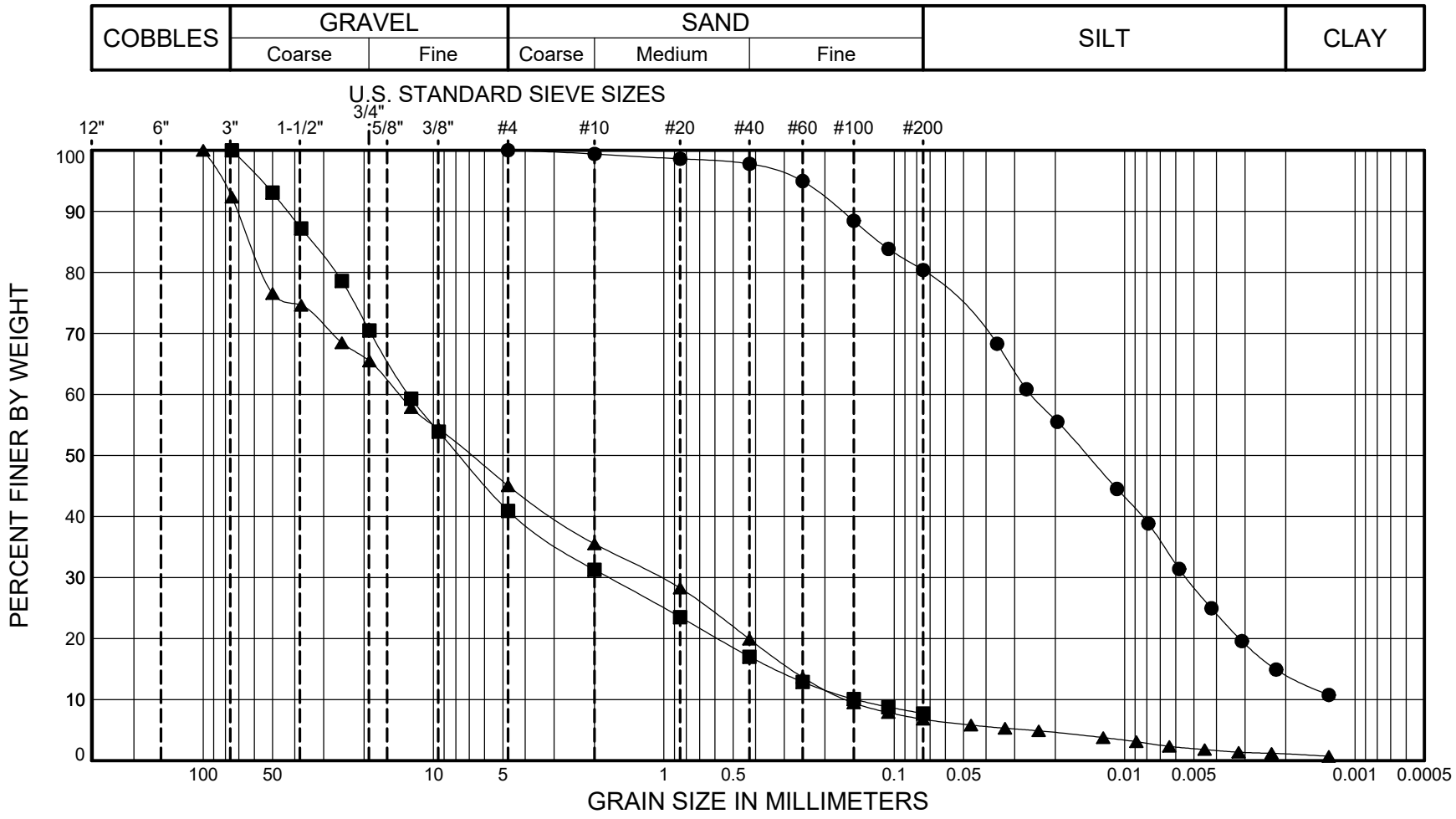
SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	% Cobble	% Gravel	% Sand	% Fines
●	B-RR-1	R-3	10.0 - 15.0	(GP-GM) Olive-brown, poorly graded GRAVEL with silt, sand, and cobbles	7	6.5	65.5	22.8	5.2
■	B-RR-1	R-4	16.5 - 20.0	(GP) Olive-brown, poorly graded GRAVEL with sand	7	0.0	76.7	19.8	3.5
▲	B-RR-1	R-6	25.0 - 26.5	(SM) Olive-brown, silty SAND	24		2.1	74.0	23.9

HWA GeoSciences Inc.

Laboratory Testing for Shannon & Wilson
Lower Raging River - King County Levee Project
Client Project No.: 103692-303

PARTICLE-SIZE ANALYSIS
OF SOILS METHODS
ASTM D6913/D7928

PROJECT NO.: 2011-048 T900 FIGURE: 3



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	% Cobble	% Gravel	% Sand	% Fines
●	B-RR-1	R-7	31.5 - 33.0	(ML) Grayish-brown, SILT with sand	29		0.0	19.6	80.4
■	B-RR-2	R-4	17.0 - 20.0	(GW-GM) Olive-brown, well-graded GRAVEL with silt and sand	4	0.0	59.1	33.2	7.7
▲	B-RR-2	R-5	20.0 - 22.0	(GP-GM) Olive-brown, poorly graded GRAVEL with silt, sand, and cobbles	11	7.7	47.3	38.3	6.8

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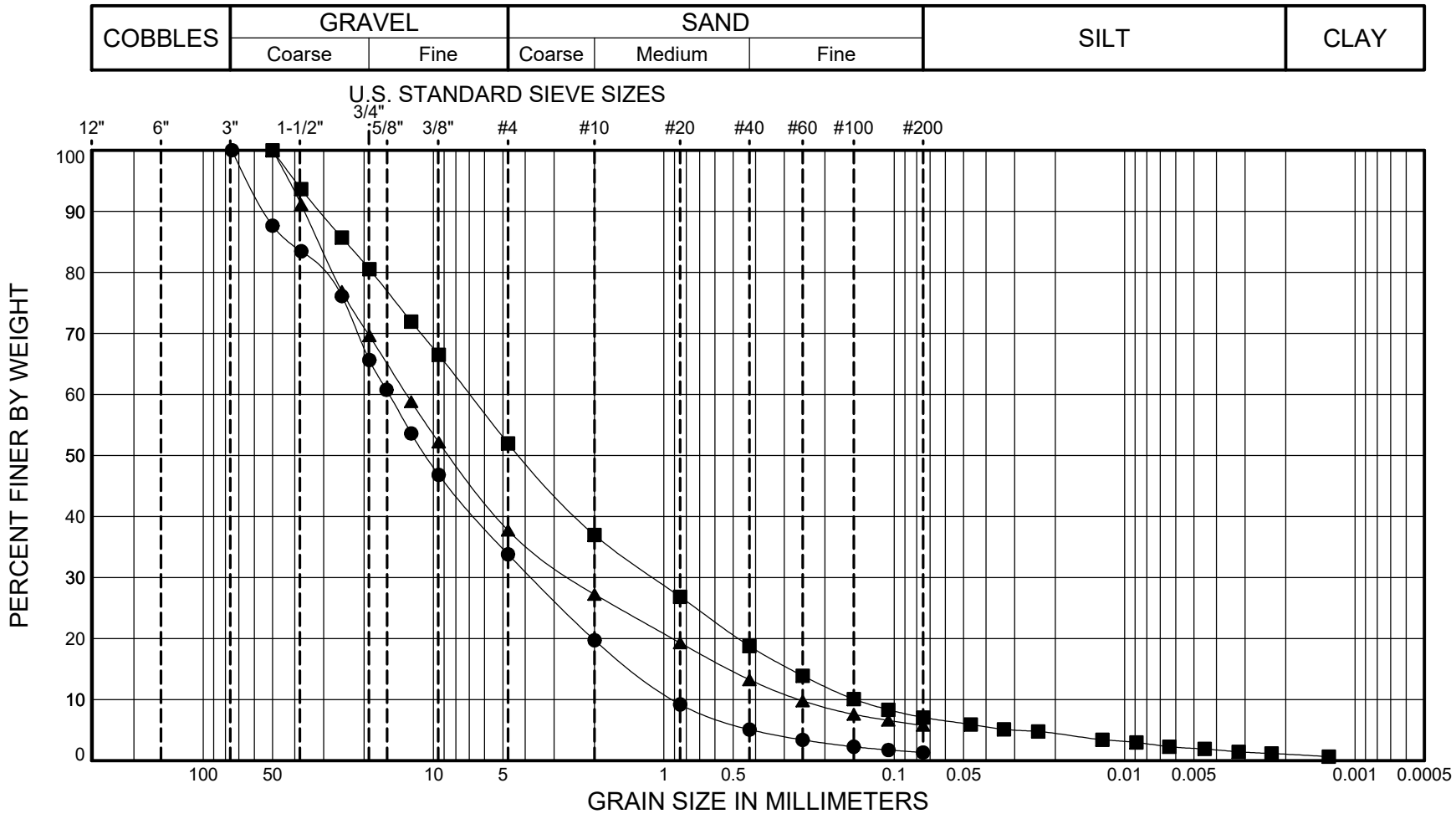
Laboratory Testing for Shannon & Wilson
Lower Raging River - King County Levee Project
Client Project No.: 103692-303

PARTICLE-SIZE ANALYSIS
OF SOILS METHODS
ASTM D6913/D7928

PROJECT NO.: 2011-048 T900 FIGURE: 4



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	% Cobble	% Gravel	% Sand	% Fines
●	B-RR-2	R-5	23.0 - 25.0	(GW) Yellowish-brown, well-graded GRAVEL with sand	11	0.0	66.2	32.5	1.3
■	B-RR-2	R-6	25.0 - 27.0	(GW-GM) Olive-brown, well-graded GRAVEL with silt and sand	10		48.0	44.9	7.1
▲	B-RR-3	R-2	5.0 - 7.5	(GW-GM) Grayish-brown, well-graded GRAVEL with silt and sand	2		62.3	32.0	5.8

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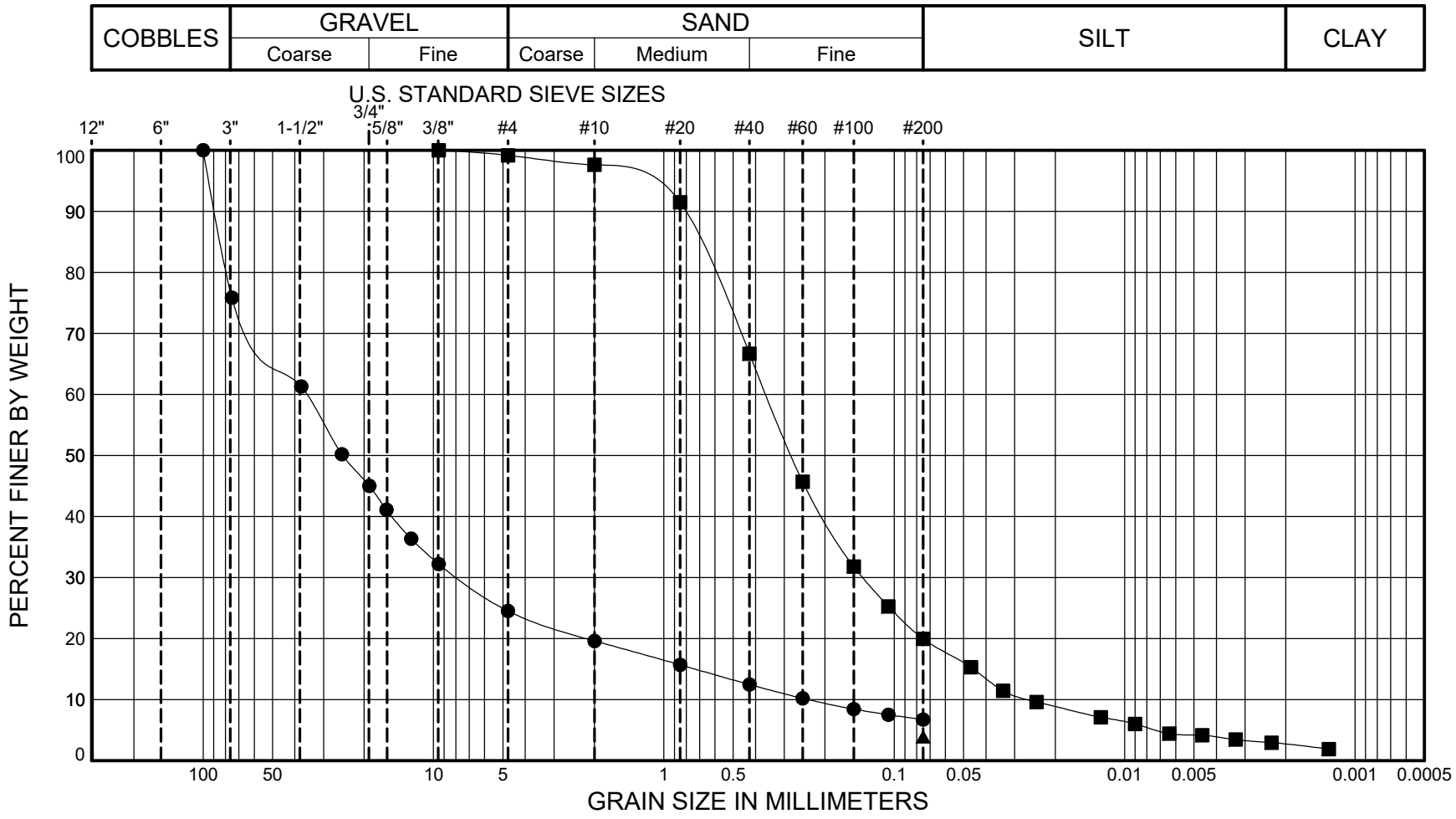
Laboratory Testing for Shannon & Wilson
Lower Raging River - King County Levee Project
Client Project No.: 103692-303

PARTICLE-SIZE ANALYSIS
OF SOILS METHODS
ASTM D6913/D7928

PROJECT NO.: 2011-048 T900 FIGURE: 5



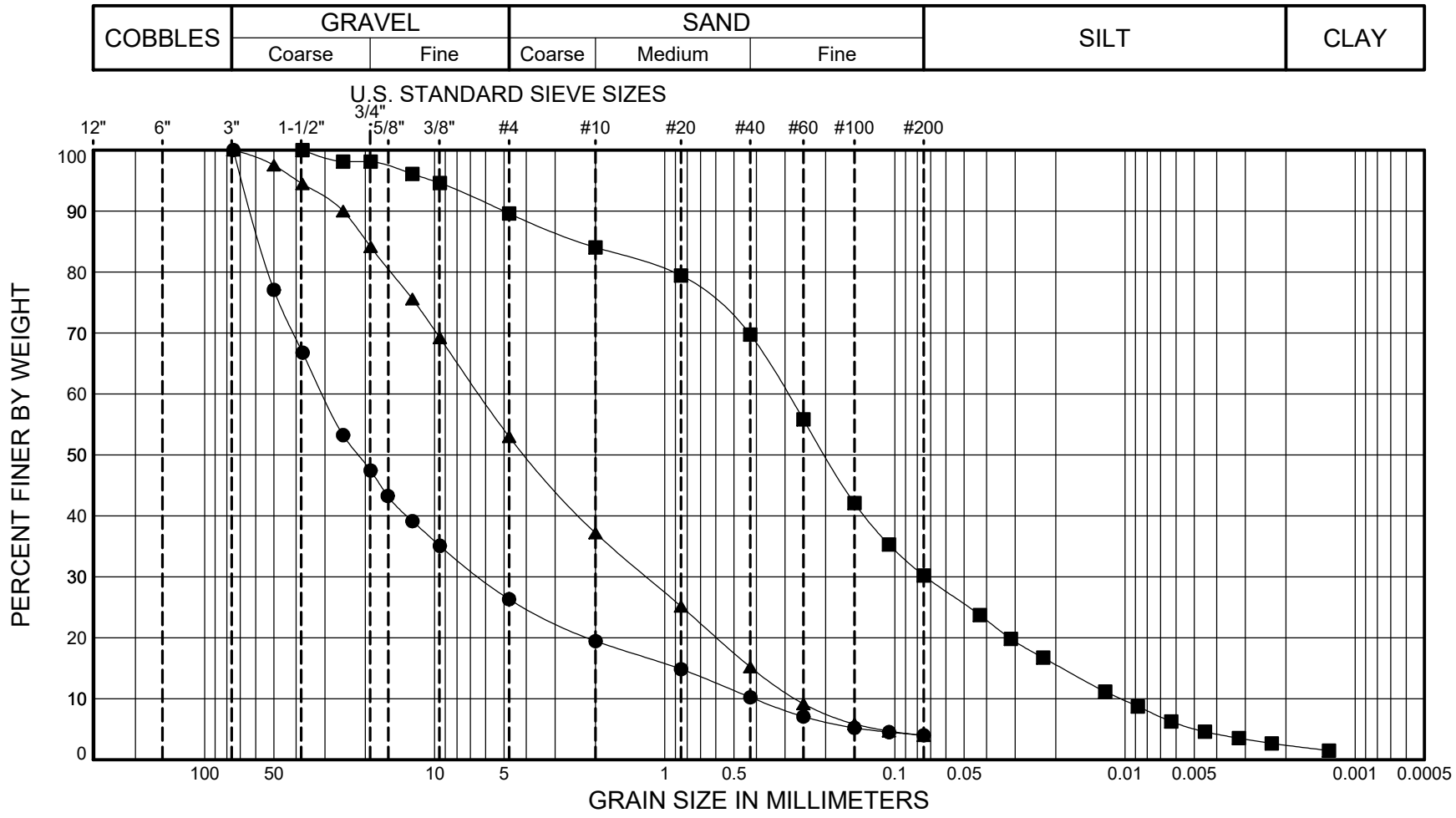
SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	% Cobble	% Gravel	% Sand	% Fines
●	B-RR-3	R-4	15.0 - 17.5	(GP-GM) Grayish-brown, poorly graded GRAVEL with silt, sand, and cobbles	4	24.2	51.3	17.8	6.7
■	B-RR-3	R-7	30.0 - 32.5	(SM) Dark gray, silty SAND	20		0.8	79.2	19.9
▲	B-RR-3	R-8	35.0 - 36.5	(SP) Grayish-brown, poorly graded SAND	23		0.0		3.9

HWA GeoSciences Inc.

Laboratory Testing for Shannon & Wilson
Lower Raging River - King County Levee Project
Client Project No.: 103692-303

PARTICLE-SIZE ANALYSIS
OF SOILS METHODS
ASTM D6913/D7928

PROJECT NO.: 2011-048 T900 FIGURE: 6



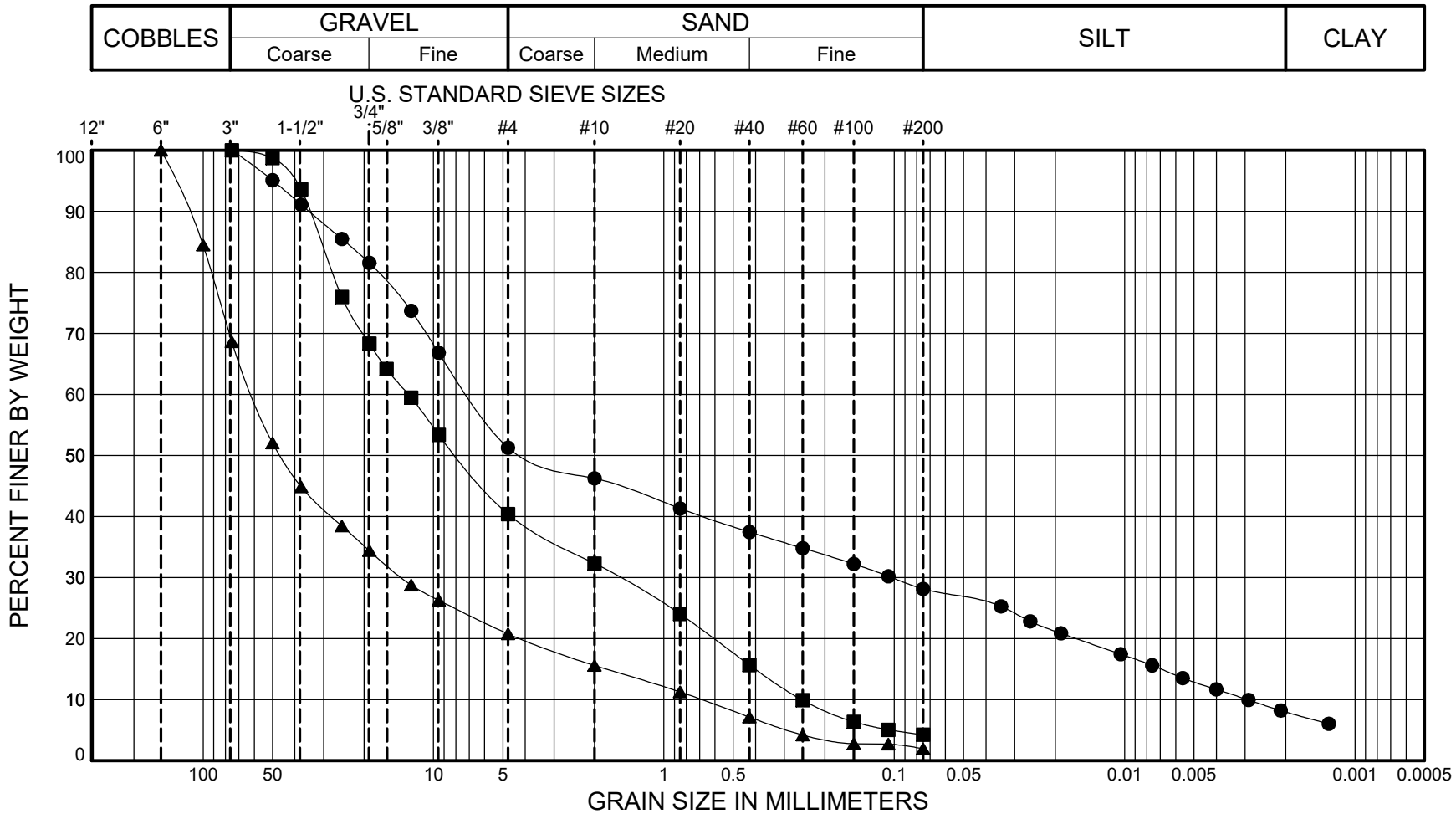
SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	% Cobble	% Gravel	% Sand	% Fines
●	B-RR-4	R-4	15.0 - 20.0	(GP) Olive, poorly graded GRAVEL with sand	8	0.0	73.7	22.3	4.0
■	TP-RR-1	S-2	4.0 - 6.0	(SM) Olive-brown, silty SAND	15		10.4	59.4	30.2
▲	TP-RR-1	S-3	6.0 - 7.0	(SP) Olive-brown, poorly graded SAND with gravel	4	0.0	47.0	49.0	4.0

HWA GeoSciences Inc.

Laboratory Testing for Shannon & Wilson
Lower Raging River - King County Levee Project
Client Project No.: 103692-303

PARTICLE-SIZE ANALYSIS
OF SOILS METHODS
ASTM D6913/D7928

PROJECT NO.: 2011-048 T900 FIGURE: 7



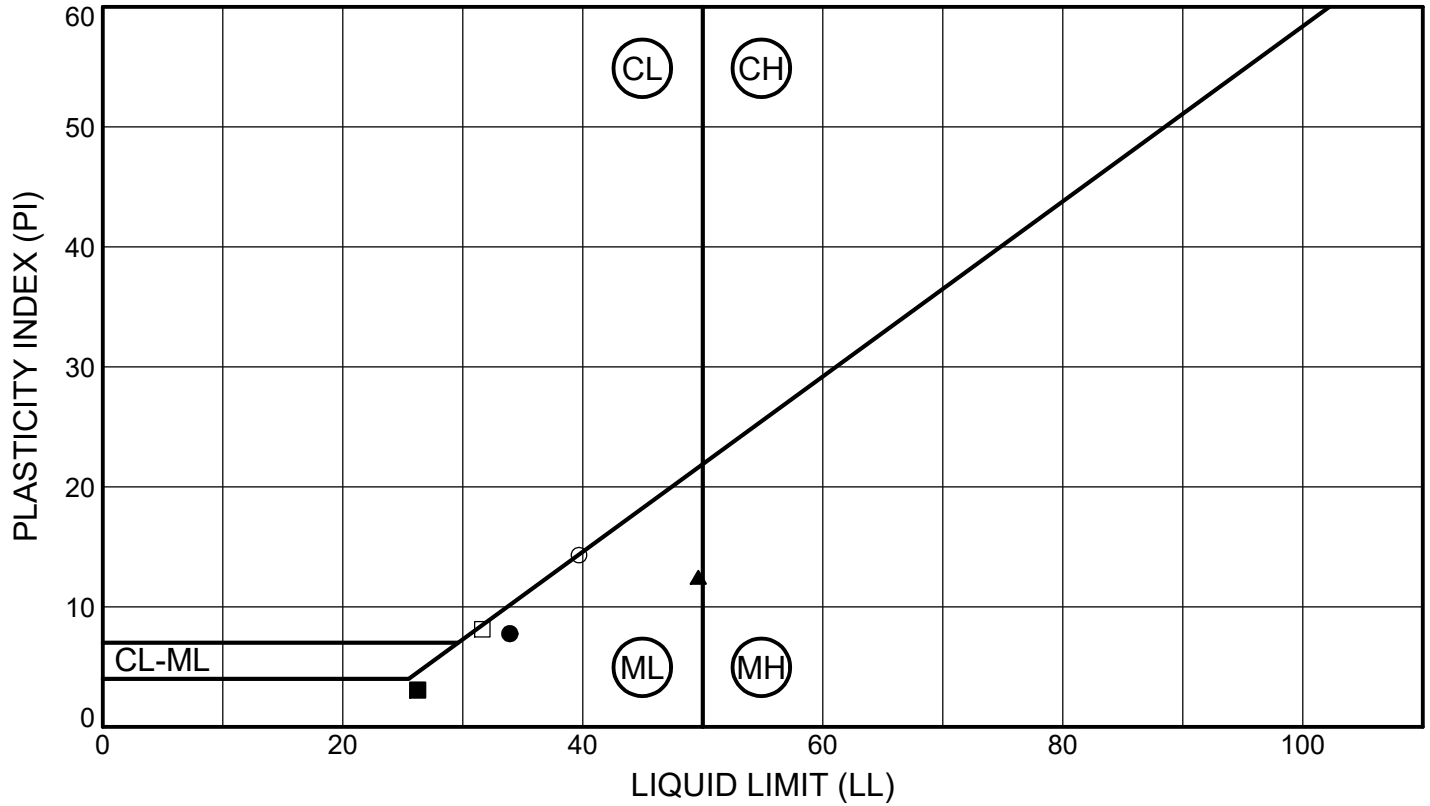
SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	% Cobble	% Gravel	% Sand	% Fines
●	TP-RR-5	S-2	1.0 - 2.0	(GM) Olive-brown, silty GRAVEL with sand	12	0.0	48.7	23.1	28.1
■	TP-RR-6	S-1	4.0 - 6.0	(GP) Olive-brown, poorly graded GRAVEL with sand	4	0.0	59.6	36.2	4.2
▲	TP-RR-8	S-1	4.0 - 6.0	(GP) Olive-brown, poorly graded GRAVEL with sand and cobbles	3	31.4	47.8	18.8	2.0

HWA GeoSciences Inc.

Laboratory Testing for Shannon & Wilson
Lower Raging River - King County Levee Project
Client Project No.: 103692-303

PARTICLE-SIZE ANALYSIS
OF SOILS METHODS
ASTM D6913/D7928

PROJECT NO.: 2011-048 T900 FIGURE: 8



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	B-RR-1	R-7	31.5 - 33.0	(ML) Grayish-brown, SILT with sand	29	34	26	8	80.4
■	B-RR-2	R-7	30.0 - 31.5	(ML) Olive-brown, SILT with sand	30	26	23	3	
▲	B-RR-3	R-6	25.0 - 27.0	(OL) Dark brown, organic SILT with sand	61	50	37	13	
○	B-RR-4	R-5	20.0 - 21.5	(CL) Dark grayish-brown, lean CLAY	31	40	25	15	
□	B-RR-4	R-6	25.0 - 26.0	(ML) Olive-brown, SILT	27	32	24	8	

GeoSciences Inc.

Laboratory Testing for Shannon & Wilson
Lower Raging River - King County Levee Project
Client Project No.: 103692-303

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
METHOD ASTM D4318

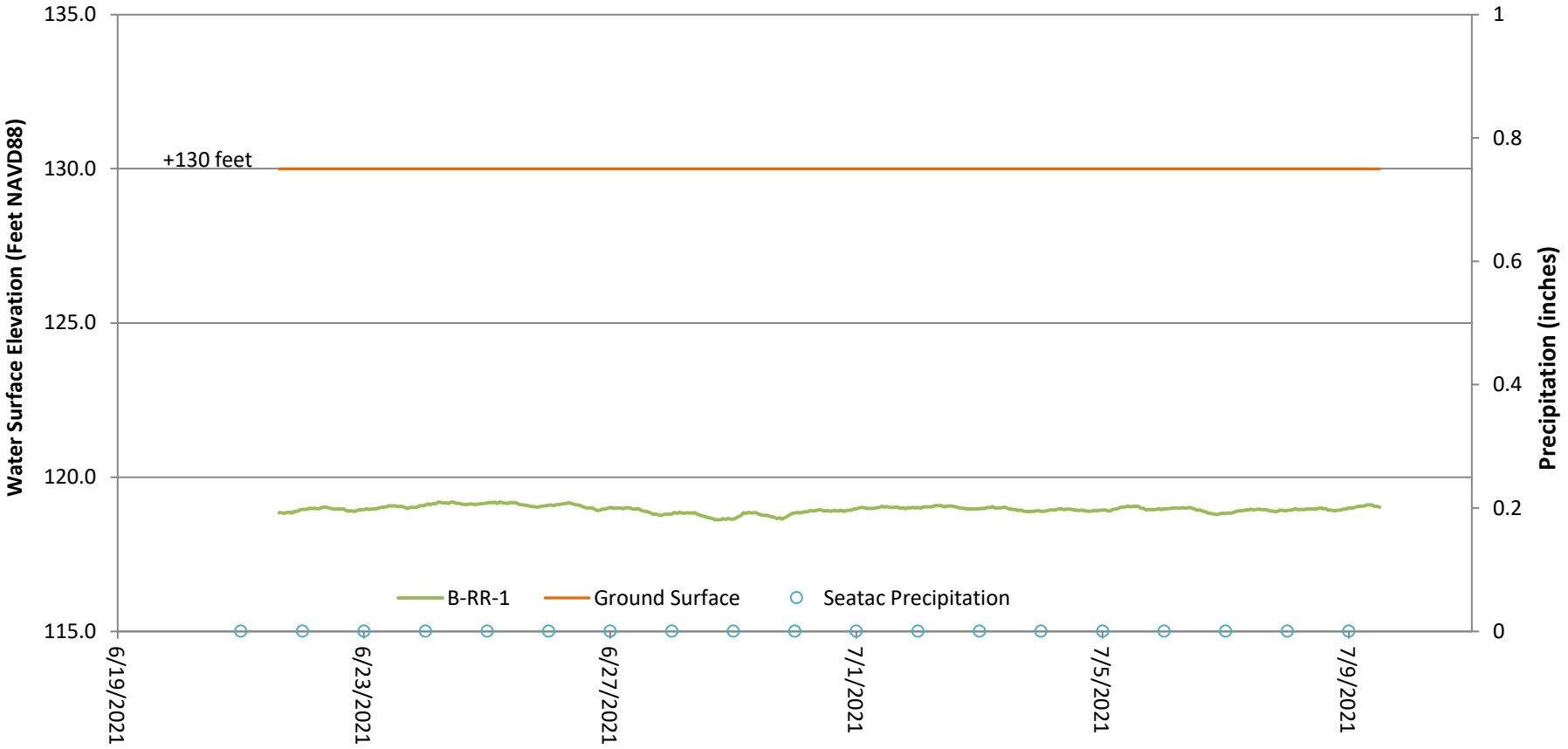
PROJECT NO.: 2011-048 T900 FIGURE: 9

APPENDIX D: HYDROGEOLOGIC DATA RESULTS

Appendix D

Hydrogeologic Data Results

CONTENTS



Notes:

1. Groundwater data recorded hourly using a vibrating wire piezometer.

2. Daily Precipitation data from the Seatac weather station:
https://www.wunderground.com/history/monthly/us/wa/seatac/KSEA/date/2021-6

Levee Breach Analysis and Risk Assessment
Geotechnical Data Report
King County, Washington

LOWER RAGING RIVER
WATER LEVEL READINGS
B-RR-1

November 2021 103692-303

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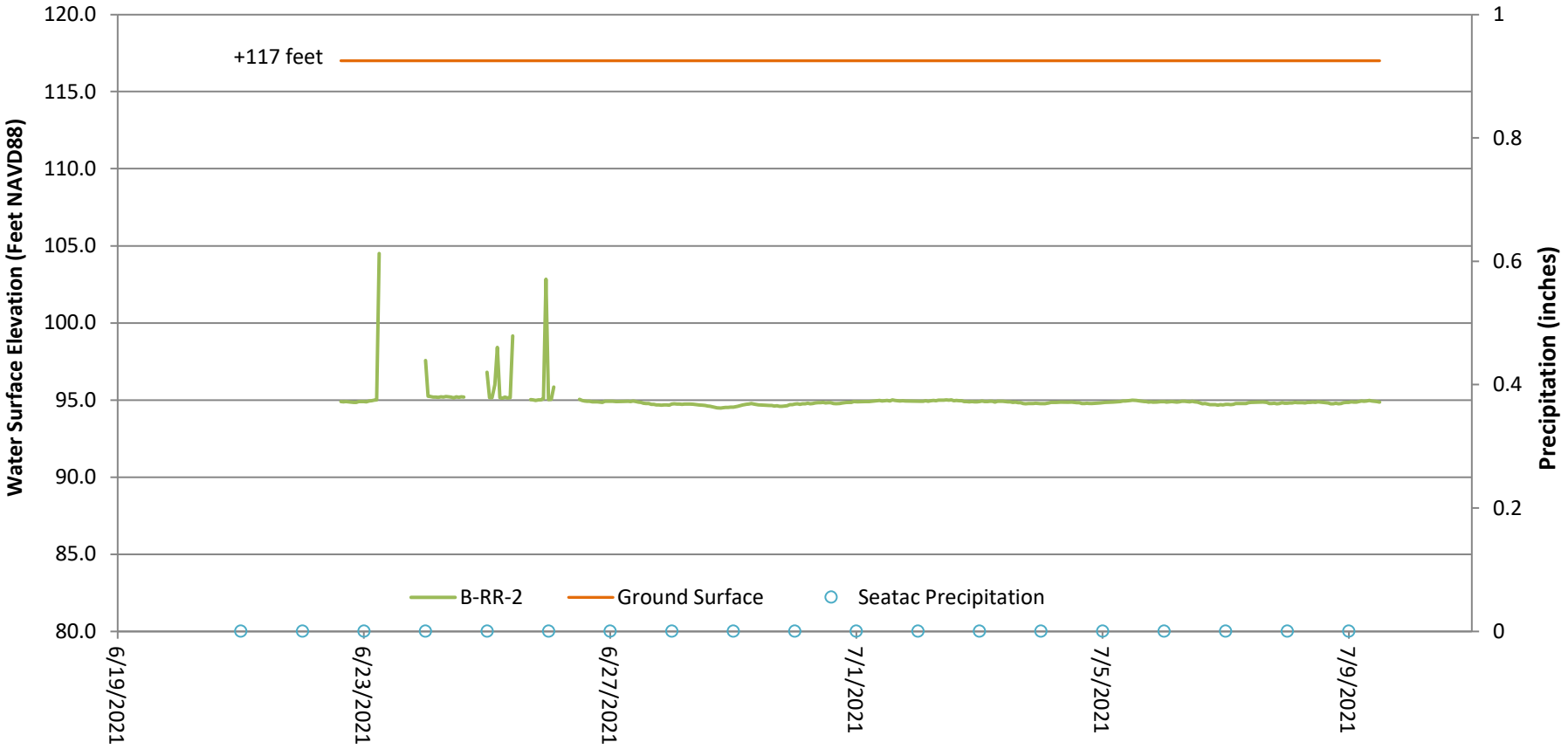
FIG. D-1

I:\EF\SEA\103000s\103692 KC Levee Breach\INSTRUMENTATION\LRR\LRR VWPs - working.xlsx <Plot B-RR-1>



Notes:

1. Groundwater data recorded hourly using a vibrating wire piezometer.

Note: Some erroneous readings were removed from the plot.

2. Daily Precipitation data from the Seatac weather station:

https://www.wunderground.com/history/monthly/us/wa/seatac/KSEA/date/2021-6

Levee Breach Analysis and Risk Assessment
Geotechnical Data Report
King County, Washington

LOWER RAGING RIVER
WATER LEVEL READINGS
B-RR-2

November 2021 103692-303

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FIG. D-2

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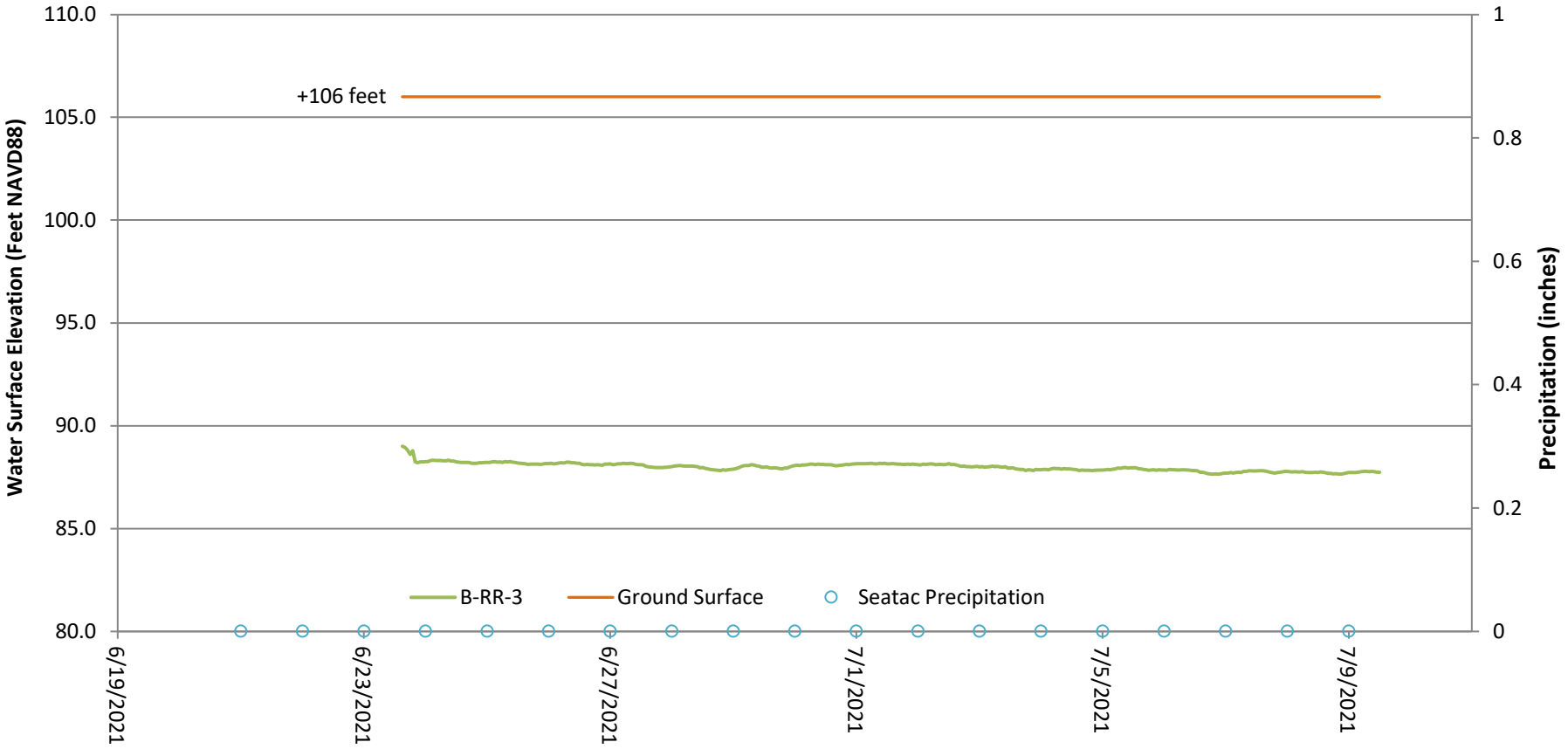

Notes:

1. Groundwater data recorded hourly using a vibrating wire piezometer.

2. Daily Precipitation data from the Seatac weather station:

https://www.wunderground.com/history/monthly/us/wa/seatac/KSEA/date/2021-6

Levee Breach Analysis and Risk Assessment
Geotechnical Data Report
King County, Washington

LOWER RAGING RIVER
WATER LEVEL READINGS
B-RR-3

November 2021 103692-303

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FIG. D-3

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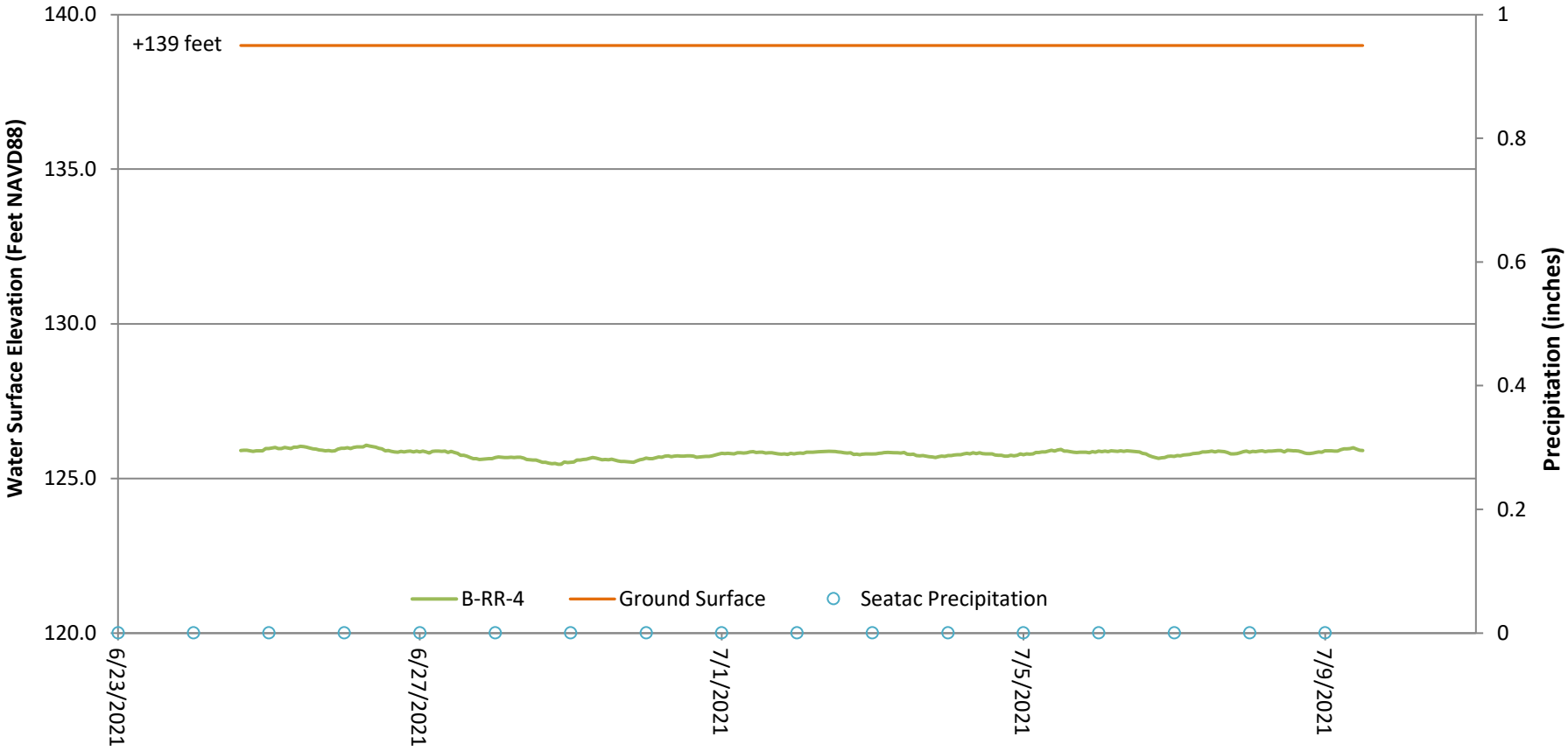

Notes:

1. Groundwater data recorded hourly using a vibrating wire piezometer.

2. Daily Precipitation data from the Seatac weather station:

https://www.wunderground.com/history/monthly/us/wa/seatac/KSEA/date/2021-6

Levee Breach Analysis and Risk Assessment
Geotechnical Data Report
King County, Washington

LOWER RAGING RIVER
WATER LEVEL READINGS
B-RR-4

November 2021 103692-303

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FIG. D-4

I:\EF\SEA\103000s\103692 KC Levee Breach\INSTRUMENTATION\LRR\LRR VWPs - working.xlsx <Plot B-RR-4>

IMPORTANT INFORMATION

Important Information

About Your Geotechnical Report

IMPORTANT INFORMATION

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

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

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

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

SUBSURFACE CONDITIONS CAN CHANGE.

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

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

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas

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not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

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

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

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

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

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

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

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READ RESPONSIBILITY CLAUSES CLOSELY.

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

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