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Pacific Northwest
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Sampling and Analysis Plan

Waste Treatment Plant
Seismic Boreholes Project

May 2006

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Abstract

This sampling and analysis plan (SAP) describes planned data collection activities for four entry boreholes through the sediment overlying the basalt, up to three new deep rotary boreholes through the basalt and sedimentary interbeds, and one corehole through the basalt and sedimentary interbeds at the Waste Treatment Plant (WTP) site. The SAP will be used in concert with the quality assurance plan for the project to guide the procedure development and data collection activities needed to support borehole drilling, geophysical measurements, and sampling. This SAP identifies the American Society of Testing Materials standards, Hanford Site procedures, and other guidance to be followed for data collection activities.

Contents

Figures

Tables

1.0 Introduction

This sampling and analysis plan (SAP) describes planned data collection activities for four entry boreholes through the sediment overlying the basalt, up to three new deep rotary boreholes through the basalt and sedimentary interbeds, and one corehole through the basalt and sedimentary interbeds at the Waste Treatment Plant (WTP) site. The SAP and Quality Assurance Project Plan (QAPjP 2006) will be used to guide the procedure development and data collection activities needed to support borehole drilling, geophysical measurements, and sampling. This SAP identifies standards (e.g., American Society of Testing Materials [ASTM]), Hanford Site procedures, and other guidance documents for data collection activities. Procedures not yet available or contractor-specific procedures will be submitted for review and acceptance prior to commencement of work on the site. All data collection activities will be governed by activity-specific procedures reviewed and accepted by the project consistent with PNWD (2005), QAPjP (2006), and DOE O 414.1C (2005). Only approved procedures will be used for this work.

2.0 Borehole Drilling and Sampling

The tasks involved in this sampling and analysis plan include

- preparation activities
- borehole location and designation
- drilling and geologic material sampling
- borehole geophysical logging
- shearwave and compressional wave data collection
- sample handling
- sample analysis
- documentation.

2.1 Preparation Activities

Preparation activities necessary before beginning fieldwork for borehole drilling and data collection include

- coordinating with team members
- coordinating with support services as addressed in the Quality Assurance Project Plan (QAPjP 2006)
- evaluating drilling techniques
- obtaining support documentation
- obtaining monitoring and sampling equipment
- ensuring that all required training has been completed.

2.2 Borehole Location and Designation

The locations for the boreholes planned for this study are shown in Figure 1. The cored borehole (C4998) is located at the site for C4997. Boreholes C4993 will be used, should insufficient data be obtained from C4997. Boreholes C4994 and C4995 are optional or backup borehole locations that will not be used unless they are deemed necessary at a future time.

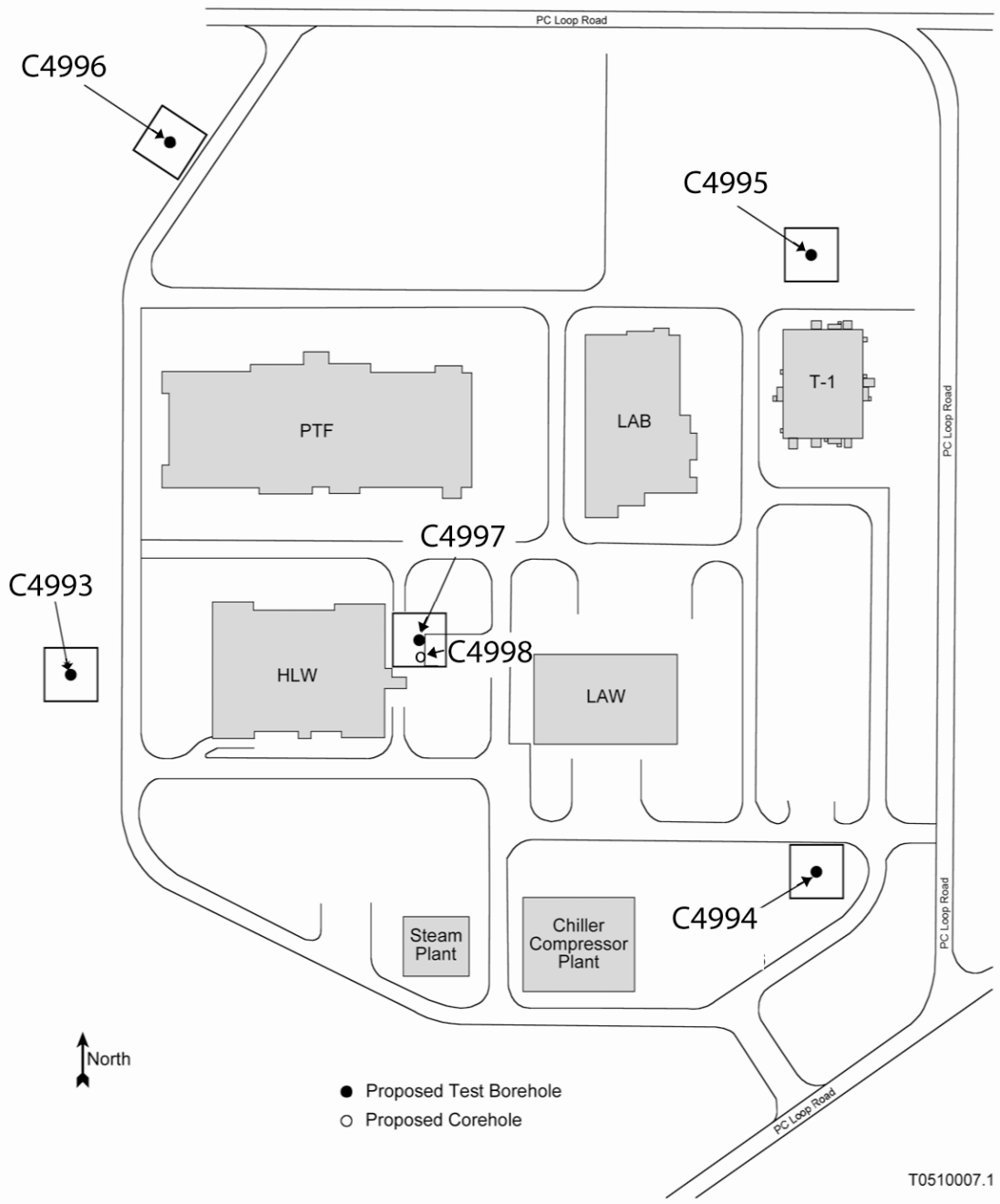

Figure 1. Location of WTP Boreholes (adapted from Gardner et al. 2006).

Initially, four entry boreholes from the surface to the top of the basalt will be drilled. These will provide access for three deep boreholes in the basalt and one corehole through the basalt. The three deep boreholes are designed primarily to provide access to the subsurface for geophysical measurement. The corehole is designed to provide a continuous record of the rock that will be penetrated by the three deep rotary boreholes. The boreholes are designed to also provide samples to 1) identify the geologic units below the WTP site, 2) characterize the sediments and basalt below the WTP, 3) provide core samples for dynamic laboratory testing, and 4) obtain geophysical data including shear wave (Vs) and compressional wave (Vp) data and downhole geophysical logging. The boreholes also will provide groundwater samples for other Hanford projects if they desire, but those projects will be responsible for their sampling and analysis requirements and quality assurance procedures; thus, groundwater sampling is not addressed further in this plan. All borings will be constructed in accordance with Washington Administrative Code (WAC) 173-160 requirements and other applicable Hanford requirements.

2.2.1 Location and Installation

The primary factor dictating the location of the boreholes is the need to acquire Vp and Vs data for the WTP site. The number of boreholes and their locations to be used in this study have been determined as a result of discussions among the team members, the U.S. Army Corps of Engineers and its contractors (referred to here as the USACE Review Panel), and the Defense Nuclear Facilities Safety Board (DNFSB).

Rationale. Major objectives of the proposed geophysical surveys in the planned deep boreholes are to obtain reliable and unambiguous data on velocity (most importantly Vs but also Vp), lithology, and thickness of the interbeds in the Saddle Mountains Basalt and to obtain sediment core from the Hanford formation and Ringold Formation for dynamic testing. The USACE Review Panel has indicated that previous site response analysis suggested overburden gravels had a more linear (sand-like) response than gravels in other testing programs. The sampling and dynamic testing are proposed to more accurately determine the nonlinear response of the Hanford gravels and Ringold Formation because this might influence predicted low-period ground surface spectral accelerations.

The primary borehole (C4997) and accompanying corehole (C4998) are located to allow collection of P-wave and S-wave velocity data near the Pretreatment Facility (PTF) and High-Level Waste Vitrification Plant (HLW). Boreholes C4995 and C4996 are placed near the PTF and HLW facilities for additional data collection if deemed necessary by the Senior Review Group, a group appointed by the U.S. Department of Energy (DOE) to oversee the project. Borehole sites C4994 and C4995 would provide data from other parts of the WTP site; these borehole sites are currently considered backup locations and not the primary data collection sites.

2.2.2 Planned Depths and Timing

The entry boreholes will be drilled to the top of basalt. The deep mud-rotary boreholes and the wireline corehole will be drilled into the top of the Wanapum Basalt, which is approximately 1250 feet below the surface (Table 1). The stratigraphy predicted to be encountered in these boreholes is given in Table 1.

Table 1. Basalt Members and Sedimentary Interbeds Expected at the WTP Borehole Sites

	C4996 Northwest		C4995 Northeast		C4997 Center		C4993 Southwest		C4994 Southeast	
Surface Elevation	690 feet (topographic map)		690 feet (topographic map)		690 feet (topographic map)		670 feet (located in Gout Vault pit)		690 feet (topographic map)	
Elevation of Top of Basalt	300 (±10) feet above MSL		300 (±10) feet above MSL		290 (±10) feet above MSL		285 (±10) feet above MSL		285 (±10) feet above MSL	
Unit	Thickness (feet)	Drilled Depth[a]	Thickness (feet)	Drilled Depth[a]	Thickness (feet)	Drilled Depth[a]	Thickness (feet)	Drilled Depth[a]	Thickness (feet)	Drilled Depth[a]
Suprabasalt Sediments	390	0	390	0	400	0	385	0	405	0
Hanford formation	250	0	250	0	260	0	245	0	260	0
Ringold Formation	140	250	140	250	140	260	140	245	145	260
Elephant Mountain Member[b,c]	100[c] ±15	390 ±15	100[c] ±15	390 ±15	100[c] ±15	400 ±15	100[c] ±15	385 ±15	100[c] ±15	405 ±15
Rattlesnake Ridge Interbed	60 ±8	490 ±8	60 ±8	490 ±8	60 ±8	500 ±8	60 ±8	485 ±8	60 ±8	505 ±8
Pomona Member[b]	185 ±10	550 ±10	185 ±10	550 ±10	185 ±10	560 ±10	185 ±10	545 ±10	185 ±10	565 ±10
Selah Interbed	22 ±5	735 ±5	22 ±5	735 ±5	22 ±5	745 ±5	22 ±5	730 ±5	22 ±5	750 ±5
Esquatzel Member[b]	100 ±10	757 ±10	100 ±10	757 ±10	100 ±10	767 ±10	100 ±10	752 ±10	100 ±10	772 ±10
Cold Creek Interbed	95 ±10	857 ±10	95 ±10	857 ±10	95 ±10	867 ±10	95 ±10	852 ±10	95 ±10	872 ±10
Umatilla Member[b,c]	150 ±10	952 ±10	150 ±10	952 ±10	150 ±10	962 ±10	150 ±10	947 ±10	150 ±10	967 ±10
Mabton Interbed	118 ±10	1102 ±10	118 ±10	1102 ±10	118 ±10	1112 ±10	118 ±10	1097 ±10	118 ±10	1117 ±10
Priest Rapids Member[b]		1220 ±10		1220 ±10		1230 ±10		1215 ±10		1235 ±10

(a) Top of unit in feet.
(b) Basalt; interbed is sediment.
(c) Eroded flow top; lava flow invaded water and sediment, producing pillowed flow top, so amount of erosion uncertain.

2.3 Borehole Designations, Design, and Core Labeling

Boreholes are given designations that relate to the area in which they are located. The designations used in this plan and locations in Hanford coordinates are listed in Table 2. Proposed casing as-builts are shown in Figure 2; the drilling oversight contractor (Duratek Federal Services) will determine the final design.

Table 2. Approximate Coordinates of WTP Boreholes

Coordinates		Location	Hanford ID No.
Primary Boreholes			
N 3,901.11	E 10,381.89	Center of site	C4997
N 3,901	E 10,381	Cored hole	C4998
Supplementary Boreholes			
N 3807.77	E 9,670.65	SW of site	C4993
N 4,745.88	E 10,005.89	NW of site	C4996
Backup Boreholes			
N 3,440.48	E 11,088.26	SE of site	C4994
N 4,610.11	E 11,072.15	NE of site	C4995

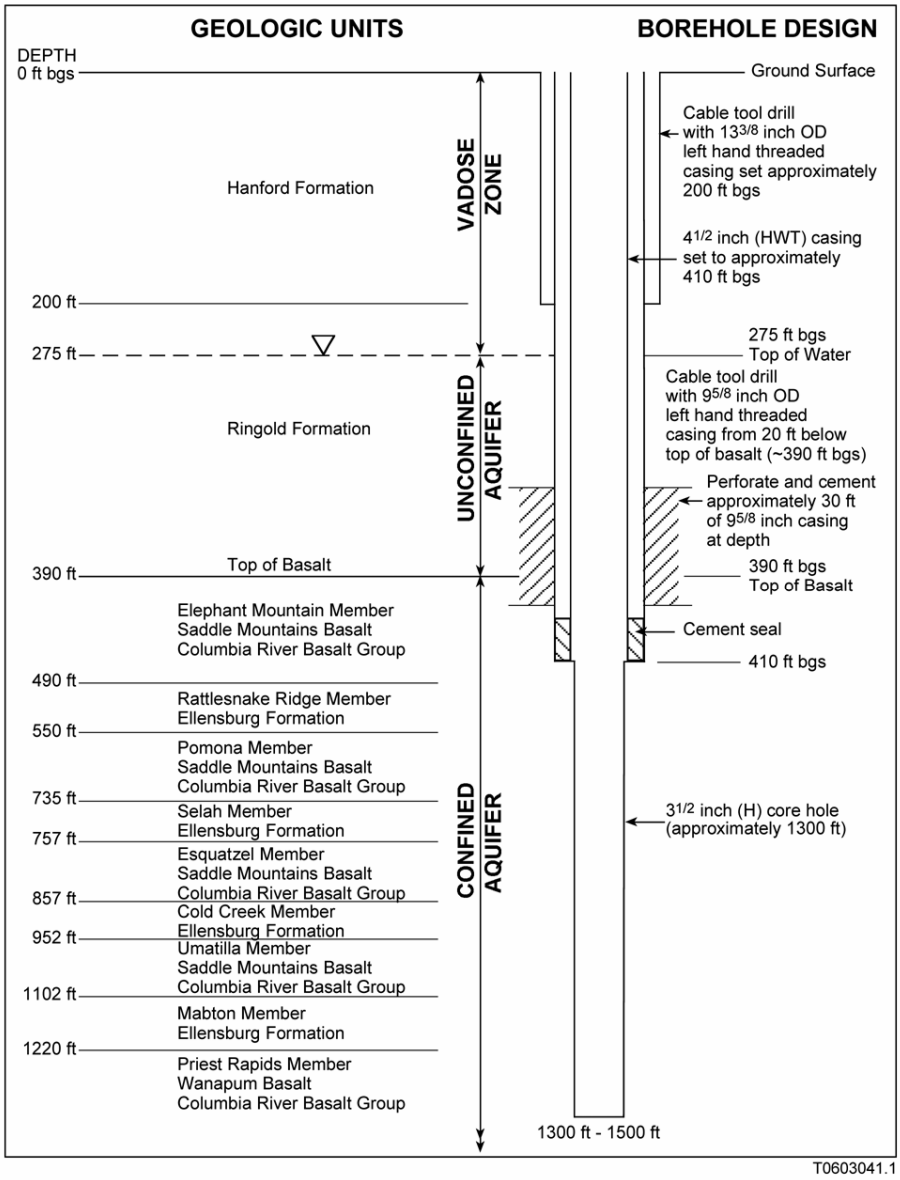

Figure 2. Proposed Design for Mud-Rotary WTP Boreholes (from Gardner et al. 2006)

2.4 Drilling Methods and Coring Procedures

2.4.1 Drilling Methods

Three types of drilling methods (suprabasalt/overburden cable tool, mud rotary, and wireline corehole), each with associated sampling, will be used. These are discussed in Gardner et al. (2006).

2.4.2 Coring Procedures

Basalt and Interbed Sediment Continuous Coring. Continuously drilled core will be taken through the basalt. This is a routine type of drilling that has been done in the past at Hanford as part of the Basalt Waste Isolation Project (BWIP). A drill rig designed for this type of coring will be used. Prior to beginning rock coring, the depth to the top of the rock surface shall be recorded. The coring shall be accomplished according to ASTM D2113-99 or equivalent standard. The exact procedure will be determined as part of the bid process. The core shall be freed from the core lifter and extruded from the barrel into a core trough in a manner that will prevent breakage and reversal of individual pieces. The trough shall be longer than the core barrel. All cores shall be arranged neatly in the partitioned boxes in the same sequence in which they occurred before removal from the hole. Facing the open box, cores shall be arranged in descending sequence beginning at the left end of the trough and continuing in the other troughs from left to right. The highest part of the core shall be placed in Box 1, and the lower portions of the core shall be placed in the other boxes in consecutive order. All drill cores will be labeled with respect to the drill site borehole and depth (beginning and ending). Core will be stored onsite for reference during drilling of the other boreholes. After it has been deemed no longer needed at the drill site, it will be transported to the Hanford Geotechnical Sample Library for permanent archival.

Suprabasalt (Overburden) Sediment Core. Core samples through the selected portions of the suprabasalt sediments also are required for dynamic testing. Recognizing that this is a difficult task but an important one, methods described in ASTM D1586-99, D1587-00, and D3550-01 or equivalent will be used that will allow collection of intact soil/sediment sample(s) (i.e., core) representative of the selected intervals. A cable tool drilling technique capable of collecting core will be used (Gardner et al. 2006).

Sediment samples obtained from the intact coring process during drilling will be sealed in liners of stainless steel or other equivalent material and follow guidance of ASTM D4220-95. Refrigeration is not required for these samples, but samples must be stored away from freezing conditions or extreme heat to protect the integrity of the core. The liners will be labeled with the borehole number and depth interval of the sample and clearly marked to indicate the sample top and bottom. After a field radiation survey, the samples will be transported to the Pacific Northwest National Laboratory (PNNL) Radiochemical Processing Laboratory (RPL). The RPL is capable of testing the samples for contamination and can release them if determined to be clean. If there are any contamination issues, the laboratory has the capability to flush samples with water to leach out tritium. This way, only certified samples that do not exceed release or testing laboratory receipt requirements would be sent offsite for dynamic testing.

2.5 Sample Types and Frequency

Three types of samples will be collected: suprabasalt (overburden) cuttings and drive samples, basalt and interbed core, and mud-rotary basalt and interbed cuttings. Core samples are addressed in Section 2.4.

The frequency of core samples through selected intervals of the suprabasalt (overburden) that will be taken for tests was determined by the USACE Review Panel and is listed in Table 3. Tests include, but are not limited to, geologic logging, physical property tests, and dynamic testing.

Table 3. Selected Intervals for Suprabasalt (Overburden) Coring

Depth (in feet)	Borehole		Physical Properties	Dynamic Testing
	C4997	C4993		
20	X	A		
30	X	A	P	RC/TS
40	X	A	P	RC/TS
50	X	A	P	RC/TS
60	X	A		
70	X	A	P	RC/TS
80	X	A		
90	X	A	P	RC/TS
100	X	A	P	RC/TS
110	X	A	P	RC/TS
120	X	A		RC/TS
130	X	A	P	RC/TS
140	X	A		
150	X	A	P	RC/TS
160	X	A		
170	X	A	P	RC/TS
180	X	A	P	RC/TS
190	X	A		
200	X	A	P	LD RC/TS
210	X	A	P	RC/TS
220	X	A		
230	X	A	P	LD RC/TS
240	X	A		
250	X		P	RC/TS
260	X		P	LD RC/TS
270	X		P	RC/TS
280	X		P	LD RC/TS
290	X		P	RC/TS
300	X		P	LD RC/TS
310	X		P	
335	X		P	LD RC/TS
350	X		P	
365	X		P	LD RC/TS
380	X		P	

A = Target interval for drive sample for borehole C4993 (optional should C4997 sampling be incomplete) and to obtain additional samples for 50 free-free resonant column testing (Procedure URC-1, Rev. 1) as requested by USACE Review Group.

LD RC/TS = Core sample interval in C4997 for large-diameter resonant column.

P = Sample interval for particle size analysis tests (ASTM D6913-04e1 and/or D5519-94).

RC/TS = Core sample interval in C4997 for resonant column/torsional shear testing (Procedure PBRCTS-1, Rev. 4). Boreholes C4993 and C4996 will be backup coreholes for these sample depths.

X = Target interval for drive sample for borehole C4997, the primary sampling borehole. The 50 samples for free-free resonant column testing (Procedure URC-1, Rev. 1) will be selected from these.