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ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 605114

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Env. Restoration	4. Related EDT No.:
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8. Originator Remarks: Approval/Release		9. Equip./Component No.: N/A
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15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-EN-AP-117		0	In-Well Vapor Stripping Drilling and Characterization Work Plan	Q S	1/2		

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 4. Review 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)	1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
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(G) Reason	(H) Disp.	(J) Name	(K) Signature (L) Date (M) MSIN	(J) Name	(K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng. K. J. Koegler	H6-05				
1	1	Cog. Mgr. M. C. Hagood	for H6-04	Steve Gorelick Stanford University		3	
1	1	QA ~~R. L. Hand~~ W.R. Thackaberry	W.R. Thackaberry H4-16 5-10-94	Dept. of Geological & Environmental Sciences; Stanford, CA 94305-2225			
1	1	Safety N. R. Kerr	~~H4-67~~ H4-67 5/3/94	S. J. Trent	H6-06	3	
1	1	Env. T. J. Gilmore	K6-84	D. L. Parker	H6-03	3	
3		L. O. Ames		EPIC ~~(2)~~ (1)	H6-08	3	
3		Central Files (2)	L8-04	IRA (2)	H4-17	3	

18. K. J. Koegler Signature of EDT Originator Apr 94 Date	19. Authorized Representative for Receiving Organization Date	20. for M. C. Hagood Cognizant/Project Engineer's Manager 14 Apr 94 Date	21. DOE APPROVAL (if required) Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

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Title: In-Well Vapor Stripping System Drilling and Characterization Work Plan

Unclassified Category UC-

Impact Level QS

New or novel (patentable) subject matter? [X] No [] Yes
If "Yes", has disclosure been submitted by WHC or other company?
[] No [] Yes Disclosure No(s).

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WHC Program/Project	~~[X]~~	[X]	G. T. Berlin	review not req'd	5/13/94
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Author/Requestor (Printed/Signature) Date
K. J. Koegler 28 Mar 94

Intended Audience
[] Internal [] Sponsor [X] External

Responsible Manager (Printed/Signature) Date
M. C. Hagood 20 Mar 94

INFORMATION RELEASE ADMINISTRATION APPROVAL STAMP

Stamp is required before release. Release is contingent upon resolution of mandatory comments.

APPROVED FOR
5/13/94

Date Cancelled

Date Disapproved

SUPPORTING DOCUMENT

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In-Well Vapor Stripping System Drilling and Characterization Work Plan

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WHC-SD-EN-AP-117

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PUBLIC RELEASE

6. Author
Name: K. J. Koegler
Kim Koegler
Signature

Organization/Charge Code
8B300/HBACA

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5/13/94 D. Jolis

Gilmore, T. J. (PNL) and K. J. Koegler (WHC), 1994, *In-Well Vapor Stripping System Drilling and Characterization Work Plan*, WHC-SD-EN-AP-117, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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9. Impact Level QS

10. RELEASE STAMP

OFFICIAL RELEASE
BY WHC
DATE MAY 13 1994
Sta. 21

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APPENDIX:

ATTACHMENTS:

1 AQUIFER TEST PROCEDURES:

FIGURES:

TABLES:

ACRONYMS

bls	below land surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DQO	data quality objective
ECN	engineering change notice
EII	Environmental Investigations Instructions
HWOP	hazardous waste operations plan
JSA	job safety analysis
NTU	nephalmetric turbidity unit
OVM	organic vapor monitor
QAPjP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
TCE	trichloroethylene
VOC	volatile organic compounds
WAC	Washington Administrative Code

1.0 SCOPE AND OBJECTIVES

This work plan provides the information necessary for drilling, sampling, and hydrologic testing of wells to be completed in support of a demonstration of the in-well vapor stripping system. The in-well vapor stripping system is a remediation technology designed to preferentially extract volatile organic compounds (VOCs) from contaminated groundwater by converting them to a vapor phase. Air-lift pumping is used to lift and aerate groundwater within the well. The volatiles escaping the aerated water are drawn off by a slight vacuum and treated at the surface while the water is allowed to infiltrate the vadose zone back to the watertable (Figure 1).

The field work described in this Drilling and Characterization Work Plan is being conducted as part of the Volatile Organic Compounds - Arid Integrated Demonstration (VOC-Arid ID). The VOC-Arid ID is one of several U.S. Department of Energy (DOE) integrated demonstrations designed to support the testing of emerging environmental management and restoration technologies. The purpose of the VOC-Arid ID is to identify, develop, and demonstrate technologies that may be used to characterize, remediate, and/or monitor arid or semiarid sites containing VOCs (e.g., carbon tetrachloride and trichloroethylene [TCE] with or without associated metal and radionuclide contamination.

The primary task covered by this work plan is the installation and characterization of three groundwater wells. One of these wells will be a large-diameter well in which the in-well vapor stripping system will be installed and demonstrated. The remaining two wells will be constructed for characterization of the test site and observation during the demonstration. Well drilling, design, materials, and construction specifications are delineated in this work plan.

The demonstration will be conducted as a field-scale pilot test within the 200-ZP-1 Groundwater Operable Unit located in the 200 West Area of the Hanford Site, Richland, Washington. Groundwater within the 200-ZP-1 Operable Unit is extensively contaminated with aqueous phase VOCs including significant concentrations of carbon tetrachloride as well as lesser amounts of chloroform and trichloroethylene.

Characterization activities will be performed concurrent with the drilling and well installation. The two characterization/observation wells will be used to characterize or detect the vertical distribution of soil chemical contaminants and aqueous phase contaminants. In addition, physical properties will be determined for geologic and hydrologic characterization purposes. Characterization efforts will focus on the area of the subsurface that will be impacted by this demonstration, namely, the lowermost portion of the unsaturated zone below the caliche layer and the uppermost portion of the unconfined aquifer.

1.1 TEST LOCATION DESCRIPTIONS

Two potential locations have been identified for the demonstration. The primary test site is located north of the 231-Z Building and south of well

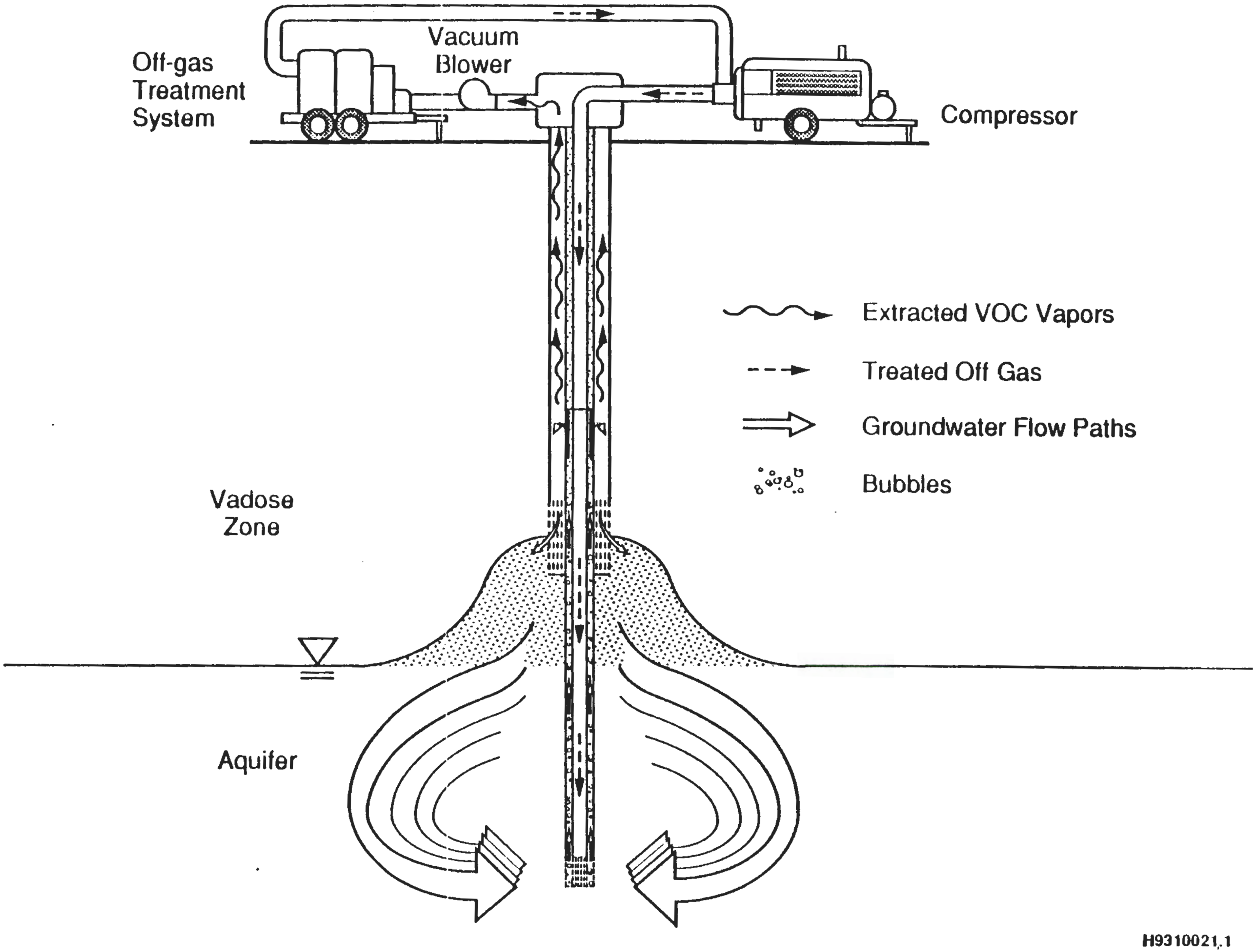


Figure 1. Stanford In-Well Vapor Stripping System.

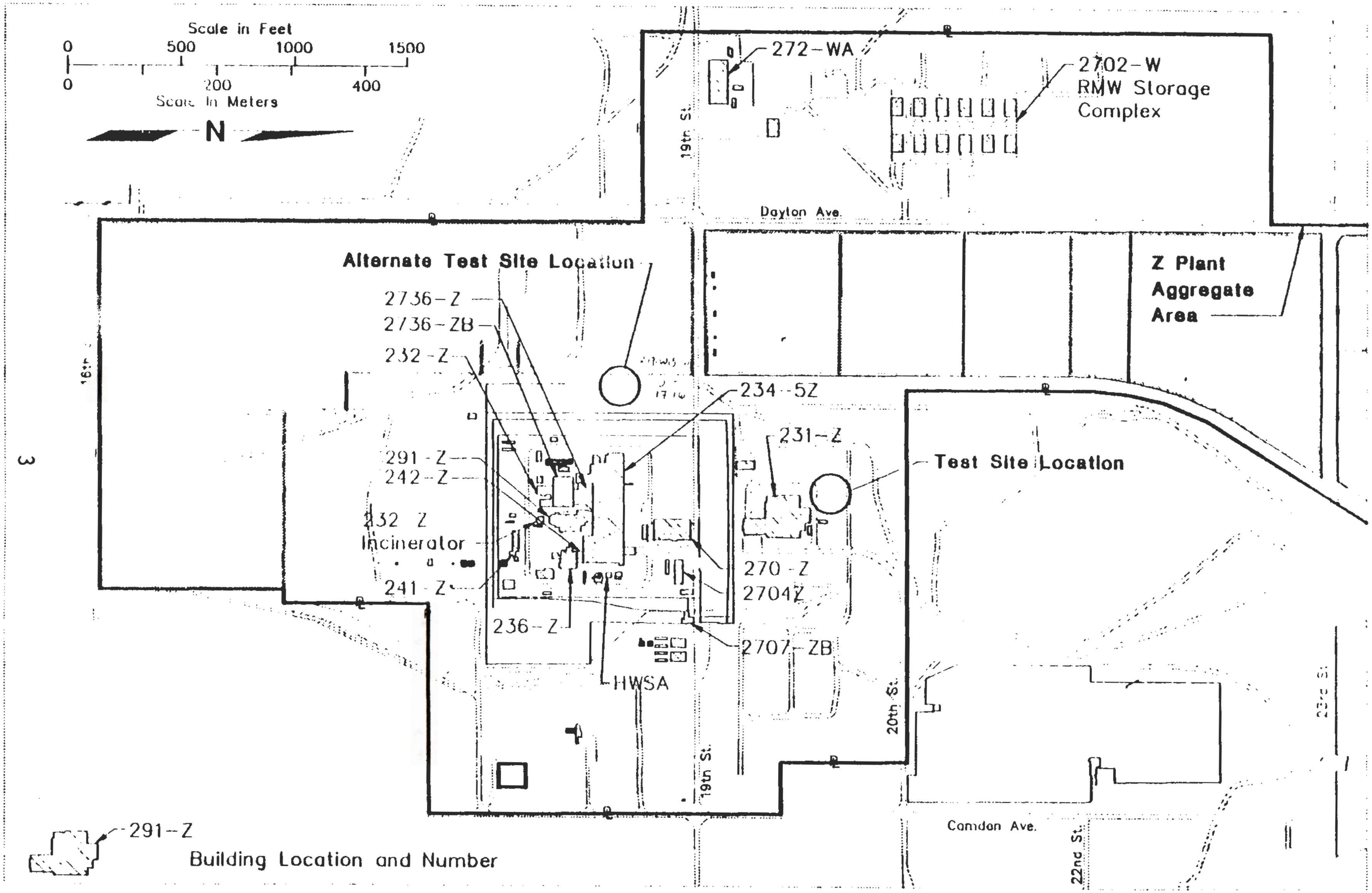


Figure 2. Location of Test Site.

299-W15-10. The alternate location is located west of Z Plant near wells 299-W15-16 and 299-W15-18. Both locations are located within the 200-ZP-1 Groundwater Operable Unit, as shown in Figure 2. Detailed background information regarding the history and current use of the 200-ZP-1 Groundwater Operable Unit is provided in Section 2.0 of the *Remedial Investigation/Feasibility Study Work Plan for the 200-ZP-1 Groundwater Operable Unit* (DOE-RL 1993a). The following discussion summarizes key characteristics of the proposed test locations.

1.1.1 Primary Test Location

The primary test site is approximately 30 m (100 ft) south of the 216-Z-16 Crib (Figure 2). This crib received approximately 102,000,000 L (27,000,000 gal) of neutral to basic liquid waste containing small quantities of plutonium from the 231-Z Building between March 1968 and January 1977. The total mass of plutonium believed to have been discharged to the 216-Z-16 Crib is 0.072 kg (0.16 lb).

Although plutonium-bearing solutions were discharged to the 216-Z-16 Crib, contaminants in the vadose zone are believed to be limited to vapor phase VOCs of unknown concentration, as gross gamma-ray logging conducted in monitoring wells in the vicinity of the 216-Z-16 Crib have not detected gamma-emitting daughter products of plutonium decay. If present, the VOC vapors are likely due to vapor phase transport of volatilized carbon tetrachloride and chloroform emanating from source terms to the south and southeast.

Groundwater concentrations of carbon tetrachloride in existing monitoring wells (299-W15-10 and 299-W15-11) near the proposed demonstration site have ranged from just below 6,000 μg/L in 1988 to approximately 1,000 μg/L in 1991. No data were available from 1991 to the present. Concentration of chloroform for the same period ranged from just below 50 μg/L to just below 20 μg/L chloroform.

Stratigraphic units beneath the test site include the Hanford formation (0 to 38 m [0 to 125 ft] below land surface [bls]), the early Palouse/Plio-Pleistocene interval (38 to 46 m [125 to 150 ft] bls), the Upper Ringold gravels (46 to 50 m [150 to 165 ft] bls), and the Ringold FSE unit (50 to 122 m [165 to 400 ft] bls). Depth to groundwater is estimated to be 64 to 65.5 m (210 to 215 ft) bls based on water levels measured in well 299-W15-10 in June 1993.

1.1.2 Alternate Test Location

The alternate test site is located west of Z Plant near wells 299-W15-18 and 299-W15-16 (Figure 2). The site is located approximately 250 m north of the 216-Z-12 Crib. This crib is reported to have received waste generated in the primary plutonium finishing plant lines. The liquid wastes were either process wastes and condensates or noncontact wastewater (DOE/RL-92-16, Rev. 0). The wastes can be characterized as having been acidic and corrosive (pH 2), high in salts, and low in organic content. The wastes contained only minor amounts of fission products and low concentrations of plutonium and other transuranic elements (DOE-RL 1993b). Discharge of these wastes was diverted from the 216-Z-12 Crib to the single-shell tanks in 1973.

Groundwater concentrations of carbon tetrachloride in existing monitoring well 299-W15-16 near the proposed alternate demonstration site were consistently just below 3,900 µg/L between 1988 and 1993. Tritium concentrations ranged from 1,000 to 12,000 pCi/L between 1989 and 1993.

Stratigraphic units beneath the site are generally similar to the primary demonstration site. There are, however, local variations on the general stratigraphy.

2.0 GENERAL REQUIREMENTS

2.1 REQUIRED DOCUMENTS AND PROCEDURES

The guidance documents and procedures for conducting this work are referenced in Appendix A, the Quality Assurance Project Plan.

2.2 HEALTH AND SAFETY

All field personnel will perform all work in accordance with the following health and safety documents and procedures:

- WHC-CM-1-6, *Radiological Control Manual* (WHC 1993)
- WHC-IP-0692, *Health Physics Procedures Manual* (WHC 1991)
- WHC-CM-4-11, *ALARA Program* (WHC 1988b)
- WHC-CM-4-3, *Industrial Safety Manual* (WHC 1987)
- WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1988c)
- Site-specific Hazardous Waste Operations Plan or Job Safety Analysis.
- Site-specific health and safety documents.

3.0 DATA QUALITY OBJECTIVES/DATA NEEDS

The number of samples proposed to be collected and the methods used to collect and analyze the sample data in this work plan were directed by the Data Quality Objectives (DQO) Process.

The DQO Process is a series of planning steps based on the Scientific Method that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application.

4.0 WELL DRILLING AND INSTALLATION

4.1 WELL DRILLING AND CONSTRUCTION SPECIFICATIONS

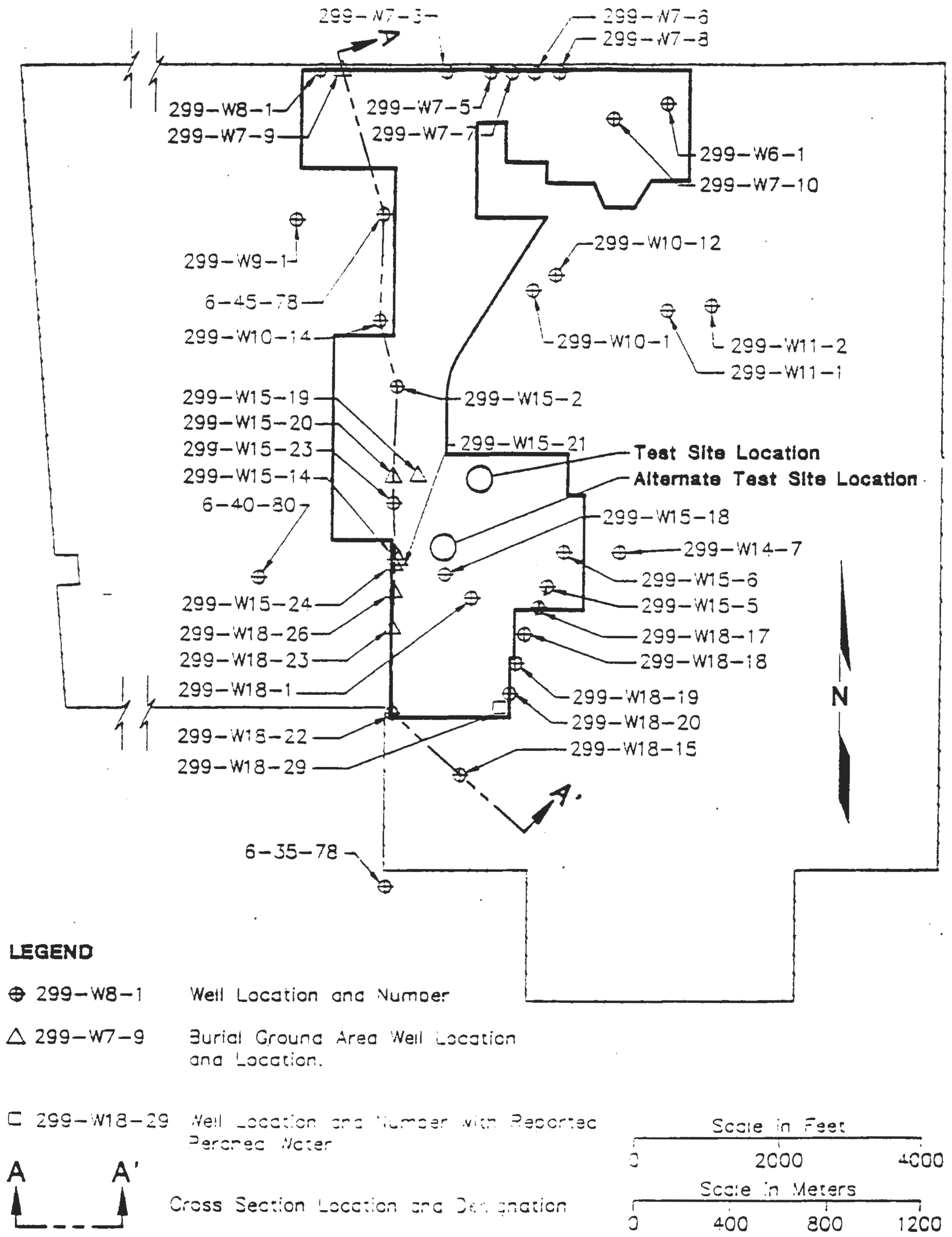
A total of three groundwater wells will be installed to support the in-well vapor system demonstration. These wells will be abandoned at the conclusion of the in-well vapor stripping demonstration. The wells will be grouped into a cluster consisting of one demonstration well (refered to as D in the tables and figures) and two characterization wells (refered to as C1 and C2 in the figures and tables). The characterization wells will be installed hydraulically downgradient and cross gradient to the demonstration test well. The cross-gradient and downgradient characterization wells will be installed at distances of approximately 25 and 50 ft from the demonstration well, respectively. The actual location of the wells will be determined by the project scientist by computer modeling of the site using the physical characteristics data from the first characterization well. A geologic cross section in the vicinity of the demonstration site is presented in Figures 3 through 5.

The demonstration and characterization wells will vary in construction details from the standard monitoring well configuration in the generic well specification (WHC 1992), but will be drilled and constructed in accordance with the rules, regulations, and standards promulgated in Washington Administrative Code (WAC) 173-160, *Minimum Standards for Construction and Maintenance of Wells*, and WAC 173-162, *Rules and Regulations Governing the Regulations and Licensing of Well Contractors and Operators*. Design and construction specifications unique to demonstration and characterization wells are provided in Section 4.1.1. It is anticipated that the two characterization wells will be drilled first, followed by the demonstration test well.

4.1.1 Design Specifications for Demonstration Well

This section delineates well design criteria and specifications required for successful drilling and installation of the demonstration well. The well will be constructed similar to specification in WHC-S-014 (WHC 1992); however, divergence in specifications occurs in those sections of WHC-S-014 detailing well construction dimensions, permanent casing and well screen selection criteria, and hydraulic testing and sampling requirements. Special instructions regarding these specifications will be included in the drilling data sheets submitted to the drilling contractor via a letter of instruction. Other design or structural changes to the well that do not require an Engineering Change Notice (ECN) to the generic well specification will be documented with a letter to file prepared by the cognizant engineer.

Figure 3. Location of Geologic Cross Sections.



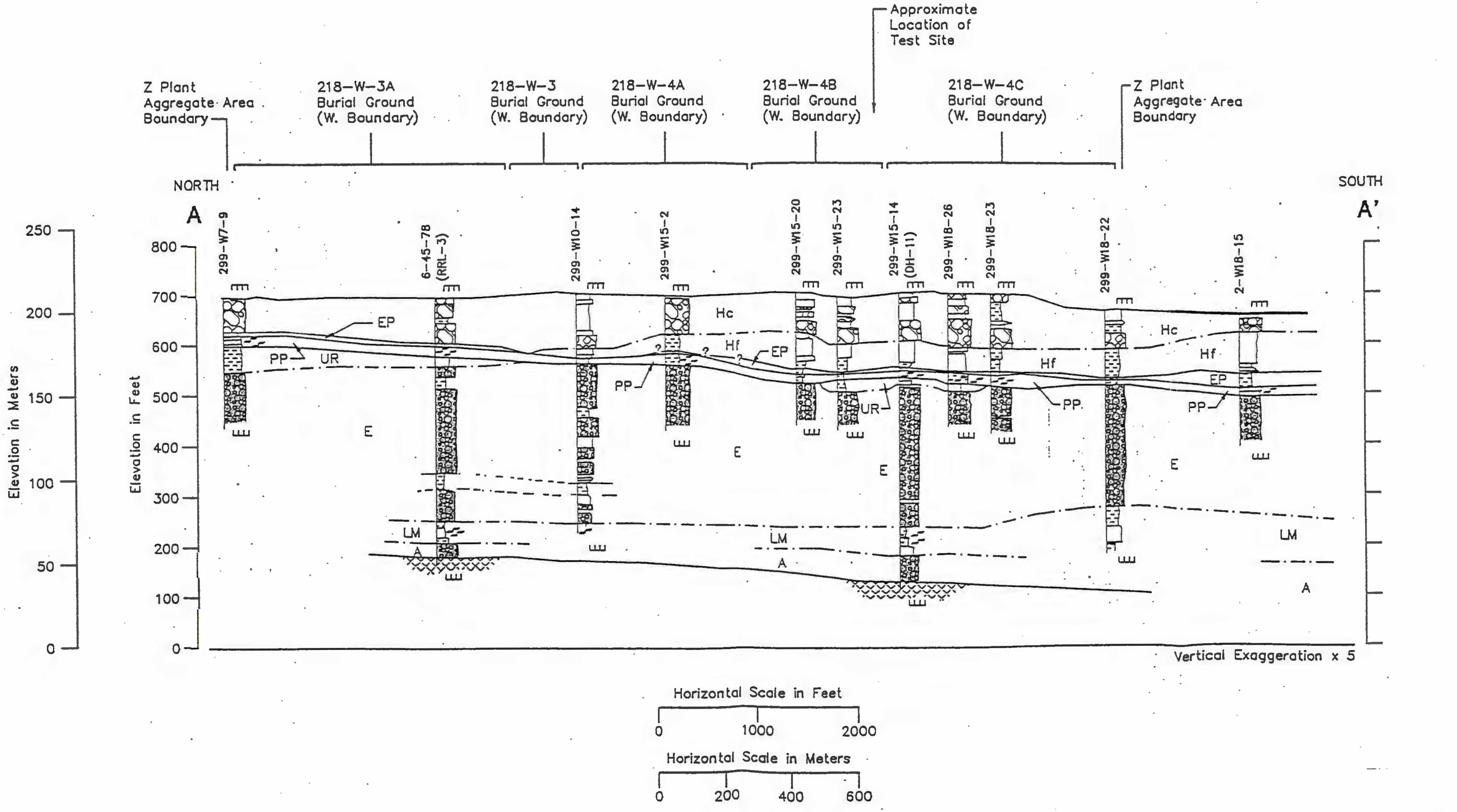
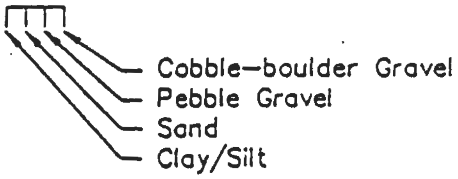


Figure 4. Geologic Cross Section A-A'.

Figure 5. Legend for Cross Sections.

GRAIN SIZE SCALE



UNIT ABREVIATIONS

Hc	Upper Coarse Unit, Hanford formation
Hf	Lower Fine Unit, Hanford formation
EP	Early "Palouse" Soil
PP	Plio—Pleistocene Unit
UR	Upper Unit, Ringold Formation
E	Gravel Unit E, Ringold Formation
LM	Lower Mud Sequence, Ringold Formation
A	Gravel Unit A, Ringold Formation

SYMBOLS

—?———	Formational Contact, ? Where Inferred
—·—?—·—	Unit Contact, ? Where Inferred
— — — — — —	Major Facies Contact
≈	Pedogenic Calcium Carbonate
▨	Paleosols
▩	Ringold Clast Supported Gravels
▦	Open Framework Hanford Gravels
▤	Laminated Muds
⩔	Basalt

Blank portions of cross section well logs represent sediments (dominantly sand) which do not fit into sediment categories depicted by symbols listed above.

The demonstration well will be drilled a nominal 14" diameter and constructed as a single-screened well with a 10 in. completion. Target depth for the demonstration well borehole is estimated at 245 ft bls. Depth of these boreholes will be based on the water table depth and vertical extent of the VOC contaminant plume as determined from background information on the site. Drilling will be performed with cable tool, air rotary, or sonic techniques to expedite the installation of the demonstration well. Permanent casing materials for the demonstration well will be stainless steel. All permanent casing joints will be configured with industry standard threads, which will permit leak-tight sealing of joints without the use of O-rings. Stainless steel screen and blanking sections configured with threads will be flash-plated with chrome to permit easy coupling and decoupling of the joints. Figure 6 illustrates the basic design and specifications.

4.1.1.1 Screened Interval. Screened intervals will be determined in the field based on VOC concentration profiles and the geology encountered. The screened interval in the water table will be located in the zone of highest VOC contamination. The infiltratiion screen that allows the treated water to infiltrate through the vadose zone will be located approximately 20 ft above the static water table in the zone of highest hydraulic conductivity. Screen placement will be determined by the project scientist. Approximate screened intervals are given in Figure 6.

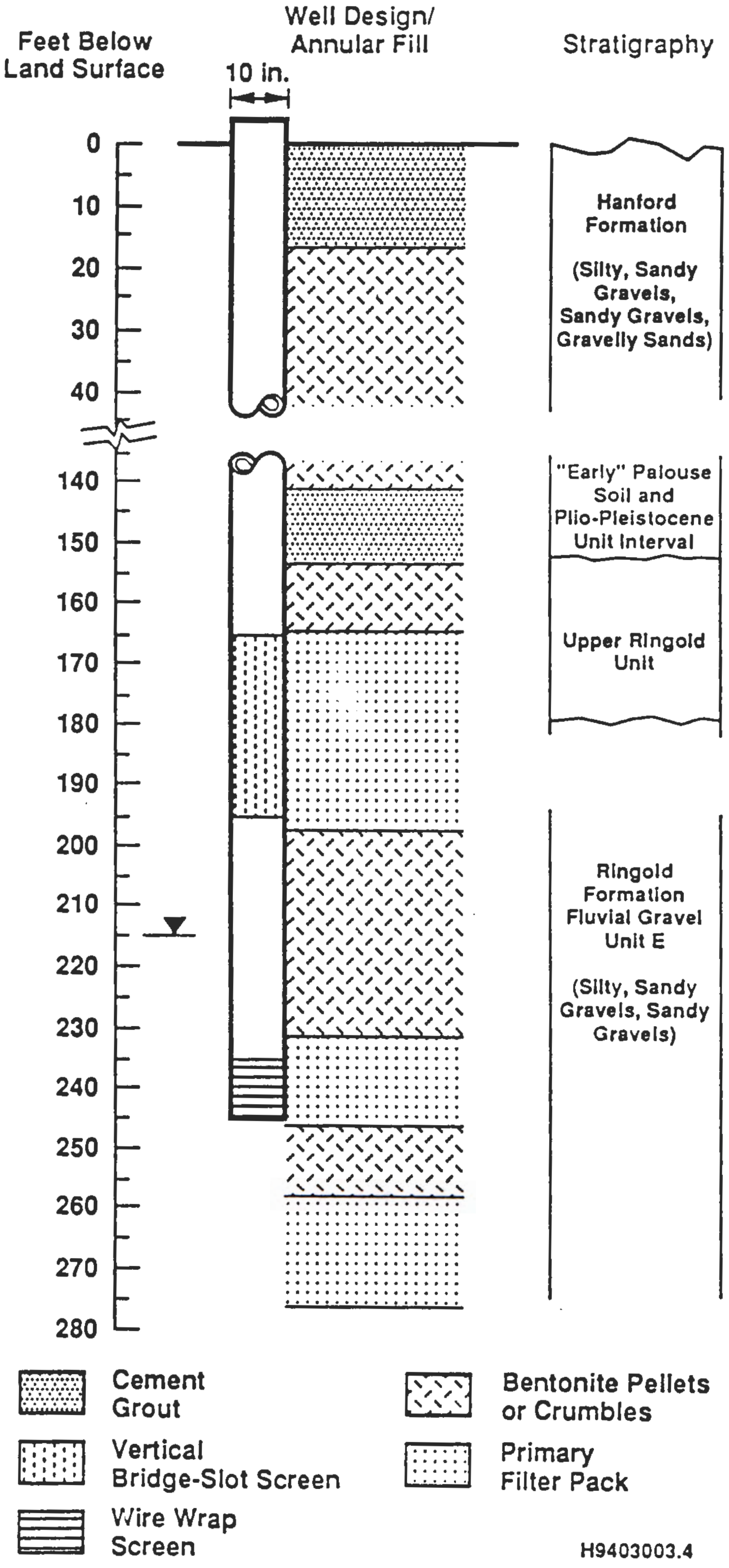
4.1.1.2 Annular Seal Materials. Annular seal construction and materials will generally conform to those specifications delineated in WHC-S-014, Rev. 7. Figure 6 identifies the type and approximate placement of annular fill materials to be used in construction of the wells. Sand and gravel packs installed in the screened intervals will be as per WHC-S-014 (WHC 1992). A surface seal of cement grout will be installed on all wells.

4.1.1.3 Well Development. The screened interval in the aquifer will be developed to remove the effects of drilling. Initially, the wells will be bailed to remove the majority of the accumulated sand and debris. The wells will then be surged over each screened interval. Surging will be followed by additional bailing if necessary to clear accumulated sediment from the bottom of the test well. Following surging, each screened interval will be hydraulically isolated and developed by submersible pumping techniques. Development of each screened interval will attempt to achieve a turbidity of 5 nephalmetric turbidity units or less within a reasonable time frame and extracted groundwater volume.

4.1.2 Design Specifications for Groundwater Characterization Wells

This section delineates well design criteria and specification required for successful drilling and installation of two groundwater characterization wells. General construction specifications and criteria for groundwater well drilling and installation on the Hanford Site are provided in WHC-S-014 (WHC 1992). Special instructions regarding these specifications will be submitted to the drilling contractor via a letter of instruction. Other design or structural changes to the well that do not require an ECN to the generic well specification will be documented with a letter to file prepared by the cognizant engineer. It is intended that the downgradient characterization well will be drilled using cable tool, air rotary, or sonic methods to ensure that subsurface sampling objectives are achieved.

Figure 6. Demonstration Well Construction.



4.1.2.1 Depth of boreholes. The downgradient groundwater characterization well will be drilled to a target depth of 270 ft bls or approximately 55 ft below the static water table. The lateral groundwater characterization well will be drilled to a target depth of 255 ft bls or approximately 40 ft below the water table. Actual total depth for both boreholes is dependent on the depth to groundwater and vertical distribution of contaminants as determined from subsurface sampling and analysis conducted during drilling of the downgradient groundwater characterization well. The project scientist will determine when total depth has been achieved based on the vertical distribution of VOC contaminants.

4.1.2.2 Screened Intervals. The groundwater characterization wells are expected to be completed at up to three separate intervals. The project scientist will determine the actual placements of the screens based on the distribution of VOC contaminants and the geology. The multiple screened intervals are a modification of the structured one screen completion of WHC-S-014.

4.1.2.3 Annular Seal Materials. Annular seal construction and materials will generally conform to those specifications delineated in WHC-S-014 (WHC 1992). Figure 7 identifies the type and approximate placement of annular fill materials to be used in construction of the characterization wells. Sand packs installed in screened intervals will be installed per WHC-S-014 (WHC 1992). A surface seal of cement grout will be installed on all wells.

5.0 ENVIRONMENTAL SAMPLING

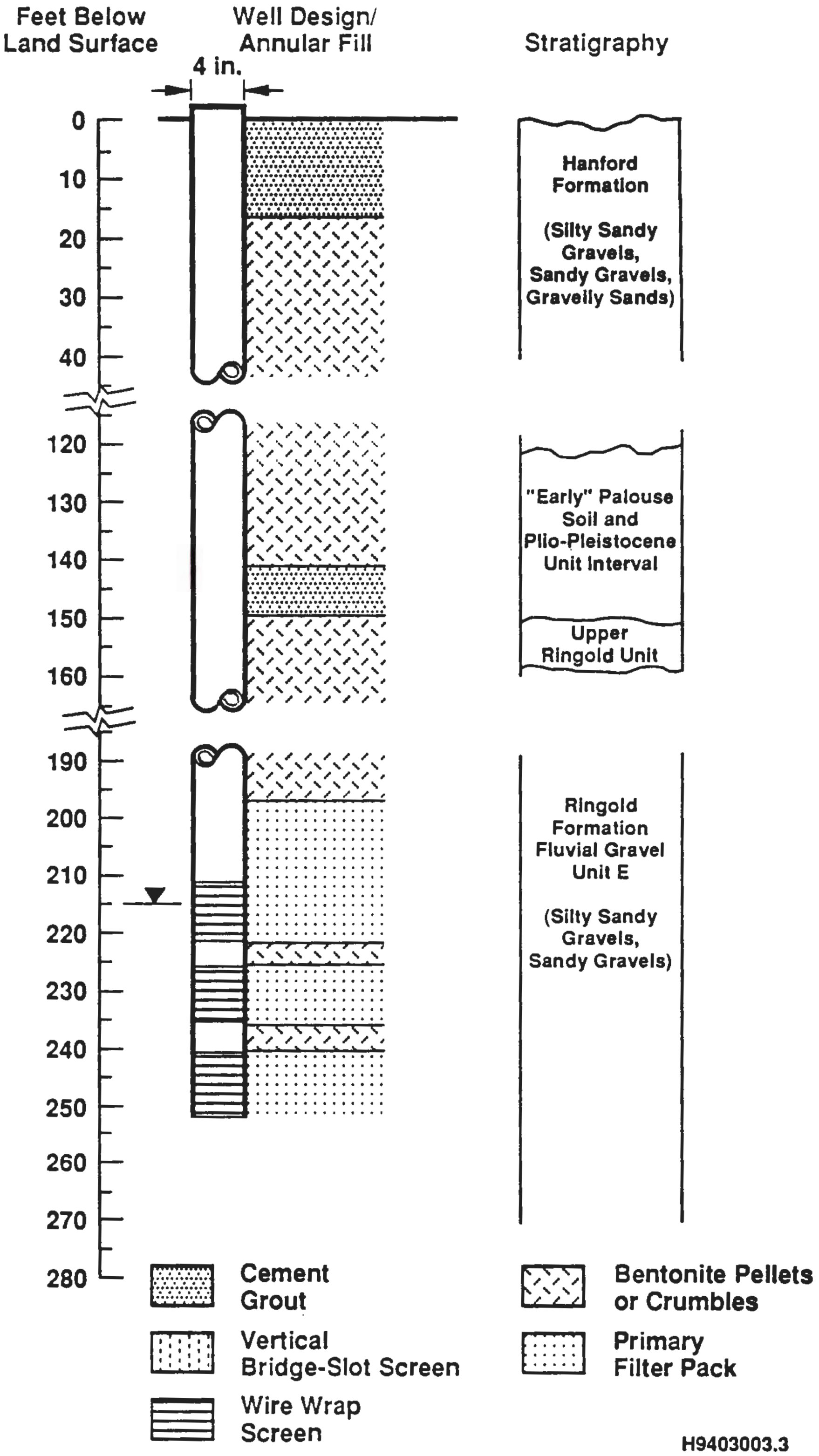
5.1 FIELD SCREENING

All samples and cuttings will be field screened for evidence of VOCs and radionuclides. Samples and cuttings will be screened for VOCs by the field geologist using an organic vapor monitor (OVM) that will be used, maintained, and calibrated consistent with EII 3.2, "Calibration and Control of Monitoring Instruments," and EII 3.4, "Field Screening, Appendix B." Radionuclide screening will be performed by the field geologist per EII 3.4, "Field Screening, Appendix A." The field geologist will record screening results in the borehole log in accordance with EII 9.1, "Geologic Logging" (WHC 1988a).

Representative samples will be sent to the 222-S Building for radiological screening prior to delivery of the analytical samples to the Sigma V Building. All samples should be cleared prior to transporting the samples from the site.

The action levels for VOC and radionuclide screening will be designated in the Site Safety Plan. Prior to initiating drilling, a one-time instrument background reading will be recorded using the OVM and radionuclide detection instrument at the drill site. Instrument background will be measured on freshly disturbed surface soil, holding the instruments <1 in. from the surface. The field geologist will record background levels in the borehole log in accordance with EII 9.1 prior to the start of drilling. Because of the vicinity of the Z Plant/Plutonium Finishing Plant/Plutonium Isolation Facility

Figure 7. Characterization Wells Construction.



complex and the presence of plutonium in the cribs adjacent to the site, the soil will be screened for alpha radiation until below the early Palouse/Plio-Pleistocene layer (approximately 125 ft bls).

5.2 SUBSURFACE SAMPLING

This section describes sampling necessary to support site evaluation activities. The focus of the subsurface sampling will be from base of the caliche layer to the total depth of the wells. The two characterization wells will have identical sampling as described below. The larger diameter demonstration test well will only have the lithologic samples collected.

Sample types and collection depths are graphically represented in Figure 8 and in the sample matrices in Tables 1, 2, and 3.

5.2.1 Sediment Samples for Chemical and Physical Analyses

A maximum of eight split spoon samples will be collected from the vadose zone, capillary fringe, and saturated zone to support site chemical and physical characterization needs. Samples will be collected in accordance with EII 5.2, "Soil and Sediment Sampling." Sample collection depths and analyses required are presented in Figure 8.

5.2.1.1 Lithologic Samples. Lithologic samples will be taken at 5-ft intervals and at major lithologic changes in all wells for the preparation of borehole logs (EII 9.1, "Geologic Logging"). The field geologist shall archive nonradioactive geologic samples in accordance with EII 5.7A, "Hanford Geotechnical Sample Library Control." All wastes generated as a result of the vadose and saturated zone investigation activities will be handled according to EII 4.3, "Control of CERCLA and other Past Practice Investigation Derived Waste."

5.2.1.2 Sediment Samples for Chemical Analysis. Sediment samples for chemical analysis will be collected every 10 ft and/or at lithologic changes beginning just below the caliche layer (~160 ft bls) and continuing until the final depth of the borehole. Samples will be collected for metals, volatiles, and semi-volatiles and sent to an analytical laboratory for analysis. Samples sent to the analytical laboratory will be delivered to Sigma V Building in the 3000 Area for distribution to the analytical laboratories. A field screening sample will also be collected for volatile organic analysis (VOA) on a short turnaround basis. A portable PID gas chromatograph (GC) will used for these screening analysis. This portable GC will be set up in either the 200 West Area or the 200 East Area. The field screening samples should be delivered to the mobile laboratory for analysis.

5.2.1.3 Sediment Samples for Radiological Analysis. Sediment samples for radiological analysis will be collected every 10 ft and/or at lithologic changes beginning just below the caliche layer (~160 ft bls) and continuing until the final depth of the borehole. Samples will be collected for gross alpha, gross beta, and gross gamma and sent to an analytical laboratory for analysis. Samples sent to the analytical laboratory will be delivered to

Table 1. Sample Matrix for Characterization Well 1. (Sheet 1 of 2)

Well	Sample Media	Sample Type	Depth (ft)	Lithology	VOA	Field VOA	Metals	SVOA	Gross Alpha	Gross Beta	Gross Gamma
C1	Soil	Split Spoon (Core)	160	x	x	x	x	x	x	x	x
C1	Soil	Grab	165	x							
C1	Soil	Split Spoon (Core)	170	x	x	x	x	x	x	x	x
C1	Soil	Grab	175	x							
C1	Soil	Split Spoon (Core)	180	x	x	x	x	x	x	x	x
C1	Soil	Grab	185	x							
C1	Soil	Split Spoon (Core)	190	x	x	x	x	x	x	x	x
C1	Soil	Grab	195	x							
C1	Soil	Split Spoon (Core)	200	x	x	x	x	x	x	x	x
C1	Soil	Grab	205	x							
C1	Soil	Split Spoon (Core)	210	x	x	x	x	x	x	x	x
C1	Soil	Grab	215	x							
C1	Soil	Grab	220	x	x	x	x	x	x	x	x
C1	Soil	Grab	225	x							
C1	Soil	Grab	230	x	x	x	x	x	x	x	x
C1	Soil	Grab	235	x							
C1	Soil	Grab	240	x	x	x	x	x	x	x	x
C1	Soil	Grab	245	x							
C1	Soil	Grab	250	x	x	x	x	x	x	x	x
C1	Soil	Grab	255	x							
C1	Soil	Grab	260	x	x	x	x	x	x	x	x
C1	Soil	Grab	265	x							
C1	Soil	Grab	270	x	x	x	x	x	x	x	x
C1	Water	Bailer/Pump	210		x	x	x	x	x	x	x
C1	Water	Bailer/Pump	220		x	x	x	x	x	x	x
C1	Water	Bailer/Pump	230		x	x	x	x	x	x	x
C1	Water	Bailer/Pump	240		x	x	x	x	x	x	x
C1	Water	Borehole Sampler	250		x	x	x	x	x	x	x
C1	Water	Borehole Sampler	260		x	x	x	x	x	x	x
C1	Water	Borehole Sampler	270		x	x	x	x	x	x	x
Note C1=Characterization Well 1											

Table 1. Sample Matrix for Characterization Well 1. (Sheet 2 of 2)

Well	Sample Media	Sample Type	Depth (ft)	Bulk Density	CaCO3	Micro-biologic	Conduct-ivity (UAF)	Alk-alinity	Anions	TOC	Coments
C1	Soil	Split Spoon (Core)	160	x	x		x			x	At base of Caliche
C1	Soil	Grab	165								
C1	Soil	Split Spoon (Core)	170	x	x		x				
C1	Soil	Grab	175								
C1	Soil	Split Spoon (Core)	180	x	x		x				
C1	Soil	Grab	185								
C1	Soil	Split Spoon (Core)	190	x	x		x				
C1	Soil	Grab	195								
C1	Soil	Split Spoon (Core)	200	x	x	x	x				
C1	Soil	Grab	205								
C1	Soil	Split Spoon (Core)	210	x	x		x				Top of Water ~213'
C1	Soil	Grab	215								
C1	Soil	Grab	220	x		x					
C1	Soil	Grab	225								
C1	Soil	Grab	230	x							
C1	Soil	Grab	235								
C1	Soil	Grab	240	x							
C1	Soil	Grab	245								
C1	Soil	Grab	250	x							
C1	Soil	Grab	255								
C1	Soil	Grab	260	x							
C1	Soil	Grab	265								
C1	Soil	Grab	270	x							
C1	Water	Bailer/Pump	210								Top of Water ~213'
C1	Water	Bailer/Pump	220								Slug Test Zone
C1	Water	Bailer/Pump	230								Slug Test Zone
C1	Water	Bailer/Pump	240					x	x	x	Slug Test Zone
C1	Water	Borehole Sampler	250								Borehole Sampler
C1	Water	Borehole Sampler	260								Borehole Sampler
C1	Water	Borehole Sampler	270								Borehole Sampler
Note C1=Characterization Well 1											

Table 2. Sample Matrix for Characterization Well 2. (Sheet 1 of 2)

Well	Sample Media	Sample Type	Depth (ft)	Lithology	VOA	Field VOA	Metals	SVOA	Gross Alpha	Gross Beta	Gross Gamma
C2	Soil	Split Spoon (Core)	160	x	x	x	x	x	x	x	x
C2	Soil	Grab	165	x							
C2	Soil	Split Spoon (Core)	170	x	x	x	x	x	x	x	x
C2	Soil	Grab	175	x							
C2	Soil	Split Spoon (Core)	180	x	x	x	x	x	x	x	x
C2	Soil	Grab	185	x							
C2	Soil	Split Spoon (Core)	190	x	x	x	x	x	x	x	x
C2	Soil	Grab	195	x							
C2	Soil	Split Spoon (Core)	200	x	x	x	x	x	x	x	x
C2	Soil	Grab	205	x							
C2	Soil	Split Spoon (Core)	210	x	x	x	x	x	x	x	x
C2	Soil	Grab	215	x							
C2	Soil	Grab	220	x	x	x	x	x	x	x	x
C2	Soil	Grab	225	x							
C2	Soil	Grab	230	x	x	x	x	x	x	x	x
C2	Soil	Grab	235	x							
C2	Soil	Grab	240	x	x	x	x	x	x	x	x
C2	Water	Bailer/Pump	210		x	x	x	x	x	x	x
C2	Water	Bailer/Pump	220		x	x	x	x	x	x	x
C2	Water	Bailer/Pump	230		x	x	x	x	x	x	x
C2	Water	Bailer/Pump	240		x	x	x	x	x	x	x
Note: C2=Charaterization well 2											

Table 2. Sample Matrix for Characterization Well 2. (Sheet 2 of 2)

Well	Sample Media	Sample Type	Depth (ft)	Bulk Density	CaCO3	Micro-biologic	Conduct-ivity (UAF)	Alk-alinity	Anions	TOC	Coments
C2	Soil	Split Spoon (Core)	160	x	x		x			x	At base of Caliche
C2	Soil	Grab	165								
C2	Soil	Split Spoon (Core)	170	x	x		x				
C2	Soil	Grab	175								
C2	Soil	Split Spoon (Core)	180	x	x		x				
C2	Soil	Grab	185								
C2	Soil	Split Spoon (Core)	190	x	x		x				
C2	Soil	Grab	195								
C2	Soil	Split Spoon (Core)	200	x	x	x	x				
C2	Soil	Grab	205								
C2	Soil	Split Spoon (Core)	210	x	x		x				Top of Water ~213'
C2	Soil	Grab	215								
C2	Soil	Grab	220	x		x					
C2	Soil	Grab	225								
C2	Soil	Grab	230	x							
C2	Soil	Grab	235								
C2	Soil	Grab	240	x							
C2	Water	Bailer/Pump	210								Top of Water ~213'
C2	Water	Bailer/Pump	220								Slug Test Zone
C2	Water	Bailer/Pump	230								Slug Test Zone
C2	Water	Bailer/Pump	240					x	x	x	Slug Test Zone
Note: C2=Charalerization well 2											

Table 3. Sample Matrix for Demonstration Well.

Well	Sample Media	Sample Type	Depth (ft)	Lithology
D	Soil	Grab	160	x
D	Soil	Grab	165	x
D	Soil	Grab	170	x
D	Soil	Grab	175	x
D	Soil	Grab	180	x
D	Soil	Grab	185	x
D	Soil	Grab	190	x
D	Soil	Grab	195	x
D	Soil	Grab	200	x
D	Soil	Grab	205	x
D	Soil	Grab	210	x
D	Soil	Grab	215	x
D	Soil	Grab	220	x
D	Soil	Grab	225	x
D	Soil	Grab	230	x
D	Soil	Grab	235	x
D	Soil	Grab	240	x
Note: D=Demonstration well				

Sigma V Building in the 3000 Area for distribution to the analytical laboratories.

5.2.1.4 Sediment Samples for Microbial Analysis. Two microbiologic samples will be collected at approximately 200 ft bls and 220 ft bls. The first sample will be just above the water table and the second from just below static water level. Samples should be delivered to Sigma V Building in the 3000 Area for distribution to the analytical laboratories. Special caution should be used in collecting these samples to ensure aseptic conditions. The project scientist should be contacted before the samples are collected so arrangements can be made for trained personnel to collect the samples.

5.2.1.5 Sediment Samples for Unsaturated Flow Analysis. Sediment samples for unsaturated flow analysis will be collected every 10 ft or from each split-spoon (core) sample collected from the base of the caliche to the static water level. Samples should be delivered to the Sigma V Building in the 3000 Area. These samples will then be delivered to the Washington State University laboratory for analysis. The UAF samples should be collected only from minimally disturbed samples from the split spoon sampler (core).

5.2.1.6 Sediment Samples for Moisture Analysis. Sediment samples for moisture analysis will be collected every 10 ft and/or at lithologic changes from the base of the caliche to the static water level. These samples can be collected along with the grain-size samples. Samples should be delivered to Sigma V Building in the 3000 Area. Contact the Pacific Northwest Laboratory (PNL) soils laboratory at the Sigma V Building upon their arrival.

5.2.1.7 Sediment Samples for Grain-Size Analysis. Sediment samples for grain-size analysis will be collected every 10 ft and/or at lithologic changes from the base of the caliche to the final depth of the well. Samples should be delivered to Sigma V Building in the 3000 Area. Contact the PNL soils laboratory at the Sigma V Building upon their arrival.

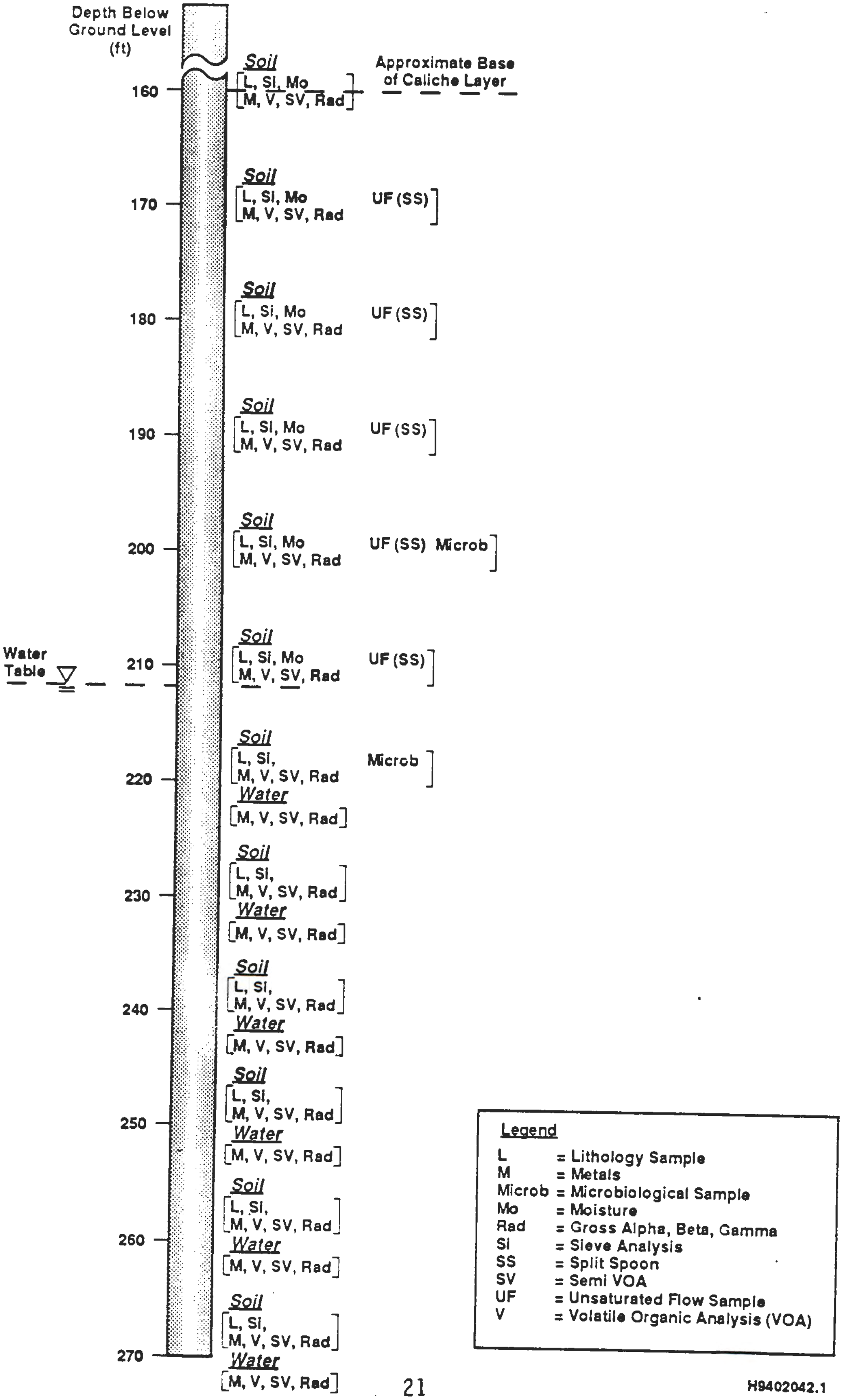
5.2.2 Groundwater Samples

Up to seven groundwater samples will be collected from the saturated zone during the drilling of the characterization wells. The groundwater samples, where possible, will be collected from stratigraphic intervals coincident with soil chemical sampling intervals. Groundwater samples will be collected by bailer or pump when coincident with aquifer slug testing or will be collected using the borehole sampler. Procedures for the borehole sampler are contained in Attachment 2.

Additional groundwater characterization sampling will occur during the hydraulic testing.

5.2.2.1 Groundwater Samples for Chemical Analysis. Groundwater samples for chemical analysis will be collected approximately every 10 ft prior to running the aquifer slug tests. During the slug test a temporary telescoping screen will be placed in the well. A groundwater sample should be collected from each of these horizons. If no slug test is run, the sample should be collected using the "borehole sampler." In the event the borehole sampler is not available, these samples should be collected using a bailer. The water

Figure 8. Soil and Water Sampling During Drilling at the In-Well Vapor Stripping Site



samples will be collected for metals, volatile organics (VOA), and semi-volatile organics and sent to an analytical laboratory for analysis. Samples sent to the analytical laboratory will be delivered to Sigma V Building in the 3000 Area for distribution to the analytical laboratories. A field screening sample will also be collected for VOA on a short turnaround basis. This portable GC will be set up in either the 200 West Area or the 200 East Area. The field screening samples should be delivered to the mobile laboratory for analysis. A field screening sample will also be collected for VOA on a short turnaround basis. A portable PID chromatograph will used for these screening analyses.

5.2.2.2 Groundwater Samples for Radiological Analysis. Groundwater samples for radiological analysis will be collected approximately every 10 ft prior to running the aquifer slug tests. During the slug test a temporary telescoping screen will be placed in the well. A groundwater sample should be collected from each of these horizons. The samples will be analyzed for gross alpha, gross beta, and gross gamma and sent to an analytical laboratory for analysis. Samples sent to the analytical laboratory will be delivered to Sigma V Building in the 3000 Area for distribution to the analytical laboratories.

6.0 GEOPHYSICAL TESTING

6.1 GEOPHYSICAL LOGGING

A minimum of one of the characterization wells (the first characterization well) will be logged using the density, neutron, and gross gamma logging tools. If scheduling permits, the second characterization well will also be logged. The logs will be run before the final completion of the well while the temporary casing is in the well. The wells will be logged using a commercial vendor. PNL will administer the contract.

6.2 SEISMIC VELOCITY MEASUREMENTS

Following completion of the wells a seismic velocity survey may be conducted. This testing is in support of on going Arid ID programs. The work plan for conducting this work will be developed by the principal investigators of the technology.

7.0 HYDRAULIC TESTING

The primary purpose of those field tests is to ascertain hydraulic properties necessary to evaluate groundwater flow and contaminant mobility at the in-well sparging test site. Field testing will consist of the following: single-well slug tests, slug interference tests (multiple well), a constant rate discharge test, a dipole flow test, and a dynamic flow meter test. The single-well tests (slug tests) are expected to provide estimates of hydraulic conductivity. The slug interference tests, dipole flow test, and multiple-well constant rate discharge tests are expected to provide vertical hydraulic anisotropy, specific yield, and elastic storage coefficient for the aquifer. A dynamic flow meter test is also proposed and will be used to estimate the relative distribution of horizontal hydraulic conductivities, the groundwater production capability at various depth intervals, and the ability of the in situ well sparging system to operate under the existing hydrogeologic conditions.

Hydraulic testing has been conveniently divided into three phases which include Phase I, pre-drilling characterization; Phase II, testing during drilling; and Phase III, testing after drilling, but before demonstration testing is initiated. Table 4 shows the types of tests that will be conducted for all three phases of testing.

Phase I testing will commence prior to the drilling of characterization well #1. A dynamic flow meter test will be conducted, if time permits, in a nearby existing observation well, to confirm the compatibility of the site hydrogeology with the in situ sparging technique. If this testing shows that a low permeability zone is present between the planned screen sections of the demonstration well, the location of the test site should be reevaluated. Previous Hanford experience using this type of technology has demonstrated that certain hydrogeologic conditions are required to set up an efficient recirculation cell. Slug tests will also be performed in the existing observation well during Phase I. An inflatable packer system may be used to isolate individual zones in the observation well for testing, thereby providing information concerning the vertical distribution of hydraulic conductivity. A recommended test spacing would be one test every 10 ft.

Phase II testing will consist of instantaneous slug tests at each temporarily screened interval during the drilling of characterization well #1. A slug interference test will also be conducted at the second screened interval, assuming an observation well is available (this method requires an observation well). This information will also provide information on the vertical distribution of hydraulic conductivity.

Phase III testing will be conducted after completion of the second characterization well and the demonstration well. Initial testing will consist of a slug test in characterization well #2 and in each of the screened zones in the demonstration well. Two slug interference tests are also recommended in the demonstration well, one in each of the screened intervals. A dipole flow test will be conducted in the demonstration well, circulating between the upper and lower screened sections. Lastly, a constant rate discharge test is highly recommended to confirm the slug interference test results. The discharge test should be done prior to air sparging.

7.1 DESCRIPTION OF TEST ACTIVITIES AND REQUIREMENTS

Types of field tests to be conducted are as follows:

- Dynamic flow meter testing
- Single-well tests (Cooper et al. 1967, Bouwer and Rice 1976)
- Slug interference tests (Novakowski 1989, 1990; Spane 1992)

- Dipole flow tests (Kabala 1993)
- Constant-rate discharge drawdown and recovery tests (Papadpulos and Cooper 1967, Neuman 1975).

Table 4. Hydrologic Test Types and Approximate Test Intervals at the Stanford In-Well Sparging Characterization Site.

Sequence	Well	Test Type	Test Interval	Comments
Phase I Testing	**Existing well**	**Slug Tests**	Every 10 ft	Each interval is packed off
		Dynamic flow meter test	Over perforated interval	Assumes purgewater can be handled
Phase II Testing	Characterization well #1	Slug tests	5-10 ft bwt[a] 10-20 ft bwt 20-30 ft bwt	
		Slug interference test	10-20 ft bwt	Assumes obs.well is available
Phase III Testing	Characterization well #2	Slug test	Over screened interval	
		Pumping/recovery test	Over screened interval	Assumes purgewater can be handled
	Demonstration well	Slug tests	Across each screen section	Each screen section packed off
		Slug interference tests	Both screen intervals	
		Dipole flow tests	Between two screened sections	

[a] bwt = below water table.

7.1.1 Dynamic Flow Meter Test

Dynamic flow meter testing should be conducted in the existing observation well prior to drilling any wells at the test site. Flow testing should help determine the vertical distribution of horizontal hydraulic conductivity and the relative production capability of different zones throughout the screened or perforated interval (i.e., preferred flow pathways). These test data may be useful for locating low-permeability zones that could impede recirculation of groundwater between the upper and lower screen sections in the demonstration well. If such a zone exists, it could significantly reduce the performance of the demonstration system.

The general procedure for conducting this test is to set a discharge pump near the top of the water table (intake ~5 to 10 ft or more below static surface). Begin discharging groundwater at a constant rate into a purgewater truck or other acceptable storage container. As water is discharged, raise the flow meter from the bottom of the well to the bottom of the pump, measuring the change in flow rate.

The flow meter must be calibrated, either in the laboratory or onsite under known flow conditions. An independent calibrated surface flow meter may be used to measure the purgewater discharge rate into the truck (or storage container). This test is designed to limit the volume of purgewater produced (i.e., no more than two 3,000- to 4,000-gal purgewater trucks would be used over the period of the test), or logistical and time constraints are overly restrictive.

7.1.2 Single-Well Slug Tests

Single-well slug tests will be conducted in the wells shown in Table 4. Testing activities will follow the procedure contained in the *Environmental Investigations Instruction Manual* (Section 10.1, "Aquifer Testing"). Transducers should be placed in observation wells located within 100 ft of the stress well (to measure potential water-level responses during the tests at these observation points).

7.1.3 Slug Interference Test

Slug interference tests will be performed using the procedure contained in Appendix A. During the slug interference test, transducers should be placed in all observation wells within 100 ft of the stress well. The test procedure will follow the pressurized gas test method (Spane 1992). Figure 1 in Attachment 1 is a generalized diagram showing the well-head set up for the slug interference test.

7.1.4 Dipole Flow Test

The dipole flow tests will be performed using the procedure contained in Attachment 1. During the dipole flow tests, transducers should be placed in all observation wells within 100 ft of the stress well. This test may also be conducted concurrently with testing and operation of the in situ well sparging system (assuming this will not interfere with system operation). Figure 2 in Attachment 1 is a generalized diagram showing a possible well-head set up for the dipole flow test.

7.1.5 Constant Rate Discharge Test

The constant rate discharge test (pumping test) will be conducted in accordance with EII 10.1, "Aquifer Testing" (WHC 1988a). This procedure contains most of the requirements for the test. A test will not be conducted if the generated purgewater cannot be stored and properly disposed. Generally, problems with storage will occur if the aquifer is moderately to highly productive and, therefore, produces large volumes of discharge water.

If a constant rate discharge test is conducted, the pump should be installed within 5 ft of the bottom of the screen or at a depth that is at least 3 to 5 ft below the level of maximum expected drawdown. This setting should provide an adequate buffer to prevent cavitation during pump operation.

During step-drawdown pumping and constant rate discharge tests, water will be removed from the aquifer at a constant rate. Step-drawdown pumping will consist of discharging groundwater at a constant rate for 60 to 90 min and then increasing the discharge rate to a higher discharge rate for an equal period of time. This process will be repeated three to five times. Step-drawdown pumping will be used to assess well losses at the pumping well and to determine the optimum pumping rate for the constant rate discharge test (unless diagnostic development data are available from other earlier development work).

The discharge rate for the pumping test will depend on the results of the step-drawdown pumping or the development data. The hydrologic test lead will make the final determination of the flow rate. Flow rates should be recorded at least every 5 min at the start of the test and at a maximum of 30- to 60-min intervals after the first 30 min. If a transducer can be used for recording flow rates, the rate should be set to a logarithmic recording frequency at the start of the test with a maximum rate of every 30 to 60 min.

Pressure transducers will be placed in all of the observation wells within 100 ft of the pumping well. Barometric pressures will also be measured at the test site from baseline monitoring at least through the end of recovery monitoring. The riser pipe from the pump must have a backflow valve or a surface valve installed to help prevent water in the pipe from draining back into the aquifer after the pump is shut off. At a minimum, a valve should be installed at ground surface that can be closed at the end of the pumping period.

It is anticipated that the test will run 8 to 24 h. Final determination on the length of the test is at the discretion of the hydrologic test lead.

After pumping is terminated, water-level data collection will continue throughout the recovery period until a dynamic equilibrium is re-established or the recovery has reached pre-test static-level conditions. In most cases full recovery is expected to occur in about 1 to 3 days following test termination.

7.2 GENERAL EQUIPMENT REQUIREMENTS

Calibrated pressure transducers must be used for baseline monitoring, pre-test water-level monitoring, and during the hydraulic tests. Calibrated equipment other than flow measurement devices shall be controlled as described in EII 3.2 (WHC 1988a). The transducer should be located in the well as stated in EII 10.1, "Aquifer Testing," or as defined in the attached procedures for the slug interference test and the dipole flow tests. Steel tapes and electric tapes used for measuring water levels must meet the calibration and standardization requirements of EII 10.2.

A calibrated flow measurement device (which includes orifice-type devices) will be used to monitor the discharge rates during the pumping test. The orifice device is considered calibrated if it was constructed according to standard industry specifications (e.g., Driscoll 1986). The discharge rate will not be confirmed during the test using a stop watch and container of known volume (for example) because of contaminated purgewater. The error of the flow measurement device should not exceed ±10% of the total flow.

7.3 PRE- AND POST-HYDRAULIC TEST MONITORING

Water levels and barometric pressures in surrounding wells must be recorded at 15-min to 1-h intervals, 1 to 2 weeks before step-drawdown pumping, constant rate discharge tests, and dipole flow testing is initiated, throughout the testing activities, and for 1 to 2 weeks after all testing is completed. Barometric recording rates should be set at the same recording frequency as the water-level pressure transducer frequencies.

Prior to step-drawdown pumping, constant rate discharge tests, and dipole flow tests, water levels should also be measured from 1 to 5 days. In general, pre-test measurements should exceed the expected length of the test by a factor of about 2 or 3. The maximum measurement interval is 1 h.

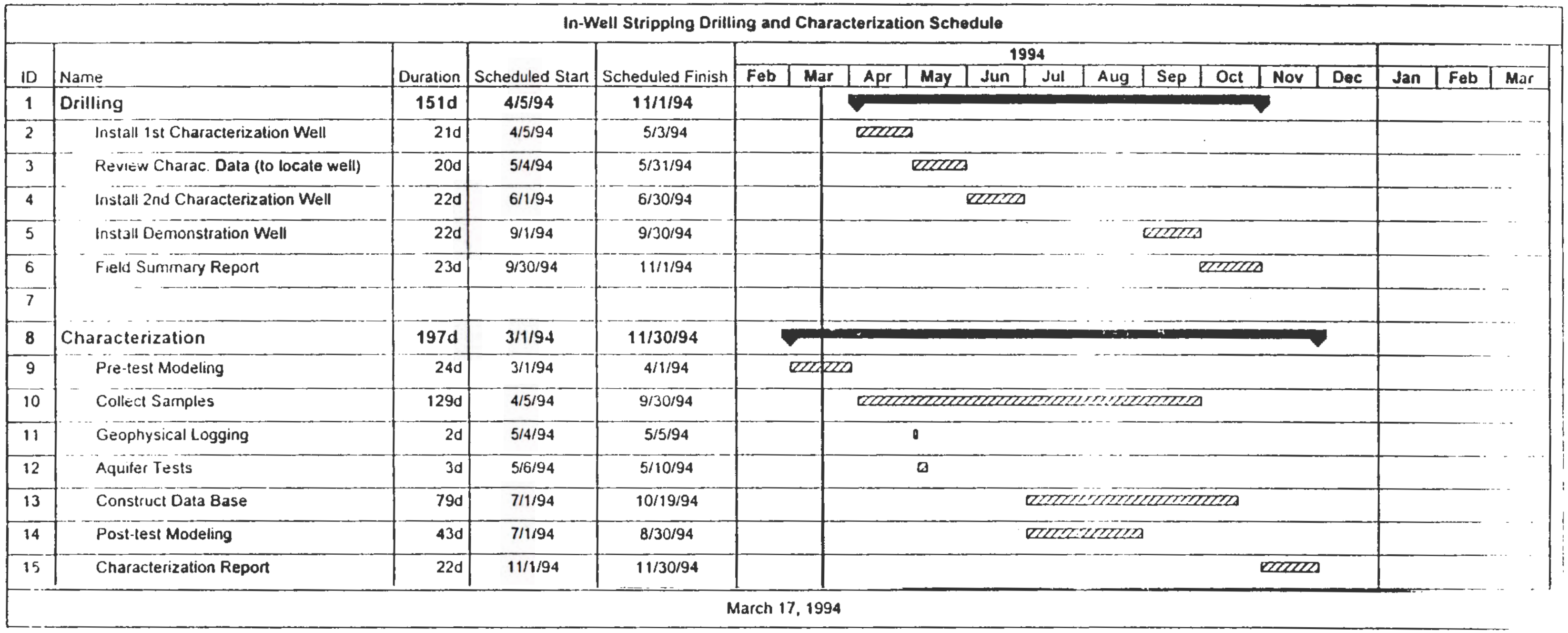
Water levels must be monitored just prior to initiation of any of the tests to establish any short-term trends or disturbances from recent operational activities. The time of monitoring could range from 30 min to 1 day, or until dynamic-equilibrium conditions are evident (water level is at static).

8.0 ANALYSIS AND DATA INTERPRETATION

All data generated by the activities described in this work plan will be evaluated in accordance with procedures described in the Quality Assurance Project Plan. Results will be compiled in a project document at the completion of the characterization activities.

9.0 SCHEDULE

All drilling and site evaluation activities will be completed during fiscal year 1994. The following schedule delineates the target dates for initiation and completion of major activities associated with well installation, sampling, and testing activities.



In-Well Stripping Drilling and Characterization Schedule

ID	Name	Duration	Scheduled Start	Scheduled Finish
1	**Drilling**	**151d**	**4/5/94**	**11/1/94**
2	Install 1st Characterization Well	21d	4/5/94	5/3/94
3	Review Charac. Data (to locate well)	20d	5/4/94	5/31/94
4	Install 2nd Characterization Well	22d	6/1/94	6/30/94
5	Install Demonstration Well	22d	9/1/94	9/30/94
6	Field Summary Report	23d	9/30/94	11/1/94
7				
8	**Characterization**	**197d**	**3/1/94**	**11/30/94**
9	Pre-test Modeling	24d	3/1/94	4/1/94
10	Collect Samples	129d	4/5/94	9/30/94
11	Geophysical Logging	2d	5/4/94	5/5/94
12	Aquifer Tests	3d	5/6/94	5/10/94
13	Construct Data Base	79d	7/1/94	10/19/94
14	Post-test Modeling	43d	7/1/94	8/30/94
15	Characterization Report	22d	11/1/94	11/30/94

March 17, 1994

Figure 9. In-Well Stripping Drilling and Characterization Schedule.

10.0 REFERENCES

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APPENDIX A QUALITY ASSURANCE PROJECT PLAN

CONTENTS

TABLES:

1.0 PROJECT DESCRIPTION

This Quality Assurance Project Plan (QAPjP) has been prepared to support activities related to field demonstration of the Stanford in-well vapor stripping system. The purpose of this QAPjP is to ensure the objectives described in the work plan will be met. Demonstration testing will be conducted as a part of the U.S. Department of Energy's Volatile Organic Compound - Arid Integrated Demonstration (VOC-Arid ID) program.

1.1 BACKGROUND INFORMATION

The technology description and site location are presented in Section 1.0 of this report.

1.2 PROJECT OBJECTIVES

The primary objectives of the demonstration are as follows:

- Determine the removal efficiencies of volatile organic compounds (VOCs) in the groundwater by the Stanford system
- Determine the radius of influence of the Stanford system and its interrelationship to measured site hydrogeologic characteristics
- Identify and evaluate negative impacts on the site formation that could potentially be caused by an in-well sparging system (e.g., geochemical or biological changes that reduce the hydraulic conductivity of the saturated zone).

These objectives will be met through (1) pre-test sampling and testing to establish a baseline and characterize the site, (2) monitoring system variables and site parameters during the demonstration, and (3) post-test sampling and testing for comparisons with the pre-test baseline to access effectiveness of system and the potential impacts operating the system had on the environment. Data collection methodologies and frequencies used to achieve these objectives are generally outlined in Section 5 of the integrated demonstration work plan.

Using the data quality objectives methodology (Bates et al. 1994), the criteria for the successful measurement of the test parameters have been developed (Table A-1). Data collection will be focused to support these parameter objectives. Secondary data will also be collected in support of the stakeholders concerns that were captured in stakeholders process being conducted and documented by the VOC-Arid ID program.

Table A-1. Matrix of Parameters to be Measured and Success Criteria.

Parameters to be Measured During Pre-Demonstration Characterization				
Category/Parameter to be measured	*Expected Range*		*Criteria for Successful Test*	*Measurements*
	High	*Low*		*Before Test Operations*
Initial Environmental Conditions				
a. Lithology				
-Lithology	Gravel	Silty Clay	No consolidated media or extensive clay layer	litho. samples taken every 5 ft. caliche layer to well completion at approx 75 ft (C1) and 45 ft (C2) below water table. Must be able to recognize litho changes and sample at changes
-Lithology thickness	100 ft	0.2 ft	Impermeable layer (inches thick) could inhibit vertical circ. in flow cell; model to determine feasibility of flow using results of wells C1, C2.	same as above
b. Aquifer	multiple aquifers	single aquifer	single aquifer	
-Hydraulic conductivity (Vertical)	1.00E-03	1.00E-07	1.0E-7 cm/sec	aquifer tests at water table and every 10 ft. to well completion (C1, C2)
-Hydraulic conductivity (Horizont	1.00E-03	1.00E-07	1.0E-7 cm/sec	aquifer tests at water table and every 10 ft. to well completion (C1, C2)
-Hydraulic gradient (Vertical)			N/A	water-levels
-Hydraulic gradient (Horizontal)			N/A	water-levels
-Porosity	50%	5%	< 5%	core samples every 10 ft. in range: water table to 75 ft. below water table, C1; 45 ft below water table, C2
-Anisotropy (Kh/Kv)	> 1:1	30:1	< 30 : 1	
-Groundwater velocity			TBD by model: down gradient well locations and monitoring frequency must be able to detect cont. concentration changes.	
-Contaminants (VOCs)			< 100 x MCLs; if major chemical gradient, plug and isolate	g/w samples every 10 ft. in range: water table to well completion (C1, C2)
-Co-Contaminants: metals (As, Cr); anions (NO3); R/N (Tr); Semi-VOCs			< 100 x B/G for metals and naturally occuring elements; 100 x MCLs for chemicals and rad.	g/w samples every 10 ft. in range: water table to well completion (C1, C2)
c. Sediments				
-Contaminants (VOCs)			< soil health risk standards	split spoon samples every 10 ft. from caliche layer to g/w (C1, C2)
-Co-Contaminants: metals (As, Cr); anions (NO3); R/N (Tr); Semi-VOCs			< 100 x background for metals and naturally occuring elements; 100 x soil health risk stnds for chem. and rad.	split spoon samples every 10 ft. from caliche layer to g/w (C1, C2)
-Unsat. hydraulic cond. (Vertical)				core samples every 10 ft.
-Moisture			If find perched water, change test well design to reinject below impermeable layer	core samples every 10 ft.
-Air/water interfacial tension			TBD by model; infiltration rates can't exceed pumping rates	from textbook
-Water retention curves			TBD by model; reinjection and circulation flow cell must be viable	from textbook
Legend: T - Air Sparging Test Well; C1 -Down Gradient Characterization and Monitoring Well; C2 - Cross-Gradient Characterization and Monitoring Well				

1.3 QUALITY ASSURANCE PROJECT PLAN SCOPE AND RELATIONSHIP TO WESTINGHOUSE HANFORD COMPANY QUALITY ASSURANCE PROGRAM

This QAPjP describes how data will be gathered and managed to assess the effectiveness of the in-well vapor stripping system in reducing the concentrations of selected toxic organic compounds in groundwater within the 200-ZP-1 Groundwater Operable Unit. The critical toxic organic contaminants present in the 200-ZP-1 Operable Unit that will be treated by the system include chlorinated VOCs, primarily carbon tetrachloride, chloroform, and trichloroethylene.

This QAPjP applies specifically to the field activities and laboratory analyses performed as part of a demonstration test conducted under the VOC-Arid ID program, and is prepared in compliance with the requirements of the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a). WHC 1990a describes the means selected to implement the overall Quality Assurance (QA) program requirements defined by the *Quality Assurance Manual* (WHC 1991), as applicable to environmental investigations, while accommodating the specific requirements for project plan format and content agreed on in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989). It contains a matrix of procedural resources from the *Quality Assurance Manual*, the *Environmental Investigations and Site Characterization Manual* (WHC 1988b), and other sources that have been drawn upon to support the demonstration test QAPjP.

The analytical work will conducted using Pacific Northwest Laboratory's Quality Assurance Project Plan OHE-018 (the *Resource Conservation and Recovery Act (RCRA) and Operational Ground-Water Monitoring Support Project Quality Assurance Project Plan)*.

Interim changes to this QAPjP or the work plan shall be documented, reviewed, and approved as required by Section 6.6 of EII 1.9, "Work Plan Review" (WHC 1988b). The QAPjP distribution shall routinely include all review/acceptance personnel of the document and all other individuals designated by the Westinghouse Hanford technical lead. All plans and procedures referenced in the QAPjP are available for regulatory review on request at the direction of the technical lead.

1.4 PROJECT ACTIVITIES

The procedures and documents directly applicable to the tasks for constructing and evaluating the in-well vapor stripping system are as follows:

- WHC-S-014, Revision 7, *Generic Well Specification* (WHC 1992)
- Washington Administrative Code (WAC) 173-160 and WAC 173-162
- WHC-CM-7-7, *Environmental Investigations and Site Characterization Manual* (WHC 1988), including the following Environmental Investigations Instructions (EIIs):
    - EII 1.1, "Hazardous Waste Site Entry Requirements"

- EII 1.5, "Field Logbooks"
- EII 2.1, "Preparation of Site Specific Health and Safety Plans
- EII 3.2, "Calibration and Control of Monitoring Instruments"
- EII 3.4, "Field Screening"
- EII 4.3, "Control of CERCLA and Other Past Practice Investigation Derived Waste"
- EII 5.2, "Soil and Sediment Sampling"
- EII 5.4, "Field Cleaning and/or Decontamination of Equipment"
- EII 5.7A, "Hanford Geotechnical Sample Library Control"
- EII 5.10, "Obtaining Sample Identification Numbers and Accessing HEIS Data"
- EII 5.11, "Sample Packaging and Shipping"
- EII 6.7, "Documentation of Well Drilling and Completion Operations"
- EII 9.1, "Geologic Logging"
- EII 10.1, "Aquifer Testing"
- EII 10.3, "Purgewater Management."

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project team will ensure that analytical data are valid and will routinely assess measurement systems for precision and accuracy. A brief description of personnel responsibilities is presented in the following sections.

2.1 QUALITY ASSURANCE OFFICER RESPONSIBILITIES

The Quality Assurance (QA) Officer is responsible for overseeing the performance of the project with respect to the QAPjP requirements and may conduct surveillances. The QA Officer has the necessary organizational independence and authority to identify conditions adverse to quality and to inform the technical lead of needed corrective action.

2.2 TECHNICAL LEAD RESPONSIBILITIES

Environmental Restoration Engineering of Westinghouse Hanford Company has the primary responsibility for conducting the test of the in-well vapor stripping system.

External participant contractors or subcontractors shall be evaluated and selected for certain portions of task activities at the direction of the technical lead in compliance with procedures QR 4.0, "Procurement Document Control;" QR 7.0, "Control of Purchased Items and Services" (WHC 1991); and other procedures as identified under criteria four and seven of the QAPI included in WHC (1990a). All contractor or subcontractor plans and procedures shall be approved before their use, and shall be available for regulatory review after WHC acceptance.

2.3 ANALYTICAL LABORATORIES

Datachem Laboratories, Salt Lake City, Utah, will be the primary laboratory for conducting the sample analysis. A work order will be supplied to Pacific Northwest Laboratory to oversee the analytical work conducted by Data Chem and provide the analytical results in a database for use on this project.

The field sampling team will be responsible for having samples screened for total activity at the 222-S Laboratory prior to offsite release for laboratory analyses.

2.4 OTHER SUPPORT CONTRACTORS

Procurement of all other field services and supporting items, materials, or equipment shall comply with standard WHC procurement procedures.

3.0 QUALITY ASSURANCE OBJECTIVES

The QA objective for this demonstration test is to produce well-documented data of known quality. Such quality is measured by the data's precision, accuracy, completeness, representativeness, comparability, and target reporting limits (TRL) for the analytical methods.

If analytical data fail to meet the QA objectives described in this section, WHC will explain in the technology evaluation report why the data failed to meet the objectives (e.g., because of matrix interferences) and describe the limitations and usefulness of the data.

The following corrective actions may be taken for data that do not meet QA objectives: (1) verify that the analytical measurements and calculations were accurate, (2) reanalyze the affected samples if authorized by the Westinghouse Hanford technical lead and if a sufficient quantity of sample is available, and (3) accept the data and acknowledge the uncertainty; such data will be flagged with data qualifiers.

The rationale for establishing DQOs and data needs for this investigation is presented in the performance assessment document in the project records.

3.1 PRECISION AND ACCURACY

Precision and accuracy goals depend on the types of samples and analyses to be performed and the ultimate use of analytical data. Tables QAPjP-1 and QAPjP-2 summarized the precision and accuracy goals for laboratory analyses for critical chemical parameters and online monitoring, respectively.

Precision

For the critical contaminants, precision will be estimated as the relative percent difference (RPD) between the analysis results of the matrix spike (MS) and matrix spike duplicate (MSD) samples for low-level samples (EQ 1) and the duplicate samples (D) for high-level samples (EQ 2). The laboratory will perform screening analyses, as necessary, to determine the appropriate spiking levels. The spiking solution for each matrix spike analysis will contain the identified critical compounds.

$$\frac{\text{MS}}{\text{MSD}} \text{ X } 100 = \text{RPD (for low-level samples)} \qquad \text{EQ 1}$$

$$\frac{\text{MS}}{\text{D}} \text{ X } 100 = \text{RPD (for high-level samples)} \qquad \text{EQ 2}$$

Accuracy

Accuracy for critical compounds will be estimated from matrix spike samples as percent recovery. The target percent recovery ranges are listed in Tables QAjPla and QAjPlb.

3.2 COMPLETENESS

Completeness is defined as the total number of samples taken for which acceptable analytical data are generated divided by the total number of samples analyzed and multiplied by 100 (EQ 3). An overall completeness goal for this project has been set at 90 %.

$$\frac{\text{Samples Collected}}{\text{Samples that meet DQOs}} \text{ X } 100 = \text{\%completeness} \qquad \text{EQ 3}$$

3.3 REPRESENTATIVENESS

For this project, representativeness involves sample size, sample volume, sampling times, and sampling locations. The QA goal is to obtain an adequate number of samples that represent the environment and system processes. The volume of sample collected also depends on the analytical method chosen, allowing for quality control (QC) sample analyses and reanalysis, if needed.

Goals for data representativeness will be addressed qualitatively by the specification of sampling depths and intervals in the test plans prepared for this investigation. Sampling locations will be specified in the work plans

Table QAPjP 1a. Method, Target Detection Limit, and Quality Assurance Objectives for the Analysis of Groundwater. (sheet 1 of 2)

Parameter	Method	Target Detection Limit ($\mu g/L$)	Precision (Relative % Difference)	Accuracy (% Spike Recovery)	Completeness (%)
Volatile Organics	8010/8020		[b]	[b]	95
Benzene		2			
Carbon Tetrachloride		1			
Chloroform		0.5			
p-Dichlorobenzene		2			
1,1-Dichloroethane		1			
1,2-Dichloroethane		0.5			
cis-1,2-Dichloroethylene		1			
trans-1,2-Dichloethylene		1			
Ethylbenzene		2			
Methylene Chloride		5			
Tetrachloroethylene		0.5			
Toluene		2			
1,1,1-Trichloroethane		0.5			
1,1,2-Trichloroethane		0.2			
Trichloroethylene		1			
Vinyl Chloride		2			
Xylene (total)		5			
Semivolatile Organic Compounds	8270		[b]	[b]	95
o-Cresol		10			
m-Cresol		10			
p-Cresol		10			
Decane		10			
Dodecane		10			
Tetradecane		10			
Naphthalene		10			
Pentachlorophenol		50			
Phenol		10			
Tributyl Phosphate		10			
Tris-2-Chloroethyl Phosphate		10			
Benzothiazole		10			
Bis(2-Ethylhexyl)Phthalate		10			
2,4-Dichlorophenol		10			
2-Nitrophenol		10			
Tentatively Identified Compounds (TICs) (EPA/NIH Data Base)					
Anions	D4327-88		[b]	[b]	95
Bromide		500			
Chloride		200			
Fluoride		100			
Phosphate		500			
Sulfate		500			
Nitrite		200			
Nitrate		200			
Total Dissolved Solids	209B	10,000	[b]	NA	95
Alkalinity	310.2	50,000	[b]	NA	95
Total Organic Carbon	9060	1,000	[b]	[b]	95

Table QAPjP 1a. Method, Target Detection Limit, and Quality Assurance Objectives for the Analysis of Groundwater. (sheet 2 of 2)

Parameter	Method	Target Detection Limit (µg/L)	Precision (Relative % Difference)	Accuracy (% Spike Recovery)	Completeness (%)
ICP Metals			[b]	[b]	95
Aluminum, Al	6010	200			
Antimony, Sb	6010	200			
Arsenic, As	7060	5			
Barium, Ba	6010	20			
Beryllium, Be	6010	3			
Cadmium, Cd	6010	10			
Calcium, Ca	6010	100			
Chromium, Cr	6010	20			
Cobalt, Co	6010	20			
Copper, Cu	6010	20			
Iron, Fe	6010	20			
Lead, Pb	7421	5			
Magnesium, Mg	6010	100			
Manganese, Mn	6010	10			
Nickel, Ni	6010	30			
Potassium, K	6010	1000			
Silver, Ag	6010	20			
Sodium, Na	6010	300			
Zinc, Zn	6010	10			

[a] U.S. EPA. Test Methods for Evaluating Solid Waste (SW-846). Third Edition. September 1986.

[b] Precision and Accuracy requirements will be those identified in the Analytical Support Services Project Statements of Work to subcontracted laboratories (Contract 121121 & 163635).

NA = Not applicable.

Table QAPjP 1b. Method, Target Detection Limit, and Quality Assurance Objectives for the Analysis of Soil. (sheet 1 of 2)

Parameter	Method	Target Detection Limit (μg/Kg)	Precision (Relative % Difference)	Accuracy (% Spike Recovery)	Completeness (%)
Volatile Organics	8010/8020		[b]	[b]	95
Benzene		2			
Carbon Tetrachloride		1			
Chloroform		0.5			
p-Dichlorobenzene		2			
1,1-Dichloroethane		1			
1,2-Dichloroethane		.05			
cis-1,2-Dichloroethylene		1			
trans-1,2-Dichloethylene		1			
Ethylbenzene		2			
Methylene Chloride		5			
Tetrachloroethylene		0.5			
Toluene		2			
1,1,1-Trichloroethane		0.5			
1,1,2-Trichloroethane		0.2			
Trichloroethylene		1			
Vinyl Chloride		2			
Xylene (total)		5			
Semivolatile Organic Compounds	8270		[b]	[b]	95
o-Cresol		660			
m-Cresol		660			
p-Cresol		660			
Decane		660			
Dodecane		660			
Tetradecane		660			
Naphthalene		660			
Pertachlorophenol		3300			
Phenol		660			
Tributyl Phosphate		660			
Tris-2-Chloroethyl Phosphate		660			
Benzothiazole		660			
Bis(2-Ethylhexyl)Phthalate		660			
2,4-Dichlorophenol		660			
2-Nitrophenol		660			
Tentatively Identified Compounds (TICs) (EPA/NIH Data Base)					

Table QAPjP 1b. Method, Target Detection Limit, and Quality Assurance Objectives for the Analysis of Soil. (sheet 2 of 2)

Parameter	Method	Target Detection Limit (μg/Kg)	Precision (Relative % Difference)	Accuracy (% Spike Recovery)	Completeness (%)
ICP Metals			[b]	[b]	95
Aluminum, Al	6010	20000			
Antimony, Sb	6010	20000			
Arsenic, As	7060	500			
Barium, Ba	6010	2000			
Beryllium, Be	6010	300			
Cadmium, Cd	6010	1000			
Calcium, Ca	6010	10000			
Chromium, Cr	6010	2000			
Cobalt, Co	6010	2000			
Copper, Cu	6010	2000			
Iron, Fe	6010	2000			
Lead, Pb	7421	500			
Magnesium, Mg	6010	10000			
Manganese, Mn	6010	1000			
Nickel, Ni	6010	3000			
Potassium, K	6010	100000			
Silver, Ag	6010	2000			
Sodium, Na	6010	30000			
Zinc, Zn	6010	1000			

[a] U.S. EPA. Test Methods for Evaluating Solid Waste (SW-846). Third Edition. September 1986.

[b] Precision and Accuracy requirements will be those identified in the Analytical Support Services Project Statements of Work to subcontracted laboratories (Contract 121121 & 163635).

NA = Not applicable.

and in work orders issued to the subcontractors or participating contractors responsible for conducting sampling activities.

3.4 COMPARABILITY

The comparability of the data will be maximized by using standard U.S. Environmental Protection Agency (EPA) analytical methods and by reporting data in a tabular or graphical format. Approved analytical procedures shall require the use of the reporting techniques and units specified in the EPA reference methods specified in Table QAPjP-1 to facilitate the comparability of data sets in terms of precision and accuracy.

All methods used will be specified and any deviations from the methods will be documented. All laboratory calibrations will be performed with standards traceable to the National Institute for Standards and Technology (NIST) or other EPA-approved sources.

3.5 DETECTION/QUANTITATION LIMITS

The detection/quantitation levels for chemical analyses for the integrated demonstration test are specified in Table QAPjP-1.

4.0 SAMPLING PROCEDURES

4.1 SAMPLE ACQUISITION

All soil sampling shall be performed in accordance with EII 5.2, "Soil and Sediment Sampling" (WHC 1988b). All drilling activities shall be in compliance with EII 6.7, "Resource Protection Well and Test Borehole Drilling" (WHC 1988b). All boreholes shall be logged in compliance with EII 9.1, "Geologic Logging" (WHC 1988b). Groundwater sampling will generally be performed in accordance with EII 5.8, "Groundwater Sampling" (WHC 1988b).

4.2 SAMPLE CONTAINER SELECTION

Sample container types, preservation requirements, preparation requirements, and special handling requirements are defined in the contract between Data Chem Laboratory and PNL.

Tables QAPjP-2a and QAPjP-2b lists by constituent the container, preservative, and holding times required for water and soil samples respectively.

Table QAjP2a. Container, Preservative, and Holding Time Requirements - Water.

Parameter	Container	Preservative	Holding Time
Volatile Organics	40-mL glass TLS	Cool 4 • C pH < 2	14 days
Semivolatile Organics	1-L GATLC	Cool 4 • C	7 days until extraction 40 days after extraction
Metals Lead, Arsenic	1-L polyethylene	Cool 4 • C + 2-ml HNO_3 pH < 2	6 months
Radionuclides -Gross Alpha -Gross Beta -Gross Gamma	1-L polyethylene	HNO_3 pH < 2	N/A
Anions	125-mL polyethylene	No Preservative Cool 4 • C	F, Cl, Br, SO_4 = 28days NO_2 NO_3 PO_4 = 72 Hrs
Alkalinity	125-mL polyethylene	No Preservative Cool 4 • C	14 days
Total Dissolved Solids (TDS)	250-mL polyethylene	No Preservative Cool 4 • C	28 days
Total Organic Carbon (TOC)	250-mL GA/S	H_2SO_4 to pH < 2	28 days

Notes: Additional containers will be required for collecting MS/MSD samples
TLS = Teflon-lined septum
TLC = Teflon-lined cap.
GA = Glass Amber
GA/S = Glass Amber septum

*Teflon is a trademark of E. I. du Pont de Nemours & Company, Wilmington, Delaware

Table QAjP2b. Container, Preservative, and Holding Time Requirements - Soil.

Parameter	Container	Preservative	HoldingTime
Volatile Organics	40-mL GA/S	Cool 4 °C + MEOH	14 days
Semivolatile Organics	125-mL GA	Cool 4 °C	14 days until extraction 40 days after extraction
Metals Lead, Arsenic	125-mL glass	Cool 4 °C	6 months
Radionuclides -Gross Alpha -Gross Beta -Gross Gamma	40-mL GA 250-mL GA	No preservative	N/A

Notes: For equipment blanks, use container, preservative, and holding time requirements for water.
GA = Glass Amber
GA/S = Glass Amber septum

4.3 OTHER INVESTIGATIVE AND SUPPORTING PROCEDURES

Other procedures that will be required to conduct these tests are identified in Table QAPjP-3, referenced to individual tasks as applicable. Documentation requirements shall be addressed within individual procedures and/or the Information Management Overview (IMO) as appropriate. Analytical procedures are listed in Table QAPjP-1.

4.4 PROCEDURE CHANGES

Should deviations from established EIIs be required to accommodate unforeseen field situations, they may be authorized by the field team leader in accordance with the requirements specified in EII 1.4, "Deviation from Environmental Investigations Instructions" (WHC 1988b). Documentation, review, and disposition of instruction change authorization forms shall be defined by EII 1.4. Other types of procedure change requests shall be documented as required by QR 6.0, "Document Control" (WHC 1988b), or other procedures as identified under criterion six of the QAPI included in WHC-EP-0383 (WHC 1990a).

5.0 SAMPLE CUSTODY

Samples obtained during the course of this investigation and sent to analytical labs shall be controlled as required by PNL-MA-567 AD-2 and AD-4, "Chain of Custody Procedures for Groundwater and Soil," from the point of origin to the analytical laboratory.

6.0 CALIBRATION PROCEDURES

Calibration of all WHC measuring and test equipment, whether in existing inventory or purchased for this investigation, shall be controlled as required by QR 12.0, "Control of Measuring and Test Equipment" (WHC 1991). Generally, these procedures are in accordance with the manufacturer's instructions.

7.0 ANALYTICAL PROCEDURES

In selecting appropriate analytical methods, the specific analytes of interest, the sample matrices, and the minimum detectable concentrations needed to achieve the project objectives were considered. The selection process involved the following hierarchy of EPA-approved methods:

- EPA Contract Laboratory Program Statements of Work for Inorganic and Organic Analyses (EPA 1991a, 1991b)
- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA 1986), often referred to as "SW-846"
- *Methods for the Chemical Analysis of Water and Wastes* (MCAWW) (EPA 1983)
- Methods published annually by the American Society of Testing and Materials (ASTM) (ASTM 1991)
- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air* (CMDTOCAA) (EPA 1988).

All analytical methods that have been selected for this investigation are listed in Table QAPjP-1, cross-referenced to the parameters of interest and the maximum detection or quantitation limit values and maximum acceptable ranges for precision and accuracy for both soil and water matrices. The precision and accuracy ranges provided shall be considered maximum values that can be reliably achieved by analytical laboratories. Applicable physical testing parameters for soils are defined in Table QAPjP-3. To facilitate the comparability of data sets in terms of precision and accuracy, all analytical data shall be reported in the standard units specified in the applicable reference method.

Table QAPjP-3. Soil Physical Parameters.

Parameter	ASTM or other standard method
Particle density	PNL SA-9 ASTM D-854
Particle size distribution	PNL SA-2, ASTM C-136 and PNL SA-3, ASTM D-422
Permeability	Unsaturated Flow Apparatus (Wash. State Univ)
Moisture content	PNL SA-7 ASTM D-2216
Calcium carbonate content	ASA 91-6 (1965) or ASTM D-4373

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

Procedures must be used to ensure that all laboratory data generated and processed are scientifically valid, defensible, and comparable. The following sections describe the data reduction, package preparation, validation, records management, and unacceptable or suspect data procedures that will be used in this project.

8.1 DATA REDUCTION AND DATA PACKAGE PREPARATION

All analytical laboratories shall be responsible for preparing a report summarizing the results of analysis. Approximately 10% of the data, identified by the technical project manager, will be validated by reviewing sample identification, sampling and analysis dates, raw analytical data, reduced data, data outliers, reduction formulas, recovery percentages, QC check data, equipment calibration data, supporting chromatogram or spectrograms, and documentation of any nonconformances affecting the measurement system in use during the analysis of the particular group of samples. Data reduction schemes shall be contained within individual laboratory analytical methods and/or QA manuals, submitted for WHC review and acceptance as discussed in Section 4.1. The completed data package shall be reviewed and approved by the analytical laboratory's QA manager (or field team leader for field screening type analysis) before its submittal to the WHC technical lead.

8.2 VALIDATION

Validation of the completed data package will be performed by qualified personnel at PNL. Subcontracted validation responsibilities shall be defined in procurement documentation or work orders as appropriate. All data packages shall be verified; 10% shall receive full validation. Data packages requiring full validation shall be specified by the technical project manager.

8.3 FINAL REVIEW AND RECORDS MANAGEMENT CONSIDERATIONS

All verification and validation reports and supporting analytical data packages shall be subject to a final technical review at the direction of the technical project manager, before their submittal to regulatory agencies; prior to entry into the Hanford Environmental Information System (HEIS) in compliance with EII 14.1, "Analytical Laboratory Data Management" (WHC 1988b), or before inclusion in reports or technical memoranda. All verification and validation reports, data packages, and review comments shall be retained as permanent project quality records in compliance with Section 9 of WHC-CM-3-5 (WHC 1990b).

8.4 REQUIREMENTS FOR HANDLING UNACCEPTABLE OR SUSPECT DATA

The analytical data flow and data management process is described in detail in EII 14.1, "Analytical Laboratory Data Management" (WHC 1988b). Data errors or procedural discrepancies related to laboratory analytical processes shall prompt data requalification by the validator, requests for reanalysis, or other appropriate corrective action by the responsible laboratory as required by governing WHC or approved subcontractor data validation procedures.

9.0 INTERNAL QUALITY CONTROL

Internal QC consists of the checks and procedures performed with the project to ensure that the QA objectives are met. These checks and procedures document compliance with the objectives or demonstrate the need for corrective action. These checks are typically of two kinds: (1) checks controlling field activities, such as sample collection and shipping, and (2) checks controlling laboratory activities, such as extraction and analysis. These checks are discussed below.

All analytical samples shall be subject to in-process QC measures in both the field and laboratory. Unless otherwise specified in the approved test plans or work orders for sampling activities, or in applicable EIIs, the following minimum field QC requirements shall apply. These requirements are adapted from *Test Methods for Evaluating Solid Waste* (EPA 1986), as modified by the proposed rule changes included in the *Federal Register*, 1989, Volume 54, No. 13, pp. 3212-3228, and 1990, Volume 55, No. 27, pp. 4440-4445.

- Field Duplicate Samples. A minimum of 10% of the total collected samples shall be duplicated, or 1 duplicate shall be collected for every 20 samples, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment and sampling technique, and shall be placed into two identically prepared and preserved containers. All field duplicates shall be analyzed independently to provide an indication of field variability for soil samples and gross errors in sampling analytical techniques for groundwater samples.

- Split Samples. Upon specific WHC request, and at the technical lead's direction, field or field duplicate samples may be split in the field and sent to an alternative laboratory as a performance audit of the primary laboratory. Frequency shall meet the specific needs of the requesting organization.

- Blind Samples. At the technical lead's discretion, blind reference samples may be introduced into any sampling round as a QC check of the primary laboratory. Blind sample type shall be as directed by the technical lead.

- Equipment Rinsate Blanks. Equipment blanks are intended to identify sources of (1) contamination from sampling equipment, (2) cross contamination from previously collected samples, or (3) contamination from conditions that occurred during sampling. Equipment blanks shall consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures, and shall be collected at the same frequency as field duplicate samples where applicable.

- VOA Trip Blanks. Trip blanks are used to check contamination of the samples during shipment and handling. The VOA trip blanks consist of pure deionized distilled water added to clean sample containers, accompanying each cooler of containers shipped to the sampling facility. Trip blanks shall be returned unopened to the laboratory and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for volatile organic constituents only, as shown on EPA's target compound list (TCL; see EPA 1991b). In compliance with standard WHC procurement procedures, requirements for trip blank preparation shall be included in procurement documents of work orders to the sample container supplier and/or preparer.

Laboratory QC checks are designed to determine precision and accuracy of the analyses, to demonstrate the absence of interferences and contamination from glassware and reagents, and to ensure the comparability of data. Unless otherwise specified, internal QC checks performed by analytical laboratories shall be consistent with the Analytical Support Services Project Statements of Work to subcontracted laboratories (121121 and 163635) Contract.

- Matrix-Spike/Matrix-Spike Duplicate Samples. The MS samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage and as a test of analytical precision. The spike shall be made in a replicate of a field duplicate sample. Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations shall be described in the analytical procedures submitted for WHC review and acceptance. One sample shall be spiked per analytical batch, or once every 20 samples, whichever is more frequent.

- Quality Control Reference Samples. A QC reference sample shall be prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples are required as an independent check on analytical technique and methodology, and shall be run with every analytical batch, or every 20 samples, whichever is more frequent.

For field screening gas chromatography analysis, at least one duplicate sample per shift shall be routed to a qualified laboratory for EPA Level III analysis as an overcheck on the proper use and functioning of field gas chromatography procedures and equipment. Duplicates shall be selected, whenever possible, from samples in which significant readings have been observed during field analysis. The minimum requirements of this section shall be invoked in procurement documents or work orders in compliance with standard WHC procedures as noted in Section 4.1 of this QAPjP.

10.0 PERFORMANCE AND SYSTEM AUDITS

No performance or system audits are scheduled for these activities. The QA officer will regularly perform surveillances throughout the course of the work plan activities in accordance with Standard Operating Procedure QI 10.4, "Surveillance" (WHC 1991). Additional performance and system "surveillance" may be scheduled as a consequence of corrective action requirements, or may be performed upon request. All quality-affecting activities are subject to surveillance.

11.0 PREVENTIVE MAINTENANCE

All measurement and testing equipment used in the field and laboratories that directly affect the quality of the field and analytical data shall be subject to preventive maintenance measures that ensure minimization of measurement system downtime and corresponding schedule delays. Laboratories shall be responsible for performing or managing the maintenance of their analytical equipment. Maintenance requirements, spare parts lists, and instructions shall be included in individual laboratory QA plans, subject to WHC review. When samples are analyzed using EPA reference methods, the preventive maintenance requirements for laboratory analytical equipment are as defined in the procured laboratory's QA plan(s). WHC field equipment shall be drawn from inventories subject to standard preventive maintenance and calibration procedures as noted under criterion 12 of the QAPI included in WHC-EP-0383 (WHC 1990a). Any field procedures submitted for WHC acceptance by participant contractors or subcontractors shall contain, as appropriate, provisions for preventive maintenance schedules and spare parts lists to ensure minimization of equipment downtime.

12.0 CORRECTIVE ACTION

Corrective actions will be taken when any problems are identified in the program that affect product quality. The project team is responsible for identifying the causes of the problems and developing a solution. The cause of the problem must first be determined so that the effect of the problem on the overall project can be identified. The project team will then develop a plausible corrective action and the effects of the action will be examined to determine whether the problem was corrected.

12.1 GENERAL REQUIREMENTS FOR CORRECTIVE ACTION

Corrective action requests required as a result of surveillance reports, nonconformance reports, program audit activities, or as a result of the specific request of the operable unit manager, shall be documented and dispositioned by the WHC technical lead and QA coordinator as required by QR 16.0, "Corrective Action" (WHC 1991). Corrective action reports prepared under QR 16.0 requirements shall identify the affected requirement, the probable cause of the deviation, any data that may have been affected by the deviation, and the corrective action required both to resolve the immediate situation and to reduce or preclude its recurrence. Corrections of plans or procedures related to the overall measurement system that do not constitute nonconformances, but may be required as a result of data validation, data assessment, or routine review processes, shall be resolved as required by their governing procedures or shall be referred to the WHC technical lead for resolution and appropriate management action. All documentation related to surveillance, audits, and corrective action shall be maintained in compliance with EII 1.6, "Records Management" (WHC 1991), and routed to the project quality records upon completion or closure for retention in compliance with Section 9 of WHC-CM-3-5 (WHC 1990b), and shall be made available for operable unit manager review upon request through the WHC technical lead.

12.2 CORRECTIVE ACTION REQUIREMENTS RELATED TO CALIBRATION ERRORS

Field measuring and test equipment found to be out of calibration shall be documented as a nonconformance in compliance with QR 15.0, "Control of Nonconforming Items" (WHC 1991). Nonconforming items shall be tagged, removed from service, and segregated pending resolution of the nonconformance and initiation of appropriate corrective action in compliance with QR 16.0, "Corrective Action" (WHC 1991). Calibration errors related to laboratory analytical processes that may be observed in the data validation activities described in Section 8 shall prompt requests for reanalysis or other appropriate corrective action by the responsible laboratory.

12.3 CORRECTIVE ACTION RELATED TO PROCEDURAL DEVIATIONS

Planned deviations from EII requirements shall be processed in compliance with EII 1.4, "Deviations from Environmental Investigations Instructions." Unplanned procedural deviations observed during system audit, surveillance, or program audit activities shall be documented as nonconformances, findings, or observations in compliance with the procedures described in Section 10. Corrective action shall be initiated in compliance with QR 16.0, "Corrective Action" (WHC 1991), as previously noted in Section 13.1.

12.4 CORRECTIVE ACTION REQUIREMENTS RELATED TO PURCHASED MATERIALS, ITEMS, OR EQUIPMENT

Purchased materials, items, and equipment found to be out of compliance with their governing procurement specifications shall be documented as a nonconformance in compliance with QR 15.0, "Control of Nonconforming Items" (WHC 1991). Nonconforming items shall be tagged and segregated pending resolution of the nonconformance and initiation of appropriate corrective action in compliance with QR 16.0, "Corrective Action" (WHC 1991).

13.0 QUALITY ASSURANCE REPORTS

Project activities shall be regularly assessed by surveillance. Effective management of environmental measurement efforts requires timely assessment and review. This assessment and review requires effective interaction and feedback between the project team members. Periodic internal reports are necessary to provide ongoing evaluation of measurement data quality. Surveillance, nonconformance, and corrective action documentation shall be routed to the project quality records on completion or closure of the activity. A report summarizing corrective action and instruction change authorization activity as well as any associated corrective actions, shall be prepared for the technical lead by QA at the completion of the field and laboratory investigations. Such information will become part of the project record.

14.0 REFERENCES

ASTM, 1991, *1991 Annual Book of ASTM Standards*, American Society for Testing and Materials, Philadelphia, Pennsylvania.

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ATTACHMENT 1

AQUIFER TEST PROCEDURES

ATTACHMENT 1
AQUIFER TEST PROCEDURES

1.0 SLUG INTERFERENCE TEST PROCEDURE

1.1 PREREQUISITE

1. Before installing any calibrated test equipment, verify and record that the equipment will remain in calibration over the period of the test.

2. Pre-test monitoring of water levels at each well must start at least 1 day before the field testing begins to establish water-level trends. A barometric pressure transducer must be used to monitor atmospheric pressure changes over the same period of time. Both transducers must be set to the same recording rate and time (a maximum of 10-min intervals).

1.2 PROCEDURE

1. Install an inflatable packer on a working string in the observation well as close as possible to the top of the well screen. The packer generally should not be seated inside the well screen, but may be if the screen is a louvered or bridge slot type. The packer must be set below the top of the water table. Note: The test can still be conducted even if a packer is not set (e.g., testing a well with a wire wrap screen that transects the water table), although this is not the preferred method. Install the observation well transducer within the screened interval of the well.

2. Begin baseline monitoring of water-levels and barometric pressures at the observation well(s) at 10 minute intervals.

3. Makeup the wellhead assembly to the stress well.

4. Install two pressure transducers in the screen section of the stress well: one at the maximum depth that the water level will be depressed, and the other above the water table. An electric tape (E-tape) may be placed at or below the lower transducer as a check to insure that the water level is not depressed into the well screen (E-tape optional). Begin baseline monitoring with the transducer at 10 minute intervals.

5. Connect the gas line from the gas cylinder to the wellhead assembly, and make sure the ball valves are closed. An inert type of gas must be used such as nitrogen.

6. Set the transducer recording rates to 1 minute for both the observation well and stress well. Make sure that the transducers in both the stress and observation wells are recording at the same rate and at the same time.

7. Pressure the well casing by opening the valve on the gas cylinder, and thereby depress the water level in the well to near the top of the well screen (maximizing the volume displaced), but not below the screen top. The well should be pressurized until the pressure reading on both transducers is about the same. Care should be taken not to depress the water level into the well screen. If the water-level drops below the electric tape, the tape will no longer buzz when tested. This indicates that the water level has entered the well the screen. The the test must then be abandoned (the test can be restarted after the water-level restabilizes).

8. Hold the water-level at this elevation until the transducers indicate the formation has restabilized (i.e., the pressure readings are relatively constant).

9. Reset the transducer recording rates to the most rapid recording rate (less than one second is preferred), making sure that the transducers and data recording equipment in the stress and observation wells are synchronized.

10. Open the ball valve on the wellhead assembly to instantaneously release the pressure in the casing, and monitor the water level recovery in both the stress well and the observation wells until they return to static.

11. Repeat the process of pressurizing and depressurizing as many times as desired. At least two cycles are recommended.

1.3 VARIATIONS IN STRESS WELL CONFIGURATION

A. If the stress well has a double screen section, and the upper screen section will be tested, an inflatable packer on a working string must be installed in the blank casing section between the screens. Placement of the packer will isolate the two screen sections. The wellhead assembly is constructed to allow access to the lower screen section, but still allow pressurization and depressurization of the upper screen interval (annular space).

Using this configuration, a third transducer should be installed through the working string to monitor water-level changes in the lower screen section. The recording rate and recording times must be synchronized with the transducer in the upper screen.

B. If in a double screened well the lower screen section is to be tested, the same packer and transducer configuration can be used as for Variation A above. However, the working string is pressurized and then depressurize instead of the annular space.

2.0 DIPOLE FLOW TEST PROCEDURE

2.1 PREREQUISITES

1. Before installing any calibrated test equipment, verify and record that the equipment calibration is valid over the period of the test.

2. Pre-test monitoring of water levels at the test well must start 1 to 5 days before the test begins. This data will be used to establish water-level trends. A barometric pressure transducer must also be used to monitor atmospheric pressure changes over the same period of time. Both transducers must be set to the same recording rate. A recording interval of 10 min is recommended.

2.2 PROCEDURE

1. If an observation well is used (it is not a requirement), install a pressure transducer in the screen section of the observation well. Begin baseline monitoring at 10 minute intervals.

2. Remove the pressure transducer used for pre-test monitoring from the stress well. Set an inflatable packer on a working string between the two screen sections to isolate each screened interval. The working string also includes an in-line pump (with a check valve) located just above the packer (Figure 1), and a transducer that monitors the lower screen section.

3. Install a pressure transducer in the upper screen section, Begin baseline monitoring at 10 minute intervals with the transducers in the upper and lower screen sections, and a surface barometric pressure transducer.

4. Makeup the recirculation piping at ground surface with the flow measurement device in line, if it is necessary to monitor the flow rate.

5. Allow the water-level to re-equilibrate to static level. Set all transducers to a log cycle recording rate, making sure they are all synchronized.

6. Begin pumping at the sustainable flow rate established during well development, or the step-drawdown test, or the constant discharge test. Monitor flow rates every 5 minutes at the start of the test for 30 minutes and then increase to 30 min intervals.

7. Continue pumping until the pressure measurements have become stable for an extended period of time within the pumped and injection intervals at the stress well.

8. Shut off the pump after resetting all transducers to a synchronized log cycle recording rate.

9. Continue monitoring and recording time-recovery data until the water-levels have fully recovered to the pre-pumping level.

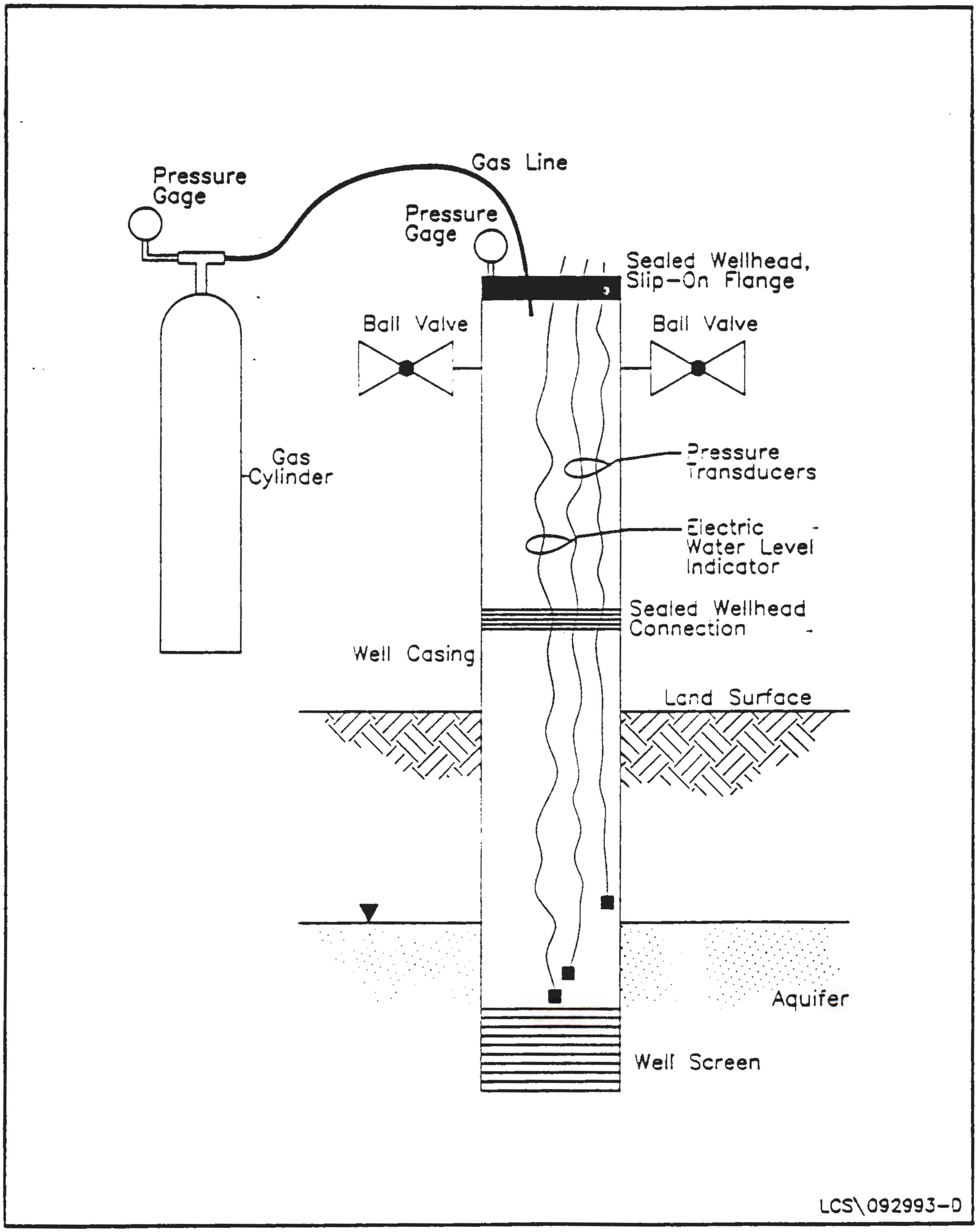
2.3 VARIATIONS IN EQUIPMENT CONFIGURATION

A. The flow rate during the test does not need to be measured unless partially penetrating observation well data are to analyzed. Even so, it is important to maintain a constant flow rate during the test (an inherent assumption of the analytical method). An electronic flowmeter may be installed downhole to measure flow rates. Two other methods that may be used to measure flow rates are the downhole weir box, and the motor controller method. A transducer placed in a downhole could measure water-level changes which correspond to specific flow rates. This technique is still in the developmental stages.

A second method employs an electronic motor controller to maintain a constant pump speed (revolutions per minute or hertz). The pump will then produce a constant discharge rate because of the constant operating speed.

If either one of these alternate methods is used, Step 4 in the procedure would be eliminated. The downhole equipment would be configured to support these methods prior to installation.

Figure Att 1-1. Generalized Well Configuration for Slug Interference Test.



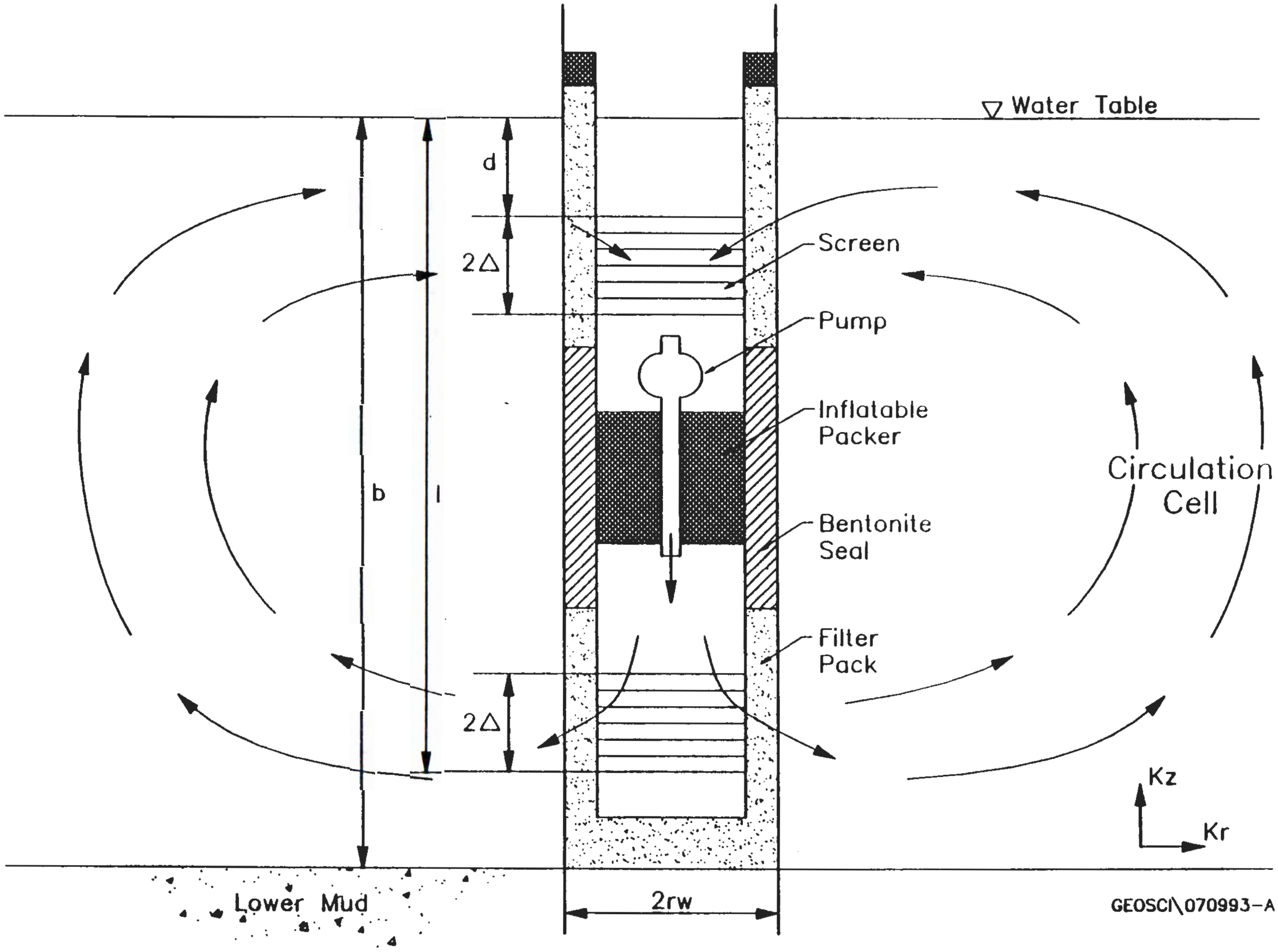


Figure Att 1-2. Generalized Well Configuration for Dipole Flow Test.

ATTACHMENT 2

BORESAMPLER SOIL-GAS AND GROUNDWATER SAMPLING PROCEDURE

ATTACHMENT 2

BORESAMPLER SOIL-GAS AND GROUNDWATER SAMPLING PROCEDURE

1.0 DISCUSSION OF METHOD

The BoreSampler device can be used for obtaining soil-gas samples and groundwater samples between drilling runs during borehole drilling. This device can obtain depth-discrete soil-gas or groundwater samples, thus providing a means of characterizing contaminant concentrations vertically without installing multiple wells.

The device is designed to collect either soil-gas (in unsaturated zone) or groundwater samples during the drilling phase of well installation and to be compatible with standard cable-tool drilling equipment. It consists of a reinforced probe and well point attached to the bottom of a larger chamber, referred to as the carrier. To collect water samples, a sample collection container with check valves is held within the inner part of the carrier. To collect soil-gas samples, the sample collection container is replaced by a tube that leads from the probe to an access port attached to the outside of the carrier. A flexible tube extends from this port to the surface. The carrier physically supports the sample container, provides excess fluid retention for sample purging, and provides valves for air discharge.

The device is threaded to the bottom of the drill string below a set of cable-tool drilling jars and is operated by driving the length of the probe (approximately 46 cm) into the sediments below the borehole bottom. The cable is then pulled back approximately 8 cm to open the sleeve and expose the open section of the probe.

During groundwater sampling, water enters the probe and moves through the sample container and into the carrier until both the sample container and the carrier are full. Water enters the system by the force of the hydrostatic head of the aquifer being sampled. A representative sample of groundwater is thus retained in the container. For soil-gas sampling, a vacuum is applied at the surface and the gas is pulled through a tube to a sample collection apparatus at the surface. Deployment and sampling at one depth interval is expected to take approximately 1 hour.

2.0 EQUIPMENT REQUIREMENTS

BoreSampler sampling equipment may include, but is not limited to, the following.

Equipment required at the site for BoreSampler soil-gas sample collection is listed below:

- BoreSampler device assembled with soil-gas sampling components (tube sleeve in probe and internal hose/tubing in carrier) and reinforced tubing

- Chain wrenches (2) and pipe rack
- Metal bellows vacuum sampling pump
- Gas-flow meter
- Sample tubing
- Soil-gas sample containers.

Equipment required at the site for BoreSampler groundwater sample collection is listed below:

- BoreSampler device assembled with groundwater sampling components (filter sleeve in probe and sample container in carrier) and tubing access port plugged
- Chain wrenches (2) and pipe rack
- Groundwater sample containers.
- OUM

The field equipment must be calibrated or standardized as directed in EII 3.4, "Field Screening" and in accordance with the organic vapor monitor (OVM) manufacturer's instructions.

3.0 PROCEDURE

This section describes the procedural details for collecting soil-gas and groundwater samples with the BoreSampler. All information and data and information collected during sampling will be recorded in the sampling field logbook and the Groundwater Sample Report form.

3.1 SOIL-GAS SAMPLING

3.1.1 Order of Soil-Gas Sample Collection

The order of events for collecting soil-gas samples with the BoreSampler is listed below.

1. Ensure drive casing is at bottom of borehole (if possible) and clean borehole of sluff material (in some cases movement of casing will be dictated by confining layers or other factors).
2. Deploy, collect sample, and retrieve BoreSampler.

3.1.2 BoreSampler Deployment

Deployment of the BoreSampler for soil-gas sampling will be accomplished as follows.

1. Ready the device for soil-gas sampling by attaching the modular soil-gas sampling adaptations within the probe and carrier and attaching the vacuum tube to the external port.
2. Attach the BoreSampler to the drill line and lower it, along with the vacuum tubing, to the bottom of the borehole.
3. Attempt to drive the sampler into the sediments to a depth equal to the length of the probe using the drill jars. A maximum of 50 blows per 15 cm <u>or</u> 10 consecutive blows, if no advance is made, will be allowed.
4. If the probe has penetrated approximately 20 cm or more into the sediments, a sample will be collected. If the probe has penetrated less than approximately 20 cm, a sample will not be collected. The optimum condition for sampling is to drive the entire length of the probe into the sediments before sampling.
5. Attach the vacuum tubing from the BoreSampler to the sample pump and sample collection apparatus before the sleeve on the probe is opened.
6. Open the sleeve on the probe by pulling the drill cable upward a distance of approximately 8 cm.

3.1.3 Soil-Gas Sample Collection

The following procedure is to be employed for collection of soil-gas samples using the BoreSampler device.

1. Attach a 0.5-μm or less pore size particle filter into the sample line above (upflow from) the point of sample collection.
2. Direct the discharge line through which excess soil gas will be purged downwind and away from field personnel.
3. If directed by the site safety officer, attach a charcoal filter in the discharge line before it vents to the atmosphere.
4. Connect the vacuum pump.
5. Pump at a rate of between 1 and 5 L/m during purging. If BoreSampler probe is not driven more than a length of approximately 30 cm, the pumping rate during purging will be reduced to no more than 2 L/m to prevent short-circuiting with the air within the borehole.

6. Purge a volume of approximately five times the volume of the sample container plus the sample tubing through the system before sample collection. The sample tubing volume is approximately 1 L per 30 m. The sample container volume is approximately 500 mL.

7. Reduce the flow rate to between 0.5 and 1 L/m for sample collection. Either a pump with a known flow rate will be used or a flow meter will be attached in-line to measure the flow rate. The flow rate can be estimated by using a pump with a known flow rate if a gas flow rate measurement device is not available.

8. Purge a 500-mL sample container with inert gas before using it.

9. Connect the sample container into the sample line either directly or through a tee that will divert the flow into two lines.

10. Sample collection will be initiated by turning on the vacuum pump. The gas flow rate and total gas volume pumped will be measured or estimated and documented.

11. Open the sample container entry and exit valves to allow the gas to flow into and through the container until purging of the container has been completed. The OVM may be used to pull the sample into the sample container if the container is put in-line from a tee. A minimum purge volume of five times the sample container plus the sample tubing volume must pass through the sample container prior to sample collection.

12. Monitor VOC concentrations during soil-gas pumping with the OVM and record the results (a few measurements indicative of the relative concentrations over time will be adequate). The readings may be used to determine the peak concentration of the contaminants after the sample container has been purged; the sample can be collected when the peak concentration is reached. If the OVM does not indicate the presence of contaminants, the sample will be collected after the minimum purge volume has passed through the sample container.

13. Close the entry valve then the exit valve on the container to collect the sample. NOTE: It is important not to allow pressure to build up in the sample container to prevent breakage of the glass. One sample will be collected from each sample interval by this method.

14. Handle and transport the samples under chain-of-custody control to the designated laboratory for VOC analysis. The maximum holding time will be 24 hours; therefore samples will not be collected on a Friday unless they can be analyzed the same day.

15. Retrieve the BoreSampler and decontaminate per requirements found in EII 5.4, "Field Decontamination of Drilling, Well Development and Sampling Equipment." Decontamination should

    - Brushing the exterior of the device to remove loose material

- Washing the exterior with a nonphosphate detergent, and rinsing with distilled water to remove any external contamination
- Removal of the probe from the carrier and washing the inside of the probe with a nonphosphate detergent, and rinsing with distilled water to remove any internal contamination
- Purging the inside of the probe with nitrogen for a time long enough to remove any remaining water (5 min should be sufficient)
- Purging the sample tubing with nitrogen gas by forcing the gas into the sample collection end of the sample tubing and pushing toward the BoreSampler device. This will push any fine particles from the sample tubing and prevent particles from being pushed into the sample tubing during future sampling events
- Containment and disposal of all decontamination fluids as specified in EII 5.4.

3.2 GROUNDWATER SAMPLING

Groundwater sampling with the BoreSampler can only be accomplished at depths below the water table greater than the total length of the BoreSampler. This ensures that the hydraulic head is sufficient to push water completely through the sample container and into the overflow portion of the carrier.

3.2.1 Order of Groundwater Sample Collection

The order of events for collecting groundwater samples with the BoreSampler is listed below.

1. Ensure drive casing is at bottom of borehole (if possible) and clean borehole of sluff material (in some cases movement of casing will be dictated by confining layers or other factors).
2. Deploy, collect sample, and retrieve BoreSampler.

3.2.2 BoreSampler Deployment

Deployment of the BoreSampler for groundwater sampling will be accomplished as listed below.

1. Ready the device for groundwater sampling by attaching the modular groundwater sampling adaptations within the probe and carrier and plugging the external port.
2. Attach the BoreSampler to the drill line and lower it to the bottom of the borehole.

3. Attempt to drive the sampler into the sediments to a depth equal to the length of the probe using the drill jars. A maximum of 50 blows per 15 cm <u>or</u> 10 consecutive blows, if no advance is made, will be allowed.

4. If the probe has penetrated approximately 20 cm or more into the sediments, a sample will be collected. If the probe has penetrated less than approximately 20 cm, a sample will not be collected. The optimum condition for sampling is to drive the entire length of the probe into the sediments before sampling.

5. Open the sleeve on the probe by pulling the drill cable upward a distance of approximately 8 cm.

6. Allow a minimum of 30 minutes for water to fill the sample container and overflow capacity of the carrier. (This time will be a function of depth below the water table and permeability of the aquifer at the sampling location).

3.2.3 Groundwater Sample Collection

The following procedure is to be employed for retrieval and collection of groundwater samples using the BoreSampler device.

1. Retrieve the BoreSampler to the surface and remove from the borehole.

2. Suspend the BoreSampler with the drill line with the bottom tip about 4 ft above the ground surface.

3. Unthread the retaining ring which holds the probe to the carrier.

4. Lower the probe from the carrier and grasp the sample container to keep it from falling or tipping. Continue to lower the probe and remove it from the sample container, continuing to keep the sample container upright.

5. Insert a closed controlled flow bailer valve into the bottom of the sampler container.

6. Position the opening of the controlled flow bailer valve over the selected sample bottle and open the valve to fill the sample bottle.

7. Close the bailer valve when the sample bottle is filled to the required volume. Repeat steps 6 and 7 for each desired sample bottle.

8. Handle and transport the samples under chain-of-custody control to the designated laboratory for designated analysis.

9. Decontaminate the BoreSampler per requirements found in EII 5.4, "Field Decontamination of Drilling, Well Development and Sampling Equipment." Decontamination should include:

   - Brushing the exterior of the device to remove loose material
   - Removal of the probe from the carrier and removal of the filter sleeve from the probe
   - Washing the exterior and interior of the carrier with a nonphosphate detergent, and rinsing with distilled water to remove any contamination
   - Washing the exterior and interior of the sample collection container with a nonphosphate detergent, and rinsing with distilled water to remove any contamination
   - Washing the inside of the probe with a nonphosphate detergent, and rinsing with distilled water to remove any internal contamination
   - Washing the filter sleeve with a nonphosphate detergent, and rinsing with distilled water to remove any internal contamination (a replacement sleeve and/or filter material may be placed into the probe during decontamination to reduce downtime of the BoreSampler)
   - Reassembly of BoreSampler by replacing the sample container into the carrier, replacing the filter sleeve into the probe, reassembling the probe onto the body, and closing the sleeve before future sampling
   - Containment and disposal of all decontamination fluids as specified in EII 5.4.