Final Work Plan
Bedrock Groundwater Study
At Landfill 6, Building 775, AOC 9, and Building 817/WSA

Former Griffiss Air Force Base
Rome, New York

Contract No. DACW41-99-D-0005
Task Order No. 001
WAD 04 - Feasibility Study

February 2002

U.S. ARMY CORPS OF ENGINEERS
Kansas City District
601 East 12th Street
Kansas City, Missouri 64106

Prepared by:

ECOLOGY AND ENVIRONMENT, INC.
368 Pleasant View Drive
Lancaster, New York 14086

ecology and environment, inc.
International Specialists in the Environment
BUFFALO CORPORATE CENTER 368 Pleasant View Drive, Lancaster, New York 14086
Tel: 716/684-8060, Fax: 716/684-0844

recycled paper

Table of Contents

List of Tables

List of Figures

Figure **Page**

List of Acronyms

AOC	area of concern
B775	Building 775
B817/WSA	Building 817, south of the Weapons Storage Area
BGS	below ground surface
E & E	Ecology and Environment, Inc.
ERDC	United States Army Engineer Research and Development Center
FSP	Field Sampling Plan
GPM	gallons per minute
Griffiss AFB	former Griffiss Air Force Base
HASP	Health and Safety Plan
IRP	Installation Restoration Program
LF6	Landfill 6
NYSDEC	New York State Department of Environmental Conservation
PCE	perchloroethene
QAPjP	Quality Assurance Project Plan
QC	quality control
RI	Remedial Investigation
SI	Supplemental Investigation
SMC	Six Mile Creek
TCE	trichloroethene
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WAD	Work Authorization Directive
WSA	Weapons Storage Area

1 Introduction

Ecology and Environment, Inc. (E & E), under contract to the United States Army Corps of Engineers (USACE), Kansas City District, Contract No. DACW41-99-D-0005, Work Authorization Directive (WAD) 04, will be performing a Bedrock Groundwater Study at the Landfill 6 (LF6) and Building 775 (B775) Areas of Concern (AOCs), AOC 9, and the On-Base Groundwater AOC near Building 817, south of the Weapons Storage Area (B817/WSA), at the former Griffiss Air Force Base (Griffiss AFB) in Rome, New York.

1.1 Purpose of Investigation

In June 2001, USACE requested E & E to evaluate the potential for the migration of contaminated groundwater into the bedrock at LF6, B775, AOC 9, and B817/WSA; and develop a project scope. The purpose of this task was to finalize the overall strategy for installation of bedrock wells at the base. This request was generated because the United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC) have requested a bedrock monitoring program at a number of contaminated sites at Griffiss AFB.

1.2 Background Information

Groundwater at Griffiss AFB and in the surrounding area of Rome, New York occurs in both the overburden and bedrock. The overburden is typically composed of poorly sorted sands, silts, and gravels. The uppermost unit of bedrock is the Utica Shale. It is approximately 300 feet thick and is composed of a black to gray, carbonaceous and

highly fissile to massive shale. The depth to bedrock at Griffiss AFB varies from surface to approximately 20 feet below ground surface (BGS) on the north side of the base, to approximately 130 feet BGS on the south side. Average depths typically range from 30 to 50 feet BGS. Most groundwater investigation work has focused on overburden groundwater. However, four overburden/bedrock interface wells (all at Landfill 1) were installed by Roy F. Weston under the Installation Restoration Program (IRP) Phase II - Problem Confirmation and Quantification Study (Weston 1985), and eight bedrock monitoring wells (one at each of the following AOC sites: Landfills 1, 2/3, and 6; Coal Storage Yard; Lot 69; T-9 Storage Area; On-Base Groundwater [near intersection of Mohawk Drive and Hill Road]; and Off-Base Groundwater [near intersection of Ellsworth Road and Fort Craven Drive across from the former mobile home park]) were installed by Law Environmental, Inc. under the Remedial Investigation (RI) (Law 1996). In addition, seven well borings (one at each of the following sites: Hydrologic Study Areas 1, 2, 3, 4, 6, 7, and 8) were drilled into the bedrock by UNC Geotech, however, the wells were completed in the overburden (UNC Geotech 1991). In general, the bedrock wells had low yields.

When developing a conceptual model to investigate contaminated groundwater, it is important to consider the potential receptors. Although bedrock groundwater is not being used as a potable water source at Griffiss AFB or by the City of Rome and its surrounding areas, there are two other possible receptors in the Griffiss AFB area. First, bedrock groundwater could flow off base and discharge to surface water (New York State Barge Canal and the Mohawk River). Second, although there are no known uses, bedrock groundwater could flow off base and potentially impact residences that may use bedrock groundwater for drinking or irrigation. However, if the bedrock groundwater beneath the base is contaminated, the levels of contaminants in off site discharge water would be significantly reduced due to dispersion and attenuation. This is particularly true for any potential discharges into the Canal and the Mohawk River because of their volume. In order to impact private wells, a plume would have to flow off base at least 1 to 2 miles. Over this distance, the plume would continue to disperse and attenuate. Therefore, it is unlikely that bedrock groundwater from the base would adversely impact public health or the environment.

2 AOC-Specific Groundwater Studies

This section of the work plan discusses the field activities to be performed under this investigation. The work at all four sites described in this plan was derived from the November 19, 2001 bedrock well proposal and subsequent USEPA and NYSDEC comments (see Appendices A and B) (E & E 2001a).

2.1 Scope of Work

All four of the sites being investigated contain chlorinated ethene plumes in the overburden, which can be density driven in an undissolved state. Contamination in the overburden at these sites has been detected immediately above bedrock. The contamination includes the following: trichloroethene (TCE), perchloroethene (PCE), and their breakdown products at LF6, B775, and B817/WSA; and a mixed plume of chlorobenzene and TCE and its breakdown products at AOC 9.

In order to assess whether this contamination has migrated into the bedrock, bedrock wells will be installed at each of these sites in a phased approach. The first phase will include the installation of one bedrock well at each site:

- LF6MW-12RBr (see Figure 2-1)
- 775MW-22Br (see Figure 2-2)
- AOC9-MW9Br (see Figure 2-3)
- WSA-MW12Br (see Figure 2-4)

If the well is dry after drilling a maximum of 20 feet into bedrock, no other bedrock wells will be installed at that site. If the bedrock well produces a sufficient amount of water to allow development and sampling (i.e., a production retest of at least 0.5 gpm), the remaining proposed site bedrock wells will be installed as part of the second phase. The second phase will be implemented immediately following the first phase (i.e., a second mobilization will not be required). If the second phase of drilling is warranted (i.e., the first well produces a sufficient amount of groundwater to be sampled), the following hydrologic issues will be addressed:

- **Flow Direction** - Determine the flow direction of bedrock groundwater at each site; and
- **Vertical Gradient** - Determine if vertical gradients exist between overburden and bedrock at each site. For instance, a downward vertical gradient could carry a plume down into the bedrock whereas an upward vertical gradient, could result in discharge of a plume to surface water. In general, a plume in an overburden aquifer will not penetrate to the bedrock if the vertical gradient is neutral, unless it is density driven.

All bedrock wells will be installed using an overburden casing to prevent cross-contamination of overburden groundwater to bedrock groundwater. This will be accomplished by grouting a 4-inch carbon steel casing from surface to 3 to 5 feet into bedrock. Mud rotary drilling techniques at LF6 and B775 and 8.25-inch inner diameter hollow stem augers at AOC 9 and B817/WSA will be used to drill the boring and install the casing. The grout will be allowed to set prior to advancing 10 feet further into the rock with a core barrel. If sufficient water is obtained (i.e., at least 0.5 gallons per minute [GPM]), the well will be completed at that depth. If sufficient water is not obtained, an additional 10 feet will be drilled. The wells will remain open to bedrock if conditions allow. One hydropunch groundwater sample will be collected from the overburden zone immediately above the top of bedrock prior to advancing into the bedrock. These samples will be tested for volatile organic compounds (VOCs). The estimated well depths will range from approximately 24 to 54 feet at AOC 9 and B817/WSA; and 86 to 141 feet at LF6 and B775. Drilling procedures are described in Appendix C. A summary of anticipated bedrock well drilling and installation parameters is provided in Table 2-1.

LEGEND

- PROPOSED LANDFILL 6 OVERBURDEN WELL
- PROPOSED LANDFILL 6 BEDROCK WELL
- LANDFILL 6/BUILDING 775 GROUNDWATER STUDY PERMANENT MONITORING WELL LOCATION
- LANDFILL 6/BUILDING 775 GROUNDWATER STUDY TEMPORARY MONITORING WELL LOCATION
- LANDFILL 6/BUILDING 775 VERTICAL PROFILE HYDROPUNCH SAMPLING LOCATION (WELL NOT INSTALLED)
- EXISTING MONITORING WELL
- MONITORING WELL RESAMPLED DURING ROUND 1 GROUNDWATER STUDY (MAY 2000)
- DECOMMISSIONED MONITORING WELL
- SUPPLEMENTAL INVESTIGATION GEOPROBE GROUNDWATER SCREENING SAMPLE LOCATION
- HARDFILL AREA
- LANDFILL BOUNDARY
- APPROXIMATE BOUNDARY OF B775 PLUME (DASHED WHERE INFERRED)
- APPROXIMATE BOUNDARY OF LF6 PLUME (DASHED WHERE INFERRED)
- TOTAL CHLORINATED VOC CONCENTRATION CONTOUR LINE FROM HYDROPUNCH DATA

SCALE IN FEET
0 150 300 450

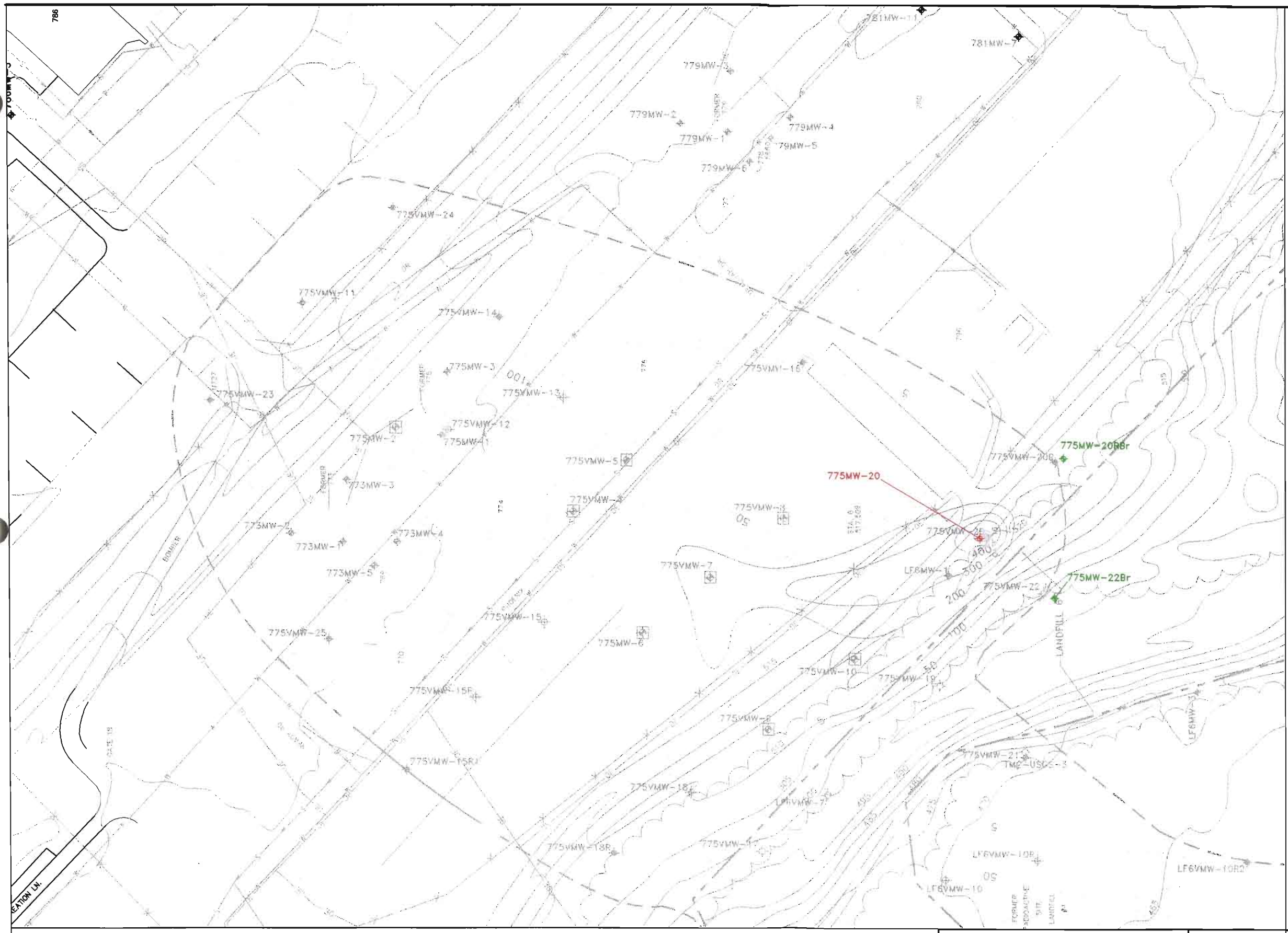
NO.	DATE	DWN	APP'D	DESCRIPTION
				REVISIONS

ecology and environment inc.
International Specialists in the Environment

DESIGNED BY	CHECKED BY
GENE FLORENTINO	GENE FLORENTINO
DRAWN BY	APPROVED BY
KEVIN KRAJEWSKI	GENE FLORENTINO

Figure 2-1: PROPOSED LF6 BEDROCK GROUNDWATER STUDY WELL LOCATIONS

SCALE	DATE ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.
1"=150'	2/21/01	UK04_4-3.dwg	FIG - 4-3	



LEGEND

- PROPOSED BUILDING 775 OVERBURDEN WELL
- PROPOSED BUILDING 775 BEDROCK WELL
- LANDFILL 6/BUILDING 775 GROUNDWATER STUDY PERMANENT MONITORING WELL LOCATION
- LANDFILL 6/BUILDING 775 GROUNDWATER STUDY TEMPORARY MONITORING WELL LOCATION
- LANDFILL 6/BUILDING 775 VERTICAL PROFILE HYDROPUNCH SAMPLING LOCATION (WELL NOT INSTALLED)
- EXISTING MONITORING WELL
- MONITORING WELL RESAMPLED DURING ROUND 1 GROUNDWATER STUDY (MAY 2000)
- DECOMMISSIONED MONITORING WELL
- SUPPLEMENTAL INVESTIGATION GEOPROBE GROUNDWATER SCREENING SAMPLE LOCATION
- HARDFILL AREA
- LANDFILL BOUNDARY
- APPROXIMATE BOUNDARY OF B775 PLUME (DASHED WHERE INFERRED)
- APPROXIMATE BOUNDARY OF LF6 PLUME (DASHED WHERE INFERRED)
- 5 TOTAL CHLORINATED VOC CONCENTRATION CONTOUR LINE FROM HYDROPUNCH DATA

SCALE IN FEET
0 150 300 450

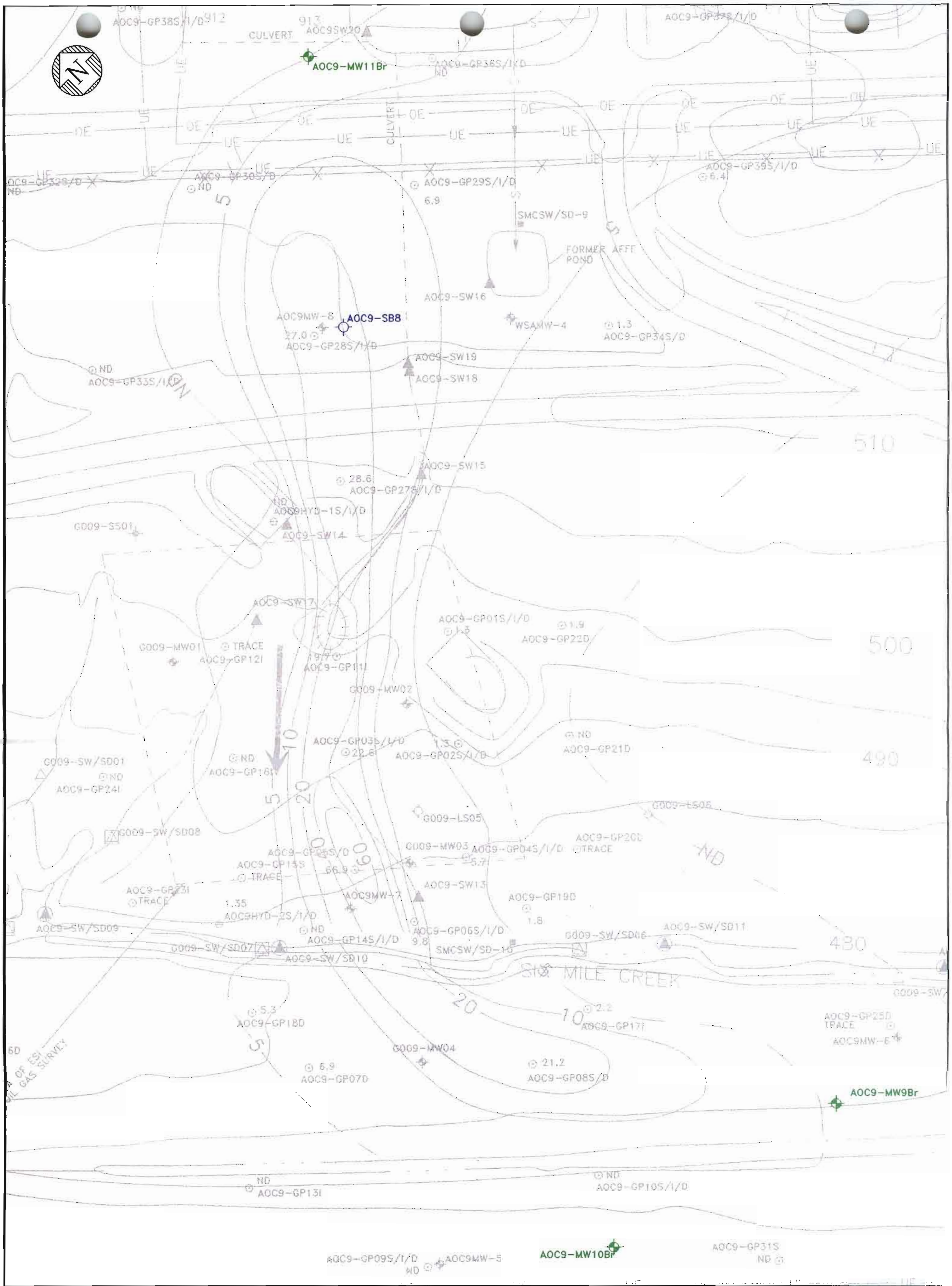
NO.	DATE	DSN	APP'D	DESCRIPTION
REVISIONS				

ecology and environment inc.
International Specialists in the Environment

DESIGNED BY	CHECKED BY
GENE FLORENTINO	GENE FLORENTINO
DRAWN BY	APPROVED BY
KEVIN KRAJEWSKI	T. FERRARO

Figure 2-2: PROPOSED B775 BEDROCK GROUNDWATER STUDY WELL LOCATIONS

SCALE	DATE ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.
1"=150'	2/21/01	UK04_5-3.dwg	FIG - 5-3	



LEGEND

5.7 GEOPROBE LOCATION MAX. TCE($\mu g/L$)
S=SHALLOW/I=INTERMEDIATE/D=DEEP.

PROPOSED AOC9 BEDROCK WELL LOCATION

PROPOSED AOC9 SOIL BORING LOCATION

EXISTING OVERBURDEN WELL LOCATION

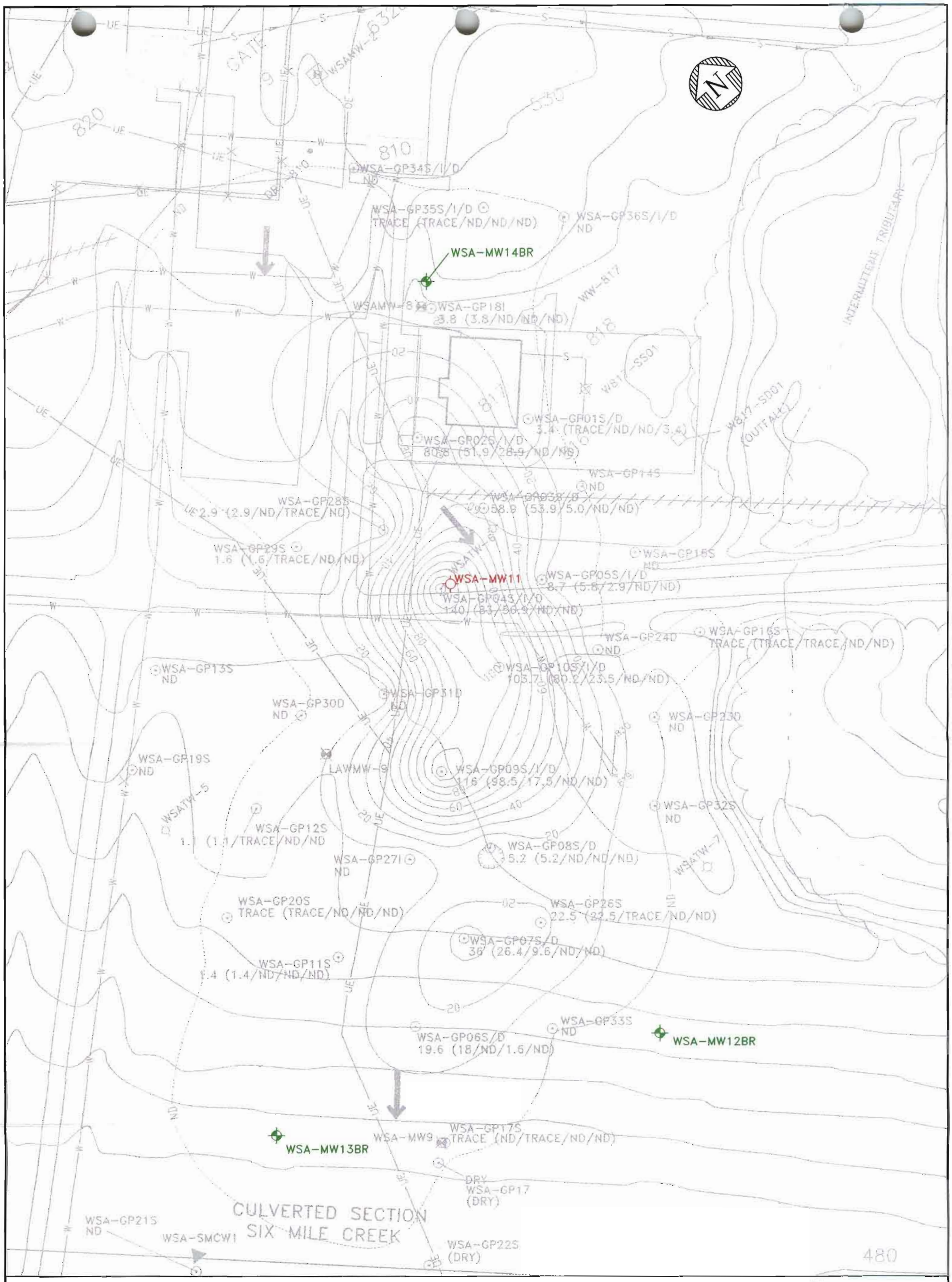
SCALE IN FEET
0 80 160 240

ecology and environment inc.
International Specialists in the Environment

DESIGNED BY	CHECKED BY
R.MEYERS	R. MEYERS
DRAWN BY	APPROVED BY
K.KRAJEWSKI	T. FERRARO

FIGURE 2-3: PROPOSED AOC9 BEDROCK GROUNDWATER STUDY WELL LOCATIONS

SCALE	DATE ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.
1"=80	6/01	CK1S028D_2	GRIFFIS JUNE 2001	



LEGEND

5(2/6/8/3) GEOPROBE LOCATION WITH TOTAL ETHENES(µg/L) AND TCE/PCE/cis-1,2 DCE/VC IN µg/L.

PROPOSED B817/WSA OVERBURDEN WELL LOCATION

PROPOSED B817/WSA BEDROCK WELL LOCATION

EXISTING OVERBURDEN WELL LOCATION

SCALE IN FEET

0 100 200 300

ecology and environment inc.
International Specialists in the Environment

DESIGNED BY	CHECKED BY
R.MEYERS	R.MEYERS
DRAWN BY	APPROVED BY
K.KRAJEWSKI	T.FERRARO

FIGURE 2-4: PROPOSED B817/WSA BEDROCK GROUNDWATER STUDY WELL LOCATIONS

SCALE	DATE ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.
1"=100	6/01	CK1S030D_2	GRIFFIS JUNE 2001	

Table 2-1 Anticipated Well Drilling and Installation Parameters, Bedrock Groundwater Study, Former Griffiss AFB, Rome, NY

Proposed Well No.	Well Type O/B	Anticipated Depth to Bedrock (ft BGS)	Depth Interval for Soil Sampling (ft BGS)	Depth Interval for Hydropunch Sampling (ft BGS)	Anticipated Well Completion Depth (ft BGS)	Anticipated Well Screen or Open Hole Interval (ft BGS)
LF6						
LF6MW-12RBr	B	71.5	41-51[1]	66.5-71.5	86.5 or 96.5	76.5-86.5 or 76.5-96.5
LF6MW-12	O	77	41-51[1]	–	41 or 51	41-51
LF6MW-14Br	B	85.5	–	80.5-85.5	100.05 or 110.5	90.5-100.5 or 90.5-110.5
B775						
775MW-22Br	B	106	101-106[1]	101-106	121 or 131	111-121 or 111-131
775MW-20	O	122	107-122[1]	–	112 or 122	112-122
775MW-20RBr	B	116	–	111-116	131 or 141	121-131 or 121-141
AOC9						
AOC9-MW9Br	B	16	11-16[1]	11-16	31 or 41	21-31 or 21-41
AOC9-SB8	O	20.5	15.5-20.5[1]	–	–	–
AOC9-MW10Br	B	16	–	11-16	31 or 41	21-31 or 21-41
AOC9-MW11Br	B	29	–	24-29	44 or 54	34-44 or 34-54
B8717/WSA						
WSA-MW12Br	B	19	9-11	14-19	34 or 44	24-34 or 24-44
WSA-MW11	O	15.3	9-11	–	12	7-12
WSA-MW13Br	B	9	–	4-9	24 or 34	14-24 or 14-34
WSA-MW14Br	B	22	–	17-22	37 or 47	27-37 or 27-47

[1] Due to drilling difficulties caused by anticipated flowing sands, and the volume of soil required, the soil sample for the treatability study bench-scale tests can be collected at any depth within the specified interval.

Key:

B = bedrock
BGS = below ground surface
ft = ft
O = overburden

In addition to the bedrock wells, one soil boring will also be drilled at AOC 9 and overburden wells will be drilled and installed at LF6, B775, and B817/WSA. The overburden wells at LF6 and B775 are part of the scope of work presented in the November 19, 2001 Bedrock Groundwater Study Proposal (E & E 2001a). The primary purpose of these wells is to provide monitoring points at the hot spots at these sites. Contaminated groundwater and soil from these overburden wells will also be collected for a permanganate bench-scale study to supplement the Groundwater Treatability Pilot Study that will

also be implemented under this WAD in spring of 2002. The soil boring and overburden well in the hotspots at AOC 9 and B817/WSA were added to this work plan to supplement the Treatability Pilot Test Program. The purpose of the soil boring at AOC 9 is to collect contaminated soil for a peroxide bench-scale test (contaminated groundwater for the bench-scale test will be collected from existing well AOC9-MW08). The overburden well at B817/WSA will provide both contaminated soil and groundwater for a permanganate bench-scale test, and the well will serve as an injector/monitoring point for the field pilot. Clean soil and groundwater will also be collected during this program from one of the proposed bedrock program wells at all four sites to be used for the treatability bench-scale tests. A summary of the anticipated overburden well drilling and installation parameters is also provided in Table 2-1.

The following subsections describe the location and purpose of each of the wells to be installed at each site.

2.1.1 Landfill 6 and Building 775

Groundwater in the bedrock in the LF6 and B775 areas will be examined to determine if it poses a risk to downgradient receptors. Groundwater contamination would have to migrate approximately 1 mile before it could come in contact with any potential receptors. These objectives would be met through the installation of one overburden and two bedrock wells at each of the two sites. The proposed monitoring wells appear on Figure 2-1 (LF6) and Figure 2-2 (B775).

LF6 Proposed Wells

The LF6 proposed wells will be installed in the following order:

- **First Phase**
  - **LF6MW-12RBr:** The highest concentrations detected in the LF6 plume were at the vertical profile boring LF6VMW-12 (E & E 2000a). This vertically profiled borehole showed that contamination extended to the base of the overburden, (77 feet BGS), although the highest concentrations of contaminants were about halfway between the bedrock and the top of the water table (41 to 51 feet BGS). The bedrock well will be installed downgradient of this location adjacent to existing overburden well LF6VMW-12R. It will be used to determine if contaminants have migrated downward into the bedrock, to measure vertical gradient, and to serve as a long-term monitoring point (see Figure 2-1). A soil sample from the 41- to 51-foot depth interval and a groundwater

sample from the completed well will be used for the treatability bench-scale study.

- **LF6MW-12:** This overburden well will be installed at the original location of the LF6VMW-12 vertical profile borehole to monitor changes in contaminant levels at this location and serve as a long-term monitoring point (see Figure 2-1). A soil sample from the 41- to 51-foot depth interval and a groundwater sample from the completed well will be used for the treatability bench-scale study.

- **Second Phase (if necessary)**
  - **LF6MW-14Br:** This downgradient bedrock well will be installed adjacent to existing overburden well LF6VMW-14. It will be used to determine if contaminants have migrated downward into the bedrock, to measure vertical gradient, and to serve as a long-term monitoring point (see Figure 2-1).

B775 Proposed Wells

The B775 proposed wells will be installed in the following order:

- **First Phase**
  - **775MW-22Br:** The highest concentrations detected in the B775 plume were at the vertical profile boring 775VMW-20 (E & E 2000a). This vertically profiled borehole showed that contamination extended from 107 feet BGS to the base of the overburden (122 feet BGS), with the highest concentrations at the bedrock/overburden interface. The bedrock well will be installed downgradient of this location adjacent to existing overburden well 775VMW-22 to determine if contaminants have migrated further downward into the bedrock, to measure vertical gradient, and to serve as a long-term monitoring point (see Figure 2-2). A soil sample from the 101- to 106-foot depth interval and a groundwater sample from the completed well will be used for the treatability bench-scale study.
  - **775MW-20:** This overburden well will be installed at the original location of the 775VMW-20 vertical profile borehole to monitor changes in contaminant levels at this location and serve as a long-term monitoring point (see Figure 2-2). A soil sample from the 107- to 122-foot depth interval and a groundwater sample from the completed well will be used for the treatability bench-scale study.

- **Second Phase (if necessary)**
  - **775MW-20RBr:** This downgradient bedrock well will be installed adjacent to existing overburden well 775VMW-20R. It will be used to determine if contaminants have migrated downward into the bedrock, to measure vertical gradient, and to serve as a long-term monitoring point (see Figure 2-2).

2.1.2 AOC 9 and B817/WSA

Contaminated groundwater from these areas will have to migrate more than 2 miles beneath the base within the bedrock aquifer before reaching any potential receptors. In addition to determining the potential for downgradient migration, the proposed bedrock program will also determine if there are any upgradient bedrock aquifer contaminant sources (i.e., from the WSA [Weapons Storage Area]). Unlike the LF6 and B775 sites, the sources of contamination at AOC9 and B817/WSA are not as well known, and thus documentation of upgradient bedrock aquifer conditions is important in order to interpret any contamination that may be found in the bedrock downgradient of the overburden plumes.

AOC 9 Proposed Wells

The AOC 9 proposed wells will be installed in the following order:

- **First Phase**
  - **AOC9MW-9Br:** The highest concentration of contaminants was detected in overburden well AOC9-MW08 at a depth of 20.5 feet BGS (E & E 2001b). The plume is elongated and extends toward Six Mile Creek (SMC). The bedrock well will be installed downgradient of the plume to determine if contaminants have migrated further downward into the bedrock, and to serve as a long-term monitoring point (see Figure 2-3). A soil sample from the 15.5- to 20.5-foot depth interval and a groundwater sample from the completed well will be used for the treatability bench-scale study.
  - **AOC9-SB8:** This overburden soil boring well will be drilled adjacent to existing well AOC9-MW8 (see Figure 2-2). The purpose of this boring is to collect a soil sample from the 15.5- to 20.5-foot depth interval to be used for the treatability bench-scale study. Groundwater from AOC9-MW-8 will also be collected for the treatability bench-scale study.

- **Second Phase (if necessary)**
  - **AOC9MW-10Br:** This bedrock well will also be installed downgradient of the plume. It will be used in conjunction with the other two bedrock wells to be installed at this site, to determine the flow direction of groundwater to the west of SMC and within the SMC discharge zone. This information is important in determining the direction in which the plume would migrate off site.
  - **AOC9MW-11Br:** To document upgradient bedrock conditions, a bedrock well is proposed to be located inside the WSA between 2000 Supplemental Investigation (SI) Geoprobe locations AOC9-GP36 and AOC9-GP38 (see Figure 2-3). This well will determine if contaminants are migrating from an upgradient location within the WSA. As stated above, it will also help to determine the direction of groundwater flow in the bedrock.

B817/WSA Proposed Wells

The B817/WSA proposed wells will be installed in the following order:

- **First Phase**
  - **WSA-MW12Br:** The two highest concentrations detected in the plume at this site were found at Geoprobe point locations WSA-GP04 and WSA-GP09 at a depth of 13 to 15 feet BGS (E & E 2001c). This bedrock well will be installed downgradient of these points where bedrock is expected to be 20 to 25 feet BGS (see Figure 2-4). A soil sample from the 13- to 15-foot depth interval and a groundwater sample from the completed well will be used for the treatability bench-scale study.
  - **WSA-MW11:** This overburden well will be installed at the original location of Geoprobe point WSA-GP04 to monitor changes in contaminant levels at this location and serve as a long-term monitoring point (see Figure 2-4). A soil sample from the 13- to -15-foot depth interval and a groundwater sample from the completed well will be used for the treatability bench-scale study.

- **Second Phase (if necessary)**
  - **WSAMW-13Br:** This well will also be downgradient of the plume, approximately 20 feet deep in an area where bedrock is expected to be less than 10 feet deep (see Figure 2-4). It will help determine the flow directions, identify if contamination exists within the bedrock, and determine its potential to move off site.
  - **WSAMW-14Br:** This well will be an upgradient well paired close to the existing overburden well WSAMW-8, where bedrock was encountered approximately 18 feet BGS (see Figure 2-4). These wells will be used to determine the vertical gradient, as well as to document bedrock groundwater quality entering the site. It will also be also used to determine the flow direction of bedrock groundwater.

2.2 Sampling, Data Interpretation, and Reporting

Newly installed monitoring wells will be developed, sampled, and aquifer tested (slug tests) following drilling and completion. Additionally, existing well AOC9-MW8 will be sampled for the treatability study bench-scale tests. Table 2-2 presents a summary of the wells to be developed, sampled, and aquifer tested, and the sampling parameters for each well, and Table 2-3 presents a list of all samples to be collected and the planned testing. A summary report will be prepared documenting the following: installation, development, and sampling; data interpretation; bedrock groundwater conditions; hydrologic relationship between bedrock and the overburden; potential for migration off site; and recommendations for future actions.

Table 2-2 Summary of Wells to be Developed, Sampled, and Aquifer Tested, Bedrock Groundwater Study, Former Griffiss AFB, Rome, NY

Proposed Well No.	Well Development Y/N	Treatability Bench-Scale Samples (S/W)	Groundwater Samples (Y/N)		Aquifer Testing (Y/N)
			Hydropunch	Well	
LF6					
LF6MW-12RBr	Y	S/W	Y	Y	Y
LF6MW-12	Y	S/W	N	Y	Y
LF6MW-14Br	Y	–	Y	Y	Y
B775					
775MW-22Br	Y	S/W	Y	Y	Y
775MW-20	Y	S/W	N	Y	Y
775MW-20Br	Y	–	Y	Y	Y
AOC9					
AOC9-MW9Br	Y	S/W	Y	Y	Y
AOC9-SB8	N	S	N	N	N
AOC9-MW8	N	W	N	Y	N
AOC9-MW10Br	Y	–	Y	Y	Y
AOC9-MW11Br	Y	–	Y	Y	Y
B817/WSA					
WSA-MW12Br	Y	S/W	Y	Y	Y
WSA-MW11	Y	S/W	N	Y	Y
WSA-MW13Br	Y	–	Y	Y	Y
WSA-MW14Br	Y	–	Y	Y	Y

Table 2-3 Sample Listing, Bedrock Groundwater Study, Former Griffiss Air Force Base, Rome, NY

									ANALYSES																					
Location	Date	Sample Number	Lab	Sample Depth[a]	Matrix	WP	Stat	Type	Treatability Bench-Scale Tests Water	Treatability Bench-Scale Tests Soil	TCL VOCs -SW8260B	TCL VOCs -SW8021B	TCL VOCs -EPA 524.2	MEE[b]	Anions[c]	Sulfide	Dissolved Organic Carbon	Total Organic Carbon	% Solids -ASTM_D2216	TCLP VOCs	TCLP SVOCs	TCL PCBs	TCLP Metals/Mercury	Ignitability	pH	Reactivity
Landfill 6	TBD	LF6MW-12RBr-SO	ASC	41' - 51'	Subsurface Soil	Y	O	N		X																	
	TBD	LF6MW-12RBr-HP	ASC	66.5' - 71.5'	Groundwater	Y	O	N				X															
	TBD	LF6MW-12RBr	ASC	76.5' - 96.5'	Groundwater	Y	O	N	X				X	X	X	X	X										
	TBD	LF6MW-12RBr (MS/MSD)	ASC	76.5' - 96.5'	Groundwater QC	Y	O	MS					X	X	X	X	X										
	TBD	LF6MW-12-SO	ASC	41' - 51'	Subsurface Soil	Y	O	N		X	X							X	X								
	TBD	LF6MW-12	ASC	41' - 51'	Groundwater	Y	O	N	X				X	X	X	X	X										
	TBD	LF6MW-14Br-HP	ASC	80.5' - 85.5'	Groundwater	Y	O	N				X															
	TBD	LF6MW-14Br	ASC	90.5' - 110.5'	Groundwater	Y	O	N					X	X	X	X	X										
B775	TBD	B775MW-22Br-SO	ASC	101' - 106'	Subsurface Soil	Y	O	N		X																	
	TBD	B775MW-22Br-HP	ASC	101' - 106'	Groundwater	Y	O	N				X															
	TBD	B775MW-22Br-HP/D	ASC	101' - 106'	Groundwater	Y	O	FD				X															
	TBD	B775MW-22Br-HP/S	ERDC	101' - 106'	Groundwater	Y	O	FR				X															
	TBD	B775MW-22Br	ASC	111' - 131'	Groundwater	Y	O	N	X				X	X	X	X	X										
	TBD	B775MW-20-SO	ASC	107' - 122'	Subsurface Soil	Y	O	N		X	X							X	X								
	TBD	B775MW-20	ASC	112' - 122'	Groundwater	Y	O	N	X				X	X	X	X	X										
	TBD	B775MW-20/D	ASC	112' - 122'	Groundwater	Y	O	FD					X	X	X	X	X										
	TBD	B775MW-20/S	ERDC	112' - 122'	Groundwater	Y	O	FR					X	X	X	X	X										
	TBD	B775MW-20Br-HP	ASC	111' - 116'	Groundwater	Y	O	N				X															
	TBD	B775MW-20RBr	ASC	121' - 141'	Groundwater	Y	O	N					X	X	X	X	X										
AOC9	TBD	AOC9-MW9Br-SO	ASC	11' - 16'	Subsurface Soil	Y	O	N		X																	
	TBD	AOC9-MW9Br-HP	ASC	11' - 16'	Groundwater	Y	O	N				X															
	TBD	AOC9-MW9Br	ASC	21' - 41'	Groundwater	Y	O	N	X				X	X	X	X	X										
	TBD	AOC9-SB8-SO	ASC	15.5' - 20.5'	Subsurface Soil	Y	O	N		X	X							X	X								
	TBD	AOC9-MW8	ASC	15' - 20'	Groundwater	Y	O	N	X																		
	TBD	AOC9-MW10Br-HP	ASC	11' - 16'	Groundwater	Y	O	N				X															
	TBD	AOC9-MW10Br	ASC	21' - 41'	Groundwater	Y	O	N					X	X	X	X	X										
	TBD	AOC9-MW11Br-HP	ASC	24' - 29'	Groundwater	Y	O	N				X															
	TBD	AOC9-MW11Br	ASC	34' - 54'	Groundwater	Y	O	N					X	X	X	X	X										
	TBD	AOC9-MW11Br (MS/MSD)	ASC	34' - 54'	Groundwater QC	Y	O	MS					X	X	X	X	X										

Key at the end of Table

Table 2-3 Sample Listing, Bedrock Groundwater Study, Former Griffiss Air Force Base, Rome, NY

									ANALYSES																					
Location	Date	Sample Number	Lab	Sample Depth[a]	Matrix	WP	Stat	Type	Treatability Bench-Scale Tests Water	Treatability Bench-Scale Tests Soil	TCL VOCs -SW8260B	TCL VOCs -SW8021B	TCL VOCs -EPA 524.2	MEE[b]	Anions[c]	Sulfide	Dissolved Organic Carbon	Total Organic Carbon	% Solids -ASTM D2216	TCLP VOCs	TCLP SVOCs	TCL PCBs	TCLP Metals/Mercury	Ignitability	pH	Reactivity
B817/WSA	TBD	WSA-MW12Br-SO	ASC	9' - 11'	Subsurface Soil	Y	O	N		X																
	TBD	WSA-MW12Br-HP	ASC	14' - 19'	Groundwater	Y	O	N				X														
	TBD	WSA-MW12Br	ASC	24' - 44'	Groundwater	Y	O	N	X				X	X	X	X	X									
	TBD	WSA-MW11-SO	ASC	9' - 11'	Subsurface Soil	Y	O	N		X	X							X	X							
	TBD	WSA-MW11	ASC	7' - 12'	Groundwater	Y	O	N	X				X	X	X	X	X									
	TBD	WSA-MW13Br-HP	ASC	4' - 9'	Groundwater	Y	O	N				X														
	TBD	WSA-MW13Br-HP (MS/MSD)	ASC	4' - 9'	Groundwater QC	Y	O	MS				X														
	TBD	WSA-MW13Br	ASC	14' - 34'	Groundwater	Y	O	N					X	X	X	X	X									
	TBD	WSA-MW14Br-HP	ASC	17' - 22'	Groundwater	Y	O	N				X														
	TBD	WSA-MW14Br	ASC	27' - 47'	Groundwater	Y	O	N					X	X	X	X	X									
	TBD	WSA-MW14Br/D	ASC	27' - 47'	Groundwater	Y	O	FD					X	X	X	X	X									
	TBD	WSA-MW14Br/S	ERDC	27' - 47'	Groundwater	Y	O	FR					X	X	X	X	X									
All Sites - Hydropunch	TBD	Hydropunch-RB1	ASC	-	Eqpt. Washwater	Y	O	N				X														
	TBD	ASC-TB1	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ASC-TB2	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ASC-TB3	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ASC-TB4	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ASC-TB5	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ASC-TB6	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ASC-TB7	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ASC-TB8	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ASC-TB9	ASC	-	Groundwater QC	Y	O	TB				X														
	TBD	ASC-TB10	ASC	-	Water/QC Matrix	Y	O	TB				X														
	TBD	ERDC-TB1	ASC	-	Groundwater QC	Y	O	TB				X														
	TBD	Drill Water	ASC	-	Water/QC Matrix	Y	O	N				X														
All Sites - Phase I	TBD	ASC-TB11	ERDC	-	Water/QC Matrix	Y	O	TB					X													
	TBD	ASC-TB12	ASC	-	Groundwater QC	Y	O	TB					X													
	TBD	ASC-TB13	ASC	-	Water/QC Matrix	Y	O	TB					X													
	TBD	ASC-TB14	ERDC	-	Water/QC Matrix	Y	O	TB					X													
	TBD	ERDC-TB2	ASC	-	Water/QC Matrix	Y	O	TB					X	X												
	TBD	MEE-TB1	TBD	-	Water/QC Matrix	Y	O	TB						X												
	TBD	MEE-TB2	TBD	-	Water/QC Matrix	Y	O	TB						X												
	TBD	MEE-TB3	TBD	-	Water/QC Matrix	Y	O	TB						X												
	TBD	MEE-TB4	TBD	-	Water/QC Matrix	Y	O	TB						X												

Key at the end of Table

Table 2-3 Sample Listing, Bedrock Groundwater Study, Former Griffiss Air Force Base, Rome, NY

									ANALYSES																				
Location	Date	Sample Number	Lab	Sample Depth[a]	Matrix	WP	Stat	Type	Treatability Bench-Scale Tests Water	Treatability Bench-Scale Tests Soil	TCL VOCs -SW8260B	TCL VOCs -SW8021B	TCL VOCs -EPA 524.2	MEE[b]	Anions[c]	Sulfide	Dissolved Organic Carbon	Total Organic Carbon	% Solids -ASTM D2216	TCLP VOCs	TCLP SVOCs	TCL PCBs	TCLP Metals/Mercury	Ignitability	pH	Reactivity
All Sites - Phase II	TBD	ASC-TB15	ASC	-	Groundwater QC	Y	O	TB					X													
	TBD	ASC-TB16	ASC	-	Water/QC Matrix	Y	O	TB					X													
	TBD	ASC-TB17	ERDC	-	Water/QC Matrix	Y	O	TB					X													
	TBD	ERDC-TB3	ERDC	-	Water/QC Matrix	Y	O	TB					X	X												
	TBD	MEE-TB5	TBD	-	Water/QC Matrix	Y	O	TB						X												
	TBD	MEE-TB6	TBD	-	Water/QC Matrix	Y	O	TB						X												
	TBD	MEE-TB7	TBD	-	Water/QC Matrix	Y	O	TB						X												
All Sites - IDW	TBD	IDW-Soil	TBD	-	IDW	Y	O	N											X	X	X	X	X	X	X	X
	TBD	IDE-Water	TBD	-	IDW	Y	O	N												X	X	X	X	X	X	X

[a] The listed depths represent the contaminated zone to be sampled and not the actual sample depths. The actual sample depths will be determined in the field.

[b] MEE analyses will not be performed by E & E's Analytical Services Center. The subcontracted laboratory will be determined prior to initiation of fields activities.

[c] The samples will be analyzed for the following anions: sulfate, chloride, nitrate, and nitrite.

Key:

AOC9 = Area of Concern 9
ASC = E & E's Analytical Services Center
B775 = Building 775
B817 = Building 817
Br = bedrock well
/D = duplicate
Depth = depth interval at which sample will be collected
Eqpt. = equipment
ERDC = United States Army Engineer Research and Development Center
FD = field duplicate
FR = field split/replicate
HP = hydropunch sample
IDW = investigation derived waste
LF6 = Landfill 6
MEE = methane, ethane, ethene
MW = Monitoring well
MS/MSD = matrix spike/matrix spike duplicate
N = original sample
QC = quality control sample
PCB = polychlorinated biphenyl
RB = rinsate blank
/S = split.
SB = soil boring
SO = soil sample
Stat = Status (O= Open, T= Taken, S= Skipped)
SVOCs = semivolatile organic compounds
TB = trip blank
TBD = to be determined
TCL = target compound list
TCLP = toxicity characteristic leachate procedure
VOCs = volatile organic compounds
WP = sample in work plan (Y= yes, N= no)
WSA = Weapons Storage Area

Key at the end of Table

3 Field Methodology

Bedrock well drilling and installation will be performed in accordance with the procedures described in this plan (see Appendix C), and overburden well drilling, installation, development, and sampling will be performed according to the procedures outlined in the December 1999 Field Sampling Plan (FSP) for the Landfill 6 and Building 775 Areas of Concern Groundwater Study (E & E 1999), and February 2000 Addendum to the March 1997 Work Plan for the Site Investigations of Areas of Concern (for AOC 9 and B817/WSA) (E & E 2000b) for each of the respective sites. Both plans include a Quality Assurance Project Plan (QAPjP) and Health and Safety Plan (HASP) for these sites. Table 3-1 summarizes the soil and groundwater sample depths and volumes needed for the treatability bench-scale studies, Table 3-2 provides a summary of the sample containers, amounts, and holding times, and Figures 3-1 and 3-2 illustrate typical bedrock well constructions, and Figure 3-3 illustrates typical overburden well construction. Deviations from the methodologies from these FSPs or this plan will be documented on Field Adjustment Forms and presented in the report (see Figure 3-4).

Table 3-1 Soil and Groundwater Sample Depths and Amounts for Treatability Bench-Scale Studies

Well/Boring No.	Soil Sample Depth Interval (ft BGS)	Water Volume for Bench-Scale Tests	Composite Soil Volume for Bench-Scale Tests	Soil Sample Volume for ASC Tests
LF6MW-12	41-51	4 1-liter ambers	4 8-ounce jars	One 4-ounce jar and one 8-ounce jar
LF6MW-12RBr	41-51	4 1-liter ambers	4 8-ounce jars	–
775MW-20	107-122	4 1-liter ambers	4 8-ounce jars	One 4-ounce jar and one 8-ounce jar

Table 3-1 Soil and Groundwater Sample Depths and Amounts for Treatability Bench-Scale Studies

Well/Boring No.	Soil Sample Depth Interval (ft BGS)	Water Volume for Bench-Scale Tests	Composite Soil Volume for Bench-Scale Tests	Soil Sample Volume for ASC Tests
775MW-22Br	101-106	4 1-liter ambers	4 8-ounce jars	–
AOC9-SB8	15.5-20.5	–	4 8-ounce jars	One 4-ounce jar and one 8-ounce jar
AOC9-MW8	–	4 1-liter ambers	–	–
AOC9-MW9Br	11-16	4 1-liter ambers	4 8-ounce jars	–
WSA-MW11	9-11	4 1-liter ambers	4 8-ounce jars	One 4-ounce jar and one 8-ounce jar
WSA-MW12Br	9-11	4 1-liter ambers	4 8-ounce jars	–

Note: See Tables 2-3 and 3-3. Discreet samples can be collected from any interval with range specified with depth interval noted on the chain-of-custody.

Key:

ASC = Ecology and Environment, Inc.'s Analytical Services Center.
BGS = Below ground surface.

All original samples and Quality Control (QC) samples including duplicates, trip blanks, matrix spike/matrix spike duplicates, and rinsates will be sent to E & E's Analytical Services Center for standard turn around analyses:

Attn: Mr. Bill Howard
Ecology and Environment Analytical Services Center
4493 Walden Avenue
Lancaster, New York 14086
716-685-8080
716-685-0852 (fax)
whoward@ene.com

All Quality Assurance samples (i.e., split samples) will be sent to the United States Army Engineer Research and Development Center Quality Assurance Laboratory (ERDC) with the LIMS No. (6567) at the top of the chain-of-custody form:

Attn: Ms. Laura Percifield
420 South 18th Street
Omaha, Nebraska 68102-2685
402-444-4300
402-341-5448 (fax)

Table 3-2 Summary of Sample Containers, Amounts, Preservation, and Holding Times for Water Samples, Former Griffiss Air Force Base, Rome, NY

Method	Parameter	Sample Container[a, b]	Amount	Preservation	Holding Time	
					Extraction	Analysis[c]
Well Water Samples						
EPA DW 524.2	Volatile organics	Three 40-ml VOA vials with teflon septa	full; no headspace	HC1 to pH <2; Cool to 4°C	NA	7 days
EPA 300	Anions (sulfate, chloride, nitrate, nitrite)	One 1-L polyethylene bottle	Full	Cool to 4° C	NA	48 hours
EPA 376.1	Sulfide	One 1-L polyethylene bottle	Full	NaOH/Zinc acetate to pH>9; cool to 4°C	NA	7 days
SM 5310B	Dissolved organic carbon[d]	One 125 ml polyethylene bottle	Full	H_2SO_4 to pH<2; cool to 4° C	NA	28 days
SW 3810/8015 modified	Methane, ethane, and ethene	Two 40 ml glass VOA vials with teflon septa	Full; no headspace	Cool to 4° C	NA	7 days
Hydropunch Samples						
SW 8021B	Volatile organics	Two 40-ml glass VOA vials with teflon septa	Full; no headspace	Cool to 4° C	NA	7 days

Note: Holding times are from verified time of sample receipt as required by New York State Department of Environmental Conservation, Analytical Services Protocol (ASP). All soil samples must be analyzed for percent solids.

[a] All containers to have teflon-lined lids; VOA containers to have teflon-lined septa.
[b] Samples chosen from quality assurance analysis require double the number of containers indicated.
[c] All number of days are from date of collection.
[d] DOC samples will be filtered in the field prior to analysis.

Key:
DOC = Dissolved organic carbon.
EPA = United States Environmental Protection Agency, "Methods for Chemical Analysis of Water and Wastes," EP600/4-79-020, 1983.
EPA DW = United States Environmental Protection Agency, "Methods for the Determination of Organic Compounds in Drinking Water-Supplement 11," EP600/R/92/129, 1992.
HCl = Hydrochloric acid.
L = Liter.
ml = Milliliter.
NA = Not applicable.
SM = Standard Methods for Examination of Water and Wastewater, 18th ed.
SW = United States Environmental Protection Agency, "Test Methods for Evaluating Solid Wastes," SW-846, Third Edition, 1986, up to Update III.
VOA = Volatile organic analysis.

Table 3-3 Summary of Sample Containers, Amounts, Preservation Methods, and Holding Times for Soil Samples, Former Griffiss Air Force Base, Rome, NY

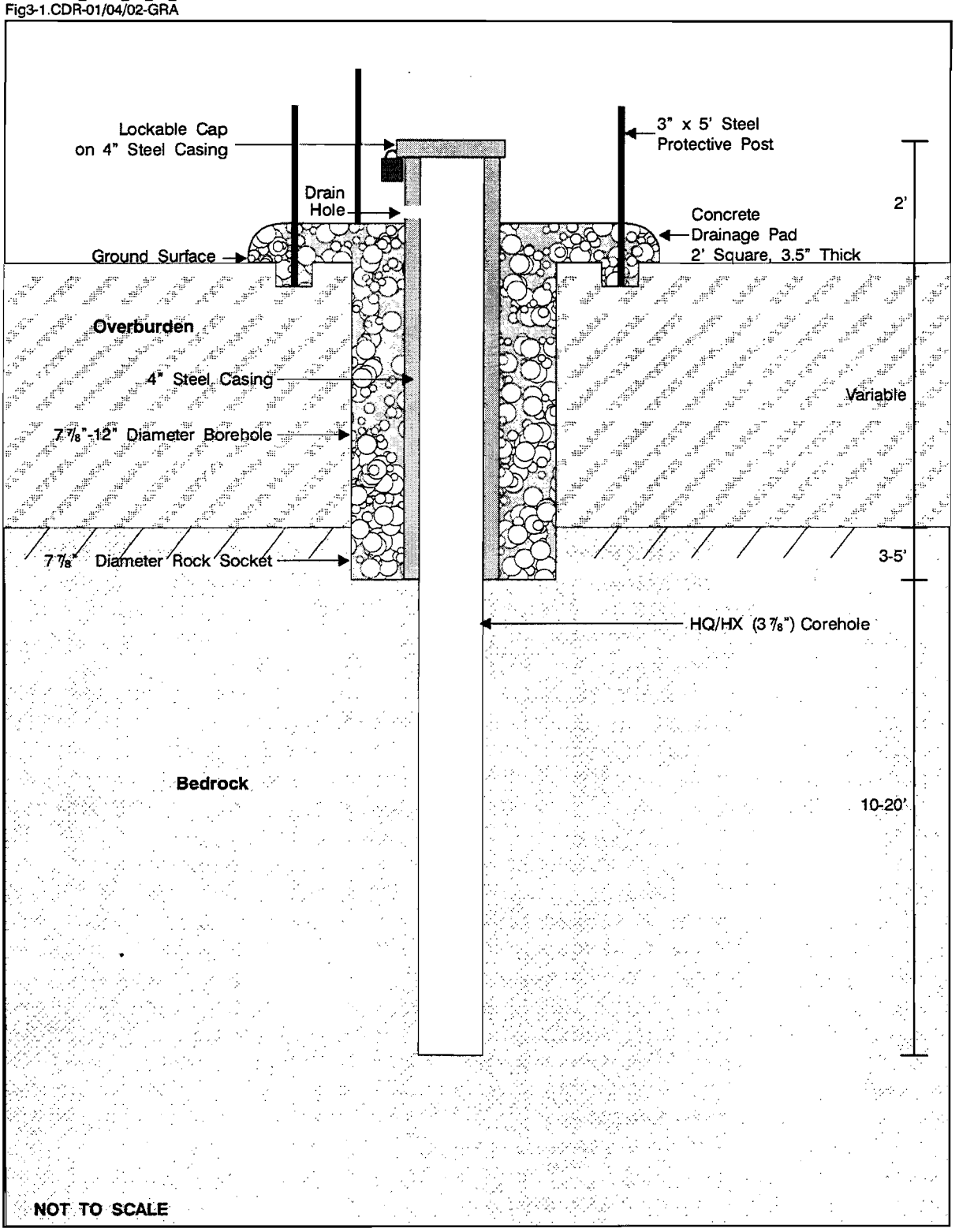
Method	Parameter	Sample Container[a, b, c]	Amount	Preservation Method	Holding Time	
					Extraction	Analysis[c]
SW 8260B	TCL Volatile Organics	One 4-ounce clear wide-mouth VOA jar with teflon septae	Full; no headspace	Cool to 4°C	NA	7 days
Lloyd Kahn	Total Organic Carbon	One 8-ounce, clean wide-mouth glass jar	–	–	NA	26 days
ASTM D2216	Percent solids					

[a] All containers to have teflon-lined lids; VOA containers to have teflon-lined septa.
[b] Samples chosen from quality assurance analysis require double the number of containers indicated.
[c] All number of days are from date of collection.

Key:

NA = Not applicable.
Lloyd Kahn = United States Environmental Protection Agency, "Total Organic Carbon by Method Lloyd Kahn," 1998.
SW = United States Environment Protection Agency. "Test Methods for Evaluating Solid Wastes," SW-846, Third Edition, 1986, up to Update III.
TCL = Target Compound List.
VOA = Volatile organic analysis.

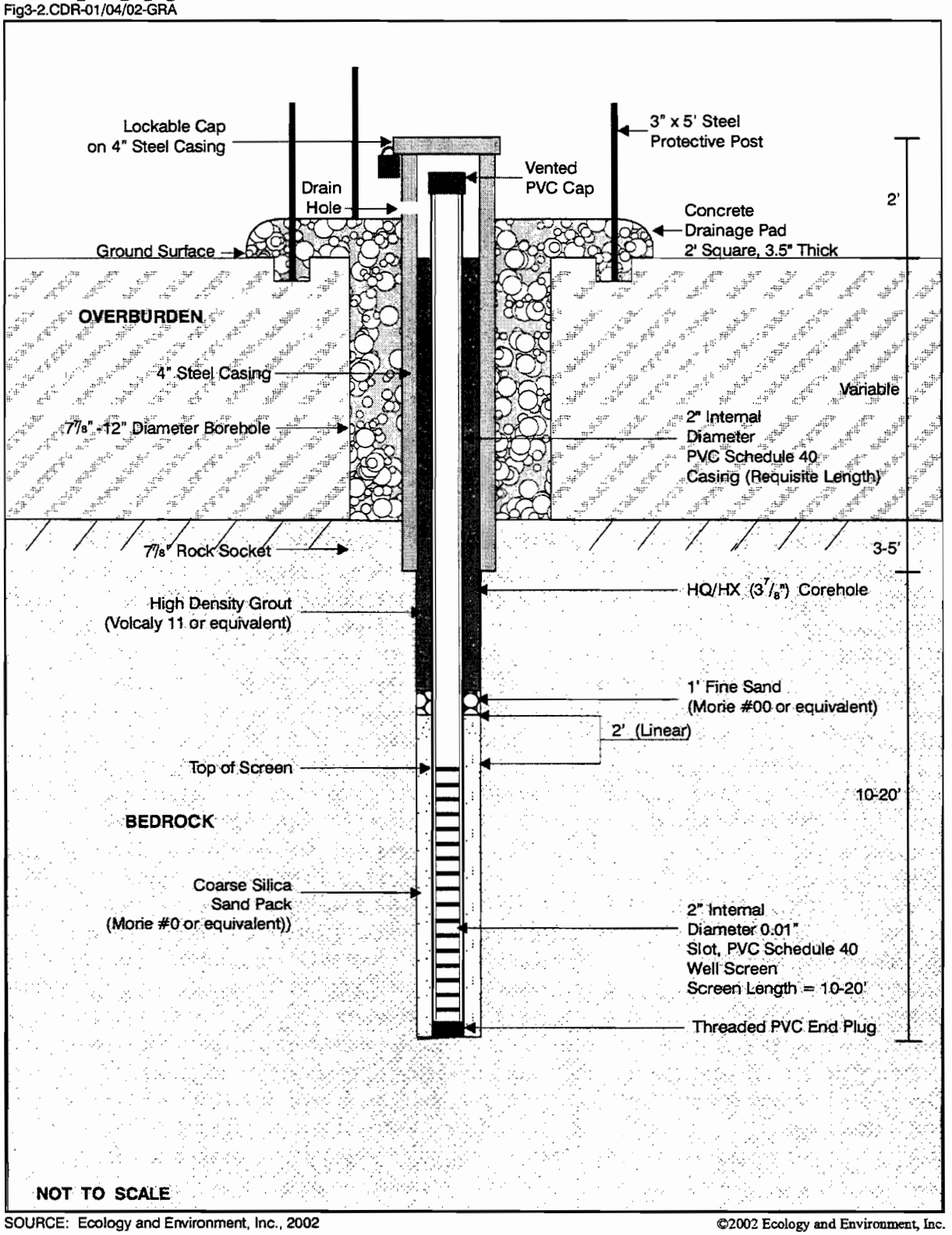
02: 001002_UK04_11_01_00-B0871
Fig3-1.CDR-01/04/02-GRA



SOURCE: Ecology and Environment, Inc., 2002

Figure 3-1 **PROPOSED CONSTRUCTION FOR OPEN-HOLE BEDROCK MONITORING WELLS**

02: 001002_UK04_11_01_00
Fig3-2.CDR-01/04/02-GRA



SOURCE: Ecology and Environment, Inc., 2002

Figure 3-2 PROPOSED CONSTRUCTION FOR BEDROCK MONITORING WELLS WITH INNER CASING AND SCREEN

02: 001002_UK04_11_01_00-B0871
Fig3-3.CDR-01/04/02-GRA

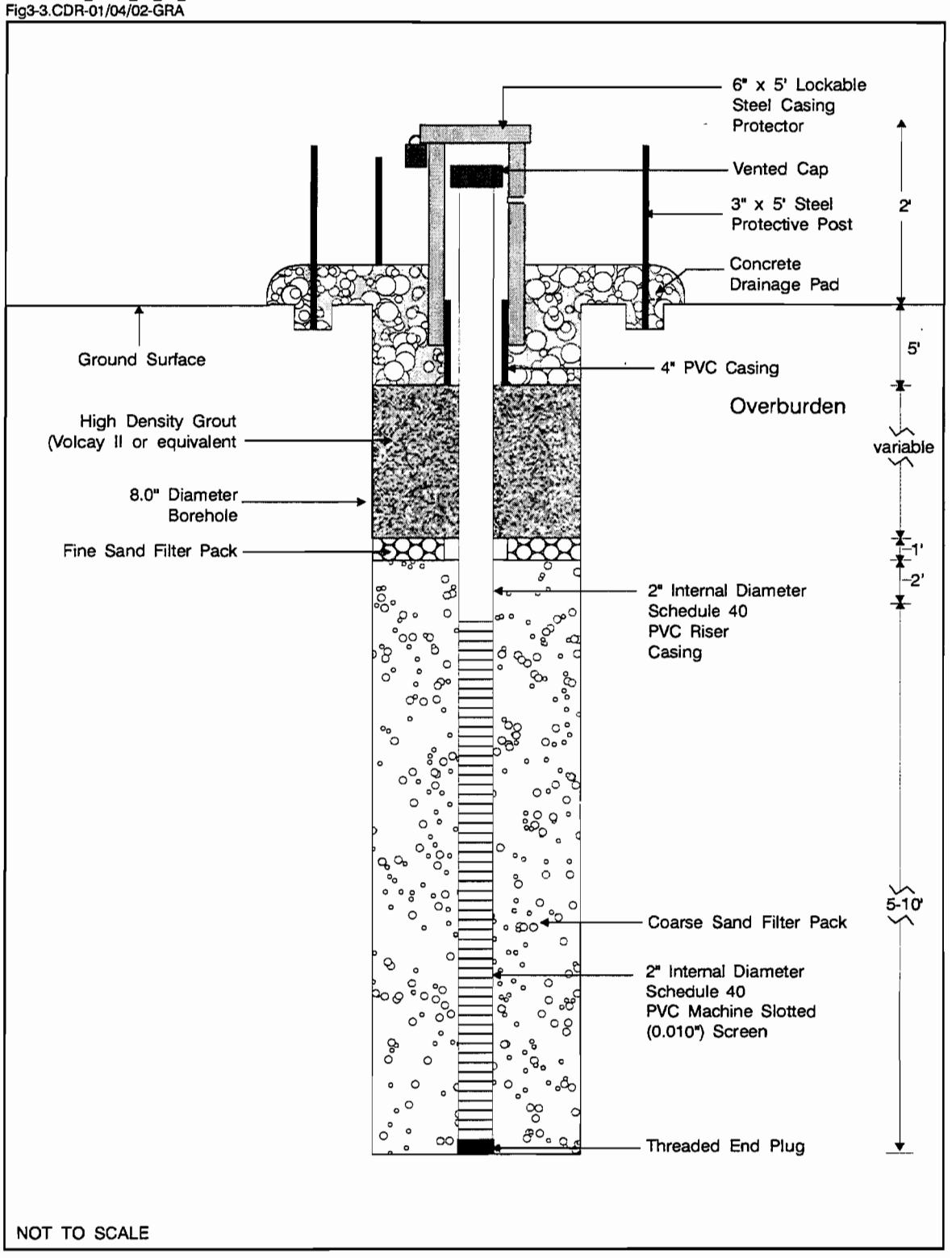


Figure 3-3 PROPOSED CONSTRUCTION FOR OVERBURDEN MONITORING WELLS

Field Adjustment Form No. __ Former Griffiss AFB			
To:	Mr. Douglas M. Pocze USEPA - Region 2 Federal Facilities Section 290 Broadway New York, New York 10007 Fax: (212) 637-3256 Office: (212 637-4432	Mr. Jonathan Greco NYSDEC Bureau of Eastern Remedial Action 50 Wolf Road Albany, New York 12233-7010 Fax: (518) 457-8990 Office: (518)457-3976	
From:	Mr. Michael McDermott AFBCA 153 Brooks Road Rome, NY 13441-4105 Fax: (315) 330-4062 Office: (315) 330-2275	Date: Time:	
Site:		**Work Plan Section:**	**Page:**
Need for Field Adjustment			
Prepared by: G. Florentino		Organization E & E	Date:
Approved by:		Org: USACE	Date:

Figure 3-4 Bedrock Groundwater Field Adjustment Form

4 References

Ecology and Environment, Inc., 2001a, Bedrock Well Proposal, November 19, 2001, Griffiss Air Force Base, Rome, New York.

_____, 2001b, *AOC 9: Weapons Storage Area (WSA) Landfill Supplemental Investigation Final Data Summary Report, Griffiss Air Force Base, Rome, New York.*

_____, 2001c, *Weapons Storage Area (WSA) Supplemental Investigation Final Data Summary Report, Griffiss Air Force Base, Rome, New York*

_____, 2000a, Landfill 6 and Building 775 Areas of Concern Groundwater Study Technical Memorandum No.1: Field Investigation Conducted in Spring 2000, Griffiss Air Force Base, Rome, New York.

_____, 2000b, Addendum to the March 1997 Work Plan for the Site Investigations of Areas of Concern, Griffiss Air Force Base, Rome, New York.

_____, 1999, *Field Sampling Plan for the Landfill 6 and Building 775 Areas of Concern Groundwater Study, Griffiss Air Force Base, Rome, New York.*

Law Environmental Services, Inc. (Law), 1996, *Draft Final Primary Report, Remedial Investigation at Griffiss Air Force Base, Rome, New York.*

UNC Geotech, 1991, *Hydrologic Study Report, Griffiss Air Force Base, Rome, New York.*

Weston, R. F., 1985, Installation Restoration Program Phase II - Confirmation/Quantification Stage 2 for Griffiss Air Force Base, Rome, New York.

Appendix A

USEPA Comments and Responses to the November 19, 2001 Bedrock Groundwater Study Proposal

1. **Comment:** *There are several aspects of the proposal that I have commented upon and need clarification. First, there exists the possibility that plumes can flow an extensive distance in bedrock without dispersion or attenuation. While currently there is no evidence of such a plume at Griffiss, the plan seems to avoid any notion of the possibility. Please note groundwater flow in bedrock primarily occurs along discrete joints, fractures and bedding planes and is significantly less prone to natural attenuation than plumes in unconsolidated formations. As is evident from previous investigations at the former Griffiss Air Force Base, merely planning to install a monitoring well 10 feet into competent bedrock does not always yield sufficient groundwater to be a useful monitoring point. This phase is not a full characterization of a bedrock plume, but only the installation of monitoring wells to assess if the bedrock aquifer is impacted from the sites. It is therefore logical and imperative to install all the newly proposed bedrock monitoring wells to a sufficient depth to ensure adequate water yield for sampling and analysis. I suggest the specifications be modified to stipulate a minimum yield (0.5 gpm should be sufficient) so that fractures or bedding/joints are certain to be intercepted before completing the borehole. A 20 foot well screen interval is permissible in tight formations.*

Response: The intent of the proposed SOW was to determine if there is a water-bearing zone in the top of competent rock, and if so, whether it is clean or contaminated. Deeper in the shale formation, it is likely that the fractures will become less frequent and tighter. Also, more importantly, the source of groundwater deeper in the formation may be from areas other than that of the site in question. Based on results of the RI bedrock wells, groundwater was encountered in the top 10 of competent rock, and sufficient volume was obtained to collect samples. Therefore, AFBCA has agreed to drilling an additional 10 feet into bedrock if the first 10 feet produces little water or is dry. However, drilling will be terminated 20 feet into bedrock regardless of whether sufficient water is encountered.

2. **Comment:** *Previous drilling and sampling has revealed the presence of contaminants to the top of bedrock. I do not believe the proposed four inch casing is*

sufficient to seal the unconsolidated formations from the competent bedrock. I suggest ODEX drilling or alternate methods instead of mud-rotary techniques may be more appropriate.

Response: A 4-inch casing set in a 7 7\8-inch diameter, 3- to 5-foot rock socket is more than sufficient in sealing-off the overburden. In addition, the mud will create a seal in the overburden during drilling further preventing the downward migration of contaminants into the rock. Furthermore, ODEX and other specialty drilling is logistically difficult at LF6 and B775 due to access problems (i.e., specialty rigs are generally larger and heavier, and will not be able to access the appropriate drilling areas without bulldozing and creating gravel access roads).

3. **Comment:** T*he use of "Hydropunch" sampling to collect a water sample immediately above top of bedrock is a good screening tool. A contingency plan for an alternate drilling location should be prepared if DNAPL is detected at any borehole.*

Response: AFBCA agrees. In the unlikely event that a DNAPL is detected above bedrock, a well will be installed at that depth, and drilling will not continue into bedrock at that location. The bedrock well will be moved further downgradient at a location agreed upon by all parties (USACE, AFBCA, E & E, USEPA, and NYSDEC).

4. **Comment:** *Figure 4 (Figure 2-4 in the work plan) indicates 1 "upgradient" and 2 "downgradient" monitoring wells. I am under the assumption that the well identified as WSA-MW2D on Figure 4, is actually proposed well WSAMW-12D on page 5 of the text. Overall, the proposed locations appear acceptable, with caution. At AOC9 and AOC - south of WSA, the distances between upgradient and downgradient as well as from the concentrated areas of the unconsolidated formation plumes is possibly too large to enable the three points to be used for flow direction analyses with any reliability. I will need to have a better explanation as*

to why these downgradient locations were selected and whether locations closer to the unconsolidated plume might be more beneficial.

Response: Yes, WSA-MW2D should have been WSA-MW-12D, however, although the well locations are the same, they have been given a new nomenclature in the work plan. The reason the distance between the upgradient and downgradient wells is due to the elongated nature of the plumes at these sites. The three points at each site should be ok to be used for determining the direction of groundwater flow.

Appendix B

NYSDEC Comments and Responses to the November 19, 2001 Bedrock Groundwater Study Proposal

1. **Comment:** Bottom of page 1 (and a few other places in the document): The likeliness (or unlikeness) of a contaminant plume migrating off-site really has no bearing upon the work plan for well installation.... Why is this discussion here?

Response: This discussion was included to provide a conceptual site model for the site to add in the understanding of the goals of the proposed work.

2. **Comment:** Page 2: How will the consultant/driller take the hydropunch sample just above the bedrock? I.E., will he be continuously driving spoons ahead of the augers, and when the spoons meet refusal, take a water sample? How will he be able to keep the mud out of the sample?

Response: Aside from some depth specific soil sampling planned to obtain samples for the upcoming treatability bench-scale studies at these sites, split spoons will not be driven during drilling because the soils information is not needed (i.e., complete drill logs exist at all four sites at or in close proximity to the proposed well locations) and there are drilling problems with flowing sands. In turn, the depth to bedrock is also known at most locations from these drill logs. Therefore, drilling will cease approximately 5 feet above top of rock, and a Hydropunch sampler will be driven two or three feet ahead of the augers to collect groundwater from the undisturbed area immediately above top of rock. The Hydropunch has a sealed tip that will keep drilling mud and/or formation water out. After driving the sampler to the desired depth, the tip falls off when the sampler is retracted approximately 6-inches. The sampler will then fill with formation water.

3. **Comment:** Once the casing is set into the bedrock, all the drilling mud should be pumped out, and the coring should be done with potable water (unless there is sufficient formation water, precluding the need for adding potable water).

Response: E & E agrees (i.e., this is what was planned).

4. **Comment:** A few drawings of the proposed wells would be nice (e.g., show the casing diameter, auger size, core size, thickness of bentonite seal at the interface, etc.).

Response: The November 19, 2001 document was not intended to be a work plan. The work plan for this investigation will include well construction diagrams, as well as all the necessary procedures.

5. **Comment:** Will the space between the boring wall and the casing be grouted? (It should be, so you'll need adequate auger diameter to allow for grouting.

Response: Yes, the annulus space between the boring wall and the 4-inch carbon steel casing will be grouted. At LF6 and B775, 7 7/8-inch mud rotary drilling techniques will be used to drill through the overburden and 3 to 5 feet into the top of tock. Therefore, the 4-inch casing will be set and grouted into a 7 7/8-inch borehole. At AOC 9 and B817/WSA, 8 ¼-inch augers will be used to drill through the overburden, then a 7 7/8-inch roller bit will be used to drill through the rock prior to installing the 4-inch steel casing.

6. **Comment:** The details of well development should be provided (e.g., what are the goals, when will it be performed, etc,).

Response: The November 19, 2001 document was not intended to be a work plan. The work plan for this investigation references well development procedures adopted for previous investigations at these sites.

7. **Comment:** Other than that, the basic plan is fine. Give me a call if you need to discuss.

Appendix C

Drilling Scope of Work

Landfill 6, Building 775, AOC 9, and Building 817
Bedrock Groundwater Study
Former Griffiss Air Force Base
Rome, New York
Drilling Scope of Work

Project Description

Ecology and Environment, Inc. (E & E), will be conducting a Bedrock Groundwater Study at the Landfill 6 (LF6), Building 775 (B775), Area of Concern 9 (AOC 9), and Building 817/Weapons Storage Area (B817/WSA) sites at the former Griffiss Air Force Base in Rome, New York. Hydropunch, drilling, and well installation services are required for this study.

Scope of Work (SOW)

Contamination in the overburden at these sites has been detected immediately above bedrock. The contamination includes the following: Trichloroethene (TCE), perchloroethene (PCE), and their breakdown products (1,2 dichloroethene and vinyl chloride) at LF6, B775, and B817/WSA; and a mixed plume of chlorobenzene and TCE and its breakdown products at AOC 9.

A maximum of one soil boring, three overburden wells, and 10 bedrock wells will be installed at these sites. The proposed bedrock wells will be installed in a phased approach. The first phase will include the installation of one bedrock well at each site. If the well is dry, no other bedrock wells will be installed at that site (but the proposed soil boring and overburden wells will be installed regardless). **If the bedrock well produces a sufficient amount of water to allow development and sampling, the remaining proposed site bedrock wells will be installed as part of the second phase. The second phase will immediately follow the first phase (i.e., an E & E development team will be following behind the E & E drilling team so that a second mobilization will not be required).**

Estimated well depths will range from approximately 140 feet at LF6 and B775 to around 30 feet at AOC 9 and B817/WSA.

The order of well installations at each site is provided below.

LF6 Proposed Wells:

- First Phase
  - LF6MW-12RBr (bedrock)
  - LF6MW-12 (overburden)

- Second Phase (if necessary)
  - LF6MW-14Br (bedrock)

B775 Proposed Wells:

- First Phase
  - 775MW-22Br (bedrock)
  - 775MW-20 (overburden)

- Second Phase (if necessary)
  - 775MW-20RBr (bedrock)

AOC 9 Proposed Wells:

- First Phase
  - AOC9-MW9Br (bedrock)
  - Boring adjacent to AOC-9SB8 (soil boring)

- Second Phase (if necessary)
  - AOC9-MW10Br (bedrock)
  - AOC9-MW11Br (bedrock)

B817/WSA Proposed Wells:

- First Phase
  - WSAMW-12Br (bedrock)
  - WSAMW-11 (overburden)

- Second Phase (if necessary)
  - WSAMW-13Br (bedrock)
  - WSAMW-14Br (bedrock)

Utility Clearance

E & E and/or the client will provide utility clearance for all subsurface activities.

Drilling Water Source

Only clean, potable water will be used for drilling. E & E will aid the drilling company with making arrangements to obtain water from the base.

Boring and Monitoring Well Installation Methodology

Soil borings and overburden monitoring wells will be drilled using 4.25-inch hollow stem augers. Soil samples will be collected at one specified depth using standard split spoon samplers, and one grab groundwater sample will be collected at one specified depth using bailers or Hydropunch samplers. Overburden wells will be installed as described below.

Bedrock wells will be drilled using 7-7/8 mud rotary techniques through the overburden to a depth of 3 to 5 feet into the top of bedrock. Soil samples will be collected using standard split spoon samplers at one specified depth, and one grab groundwater will be collected using Hydropunch samplers from immediately above top of rock. A 4-inch carbon steel casing shall be placed from 2 feet above ground surface into the top of bedrock and grouted in place. After a period of no less than 24 hours after grouting, the bedrock will be cored using HQ/HX core bits. Bedrock wells will remain as open holes if conditions permit. If an inner casing needs to be installed, it will be installed as described below.

Well Construction

- **Well Casing/Screen.** Riser material will consist of new, 2-inch ID, threaded, flush-joint polyvinyl chloride (PVC) pipe. The riser pipe will conform to American Society for Testing and Materials (ASTM) D1785 standards for Schedule 40 pipe. Well screens will consist of 10 feet of new, 2-inch ID, commercially fabricated, threaded, flush-joint, factory slotted (0.010 inch) PVC screen. A threaded PVC plug will be placed on the bottom of each well. Well material not certified as "clean" by the vendor or not sealed in plastic will be steam cleaned prior to installation.

- **Filter Pack.** A sand filter pack will be installed in the annular space between the boring and well screen. The filter pack will consist of clean, chemically inert, non-carbonated, well-sorted silica sand (Morie #0 or equivalent). Care will be taken to prevent bridging by continuously probing and measuring the thickness of the filter pack as it is placed. The filter pack can be poured in, but care must be taken to avoid bridging. The sand filter pack will be placed from 1 foot below the

well screen to approximately 2 feet above the top of the well screen. In wells with the screen set close to the surface, height of the filter pack above the top of the screen will be modified (i.e., shortened). One foot of fine sand (Morie #00 or equivalent) shall be placed above the filter pack.

- **Well Seal.** In lieu of a 3- to 5-foot conventional bentonite pellet or slurry seal followed by a cement-bentonite grout seal, a granular high solids, polymer free, single component, bentonite grout (Volclay Grout II or equivalent) will be installed from the top of the fine sand to 4 feet BGS (where possible). The remainder of the annular space will be filled with the appropriate material at the time of well completion.

  The grout is designed to be mixed at 25 percent solids. Therefore, the subcontractor will use the following mixing ratio: 18 gallons of water to one 50 pound bag. This will yield 3.0 square feet of grout with a mud weight of 9.616 per gallon. The grout must set for a period of 8 hours to be fully cured.

- **Plumbness and Alignment.** All risers and screens will be set round, plumb, and true to line. The well assembly must be hung in the borehole prior to the placement of the filter pack and not allowed to rest on the bottom of the hole so as to keep the well assembly straight and plumb. One centralizer will be installed at the bottom of the well in all wells greater than 20 feet in depth. Centralizers will be stainless steel and attached to the well casing via stainless-steel fasteners or strapping. Centralizers will not be attached to the well screen or the part of the well casing exposed to the granular filter or bentonite seal.

- **Well Completion Details.** All monitoring wells will be completed 2 feet above ground surface. The aboveground completion for monitoring wells will consist of a locking, protective steel casing painted brown and three protective posts painted yellow. Due to cold temperatures at the time of installation, the protective casing and posts could be pre-painted in a warm area, or a separate mobilization will be necessary to paint the wells at a later date. Well completion costs should include these assumptions. A 4-inch diameter overburden casing will be used as the protective casing for the bedrock wells, but a 6-inch protective casing must be used for the overburden wells. Prior to installation of the steel casing, a 4-inch diameter PVC sleeve will be placed around the 2-inch ID casing from the top of the grout seal to 1 foot above ground surface to allay frost heave in overburden wells only. Cement will be placed in the annular space between the edge of the borehole and the 4-inch PVC sleeve. The steel casing will then be placed in the cement and set 4 feet BGS. The casing will then be surrounded by a 3-foot by 3-foot by 4-inch thick concrete drainage pad. A weep hole will be drilled in the base of the protective casing, just above the concrete pad, and a vented PVC slip-on well cap will be placed on the inner casing. Three concrete-filled steel 3-inch diameter protective posts set 3 feet BGS in concrete will be installed equidistant around the locking protective casing outside the concrete drainage pad.

- **Well Identification.** Permanent wells will be identified by a brass survey marker stamped with the well identification number. The subcontractor shall provide the stamped marker and embed it in the concrete well pad.

Equipment Decontamination

The drill rig and all appurtenances must be decontaminated with high-pressure steam prior to arrival to the site. All equipment will be decontaminated again upon arrival to the site to remove road dirt only. Moreover, it is the subcontractor's responsibility to decontaminate all equipment with high-pressure steam prior to leaving the site.

Decontamination of drilling equipment will be performed prior to and after each well location. The drilling subcontractor will construct a decontamination pad, which will consist of wood and plastic sheeting, have walls approximately 5 feet tall, and include a high-pressure steam cleaner and a wastewater collection system. Metal saw horses or pallets shall be used to keep equipment to be decontaminated off the floor of the pad. Specific attention will be given to the drilling assembly and augers. Drilling decontamination will consist of:

- High-pressure steam cleaning;
- Scrubbing with brushes if soil remains on equipment; and
- Steam rinsing.

The back end of the drill rig, and all associated drilling equipment (i.e., split-spoon samplers, rods, Hydropunch equipment, and hollow-stem augers) will be decontaminated before and after each monitoring well location. Once clean, no equipment may touch the ground prior to use. The equipment must be stored on the drill rig, support truck, or on plastic sheeting.

If no contamination is detected using field instrumentation, the decontamination water will be discharged to the ground surface. If contamination is detected, the decontamination water will be placed in 55-gallon drums and labeled accordingly.

Investigation-Derived Waste (IDW)

Investigation-derived soils and water will be field screened to determine initially whether these wastes are contaminated. If contamination is noted or previous sample

data indicates the presence of contamination at a particular location, all IDW associated from these sites will be placed in 55-gallon drums.

The subcontractor will move and store all drummed cuttings and water to the decontamination area which will be located near Landfill 6. For estimation purposes, the subcontractor will assume that drill cuttings, drill water, and decontamination water will be drummed from only the shallow boring and overburden wells.