REVISED

OPERATION AND MAINTENANCE/ POST CLOSURE PLAN

MORGANTOWN ORDNANCE WORKS
OPERABLE UNIT NO. 1
MORGANTOWN, WEST VIRGINIA

PREPARED BY

OLIN CORPORATION

April 13, 2012

Contents

1.0 Introduction

1.1 General

This Post Closure Plan provides monitoring and maintenance personnel with the information necessary for monitoring conditions and performing routine maintenance and minor repair of the landfill cap system, and treatment wetlands installed at Operable Unit 1 (OU-1) at the Morgantown Ordnance Works facility in Morgantown, West Virginia. Monitoring and maintenance of the landfill cap system and treatment wetlands are required as post-closure care for OU-1. This plan satisfies the requirements specified in Section XI of the Record of Decision (ROD) for the facility.

For reference purposes, a copy of this Post Closure Plan as well as the following documents should be kept within possession of the company office responsible for implementing the monitoring and maintenance:

- Design Report
- As-Built Construction Drawings
- Technical Specifications
- Remedial Action Report

Unless catastrophic failure to the landfill cap occurs, contact with OU-1 waste material will not occur while performing the maintenance and minor repair activities specified in this plan. In the event of a catastrophic event, the Designing Engineer should be consulted to determine the appropriate action(s) necessary to address the situation.

1.2 Cap System

The cap system for the OU-1 landfill was designed and constructed to prevent direct contact with, and inhalation of, potentially harmful dust generated from contaminated soil. The cap also prevents offsite migration of contaminated soil and reduces the amount of precipitation which infiltrates through contaminated soil. The cap system is comprised of the following components:

- Vegetation
- 24 inches of protective soil cover
- A lateral drainage layer
- 40-mil textured high density polyethylene (HDPE) synthetic membrane
- A geosynthetic clay layer
- A gas vent system

1.3 Replacement Wetlands

As per the "Revision 1 Remedial Action Quality Assurance Project Plan" ESC August 22, 2003 and the draft "Revised Final Sampling Plan" (FSP) ESC September 22, 2003 the Replacement Wetland is to be inspected 'twice a year for 2 years, then once per year for three years for a total of seven monitoring events over 5 years.' The inspections were as follows: 1 time in 2003, 2 times per year in 2004 and 2005, 1 time in 2006 and 1 time in 2007 for a total of 7 'monitoring events'. With this achievement, the intent of the plans has been met and therefore no further inspections of the Replacement Wetlands are required.

1.4 Treatment Wetlands

The residual leachate from the landfill is treated utilizing a three pond wetlands system at the toe (east side) of the cap system. The design of the treatment wetlands system allows passive treatment of the leachate at the site. The system also has the ability to adapt to various flows, chemical loads, and weather conditions. The treatment wetlands system uses a subsurface flow design to minimize surface exposure to the leachate, and uses selected vegetation to avoid creating an attractive nuisance for wildlife.

The treatment wetland system consists of three ponds. The first and third ponds are shallow aerobic ponds meant to remove solids and iron. These ponds should maintain healthy vegetation. The middle pond is a deep, anaerobic pond designed to remove zinc. Vegetation in the middle pond should remain limited so oxygen to the treatment zone will not be introduced.

2.0 Water Quality Monitoring Program

In accordance with Section XI of the ROD and sections 47CSR58 through 47CSR60 of the West Virginia Regulations, since 2003, a water quality monitoring program has been implemented as part of the post closure activities at OU-1. The groundwater monitoring portion of the program has included the sampling and analysis of 10 monitoring wells around the landfill cap. The surface water portion of the program has included the sampling and analysis of the effluent from the treatment wetlands system.

2.1 Monitoring Point Locations and Construction Details

Three bedrock monitoring wells (DGW-01, DGW-05, and DGW-06) and six shallow monitoring wells (MW-1 through MW-6) located around the OU-1 landfill comprise its post closure water quality monitoring system (Figure 1). The bedrock monitoring wells were installed in 1987 as part of the OU-1 Remedial Investigation activities and the shallow wells were installed in 2003 as part of cap construction. The construction and placement of these wells is consistent with the applicable sections of 47CSR58 through 47CSR60. Lithologic logs and construction details for these monitoring wells are included in Attachment A.

In addition, one bedrock monitoring well, (DGW-3R), monitors groundwater conditions downgradient of the former lagoon area.

The locations of the wells are shown on Figure 1. Surveyed coordinates and the elevation of the top of the casing (the point used for measuring water levels) are provided below:

Well Number	Northing	Easting	Elevation
DGW-01	10,788 (1)	10,125	1,013.27
DGW-05	10,413 (1)	10,938	957.47
DGW-06	11,000 (1)	10,923 (1)	951.82
DGW-03R	10,267.8306	10,484.0564	998.9089
MW-1	10,819.6655	10,859.2291	962.5482
MW-2	10,927.2515	10,879.3844	958.1184
MW-3	10,987.7881	10,771.1599	972.2158
MW-4	10,956.7513	10,819.6452	962.6555
MW-5	10,883.8309	10,848.4165	959.4838
MW-6	10,792.0948	10,333.4603	1,007.7673

(1) Estimated, measurements not included in RI

2.2 Sampling and Analysis

2.2.1 Monitoring Wells

Bedrock monitoring wells DGW-01 and DGW-06 along with shallow monitoring wells (MW-1 through MW-6) will be sampled during the spring event for 2012. In addition to the spring event of 2012, bedrock monitoring wells DGW-01 and DGW-06 will be sampled in 2014 or year three of the five year review period ending in 2016. Provided the sample results are consistent with past sample results, no sampling of the bedrock wells will occur after the third year sampling event planned for 2014. Standard groundwater sampling procedures are provided in Attachment B.

Following the spring event of 2012, no further sampling of the shallow monitoring wells will be performed. Monitoring of the shallow groundwater will be replaced with monitoring of the influent and effluent from the Treatment Ponds on the third and fifth year of the remaining and future five year review periods. The influent sampling to the Treatment Ponds will be sampled for the same constituents as the effluent sampling. The following table illustrates sampling over the next two five year review periods:

Year	Bedrock Wells	Shallow Wells	Influent	Effluent
2012	DGW-01 & DGW-06	MW-1 through MW-6	----	Sample
2013	----	----	----	----
2014	DGW-01 & DGW-06	----	Sample	Sample
2015	----	----	----	----
2016	----	----	Sample	Sample
2017	----	----	----	----
2018	----	----	----	----
2019	----	----	Sample	Sample
2020	----	----	----	----
2021	----	----	Sample	Sample

This change in sampling frequency is supported by the consistency of the sampling results conducted in the 10 wells over the ten year period following completion of the cap and Environmental Land Use Restriction which prohibits use of the groundwater at OU-1 area.

2.2.2 Treatment Wetland System Effluent

There will be annual inspections and maintenance performed on the Treatment Ponds, if necessary, consistent with the proposed sampling plan. But, there will be no 3rd party oversight of the Treatment Ponds.

The effluent from the Treatment Ponds will be sampled at the drainage pipe discharge from Pond #3 during the scheduled sampling events. If there is no flow out of the pipe, no sample will be collected: the same can be said when sampling the influent to the Treatment Ponds.

2.3 Data Analysis and Reporting

Reporting will consist of summarizing operation and maintenance work during the given sampling year. Data related to site activities collected during previous years activities will be

submitted to USEPA and WVDEP in the next report produced during a sampling year. The data will be evaluated by comparing the results to the applicable standards (MCLs). In the absence of MCLs, the data will be evaluated for exceedance of Risk-Based Criteria (RBCs).

In addition to groundwater and Treatment Pond influent and effluent data, a summary of the cap inspection will be included in the reports. The completed inspection checklist forms (Attachment C) will be attached to the reports.

3.0 Long Term Maintenance

Maintenance and upkeep of the various components of the cap system and treatment wetlands are important to ensure their proper function. In addition, drainage systems will be maintained to assure proper drainage.

3.1 Cap System

Maintenance activities involve inspections of these areas for early signs of conditions that may discourage the effectiveness of the cap. An annual inspection checklist for the cap system is provided in Attachment C. The following is a list of general conditions which will be checked:

- Grass coverage – We have a vegetative cover on the cap to prevent erosion. The existing cover will be evaluated annually to determine if reseeding is needed. An exposed soil area greater than 10 square feet should be reseeded. Seeding should be performed in accordance with the approved Final Seeding Plan (August 20, 2003). The only anticipated cap maintenance activity is the manual removal of woody vegetation. Material damage to the grass coverage caused by O&M activities will be repaired by reseeding as soon as possible (next planting season).
- Erosion on cap - Inspections for erosion problems will be conducted annually to maintain the continuing integrity of the soil cover system. An evaluation of the affected area will be completed and a plan to address any erosion area(s) will be developed and implemented.
- Soil-dwelling animals - If an animal burrow is found within the limits of the soil cover, an appropriate attempt should be made to deter the usage of the burrow.
- Erosion in drainage areas – Sediment or stone that builds up in the receiving swales to the point of impeding flow will need to be removed. The two pipes that discharge water collected in the cap's drainage layer need to be kept free of significant sediment buildup (one is located on the east side, flowing to Swale 2; the other is located at the bottom of the northeast slope, near monitoring well MW-5).
- Land slide or slope failures - The outslopes should be inspected annually for evidence of soil movement. Evidence of a slide or slope failure may include gaps or separations the in soil cover across the outslopes or sagging areas. Should slides or slope failures

occur, a geotechnical inspection will be conducted to determine the cause and determine the appropriate means to address the situation.

- Gas Vents – The six gas vents on the surface of the cap will be checked annually to assure they have not been damaged or blocked. Screens have been placed to prevent animals from entering the vent system, and those will be maintained. If the risers are damaged or sheered off, they will be replaced, and if needed, a portion of the cap will be removed to assure proper attachment between the vertical pipe above the cap and the horizontal pipe below. No gas monitoring is required.
- Fencing – The fence around the cap and wetlands ponds will be inspected annually to assure adequate security.

3.2 Treatment Wetlands System

The primary criterion for determining if the treatment wetland system is working properly is the quality of effluent water. Pond 2 will be kept with minimal grow of vegetation. Plants that begin to grow will need to be controlled annually. Herbicides will only be used if growth is too rapid to control mechanically. The extent of erosion or sedimentation in the mitigation wetlands will be evaluated; and if required, corrective measures will be implemented.

Water levels in all three ponds can be controlled by the adjustable weir. Levels should be checked to assure that water does not back up into the landfill's toe drain system. This condition can be checked by looking in the access pipe between the drain and Pond 1.

3.3 Replacement Wetland

As per the "Revision 1 Remedial Action Quality Assurance Project Plan" ESC August 22, 2003 and the draft "Revised Final Sampling Plan" (FSP) ESC September 22, 2003 the Replacement Wetland is to be inspected 'twice a year for 2 years, then once per year for three years for a total of seven monitoring events over 5 years.' The inspections were as follows: 1 time in 2003, 2 times per year in 2004 and 2005, 1 time in 2006 and 1 time in 2007 for a total of 7 'monitoring events'. With this achievement, the requirements of the plans have been met and therefore no further monitoring is required.

3.4 Other Disturbed Areas

Other portions of the site will be inspected and maintained as follows:

- Former Lagoon Excavation Area – The lagoon area will continue to be checked and maintained under the regular program to assure that settling and ponding does not occur in the area of the oil excavation. Annual checks will include a walk over of the area to see if there is unacceptable ponding in the area of the former oil excavation.

4.0 Document Control

The records required to document maintenance and monitoring activities performed in accordance with this Post Closure Plan include the inspection logs that are taken during sampling years and are presented in Attachment C.

Each item requiring inspection under this Post Closure Plan is listed on the inspection logs contained in Attachment C. The inspector will supplement these logs with brief descriptions of required maintenance or other abnormalities. The completed inspection logs and supplemental information shall be maintained in a logbook and kept on file at the Cleveland, TN office of the party responsible for conducting the fieldwork.

4.0 References

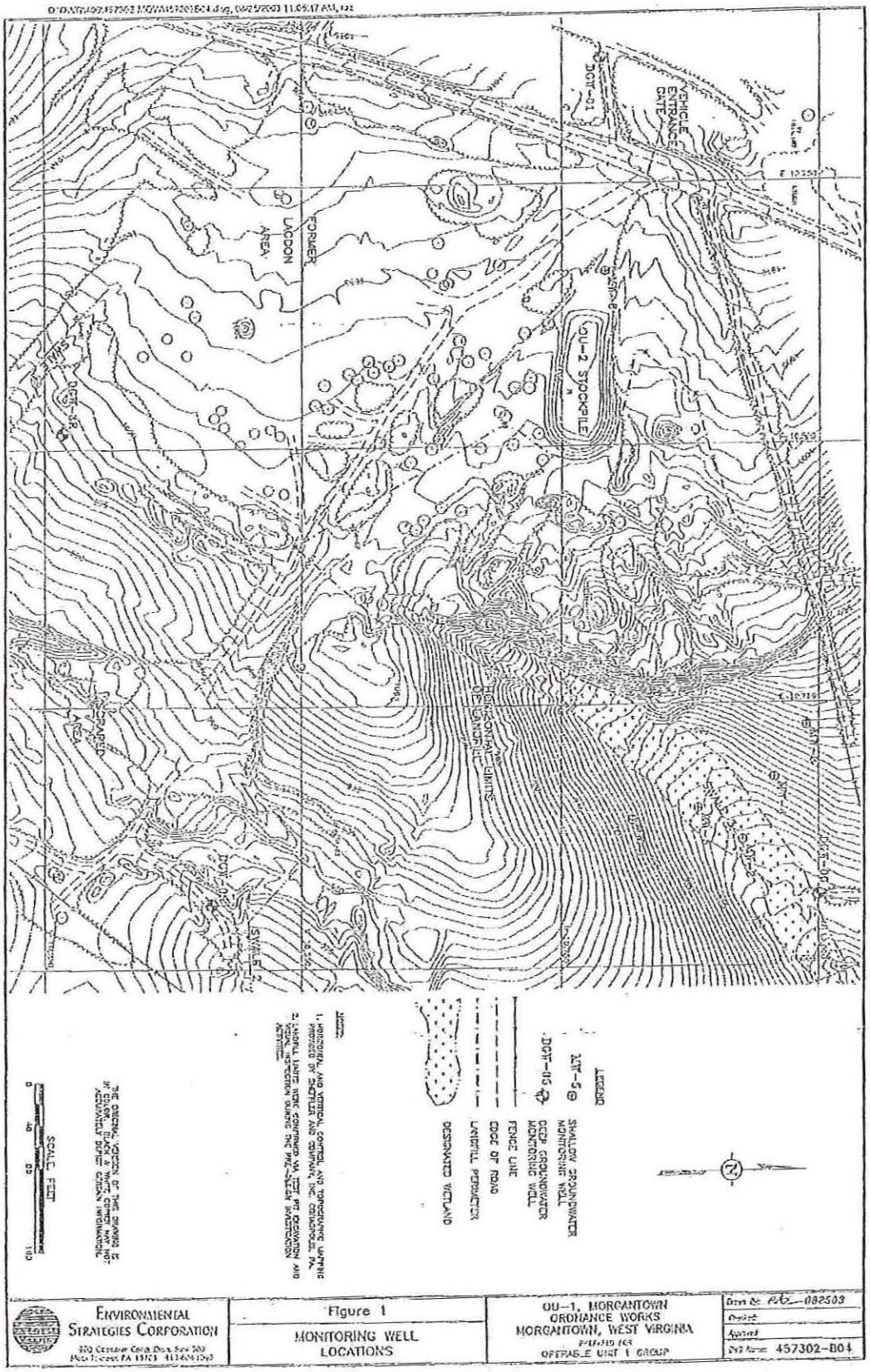
Environmental Strategies Corporation. "Design Report (Final Submittal), Morgantown Ordnance Works, Operable Unit No. 1, Morgantown, West Virginia." April 3, 2002.

Environmental Strategies Corporation. "Final Tar and Soil Excavation Work Plan, Morgantown Ordnance Works, Operable Unit No. 1, Morgantown, West Virginia." July 17, 2001.

Law Engineering and Environmental Services, Inc. "Final Focused Feasibility Study Report for the Morgantown Ordnance Works Site, Operable Unit One, Morgantown, West Virginia, Revision 2". September 1998.

Roy F. Weston, Inc and Clement Associates, Inc. "Final Remedial Investigation/Feasibility Study Report for the Ordnance Works Site, Morgantown, West Virginia, Volume 1". January 1988

Figures


OU-2 STOCKPILE
FORMER LAGOON AREA
PROPOSED LANDFILL LIMITS
VEHICLE ENTRANCE GATE
DOT-01
DOT-38
DOT-05
1MT-5
LEGEND
SHALLOW GROUNDWATER MONITORING WELL
DEEP GROUNDWATER MONITORING WELL
FENCE LINE
EDGE OF ROAD
LANDFILL PERIMETER
DESIGNATED WETLAND
NOTES:
1. HORIZONTAL AND VERTICAL CONTROL AND TOPOGRAPHIC MAPPING PROVIDED BY SHAFFER AND SEMPAK, INC. GREENSBURG, PA.
2. LANDFILL LIMITS WERE CONFIRMED VIA TEST PIT OBSERVATION AND ACTIVITIES DURING THE PHASE I INVESTIGATION
THE ORIGINAL VERSION OF THIS DRAWING IS IN COLOR. BLACK & WHITE COPIES MAY NOT ACCURATELY DEPICT CERTAIN INFORMATION.
SCALE: FEET
0
50
100
ENVIRONMENTAL STRATEGIES CORPORATION
Figure 1
MONITORING WELL LOCATIONS
OU-1, MORGANTOWN ORDNANCE WORKS MORGANTOWN, WEST VIRGINIA
PREPARED FOR OPERABLE UNIT 1 GROUP
Date: 08-25-03
Project
Approved
Project No.: 457302-B04

Attachment A - Monitoring Well Lithologic and Construction Logs

ENVIRONMENTAL STRATEGIES CORPORATION

Boring Log: MW-1

Completion Date: 5/08/2003

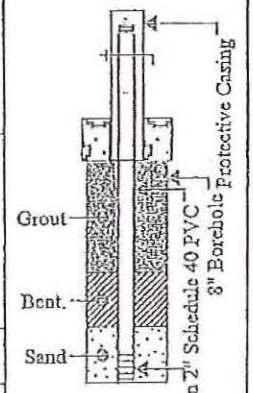
Project No.: 457302 *Surface Elevation (feet AMSL*):* -- *Northing:* --

Project: Morgantown Orduance Works *TOC Elevation (feet AMSL*):* -- *Easting:* --

Location: Morgantown, WV *Borehole Diameter (inches):* 8 *Total Depth (feet):* 4.5

* AMSL= Above mean sea level

Depth (feet)	Symbol	Description	Elevation (feet)	Sample Interval	Blow Count	Rock Quality Description	Recovery (%)	PID (ppm)	Well Completion Details
-2		Ground Surface	0.0						
0		*Clayey SILT (ml)* Light brown clayey SILT (ml), some sand and fine gravel, dry						0.0	
2			-3.5						
4		*Weathered CLAYSTONE* Light brown slightly weathered CLAYSTONE, iron stained fractures	-4.5		4 50-3				
		Refusal							
6									
8									
10									
12									



Logged By: Patrick Peterson *Method:* 4.25-inch ID

Subcontractor: Terra Testing *HSA* ☑ *Direct Push* ☐ *Rotosonic* ☐ *Cable Tool* ☐

Driller/ Operator: Pete Thompson *Rotary:* *Air* ☐ *Water* ☐ *Air Hammer* ☐

ENVIRONMENTAL STRATEGIES CORPORATION

Boring Log: MW-2

Completion Date: 5/08/2003

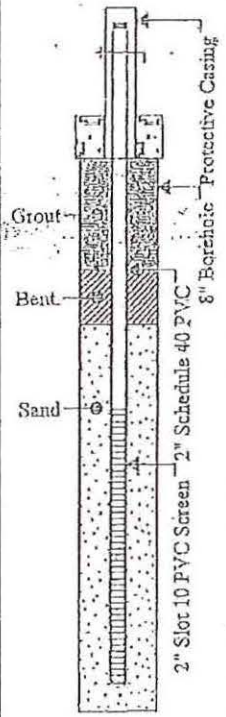
Project No.: 457302 *Surface Elevation (feet AMSL*):* -- *Northing:* --

Project: Morgantown Ordnance Works *TOC Elevation (feet AMSL*):* -- *Easting:* --

Location: Morgantown, WV *Borehole Diameter (inches):* 8 *Total Depth (feet):* 10.5

* AMSL = Above mean sea level

Depth (feet)	Symbol	Description	Elevation (feet)	Sample Interval	Blow Count	Rock Quality Description	Recovery (%)	PID (ppm)	Well Completion Details
2									
		Ground Surface	0.0						
0		*CLAY (cl)* Brown CLAY (cl), some fine gravel, plastic, soft, moist							
2									Grout
									Bent.
4									Sand
								0.0	
6									
8									
10			-10.5						
		SANDSTONE Light gray, some iron staining along bedding planes, moist to dry							
12		Refusal							



Logged By: Patrick Peterson *Method:* 4.25-inch ID

Subcontractor: Terra Testing *HSA* ☑ *Direct Push* ☐ *Rotosonic* ☐ *Cable Tool* ☐

Driller/ Operator: Pete Thompson *Rotary:* *Air* ☐ *Water* ☐ *Air Hammer* ☐

ENVIRONMENTAL STRATEGIES CORPORATION

Boring Log: MW-3 — *Completion Date:* 5/08/2003

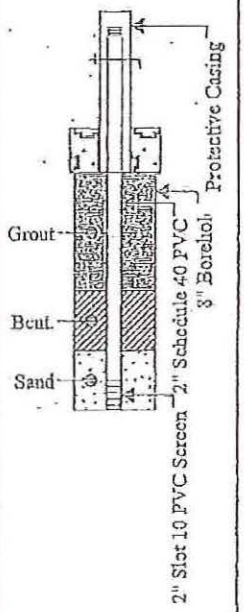
Project No.: 457302 — *Surface Elevation (feet AMSL*):* -- — *Northing:* --

Project: Morgantown Ordnance Works — *TOC Elevation (feet AMSL*):* -- — *Easting:* --

Location: Morgantown, WV — *Borehole Diameter (inches):* 8 — *Total Depth (feet):* 4.5

* AMSL= Above mean sea level

Depth (feet)	Symbol	Description	Elevation (feet)	Sample Interval	Blow Count	Rock Quality Description	Recovery (%)	PID (ppm)	Well Completion Details
		Ground Surface	0.0						
0		*Clayey SILT (ml)* Brown clayey SILT (ml), some gravel, moist						0.0	
2			-3.5						
4		*Weathered CLAYSTONE* Light brown weathered CLAYSTONE, damp	-4.5						
		Refusal							
6									
8									
10									
12									



Logged By: Patrick Peterson — *Method:* 4.25-inch ID

Subcontractor: Terra Testing — *HSA* ☑ *Direct Push* ☐ *Rotosonic* ☐ *Cable Tool* ☐

Driller/ Operator: Pete Thompson — *Rotary:* *Air* ☐ *Water* ☐ *Air Hammer* ☐

ENVIRONMENTAL STRATEGIES CORPORATION

Boring Log: MW-4 *Completion Date:* 5/09/2003

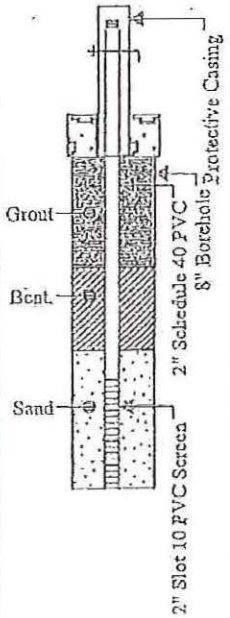
Project No.: 457302 *Surface Elevation (feet AMSL*):* -- *Northing:* --

Project: Morgantown Ordnance Works *TOC Elevation (feet AMSL*):* -- *Easting:* --

Location: Morgantown, WV *Borehole Diameter (inches):* 8 *Total Depth (feet):* 6.5

* AMSL= Above mean sea level

Depth (feet)	Symbol	Description	Elevation (feet)	Sample Interval	Blow Count	Rock Quality Description	Recovery (%)	PID (ppm)	Well Completion Details
-2									
0		Ground Surface	0.0						
		Clayey SILT (ml) Light brown clayey SILT (ml), some gravel, plastic, stiff, moist to dry							
4			-5.0						
6		*Weathered CLAYSTONE* Brown weathered CLAYSTONE, damp	-6.5						
		Refusal							
8									
10									
12									



Logged By: Patrick Peterson *Method:* 4.25-inch ID

Subcontractor: Terra Testing *HSA* ☑ *Direct Push* ☐ *Rotosonic* ☐ *Cable Tool* ☐

Driller/ Operator: Pete Thompson *Rotary:* *Air* ☐ *Water* ☐ *Air Hammer* ☐

ENVIRONMENTAL STRATEGIES CORPORATION

Boring Log: MW-5

Completion Date: 5/09/2003

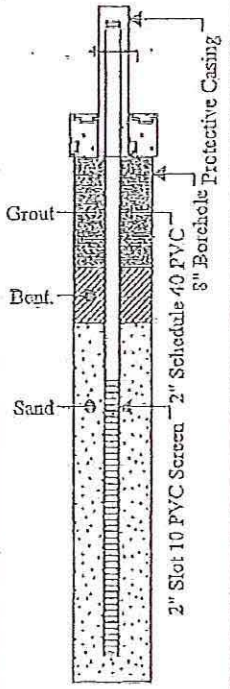
Project No.: 457302 | *Surface Elevation (feet AMSL*):* -- | *Northing:* --

Project: Morgantown Ordnance Works | *TOC Elevation (feet AMSL*):* -- | *Easting:* --

Location: Morgantown, WV | *Borehole Diameter (inches):* 8 | *Total Depth (feet):* 10

* AMSL= Above mean sea level

Depth (feet)	Symbol	Description	Elevation (feet)	Sample Interval	Blow Count	Rock Quality Description	Recovery (%)	PID (ppm)	Well Completion Details
-2									
0		Ground Surface	0.0						
		Silty CLAY (cl) Brown silty CLAY (cl), some gravel, plastic, moist							
2									
4									
6									
8									
			-9.5						
10		*Weathered SILTSTONE/CLAYSTONE* Light brown weathered SILTSTONE/CLAYSTONE, dry	-10.0						
		Refusal							
12									



Logged By: Patrick Peterson

Subcontractor: Terra Testing

Driller/ Operator: Pete Thompson

Method: 4.25-inch ID

HSA ☑ *Direct Push* ☐ *Rotosonic* ☐ *Cable Tool* ☐

Rotary: *Air* ☐ *Water* ☐ *Air Hammer* ☐

ENVIRONMENTAL STRATEGIES CORPORATION

Boring Log: MW-6 — *Completion Date:* 5/12/2003

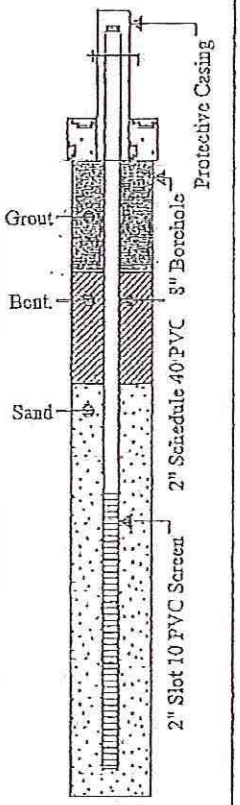
Project No.: 457302 — *Surface Elevation (feet AMSL*):* -- — *Northing:* ---

Project: Morgantown Ordnance Works — *TOC Elevation (feet AMSL*):* -- — *Easting:* --

Location: Morgantown, WV — *Borehole Diameter (inches):* 8 — *Total Depth (feet):* 12

* AMSL= Above mean sea level

Depth (feet)	Symbol	Description	Elevation (feet)	Sample Interval	Blow Count	Rock Quality Description	Recovery (%)	PID (ppm)	Well Completion Details
0		Ground Surface	0.0						
		Silty CLAY (cl) Brown silty CLAY (cl), some gravel	-1.0						
2		*Clayey SILT (ml)* Dark gray to brown clayey SILT (ml) *fill*	-4.0						
4		*CLAY (cl)* Gray/brown CLAY (cl), plastic, stiff, moist							
6									
8									
10									
12			-12.0						
		Weathered SILTSTONE Light brown weathered SILTSTONE							
		Refusal.							



Logged By: Patrick Peterson — *Method:* 4.25-inch ID

Subcontractor: Terra Testing — *HSA* ☑ *Direct Push* ☐ *Rotosonic* ☐ *Cable Tool* ☐

Driller/ Operator: Pete Thompson — *Rotary:* *Air* ☐ *Water* ☐ *Air Hammer* ☐

Location

WELL LOG

Page 1 of 2

Well No. ORD-IGW-01 Drl Company Duncan Bros. Log By J. Vann

Client CCM (CRD) Driller Jim White Field Book No.

Job No. 192-821-STGM Date Began 2/19/86 End 2/20/86 Log Date 2/19 - 2/20

Drilling Method Air Rotary Rig Davey

Sampling Method Cuttings Examined No Samples

Casing Size and Type 6-5/8" OD Steel Screen Size N/A Joint Type Screw Pipe Length 32' 25 gal

Type of Pack N/A Type of Seal Portland Cement Grout (1/1) 5 bag (94#) to bottom of annulus

Emplacement Method N/A Emplacement Method through tremie pipe

Interval N/A Interval 0-30' (2' stickup)

Development Method Flush with air for 1 hr. Gallons Removed ~ 100

Comments

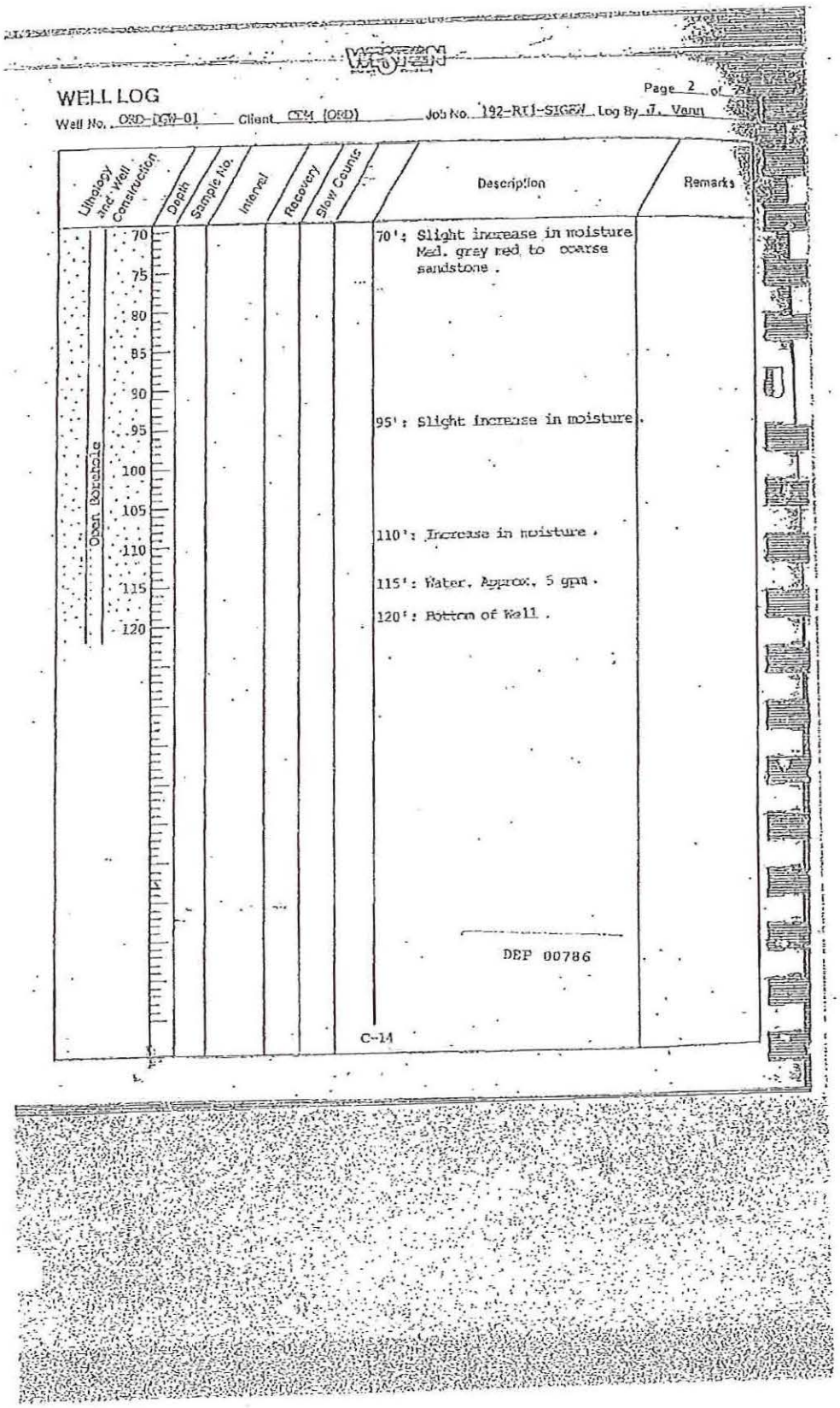
Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
	0					1': Dark brown topsoil.	
	5					10': Reddish silty to sandy clay	
	20					grey soft shale. Dry.	
	25					20': Ten sandstone (driller reported increase in hardness)	
	30					25': Slight increase in moisture.	
	35					30': Set 6-5/8" steel casing 0-30 feet.	Grouted annulus Left to set 18 hr
	40					32.5': Dark grey silty shale, dry.	DVA rig: 1ppm GCA minirae 0.11
	45					34': Reddish shale. Dry.	
	50					44': Grey fine sandy shale.	
	55					52': Dark green-grey hard sandy shale, dry.	
	60					59': Dark grey fine grained sandstone.	
	65					61': Streak of sandy shale. Dry.	
	70					62': Dark grey fine sandstone. Dry.	
						64': Slight amt of water (1gpm)	
						68.5': Sandstone as above with laminations of shale. Dry	

Surface

Open borehole

C-13

DEC 00785



WELL LOG

Page 2 of

Well No. ORD-DGW-01 Client CTM (ORD) Job No. 192-RTI-SIGW Log By J. Vanu

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
Open Borehole	70					70': Slight increase in moisture Med. gray red to coarse sandstone.	
	75						
	80						
	85						
	90						
	95					95': Slight increase in moisture.	
	100						
	105					110': Increase in moisture.	
	110						
	115					115': Water. Approx. 5 gpm.	
	120					120': Bottom of Well.	

DEP 00786

C-14

Location

Page 1 of 2

WELL LOG

Well No. OSD-DGW-0 2 Drill Company Duncan Bros. Log By J. Vann

Client CDM (GRU) Driller Jim White Field Book No.

Job No. 192-RI1-STGN Date Began 2/25/86 End 2/26/86 Log Date

Drilling Method Air Rotary Rig Davey

Sampling Method Cuttings Examined No Samples

Casing Size and Type 6-5/8" OD Steel Screen Size N/A Joint Type Screw Pipe Length ~~10~~ 29' / ~~10~~ gal / 3 bags

Type of Pack N/A Type of Seal Portland Cement Grout (I/II)

Emplacement Method N/A Emplacement Method annulus filled via tremie pipe

Interval N/A Interval 0-27' (2' stickup)

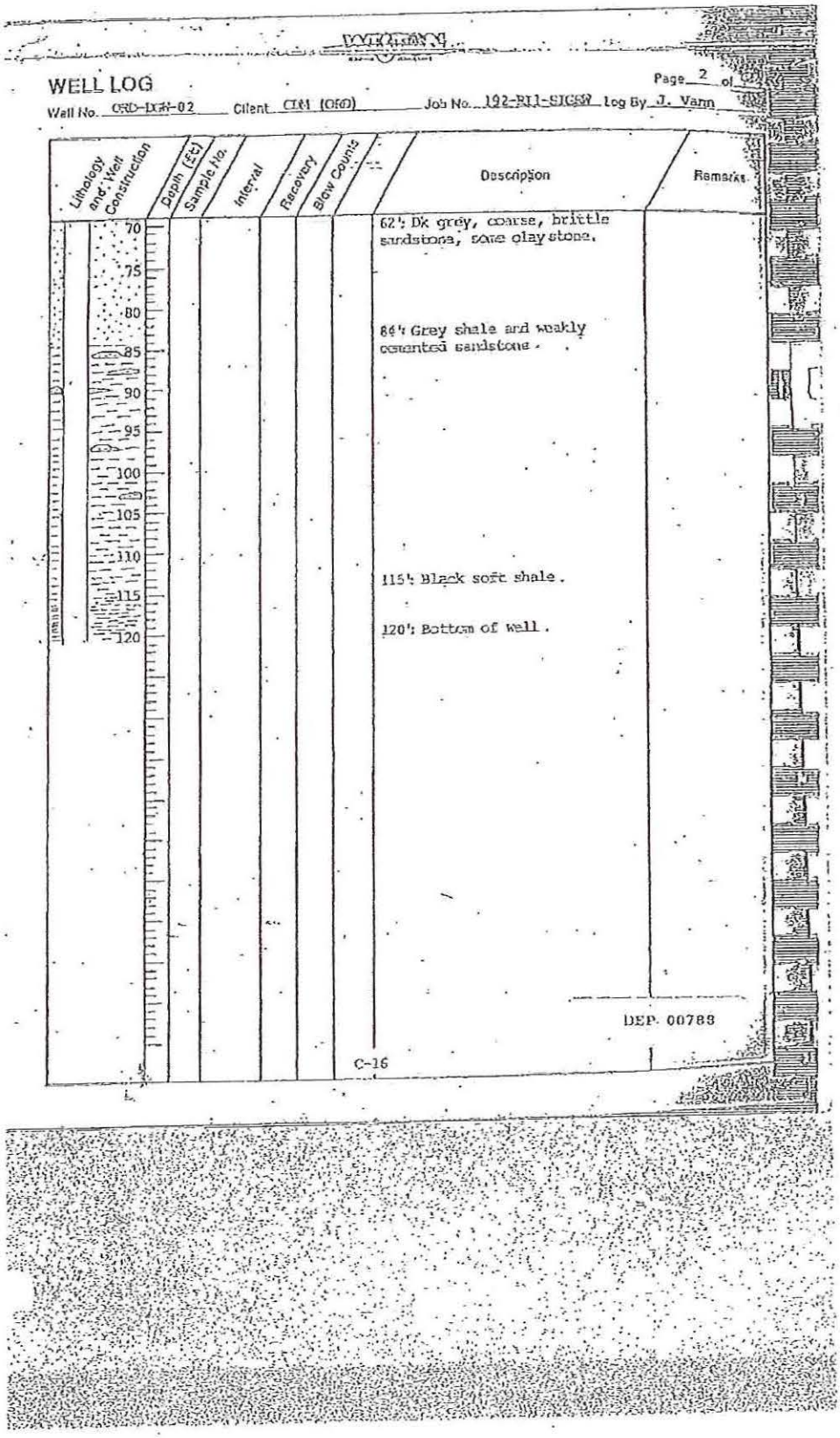
Development Method Flush with air for 75 min. Gallons Removed ~ 135

Comments

Lithology and Well Construction	Depth (ft.)	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
Surface Casing	0					3': Brown clayey silt.	
	5					5': Orange brown friable siltstone.	
	10						
	15					17': Grey sandstone, interbedded with brown shale.	
	20					21': Grey shale.	
	25					27': Set 6-5/8" steel casing 0-27'.	grouted annulus. left to set for 15.5 hrs.
	30					32': Dark grey med grained hard sandstone stained red. possible iron.	
	35					37': Red claystone/shale, little sandstone.	
	40					41': Red grey hard, silty shale, trace of dark red, fine sandstone. Dry.	
	45					46': Grey med. hard shale, some brown claystone. Dry.	
	50					47': Red, silty shale. Dry.	
	55					49.5': Dark grey shale and brown claystone. Dry.	Clay content decreases with depth.
Open Borehole	60					55': Dk grey, silty, hard shale and brown claystone. Damp.	
	65					57': Dk grey fine sandstone, some water.	
	70						

DEP 00787

C-15



WELL LOG

Page 2 of

Well No. ORD-DGW-02 Client CTM (OFD) Job No. 192-811-SIGSP Log By J. Vann

Lithology and Well Construction	Depth (Ft)	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
70						62½ Dk grey, coarse, brittle sandstone, some claystone.	
75							
80						84½ Grey shale and weakly cemented sandstone.	
85							
90							
95							
100							
105							
110						115½ Black soft shale.	
115							
120						120½ Bottom of well.	

DEP. 00788

C-16

Location

WELL LOG

Page 1 of 2

Well No. ORD-DGW-03 Drill Company Duncan Bros. Log By J. Vann

Client CDM (ICRD) Driller Jim White Field Book No.

Job No. 192-RI1-SIGW Date Began 2/20/86 End 2/21/86 Log Date

Drilling Method Air Rotary Rig Davey

Sampling Method Cuttings Examined No Samples

Casing Size and Type 6-5/8" OD Steel Screen Size N/A Joint Type Screw Pipe Length 30' 30 ga.

Type of Pack N/A Type of Seal Portland Cement Grout (I/II) 5 bags

Emplacement Method N/A Emplacement Method Filled annulus via Tremie Pipe

Interval N/A Interval 0-28'. (2' stickup)

Development Method Flush with air for 50 min. Gallons Removed ~400

Comments

Lithology and Well Construction	Depth (Ft)	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
Surface Casing	0					5': Yellow brn sticky clay.	
	10					10': Reddish clay.	
	15					17': Reddish sandy clay, green grey sandstone frags. Dry.	
	20					18': Green-grey sandstone.	
	25					19.5': Grey, soft siltstone.	
	30					21': Reddish soft clay/siltstone. Dry.	
	35					27': Grey, hard, med. coarse sandstone, some green soft shale.	
	40					28': 6-5/8" steel casing set 0-28'.	Grouted annu. left to set 15 hrs.
	45					32': Light green hard shale, some moisture.	
	50					42': Light green fine sandstone and water (~1gpm).	Interbedded sandstone and shale.
Open Borehole	55					43': Green shale.	
	60					44': Green sandstone.	
	65					45': Grey hard silty shale. Dry.	
	70					50': Grey soft sandy shale. Dry.	
						58': Lamination of brown clay, then grey, med to coarse brittle sandstone.	
						65': Dark grey, coarse, very hard sandstone with mica.	

C-17

WELL LOG 03 Page 2 of

Well No. ORO-EGW-07 Client CCM (ORD) Job No. 192-RI1-SIGEW Log By J. Varn

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
Open Borehole	70					74': Slight increase in moisture.	
	75						
	80						
	85						
	90						
	95						
	100					103': Water, Approx. 8 gpm.	Black, silty insoluble subst in flushed wate Possible coal dust
	105					104.5': Bottom of well.	
	110						
	115						
	120						

DEP 00790.

C-18

Bedrock Drilling and Monitoring Well Completion Log

Well No: DGW-03R

Project No.: 6300030017	Project: Olin MOW OU1	Checked By: JB	Ground Elevation: 1000 (est)
Client Name: Olin	Logged By: PHT	Protection Level: D	
Drilling Contractor: Terra Testing	Drilling Method: Air Hammer / 8 and 6 inch 8.25 ID Hollow Stem Auger for overburden /casing		Driller's Name: Ed Witcowshy
Bit Type/Size: Air Hammer 8" & 6"	Soil Drilled: 20 feet	Rig Type: CME 850	Start Date: 5/6/2003 / Finish Date: 5/7/2003
Bedrock Interval: 20 to 119.4		P.I.D. (eV): NA	Casing Size: 6.00 / Auger Size: 8.25 ID

Notes:
Overburden drilled with 8.25 ID HSA to weathered bedrock to 20 feet bgs
Drilled 8-inch (7 7/8) Air Hammer to 60 feet bgs
Borehole cased with 6-inch schedule 40 threaded casing to 60 feet bgs
Borehole completed to 119.4 feet bgs 2 feet of casing stick-up
Final water level 78.14 feet below top of casing

Depth (feet)	Estimated Borehole Water Discharge (GPM)	Oxidation and Fractures	Graphic Log	Well Diagram	Well Construction Notes	Rock Description and Comments on Drilling
0				24"		
5					Locking Cap	Overburden Notes: (all depths in feet from ground surface) 0 - 0.5 Silt loam, organic/forest litter 0.5 - 8 Reddish brown to light brown, dry to damp, silty CLAY w/ trace med sand. Native soil, no indication of fill.
10					Schedule 40 steel casing	8 - 14 Strong brown clayey SILT with few pebble size concretions, trace coarse sand, concretions up to 2-inches diameter @ 10-12'
15						14 -17 Olive brown clayey SILT, no concretionary pebbles 17-19 Weathered gray/green "shale" (silty claystone)
20					Bottom of HSA	19-20 Red / gray mottled silty claystone (strongly weathered) Set bottom of auger at 20 feet, commence 8-inch air hammer drilling
25						Drilled 5 foot runs, checking for water between rod changes Rod changes at 20.0, 24.1, 29.1, 34.1, 39.1, and 44.1 feet
26					Portland Type I cement / bentonite grout	
27						20-25 Light (Lt) gray to red mottled siltstone.
28	Damp	#				25-31 Lt gray (clayey) siltstone, cuttings damp at 28 feet.
29						
30					8-inch air hammer borehole	
31						
32						
33					Note: Borehole wall unstable near 28 to past 30 feet. Borehole wall caving prevented insertion of tremie pipe to bottom of casing. Casing driven and grouted from outside and inside.	
34						31-35.5 Red to strong red brown mottled siltstone.
35	< 1/4 gallon after rod change					
36						
37						35.5 - 41 Lt gray siltstone, varies to fine sandy siltstone, starting to see increases in sand content approaching 41 feet, vadose zone still making water prior to casing installation.
38						
39						
40	+/- 1/2 gallon after rod change					
41						41-47 grey, to green/gray fine to med grain sandstone, hard competent
42						
43						
44						
45						

MACTEC

Bedrock Drilling and Monitoring Well Completion Log

Well No: DGW-03R

Project No.: 6300030017	Project: Olin MOW OU1	Checked By: JB		
Client Name: Olin	Logged By: PHT	Protection Level: D	Ground Elevation: 1000 (est)	
Drilling Contractor: Terra Testing	Drilling Method: Air Hammer / 8 and 6 inch 8.25 ID Hollow Stem Auger for overburden /casing		Driller's Name: Bd Witcowshy	
Bit Type/Size: Air Hammer 8" & 6"	Soil Drilled: 20 feet	Rig Type: CME 850	Start Date: 5/6/2003	Finish Date: 5/7/2003
Bedrock Interval 20 to 119.4		P.I.D. (eV):	Casing Size 6.00	Auger Size: 8.25 ID

Notes:
Overburden drilled with 8.25 ID HSA to weathered bedrock to 20 feet bgs
Drilled 8-inch (7 7/8) Air Hammer to 60 feet bgs
Borehole cased with 6-inch schedule 40 threaded casing to 60 feet bgs
Borehole completed to 119.4 feet bgs 2 feet of casing stick-up
Final water level 78.14 feet below top of casing

Depth (feet)	Estimated Borehole Water Discharge (GPM)	Oxidation and Fractures	Graphic Log	Well Diagram	Well Construction Notes	Rock Description and Comments on Drilling
45						
46	+/- 1/2 gallon after rod change				Schedule 40 steel casing	Drilled 5 foot runs, checking for water between rod changes Rod changes at 44.1, 49.1, 54.1, 59.1, 60.0 (switch to 6-inch hammer), 64.4, 69.4, 74.4 feet
47						
48						41-47 Grey, to green/gray fn to med grain sandstone, hard, competent.
49					Portland Type I cement / bentonite	
50	+1 gallon after rod change					47-54.5 Olive gray sandy siltstone with gradual transition to gray clayey siltstone w/ trace fine sand, change in tone near 52, brief increase in sand content, varying to silty sandstone, then back to siltstone by 53.5, and back to sandstone by 54.5.
51						
52						
53					8-inch air hammer borehole	54.5 to 60 Dark gray, fine to medium grain sandstone, hard, competent.
54						
55	+1 gallon after rod change					Casing Installation: 6-inch schedule 40 steel, flush threaded casing was inserted down through 8/14-inch ID HSA into open 8-inch borehole. Hole condition collapsing just below vadose zone water entry point at 28 feet bgs. Borehole well also unstable and collapsing near 30 feet bgs within red mottled siltstone. Tremie pipe could not be inserted with advancement of casing. Casing pushed and driven to 55 feet. Ten gallons Portland Type I / bentonite grout placed by tremie pipe to bottom of 8-inch borehole (60 feet) and casing driven to 60 to complete bottom seal. HSA removed and annulus between borehole and 6-inch casing grouted w/ Portland Type I / bentonite grout placed w/ tremie pipe at 20 feet. Grout allowed to cure overnight. When drilling commenced on following day, vadose zone waters in borehole noted prior day had been sealed off indicating that casing seal was effective.
56						
57						
58						
59						
60						
61	DRY after casing grouted in place					60-75 Dark gray, fine to medium grain sandstone, hard, competent.
62						
63						
64						
65	DRY after casing grouted in place					Oxidized (reddish/orange) cuttings at 73 feet bgs, back to gray sandstone by 73.8 feet bgs. Fracture or fracture zone.
66						
67					6-inch air hammer borehole	
68						
69						
70						
71	DRY after casing grouted in place	oxidized cuttings @ 73'				
72						
73						
74						
75						

Bedrock Drilling and Monitoring Well Completion Log

Well No: DGW-03R

Project No.: 6300030017	Project: Olin MOW OU1		Checked By: JB		
Client Name: Olin	Logged By: PHT	Protection Level: D		Ground Elevation: 1000 (est)	
Drilling Contractor: Terra Testing	Drilling Method: Air Hammer / 8 and 6 inch 8.25 ID Hollow Stem Auger for overburden /casing			Driller's Name: Ed Witcowshy	
Bit Type/Size: Air Hammer 8" & 6"	Soil Drilled: 20 feet	Rig Type: CME 850	Start Date: 5/6/2003	Finish Date: 5/7/2003	
Bedrock Interval 20 to 119.4		P.I.D. (eV): NA	Casing Size 6.00	Auger Size: 8.25 ID	

Notes:
Overburden drilled with 8.25 ID HSA to weathered bedrock to 20 feet bgs
Drilled 8-inch (7 7/8) Air Hammer to 60 feet bgs
Borehole cased with 6-inch schedule 40 threaded casing to 60 feet bgs
Borehole completed to 119.4 feet bgs, 2 feet of casing stick-up
Final water level 78.14 feet below top of casing

Depth (feet)	Estimated Borehole Water Discharge (GPM)	Oxidation and Fractures	Graphic Log	Well Diagram	Well Construction Notes	Rock Description and Comments on Drilling
76						
76	DRY after casing grouted in place	oxidized cuttings @ 78'			6-inch air hammer borehole	Drilled 5 foot runs, checking for water between rod changes Rod changes at 74.4, 79.4, 84.4, 89.4, 94.4, 99.4, 104.4 feet 75-105 Dark gray, fine to medium grain sandstone, hard, competent, fractures as noted below. 78-78.6 Color change, 10-15% iron oxides (Feox) in cuttings (including limonite and possibly hematite) in cuttings, fracture or weak fracture zone but dry.
77						
78						
79						
80	DRY after casing grouted in place					
81						
82						
83						
84						
85	DRY after casing grouted in place					
86						
87						
88						
89						
90	0.6 GPM during rod change	weak oxidation 92.5-94.5				92.4-93.4, Losing dust during drilling, little moistness to cuttings. Trace oxidation in cuttings at 92.5 to 94.4, weak water bearing fracture zone. Approximately 3 gallons of water after 5 minute rod change at 94.4 feet = about 0.6 gpm (visual estimate). Soft @ 95.8 (fracture ?, possibly silty bed). Approximately 3 gallons of water after 5 minute rod change at 99.4 feet = about 0.6 gpm (visual estimate). Approximately 6 to 7 gallons of water after 10 minute rod change at 104.4 feet = about 0.6 -0.7 gpm (visual estimate). 104.2 Weak oxidation.
91						
92						
93						
94						
95	0.6 GPM during rod change	?				
96						
97						
98						
99						
100	0.6 GPM during rod change	weak oxidation 104.2				
101						
102						
103						
104						
105						

Bedrock Drilling and Monitoring Well Completion Log

Well No: DGW-03R

Project No.: 6300030017	Project: Olin MOW OU1		Checked By: JB		
Client Name: Olin	Logged By: PHT	Protection Level: D		Ground Elevation: 1000 (est)	
Drilling Contractor: Terra Testing	Drilling Method: Air Hammer / 8 and 6 inch 8.25 ID Hollow Stem Auger for overburden /casing			Driller's Name: Ed Witcowshy	
Bit Type/Size: Air Hammer 8" & 6"	Soil Drilled: 20 feet	Rig Type: CME 850	Start Date: 5/6/2003	Finish Date: 5/7/2003	
Bedrock Interval 20 to 119.4		P.I.D. (eV): NA	Casing Size 6.00	Auger Size: 8.25 ID	

Notes:
Overburden drilled with 8.25 ID HSA to weathered bedrock to 20 feet bgs
Drilled 8-inch (7 7/8) Air Hammer to 60 feet bgs
Borehole cased with 6-inch schedule 40 threaded casing to 60 feet bgs
Borehole completed to 119.4 feet bgs, 2 feet of casing stick-up
Final water level 78.14 feet below top of casing

Depth (feet)	Estimated Borehole Water Discharge (GPM)	Oxidation and Fractures	Graphic Log	Well Diagram	Well Construction Notes	Rock Description and Comments on Drilling
105						
106	1.0 -1.5 GPM during rod change	water increase @ contact			6-inch air hammer borehole	Drilled 5 foot runs, checking for water between rod changes Rod changes at 104.4, 109.4, 114.4, 119.4 feet 105 - 105 Dark gray, fine to medium grain sandstone, hard, competent. 105 -118 Sharp transition to olive gray sandy siltstone, w/ trace to little fine to med grain sand and trace oxidation near 106. Apparent increase in water flows from 106 feet to end of run, suggesting fracture zone at or near contact. Approximately 10 to 15 gallons of water after 10 minute rod change at 109.4 feet = about 1.0 -1.5 gpm (visual estimate)
107						
108						
109						
110	>1 GPM					
111						
112						
113						
114						
115	>1 GPM					
116						118-119.4 Dark gray silty sandstone. Terminate hole at Total Depth (TD) of 119.4 at 11:25 AM.
117						
118						
119						
120					TD = 119.4 feet bgs	Well Development Notes: Surged rods then shut off air allowed borehole to fill and blew hole out with compressed air at 11:40 (+/-20 gallons), 12:10 (+20 gallons), 12:30 (+/- 30 gallons), 12:40 (10-15 gallons), 12:50 adjusted air pressure and flow to allow continuous flow of water from borehole, water initially, dark orange (Feox) /turbid, slowly lightening and becoming more translucent, water flows increasing slightly as borehole is pumped, visual estimate (2-3 gpm maximum flows), 13:00 water clearing, 13:20, water clear to naked eye, 13:30 development terminated.

WESTON

Location

WELL LOG

Page 1 of 2

Well No. OMD-DGW-04 Drlg Company Duncan Bros. Log By J. Vana

Client CCM (ORD) Driller Jim Knite Field Book No.

Job No. 192-RII-SIGW Date Began 2/21/86 End 2/23/86 Log Date

Drilling Method Air Rotary Rig Davey

Sampling Method Cuttings Examined No Samples

Casing Size and Type 6-5/8" OD Steel Screen Size N/A Joint Type Screw Pipe Length 23' 10 gal/

Type of Pack N/A Type of Seal Portland Cement Grout (I/II) 3 bags

Emplacement Method N/A Emplacement Method Filled annulus via tremie pipe

Interval N/A Interval 0-21'

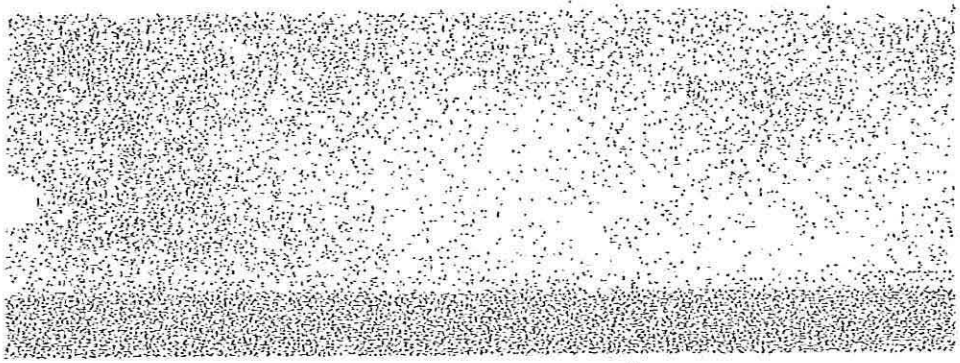
Development Method Flush with air for 68 minutes Gallons Removed ~136

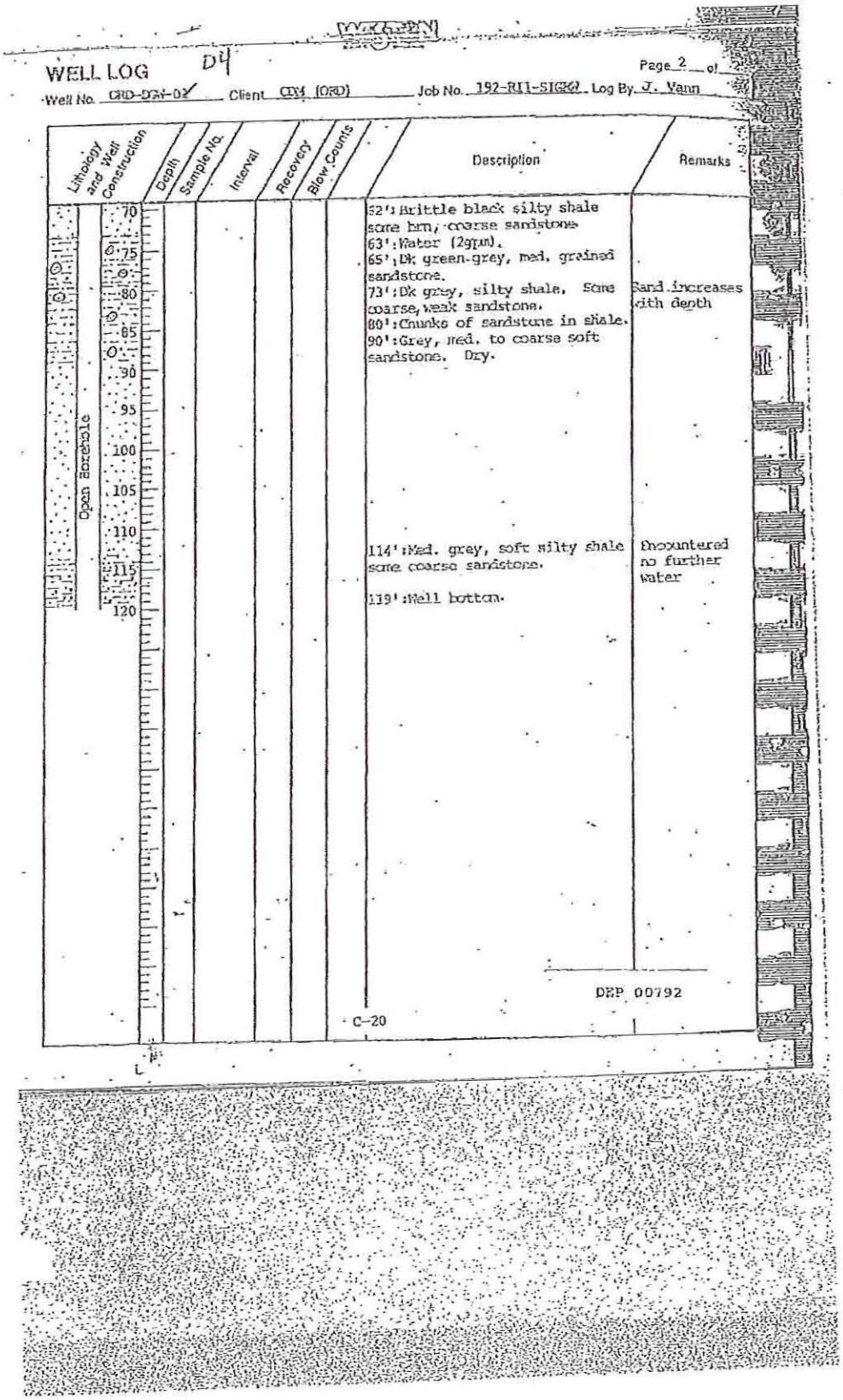
Comments

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
Surface Casing; Open Borehole	0					5': Yellow-brn soft clay.	
	5					8': Reddish sandy clay.	
	10					9.5': Dark grey soft shale, dry.	
	15					13': Dk grey, red-hard fractured shale. Dry.	Sand content increasing
	20					17.5: Dk grey, hard fine sandstone Dry.	
	25					19': Sandstone increasing in particle size to med grained with mica. Dry.	
	30					21.5': Set 6-5/8 steel casing 0-21.5'.	Grouted annulus left to set for 21.5 hrs.
	35					31': Dk grey, coarse hard sandstone. A lamination of brn clays	one.
	40					33': Lamination of grey claystone in sandstone. Brn claystone.	
	45					35': Very coarse (+) to med. grained sandstone. Stained brn, prob. from claystone. Dry.	Clay diminished with depth. S.S. weakly cemented
	50					45': Dk grey, med to coarse grained hard sandstone. Dry.	
	55					51': Brn stained weak sandstone, some dk grey coarse hard sandstone,	
	60					54': Increase in moisture.	
	65					61': Brn claystone and brn stained coarse weak sandstone with shale fragments.	
	70						

DEP 00791

C-19





WELL LOG

Page 2 of

Well No. GRD-DSH-02 Client CDM (ORD) Job No. 192-RI1-SIGW Log By J. Vann

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
Open Borehole	70					62': Brittle black silty shale some brn, coarse sandstone 63': Water (2gpm). 65': Dk green-grey, med. grained sandstone. 73': Dk grey, silty shale. Some coarse, weak sandstone. 80': Chunks of sandstone in shale. 90': Grey, med. to coarse soft sandstone. Dry.	Sand increases with depth
	75						
	80						
	85						
	90						
	95						
	100						
	105						
	110					114': Med. grey, soft silty shale some coarse sandstone. 119': Well bottom.	Encountered no further water
	115						
	120						

DRP 00792

C-20

WELL LOG

Page 1 of 2

Well No. ORD-DGM-05 Drill Company Duncan Bros. Log By J. Vann

Client CDM (ORD) Driller Jim White Field Book No.

Job No. 192-RI1-SITE6 Date Began 2/23/86 End 2/24/86 Log Date

Drilling Method Air Rotary Rig Davey

Sampling Method Cuttings Examined No Samples

Casing Size and Type 6-5/8" OD Steel Screen Size N/A Joint Type Screw Pipe Length 23'6" 16 gal/

Type of Pack N/A Type of Seal Portland Cement Grout (1/TIB bags

Emplacement Method N/A Emplacement Method Filling annulus via tremi pipe

Interval N/A Interval 0-21'

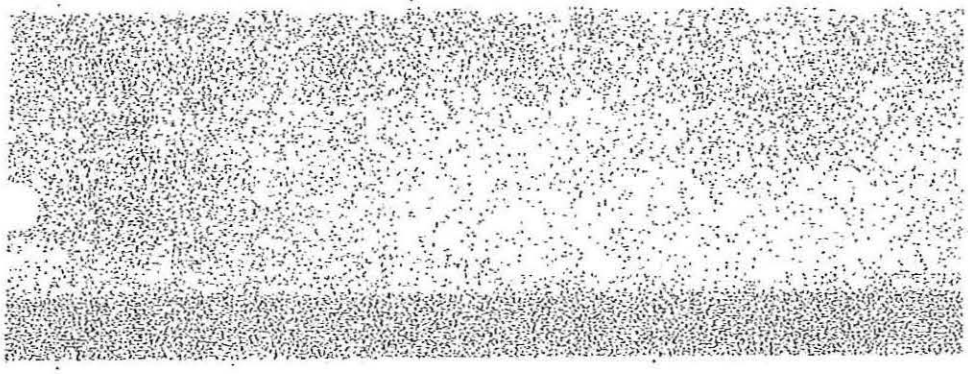
Development Method Flush with air for 70 minutes Gallons Removed

Comments

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
Surface Casing / Open Borehole	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70					5': Brn clay topsoil. 10': Yellow-brn claystone. 11': Green-grey, silty, soft shale some yellow-brn claystone. Dry. 14': Green-grey shale, some red silty shale, Dry. 15.5': Drk green, soft, silty shale, little hard brn claystone. 16.5': Red stained, silty shale and claystone. 20': Soft green-grey shale, trace yellow-brn claystone. 21.5': Set 6-5/8" steel casing 0-21.5'. 25': Green-grey, red. grained sandstone. Dry. 35': Drk grey sandstone, some hard green shale 40-41': Brn-stained coarse sandstone. Brittle & Dry. 45': Increase in moisture. 55': Dry sandstone, as above. 64': Water	Grouted annulus left to set 16 Brn stain appears to be firm clay HNU rdg: Clppm above backgrou

DEP 00793

C-21



Location

WELL LOG

Page 1 of 2

Well No. ORD-DGW-0 6 Drill Company Duncan Bros. Log By J. Vann

Client CDM (ORD) Driller Jim White Field Book No.

Job No. 192-KII-SIGNI Date Began 2/24/86 End 2/25/86 Log Date

Drilling Method Air Rotary Rig Davey

Sampling Method Cuttings Examined No Samples

Casing Size and Type 6-5/8" CO Steel Screen Size N/A Joint Type Screw Pipe Length 23½'

Type of Pack N/A Type of Seal Portland Cement Grout (I/II)

Emplacement Method N/A Emplacement Method Annulus filled via tremie pipe

Interval N/A Interval 0-21½'

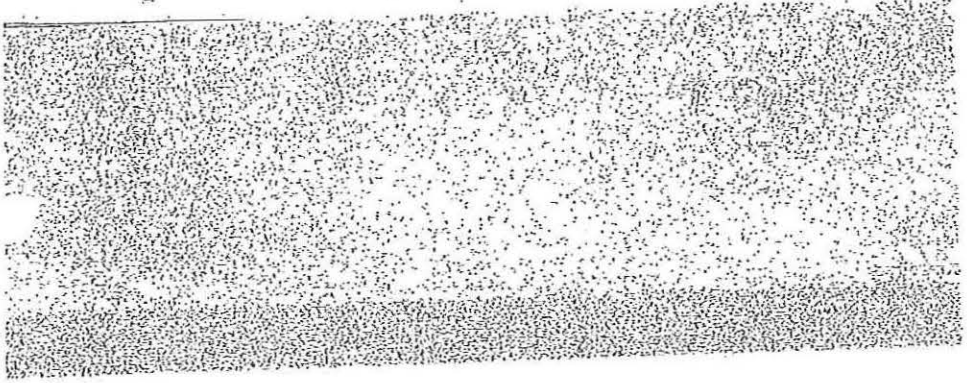
Development Method Flush with air for 45 minutes Gallons Removed

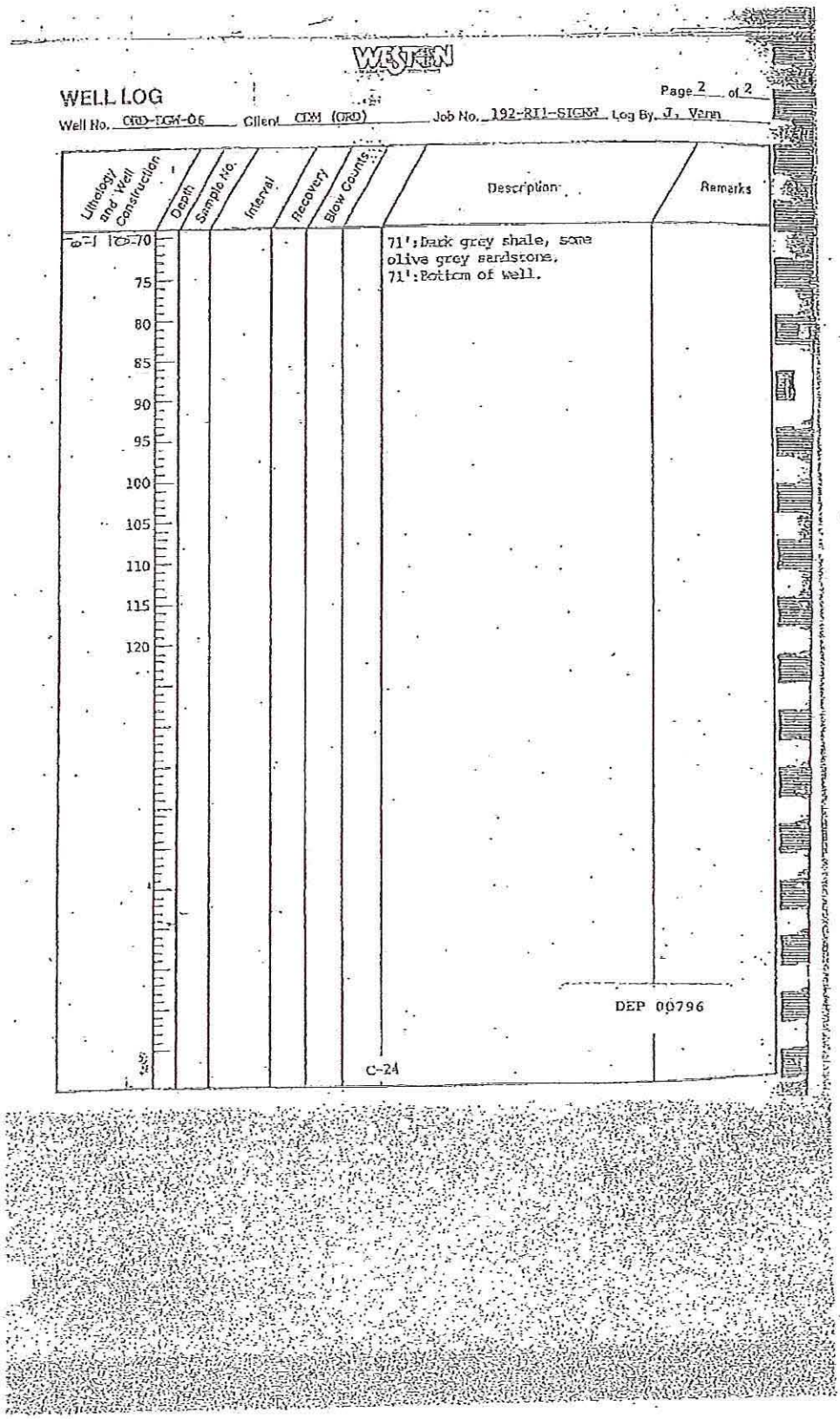
Comments

Lithology and Well Construction	Depth	Sample No.	Interval	Recovery	Blow Counts	Description	Remarks
Surface Casing	0					3': Yellow-brn clay-topsoil.	
	5					3.5': Blk-grey, med. grained sandstone with mica-brittle. Lesser yellow brn claystone.	
	10					6.5': Med. grey, brittle, soft med grained sandstone, w/frags. of harder black sandstone. Dry.	
	15					14': Brn claystone lamination, sandstone.	
	20					17': Grey-blk sandstone with mica trace red-yellow staining.,	
	25					19.5': Drk grey fine, brittle sandstone. Dry, Some brn-stained drk grey, coarse sandstone.	Stain prob. due to clay
	30					21.5': Set 6-5/8" steel casing 0-21.5'.	Grouted annulus left to set 17
Open Borehole	35					24.5: Brown claystone.	
	40					26': Sandstone.	
	45					30': Grey, silty, sandstone. Damp.	
	50					46': Brownish grey sandstone, some claystone. Damp.	
	55					47': Grey sandstone.	
	60					50': Olive grey, med. grained sandstone. Damp.	
	65					51': Water.	
	70					53': Saturated, dk grey, soft shale.	Black, insoluble dust

DBP 00795

C-23




WESTON
WELL LOG
Page 2 of 2
Well No. GRD-TGM-06 Client GTM (GRD) Job No. 192-RII-SIGM Log By J. Vann
Lithology and Well Construction
Depth
Sample No.
Interval
Recovery
Blow Counts
Description
Remarks
70
75
80
85
90
95
100
105
110
115
120
71': Dark grey shale, some olive grey sandstone.
71': Bottom of well.
DEP 00796
C-24

Attachment B - Sampling Standard Operating Procedures

Standard Operating Procedures – 1

Note Taking and Log Book Entries

Materials:

Permanently bound log book (no spiral bound log books)
Black or Blue ballpoint pen (waterproof ink)

Procedure:

1. Use black or blue ballpoint pen with waterproof ink. Felt-tip pens should not be used.
2. Enter the time (in military time, e.g.,) in the left column of each page when an entry is recorded in the field notebook.
3. If a mistake is made in an entry, cross out the mistake with one line and initial the end of the line.
4. At all times, maintain the chain of custody on the field log book.

Content:

1. Be sure that log book entries are LEGIBLE and contain accurate and inclusive documentation of project field activities.
2. Provide sufficient detail to enable others to reconstruct the activities observed.
3. Thoroughly describe all field activities while onsite. Be objective, factual, and thorough. Language should be free of personal feelings or other terminology that might prove inappropriate.
4. Describe problems, delays, and any unusual occurrences such as wrong equipment or breakdowns along with the resolutions and recommendations that resulted.
5. Fully document any deviations from or changes in the work plan.
6. Describe the weather and changes in the weather, particularly during sampling events.
7. If possible, photograph all sample locations and areas of interest. Maintain a photographic log in the field log book and include:

   Date, time, photographer, name of site, general direction faced, description of the subject taken.
8. Record the names and affiliations of key personnel onsite each day.
9. List all field equipment used and record field measurements, including distances, monitoring and testing instrument readings (e.g., pH, conductivity, model numbers, etc.), and calibration activities.
10. Record proposed work schedules and changes in current schedules in the log book.
11. Describe site security measures.

Standard Operating Procedures – 2

Sample Container, Preservatives, & Holding Times

Scope:

This operating procedure descries the ways and means of selecting the appropriate sampling containers for environmental sampling.

Application:

The purpose of this procedure is to assure that sample volumes and preservatives are sufficient for analytical services required under EPA-approved protocols.

Materials:

Sample containers
Sample Container labels
Indelible (waterproof) markers or pens
Clear tape

Procedures:

1. Refer to Table 1 for minimum sample volume and glassware types required for sampling a particular matrix and compound class.
2. Select the appropriate glassware (i.e., bottles or jars) from those provided by the analytical laboratory. Verify that the analytical laboratory has provided the correct number of sample containers and the correct preservatives for the project per the sampling plan requirements.
3. The analytical laboratory should always provide extra sample containers for all analytical parameters in case of breakage or other problems encountered in the field. This is particularly true for VOC sample containers (i.e., 40–ml vials).
4. Report any discrepancies or non-receipt of specific types of sample containers to the Quality Assurance Officer immediately. Arrangements should be made with the laboratory to immediately ship the missing or additional sampling containers to the project site.
5. Information on the sample labels should contain the following data:

    Site/Project name
    Project/Tank number
    Unique sample identification number
    Sample date
    Tine of sample collection (military system, e.g., 0000 to 2400 hours)
    Analytical parameters
    Preservative
    Sampling personnel

6. Once sample containers are properly labeled, the sample labels should be wrapped with clear tape to prevent deterioration of sample label.

7. Proceed with the sample collection per the sampling plan requirements.

8. Collected samples should be immediately placed in an iced cooler to maintain as close as possible a 4°C atmosphere for shipment to the analytical laboratory. Follow sample shipping procedures detailed in Sample shipping Standard Operating Procedures.

Standard Operating Procedures – 3

Groundwater Sampling

Materials:

Bound sampling notebook
Groundwater monitoring data log forms
Well key
Adjustable wrench or manhole wrench
Plastic sheeting
Flashlight or mirror
Electronic water level indicator or interface probe
Bailer (bottom loading)
Pump (for purging)
Nylon or polyethylene rope
Temperature, pH, and conductivity meters
Other field meters, as appropriate (i.e., turbidity meter, DO meter, etc.)
Sample bottles, labels, indelible markers, and clear tape
Peristaltic pump
0.345-micron filter
Teflon tubing
Polyethylene tubing
Pocket knife or scissors
Saranex or Tyvek suit (if required by Health & Safety Plan)
Nitrile gloves
Vinyl gloves

Procedure:

1. Verify locations of wells, media to be sampled, and parameters to be analyzed for as specified in the sapling plan.
2. Prepare field log book with description of site, weather, participants, and other relevant observations, including all sampling data necessary to complete the groundwater monitoring data log (Refer to SOP-1). Inspect the well for soundness of protective casing and surface ground seal.
3. From the top of the casing, measure the depth (in feet) to water (DTW) with an electronic water level indicator and record in the field log book. Static water level measurements must be recorded form the surveyor's mark at the top of the casing, if present. If no mark is present mark a location with a metal file or indelible marker on the casing for future reference. Measure and record the total depth (in feet) (TD) of the well.
4. Monitoring wells should be sampled by starting with the upgradient (or clean wells) and proceeding downgradient (in the order from most to least contaminated wells) for the remaining monitoring wells.

5. Calculate the length of the water columns in the well casing.

Length = (TD - DTW)

Calculate the volume of water in gallons in one well casing:

For a 2-inch well:

vol = [(TD – DTW) * 0.16]

For a 4-inch well:

vol = [(TD – DTW) * 0.65]

For a 6-inch well:

vol = [(TD – DTW) * 1.47]

or vol = $0.041\ d^2h$

where: h = TD-DTW

d = diameter of well

Or calculate the volume using the formula:

vol = $(TD - DTW)(CID)^2(0.04)$ CID = casing inside diameter in inches

6. Before sampling, each well will be purged by pumping at the lowest rate possible (typically 100 ml/min). The pumping rate should cause little or no water column drawdown (less than 0.2 feet), and the water level should stabilize. Drawdown will be monitored. To measure the volume of water being removed from the well, a calibrated 5-gallon bucket or other known volume container may be used to collect the water.

7. Monitoring wells will be purged with a peristaltic pump prior to sample withdrawal to ensure that a representative sample of formation water is collected. Dedicated tubing for each well will be used, so they do not need to be decontaminated before each sampling event. Place plastic sheeting around the well before beginning process. Once plastic is around well, the purging process may begin. Keep the plastic as clean as possible.

8. Pumping will continue until the pH, temperature, turbidity, and conductivity have stabilized (pH ± 0.1; temperature ± 1 degree Celsius; conductivity ± 3 percent; turbidity ± 10 percent). If turbidity does not stabilize within 20 NTU range, both filtered and unfiltered samples will be collected for metals analysis.

9. During the purging process, geochemical measurements (e.g., pH, conductivity, turbidity and temperature) should be collected a minimum of three times. Record these data in the field log book.

10. Wells should not be pumped dry to ensure stabilization of indicator parameters. In low yield wells, it is important to avoid dewatering the well screen interval. No specific minimum quantity of water needs to be purged from the well prior to sample collection. However, if stabilization does not occur within a reasonable period (i.e., 2 hours or less), the Olin Project Manager should be contacted for additional direction.

11. Affix a sample label to each sample container and complete all required information (sample no., date, time, sampler's initials, analysis, preservatives). Place clear tape over the label. Record sample number, well number, date, time, and the sampler's initials in the field book.

12. Collect the groundwater samples after stabilization is complete. Sample first for VOs, taking care to remove all air bubbles from the vial and minimize agitation. Collect remaining organic samples then inorganic samples.

    The recommended order of sample collection is as follows:

    In field measurements (e.g., temperature, pH, specific conductance, turbidity, dissolved oxygen)
    Volatile organic compounds (VOCs)
    Purgeable organic carbon (POC)
    Purgeable organic halogens (POX)
    Total organic halogens (TOX)
    Total organic carbon (TOC)
    Extractable organics
    Total metals
    Dissolved metals
    Phenols
    Cyanide
    Sulfate and chloride
    Turbidity
    Nitrate and ammonia
    Radionuclides

13. Thoroughly decontaminate all equipment used before proceeding to the next well. Discard plastic sheeting, towels, gloves, etc., in a plastic bag.

14. Complete chain-of-custody forms with appropriate sampling information.

15. Complete both front and back of the groundwater monitoring data log (attachment) for each monitoring well or sampling point upon return from the field, using data from the field log book.

Filtering of Metal Samples:

1. Assemble peristaltic pump per operating manual instructions, which accompany pump.

2. At the pump intake, attach polyethylene tubing to the tubing at the head of the peristaltic pump. The polyethylene tubing should be long enough to extend to the bottom of the baler. At the pump discharge end attach a clean 0.45-micron filter (or appropriate sized filter) to the Teflon tubing.

3. Turn on the pump and draw the water from the well, through the pump and filter, and into the sample container.

4. Disassemble the pump head and discard the polyethylene and Teflon tubing and filter in a plastic bag.

Attachment C - Inspection Checklist Logs

Inspection Checklist
Operable Unit 1
Morgantown Ordnance Works Site
Morgantown, West Virginia

DATE:_____ **TIME:**_____ **INSPECTOR:**_____ **WEATHER CONDITIONS:**_____

Item	OK	Requires Maintenance	Comments
Cap System			
Adequate grass coverage on all portions of soil cover system			
Soil cover areas are free of ponding surface water			
No woody plants developing on soil cover			
Protective soil cover layers are free from erosion ruts caused by surface water runoff			
No evidence of soil-dwelling animals disturbing the protective soil cover layers			
All areas of slope remain stable with no apparent slides or slope failures			
Site fence extends to within 6 inches of ground surface with no large gaps caused by erosion or animals			
Site fence and barbed wire are completely intact and upright with no damage from tree limbs or soil erosion			

Item	OK	Requires Maintenance	Comments
Wetlands - (see Section 3.2 for inspection frequency)			
Retention of 80 percent of the original wetland replacement system (1.05 acres) and 80 percent of desirable species			
Predominance of desirable, nuisance, and native hydrophytes within acceptable range.			
Occurrence of wildlife and potential for exposure to residual leachate in treatment wetland system			
Erosion or sedimentation within acceptable limits.			