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VIA FEDERAL EXPRESS (*AM Priority*)

December 23, 2003

United States Environmental Protection Agency
Region 5
Corrective Action Section, DW-8J
77 West Jackson
Chicago, Illinois 60604

Attention: Ms. Patricia J. Polston, Project Manager
Waste Management Branch

Reference: Ground Water Monitoring Technical Memorandum No. 3
Administrative Order on Consent
Vernay Laboratories, Inc.
Yellow Springs, Ohio
Project No. 0292.11.17

Dear Ms. Polston:

The Payne Firm, Inc. (Payne Firm) is pleased to submit, on behalf of Vernay Laboratories, Inc. (Vernay), the attached Ground Water Monitoring Technical Memorandum No. 3, as agreed to by the Administrative Order on Consent (AOC) journalized by the United States Environmental Protection Agency (US EPA) on September 27, 2002. The electronic version of this Technical Memorandum is also included on a CD-Rom in Appendix X of the Technical Memorandum.

Should you have any questions regarding the enclosed document, please contact either of us at (513) 489-2255 or by e-mail at dcc@paynefirm.com or ddw@paynefirm.com.

Sincerely,

The Payne Firm, Inc.

David C. Contant, C.P.G.
Project Manager

Daniel D. Weed, C.P.G.
Principal

cc: Mr. Doug Fisher – Vernay Laboratories, Inc.
Mr. Tom Matheson – US EPA
Ms. Bri Bill – US EPA
Mr. Joseph Lonardo – Vorys, Sater, Seymour and Pease
Mr. Rob Hillard – Village of Yellow Springs
Ms. Connie Collett – Yellow Springs Community Library

RCRA CORRECTIVE ACTION
TECHNICAL MEMORANDUM NO. 3
GROUND WATER MONITORING

VERNAY LABORATORIES, INC.
Plant 2/3 Facility
Yellow Springs, Ohio

Project No. 0292.11.17

December 23, 2003

Prepared For

VERNAY LABORATORIES, INC.
Yellow Springs, Ohio

Prepared By

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EXECUTIVE SUMMARY

In the September 27, 2002 Administrative Order on Consent between the US EPA and Vernay Laboratories, Inc., it was agreed that Vernay would prepare a Ground Water Monitoring Technical Memorandum. This Ground Water Monitoring Technical Memorandum, per Paragraph 13 of the AOC, includes the results of the quarterly ground water monitoring events, an evaluation of the efficacy of the ongoing ground water interim measures, well construction documentation, and ground water potentiometric surface depictions. It also includes an update of the conceptual site hydrogeologic model for the Facility and surrounding area that was initially presented in the November 2002 Current Conditions Report, and identifies additional data that is needed to complete the Phase I Facility Investigation.

The conceptual site hydrogeological model consists of two aquifers, the Cedarville Aquifer and the Brassfield Aquifer. The two aquifers provide potable and non-potable water to users in the vicinity of the Facility, and are separated from one another by less permeable geologic units that act as an aquitard. The Cedarville Aquifer is the uppermost aquifer beneath the Facility and consists of consolidate carbonate bedrock and discontinuous sand lenses that sit on top of, or near the top of, the bedrock unit. The Cedarville Aquifer can be represented as an equivalent porous medium at the scale of the Facility and vicinity, and ground water flow velocities in the Cedarville Aquifer range from approximately 5 to 30 feet per year.

Existing ground water interim measures at the Facility include two extraction wells screened in the Cedarville Aquifer, and a sump collection system. The ground water extraction wells are operating as designed by preventing the migration of contaminated ground water off of the Facility in the upper, middle, and lower portions of the Cedarville Aquifer. Based upon the results of a particle tracking analysis, the capture zone of the ground water interim measures extends at least to the base of the Cedarville Aquifer along the eastern boundary of the Facility. Ground water beneath the Facility in the Cedarville Aquifer will eventually flow to the eastern property boundary, at which point it is captured by the extraction wells. Extracted ground water is treated at the Facility.

Quarterly ground water sampling results from monitoring wells screened with the upper, middle, and lower portions of the Cedarville Aquifer, and monitoring wells screened in sewer backfill, exhibited very little variability in contaminant concentrations during quarterly monitoring in 2003. SVOCs and metals are determined not to be chemicals of concern in ground water and will not be sampled for during future quarterly ground water monitoring events. Based on the quarterly ground water sampling results, PCE, TCE, cis-1,2-DCE, 1,2-DCP, and Freon-113 are considered the primary chemicals of interest at the Facility. All VOCs presented in the Project Quality Assurance Project Plan are being assessed and will continue to be monitored during the quarterly ground water monitoring program.

The existing monitoring well network in the sewer backfill on and off of the Facility has sufficiently determined the nature and extent of contamination within this media. These monitoring wells will continue to be sampled on a quarterly basis for at least the remainder of the Phase I Facility Investigation. The existing monitoring well network in the Cedarville Aquifer is not at this time sufficient to determine the nature and extent of contamination within this aquifer. Additional ground water monitoring wells are needed in the upper, middle, and lower portions of the Cedarville Aquifer to complete the Phase I Facility Investigation. These monitoring wells are proposed to be installed in January/February 2004.

1.0 OBJECTIVES OF THE GROUND WATER MONITORING TECHNICAL MEMORANDUM

This section describes the objectives of the Administrative Order on Consent between Vernay Laboratories, Inc. and the United States Environmental Protection Agency, the Data Quality Objectives for the RCRA Corrective Action, and the objectives and contents of this Ground Water Monitoring Technical Memorandum (GWMTM).

1.1 Overall Objectives of the Streamlined Order

Vernay Laboratories, Inc. (Vernay) in an Administrative Order on Consent (AOC), journalized September 27, 2002, agreed to complete a United States Environmental Protection Agency (US EPA) Resource Conservation and Recovery Act (RCRA) Corrective Action for the Vernay facility located at 875 Dayton Street in Yellow Springs, Ohio (Facility). The AOC is a streamlined, results based order. It includes enforceable deadlines and stipulated penalties. The main objective of the AOC is to ensure protection of human health and the environment.

The primary elements that must be completed during the RCRA Corrective Action Section VI. (Work To Be Performed) are documented in the AOC. These elements include the following:

- Preparation of a Current Conditions Report;
- Installation of a Ground Water Capture System at the Facility;
- Perform a Facility Investigation to identify the nature and extent of releases of hazardous waste and hazardous constituents at or from the Facility which may pose an unacceptable risk to human health or the environment;
- Preparation of Environmental Indicator (EI) Reports for human health (CA 725) and for ground water stabilization (CA750);
- Preparation of a Final Corrective Measures Proposal to the US EPA;
- US EPA selection of its proposed corrective measures in a Statement of Basis document that the public reviews and provides comments on;
- US EPA selection of the Final Corrective Measures in a Final Decision and Response to Comments report; and
- Implementation of the Final Corrective Measures.

The Current Conditions Report (CCR) (Payne Firm, 2002) and Installation of a Ground Water Capture Treatment System (GWCTS) at the Facility were completed on schedule. Vernay is currently in the Facility Investigation phase of the Corrective Action. According to the AOC, the Facility Investigation will be performed in two phases. Phase I of the investigation will address the Cedarville Aquifer and storm sewer backfill. Phase II will address, if necessary, the Brassfield Aquifer and other hydrogeologic characterization of the Facility. A Phase I Facility Investigation Report is required to be submitted to the

US EPA on or before June 30, 2004 and the Phase II Facility Investigation Report on or before December 31, 2004. Figure 1-1 presents a schedule of deliverables required by the AOC.

1.2 RCRA Corrective Action Data Quality Objectives

As required by the AOC, all sampling and analysis has and will be performed in accordance with US EPA Region 5 RCRA Quality Assurance Project Plan (QAPP) Policy (US EPA, 1998) as appropriate for the Facility, and be sufficient to identify and characterize the nature of past releases. The Payne Firm prepared a Quality Assurance Project Plan for the Vernay Laboratories, Inc. RCRA Corrective Action dated February 11, 2003 (Payne Firm, 2003) that follows the guidelines presented in the US EPA's QAPP Policy. The QAPP presents the organization, objectives, functional activities and specific quality assurance (QA) and quality control (QC) activities associated with the RCRA Corrective Action.

Project data quality objectives (DQOs) were developed as part of the scoping phase of the RCRA corrective action. The Project DQOs were presented most recently in Technical Memorandum No. 2 (Historical Data Usage in the RCRA Corrective Action), dated December 12, 2003 (Payne Firm, 2003). Project DQOs are presented on Table 1-1.

The basis for the rationale presented in the Project DQO Table is derived from Section VI. of the AOC, the CCR, Technical Memorandum No. 2, and US EPA guidance (US EPA, 1998; US EPA, 2000). Ohio Voluntary Action Program (VAP) data is being used to support and meet certain Project DQOs during the RCRA corrective action. The rational for using Ohio VAP data during the RCRA Corrective Action is presented in Technical Memorandum No. 2 (Payne Firm, 2003). The intended use of the Ohio VAP data during the RCRA Corrective Action is presented on Table 1-1. The Project DQOs ensure that all past data, and all data collected during the RCRA Corrective Action, are of the appropriate quality and type for its intended use.

1.3 Objectives and Contents of the Ground Water Monitoring Technical Memorandum

This GWMTM is included in the AOC (Section VI. Paragraph 13.) as a component of the Phase I Facility Investigation. The AOC indicates that this GWMTM shall include, but not be limited to: 1) the results of three quarterly 2003 ground water sampling events, 2) an evaluation of the efficacy of the ground water interim measure, 3) well construction documentation, and 4) ground water potentiometric surface depictions. Given the amount of information and analytical laboratory data that has been collected at the Facility in 2003 and during the previous Ohio VAP investigations, this GWMTM also includes additional information as it relates to the ground water and hydrogeological system at and in the vicinity of the Facility.

According to the AOC, Phase I of the Facility Investigation addresses the Cedarville Aquifer and storm sewer backfill. In 2003, Vernay installed 63 Geoprobe® ground water sampling borings into sewer backfill and into the upper portion of the Cedarville Aquifer, installed eight additional monitoring wells and a second ground water extraction well in the Cedarville Aquifer, installed one additional monitoring well in the storm sewer backfill, and completed quarterly ground water monitoring.

This GWMTM is divided into the following main sections:

Executive Summary
1.0 Objectives of the Ground Water Monitoring Technical Memorandum;
2.0 Facility Background;
3.0 Conceptual Site Hydrogeologic Model;
4.0 Monitoring Well Network;
5.0 Summary of Quarterly Ground Water Monitoring Events;
6.0 Monthly Water Level Measurements;
7.0 Evaluation of the Efficacy of Existing Ground Water Interim Measures;
8.0 Additional Data Needed for the Phase I Facility Investigation;
9.0 Conclusions; and
10.0 References

2.0 FACILITY BACKGROUND

This section provides general background information about the Facility, including the Facility location.

2.1 Facility Location

The Facility is located at 875 Dayton Street in the Village of Yellow Springs, Ohio at latitude 39^{o} 48’ 10” and longitude 84^{o} 54’ 19” (Figure 2-1). Yellow Springs is located in the north-central portion of Greene County (Miami Township), which is located in the southeastern portion of Ohio. The bordering Clark County is located approximately 1.5 miles north of the Facility. The nearest major city to Yellow Springs is the City of Dayton, which is located approximately 15 miles to the west.

The Facility is comprised of approximately ten acres and is bound by Dayton Street to the north; East Enon Road to the west; commercial, agricultural, and residential properties to the east; and residential properties to the south (Figure 2-2).

The primary features at the Facility include: Plant 2 and Plant 3 buildings; a storage building located south of Plant 2; various asphalt driveways and parking lots; and, a grass field located along the western portion of the Facility. Approximately two-thirds of the Facility is covered by Plant 2, Plant 3, and parking lots, with the remaining area being the grass field. The features of the Facility, as they currently exist[1], are shown on Figure 2-2.

Plant 2 is currently used for the manufacturing of rubber products, primarily for the medical industry and covers approximately 9,000 square feet. Plant 3, which is approximately 100,000 square feet in area, is used primarily for offices and maintenance; very limited manufacturing operations are conducted in Plant 3.

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[1] The aerial photograph used for the figures in this report as obtained from the Greene County Auditors Office, dated 1998.

3.0 CONCEPTUAL SITE HYDROGEOLOGIC MODEL (CSHM)

The conceptual site hydrogeologic model (CSHM) described below presents the current understanding of the three-dimensional hydrogeologic system beneath the Facility and vicinity. The CSHM was developed using reviewed literature, site-specific data obtained from previous investigations and the Facility Investigation to date (December 2003), and ground water mathematical modeling. The CSHM will be modified as additional information is obtained during the remaining portion of the Facility Investigation.

The CSHM is a site-specific description of the hydrogeology beneath the Facility and surrounding area. Items considered in the generation of the CSHM include features that govern the entrance of water and the ability of each geologic unit to hold, transmit, and deliver water, ground water quality, and contaminant migration and transport. A Preliminary CSHM was presented in Section 4.4.1 of the CCR and was generally described as consisting of the following six units: (1) Unconsolidated Unit (vadose zone), (2) Cedarville Aquifer (uppermost aquifer), (3) Osgood Aquitard, (4) Brassfield Aquitard, (5) Brassfield Aquifer (lowermost aquifer), and the (6) Elkhorn Aquiclude. The CSHM is consistent with other work that researchers have completed in the Yellow Springs area (e.g. Frost 1977; Townsend 2002). To date, Vernay has collected site-specific data from the Facility to characterize the first three units in the CSHM. Other units may be characterized during the Facility Investigation to satisfy the Project DQOs and the requirements of the ACO. Data collected during past investigations, the RCRA Corrective Action, and previous research have contributed to the current version of the CSHM presented on Figure 3-1 and described in the following subsections.

3.1 Hydrogeologic Overview

In Greene County, ground water occurs in both unconsolidated and consolidated geologic units. Within unconsolidated deposits, ground water that is useable for potable and non-potable purposes is obtained from buried valley aquifers of high hydraulic conductivity that contain thick sequences (150 ft.) of alluvial and/or glacial outwash deposits of sand, gravel and cobbles (Bennett & Williams, 2001). Buried valley aquifers are not located beneath or in the vicinity of the Vernay Facility. The nearest buried valley aquifer is located approximately 2.5 miles to the southeast of the Facility beneath the current course of the Little Miami River where the municipal well field supplying water to the Village of Yellow Springs is located (Figure 3-2). Municipal water and private water use are described in Sections 3.5.1 and 3.5.2, respectively in the CCR.

The second type of unconsolidated deposit found in Greene County, and beneath the Facility, is glacial till. Where present, glacial till typically contains a heterogeneous mixture of unstratified materials that range in size from clay to boulders. Discontinuous silty sand seams may be present within glacial till deposits. Water may or may not be present in the discontinuous sand seams, and is not useable because of its low-yielding nature and poor water quality.

Ground water beneath the Facility and surrounding area occurs in consolidated bedrock units situated beneath the glacial deposits. Ground water within these sedimentary rocks moves laterally through horizontal bedding plane partings and through vertical (or near vertical) joint sets throughout the region. Ground water yields from these consolidated bedrock units are relatively low (5-15 gpm). A few properties in the vicinity of the Facility have private wells screened within the bedrock and use the water for potable and/or non-potable purposes. Some of the private wells are currently not being used for any purpose. A detailed description of the CSHM is presented below.

3.2 Unconsolidated Unit

The Unconsolidated Unit beneath the Facility and the surrounding area consists of fill and glacial till. Specifically, the type of glacial till deposit is referred to as a ground moraine (ODNR, 1999). The Unconsolidated Unit, consisting mostly of low-permeability clays and silts, inhibits the rapid movement of water and chemicals downward through the soil at the Facility. Precipitation slowly infiltrates vertically through the glacial till deposits providing recharge to the underlying bedrock aquifer. The Unconsolidated Unit comprises the vadose zone beneath the Facility and the surrounding area. The vadose zone is limited above by the land surface and below by the uppermost bedrock aquifer beneath the Facility (Cedarville Aquifer).

Through the inspection of borehole logs (Appendix I), the Unconsolidated Unit beneath the Facility and vicinity consists of a very firm, slightly moist silt and clay matrix. This low permeability silt and clay matrix contains laterally discontinuous poorly sorted sand lenses at or near the bedrock surface, and interbedded discontinuous poorly sorted sand seams in the upper and middle portions of the unit that vary in thickness (six inches to four feet) and vary in moisture content (dry to saturated). According to geological property laboratory results collected by the Payne Firm from the glacial till, the average moisture content, porosity, and vertical hydraulic conductivity of the Unconsolidated Unit are approximately 13%, 26%, and 2×10^{-7} centimeters per second (cm/s), respectively (Payne Firm, 2002). Of the geological property samples collected from discontinuous sand seams within the unit, the average moisture content, porosity, and vertical hydraulic conductivity were approximately 18%, 52%, and 6.5×10^{-5} cm/s, respectively.

A number of cross sections depicting the subsurface beneath the Facility (A through G) were presented in Appendix XI of the CCR. Additional cross sections have been generated from site-specific borehole data off-Property collected in 2003 (H through N). All of these cross sections are included in Appendix II of this GWMTM. As shown on all cross sections, the discontinuous sand seams are not encountered in boreholes until depths of approximately 10 feet below grade. One exception to this observation is the presence of a discontinuous sand seam from four to 11 feet below grade at MW02-03/03SE on Omar Circle (cross sections I and M [Appendix II]). The extent of this particular sand seam is known to be discontinuous both vertically and horizontally as indicated by the lack of sand at this interval in borings south and east of Omar Circle and at the Facility.

Soil borings installed by Vernay to the top of bedrock indicate the thickness of the Unconsolidated Unit ranges from approximately 11 to 25 feet. An isopach (thickness) map depicting one foot contours of the Unconsolidated Unit thickness is presented on Figure 3-4. From the isopach map, the Unconsolidated

Unit is the thickest (>20 feet): (1) beneath the western area of the Facility, (2) beneath Plant 3, and (3) along a linear area beneath the properties just east of the Facility. As described in the Section 3.3, a bedrock topographic low exists in this third general area and is interpreted to have been "filled in" with unconsolidated sediments. Moving farther to the east of the Facility and beyond Wright Street, the Unconsolidated Unit thins to a thickness of less than 15 feet. Vertically, the thickness of the Unconsolidated Unit can be observed off the Facility in cross sections H, I, J, K, L, M, and N (Appendix II).

Hydrogeology

Buildings and asphalt and/or concrete parking areas on the central and eastern portions of the Facility restrict recharge into the Unconsolidated Unit. Recharge to the Unconsolidated Unit is primarily from the western portion of the Facility, and at locations off of the Facility's property to the northwest. The topographic high point in the vicinity of the Facility is located to the northwest; the land in this area is primarily used for agricultural purposes. Contours representing the topography of the Unconsolidated Unit (i.e. ground surface topography) slope gently to the north and east of the Facility as shown on Figure 3-3.

Most of the discontinuous sand seams that were observed in boreholes drilled within the Unconsolidated Unit were dry or slightly moist. The few saturated sand seams that were observed are not interpreted to be connected to the underlying bedrock aquifer (Cedarville Aquifer) based on a significant difference in water level measurements obtained from the sand seams when compared to the potentiometric surface of the Cedarville Aquifer at the same location (Table 3-1). In addition, the discontinuous sand seams are separated from the Cedarville Aquifer by at least 3 to 10 feet of silty clay. In the example below, seven feet of head difference was measured between a saturated sand seam within the Unconsolidated Unit and the Cedarville Aquifer potentiometric surface.

Location	Sand Seam	Water Elevation (Sand)	Water Elevation (Cedarville Dolomite)
GP02-67	9-13 (ft. bgs)	1015.9 (ft. msl)	1008.9 (ft. msl)

Some discontinuous sand lenses were observed at or near the surface of the underlying bedrock unit (Cedarville Dolomite). The sand lenses that were encountered during borehole drilling were typically saturated and are interpreted inferred to be hydraulically connected with the underlying saturated Cedarville Dolomite. This observation is based on equivalent water level measurements from the sand lens when compared to the potentiometric surface at the same location (Table 3-1). In the example below, less than 0.2 feet of head difference was measured between the saturated sand lens near the bedrock surface and the potentiometric surface in the underlying Cedarville Dolomite.

Location	Sand Lens	Water Level (Sand)	Water Level (Cedarville Dolomite)
GP02-67	16-18 (ft. bgs)	1009.05 (ft. msl)	1008.9 (ft. msl)

3.3 Cedarville Aquifer (Uppermost Aquifer)

Beneath the Unconsolidated Unit, two consolidated bedrock aquifers are present beneath the Facility and vicinity. The aquifers are separated by two aquitards. As described in the CCR, both aquifers are used by some private well users for potable and non-potable purposes. The vertical and horizontal extent regionally of the aquifers and aquitards was presented on Sheets 2 and 3 in the CCR. The uppermost aquifer is described below whereas the lowermost aquifer and the aquitards are described in the following subsections.

The uppermost aquifer beneath the Facility and the surrounding area is called the Cedarville Aquifer, and consists of the discontinuous sand lenses described above and Silurian-aged carbonate bedrock (dolomite and some shale). The aquifer is approximately 75 to 84 feet in thickness beneath the Facility and vicinity. As shown on Figure 3-1, the three rock formations (youngest to oldest) comprising the Cedarville Aquifer are the Cedarville Dolomite, the Springfield Dolomite and the Euphemia Dolomite. As indicated from site-specific borehole data (Appendix I), the bottom elevation of the Cedarville Aquifer has been identified at five locations (MW01-02SE, CW01-02, MW02-03SE, MW02-08SE and MW02-11SE). From the boreholes listed above, the average thicknesses of the three geologic formations are 68 feet, 7 feet, and 6 feet, respectively, for an average Cedarville Aquifer thickness of 82 feet (Table 3-2 and Figure 3-7). The massive Cedarville Dolomite represents the thickest Silurian bedrock unit in the area. The relatively thin Springfield Dolomite, a crystalline dolomite and Euphemia Dolomite, a vuggy-weathering dolomite, are present above the Massie Shale.

At the Facility and vicinity, the depth to the top of the of the Cedarville Dolomite ranges from 11 to 25 feet below the surface (Table 3-2). As shown on Figure 3-5, contours of the regional bedrock topography indicate the Facility is located near the bedrock high for the region (ODNR, 1994). One foot contour intervals of site-specific bedrock topography data are shown on Figure 3-6. In general, contouring of the bedrock surface indicates: (1) there is a general decrease in elevation to the northeast; (2) topographic lows and highs exist beneath Plant 3; (3) an erosional surface over three feet of relief that trends to the northeast directly east of the Facility; and (4) the localized dip of the bedrock surface is approximately one foot in elevation per 50 feet in distance to the northeast, which is consistent with the reported dip for the region (Evers, 1991).

<u>Hydrogeology</u>
Because of the lack of ground water in the Unconsolidated Unit (Section 3.1), most of the known private wells in the vicinity of the Facility are drilled into the Cedarville Aquifer. Vernay has also installed a total of 40 monitoring wells, extraction wells and remediation wells within the Cedarville Aquifer. The Cedarville Aquifer is fully saturated beneath the Facility. Water stored in this aquifer occurs within intergranular and vugular pore spaces and along joints and bedding plane partings. The average ground water yield from the Cedarville Aquifer is about 5 to 15 gpm (Maxfield, 1975). Portions of the upper and middle Cedarville Aquifer the Cedarville Dolomite and Euphemia Dolomite formations have been identified as those portions of the Cedarville Aquifer that have a good production potential to residential water wells (Frost, 1977). Site-specific data from geophysical logging and core inspection support these

findings indicating the upper and middle portions of the Cedarville Aquifer are the more permeable portions of the aquifer.

Regionally, the Cedarville Aquifer is at least partially confined by the overlying glacial till. During the investigations conducted at the Facility and vicinity, observations during drilling activities consistently indicated that the borehole was relatively dry until the top of bedrock, or the top of a discontinuous sand lens immediately above the bedrock, was encountered. Once this zone was encountered, water would immediately enter into the borehole and rise to within a few feet below the surface, indicating that the underlying aquifer may be under confined or semi-confined conditions beneath the Facility and vicinity. Site-specific data indicate the potentiometric surface in monitoring wells screened into the Cedarville Aquifer is higher than the top of bedrock elevation of the Cedarville Aquifer, indicating that the Cedarville Aquifer is acting as a confined aquifer beneath the Facility and vicinity (Table 3-3). In the examples below, over eight to twelve feet of head above the bedrock surface was measured on December 3, 2003.

Well Name	Top of Bedrock	Potentiometric Surface	Difference
MW01-02	1011.13 (ft. msl)	1023.30 (ft. msl)	12.70 ft.
MW01-04	1009.26 (ft. msl)	1019.60 (ft. msl)	10.34 ft.
MW02-08	1008.61 (ft. msl)	1019.17 (ft. msl)	10.56 ft.
MW02-06	1007.86 (ft. msl)	1017.00 (ft. msl)	09.14 ft.
MW02-09	1006.10 (ft. msl)	1014.78 (ft. msl)	08.86 ft.
MW02-10	1005.14 (ft. msl)	1013.80 (ft. msl)	08.66 ft.

Based on ground water elevations measured on September 10, 1999 before the pumping began for the ground water interim measure (Figure 7-1), ground water flow at the Facility was towards the east-northeast at an estimated gradient of 0.005 ft/ft. As discussed in detail in Appendix IX, the hydraulic conductivity of the Cedarville Aquifer ranges from 1 to 4 feet per day. Therefore, the ground water flow velocity ranges from approximately 5 to 30 feet per year (if an effective porosity of 25 percent is assumed). Lithologic logs (Appendix I) indicate that there is no extensive confining or low permeability layers within Cedarville Aquifer. Water level measurements from wells that are screened within upper, middle and lower intervals of the Cedarville Aquifer indicate almost no vertical hydraulic gradient (Table 6-2). In the example shown below, less than 0.2 feet of head is measured between the three Cedarville Aquifer intervals and a slight upward hydraulic gradient is observed from the lower to upper interval.

Location	Screen Interval	Date	Potentiometric Surface
MW02-08	Upper	12/3/03	1019.17 (ft. msl)
MW02-08CD	Middle	12/3/03	1019.07 (ft. msl)
MW02-08SE	Lower	12/3/03	1019.24 (ft. msl)

It is important to note that to date no VOCs have been detected in wells screened in the lower portion of the Cedarville Aquifer. These monitoring wells are located 400 feet to the east (downgradient) from the Facility.

3.4 Osgood Aquitard

Townsend, (2002) indicates that there are three sedimentary bedrock formations (youngest to oldest, the Massie Shale, Laurel Dolomite and Osgood Shale) beneath the Cedarville aquifer that act as an aquitard as shown on Figure 3-1. An aquitard is a low-permeability unit that can store ground water and transmit it slowly from one aquifer to another (Fetter, 1994). Maxfield (1975) describes the Massie Shale as an "impermeable layer...", and further indicates that the Massie Shale and Osgood Shale have a very low porosity and are described as dense formations with a poor production potential to water wells. Norris (1956) indicates that the units comprising the Osgood Aquitard act as an "impermeable body" separating ground water from above (Cedarville Aquifer) and below (Brassfield Aquifer), and that pumping from one aquifer does not immediately affect the water level in the other.

As shown on Figure 3-1, the Osgood Shale is a relatively thick bedrock unit (approximately 20 to 25 feet). Regionally, the Osgood Shale grades upward into the Laurel Limestone, which is actually a dense dolomite (approximately 4-6 feet thick). The Massie Shale overlies the Laurel Limestone, and is a dark-colored, argillaceous shale and relatively thin in the area (approximately 5 feet thick). Site-specific borehole data has encountered the Massie Shale at five locations in the vicinity of the Facility (Table 3-2). From these five locations, the average thickness of the Massie Shale is determined to be 5.9 feet. The Laurel Limestone has been encountered at four locations (MW01-02SE, MW02-03SE, MW02-08SE, and MW02-11SE) and the thickness at MW01-02SE is 4.5 feet. The Osgood Shale was encountered at one borehole location (MW01-02SE) beneath facility at a depth of approximately 104.5 feet bgs. The borehole did not fully penetrate the unit after drilling 20 feet into it. Site-specific geophysical borehole logging and geological property sampling at MW01-02SE confirm the low-porosity/low-hydraulic conductivity of the Osgood Aquitard (Sheet 2, CCR, Marshall Miller & Associates, 1999).

The top of the Osgood Aquitard beneath the Facility and vicinity is the Massie Shale where the depth below ground surface ranges from 94 to 109 feet (Table 3-2). Using site-specific data, one foot contour intervals of the top of the Massie Shale are shown on Figure 3-8. In general, contouring of the Massie Shale surface indicates that there is a general decrease in elevation to the northeast beneath the Facility. Off-property, the dip of the Massie Shale at MW02-11SE is also to the northeast but, in the area of MW02-03SE, the dip trends more to the southeast. In general, the average dip of the Massie Shale is one foot in elevation per 60 feet in distance to the east-northeast, consistent with the regional dip of the region.

3.5 Brassfield Aquitard

The Brassfield Aquitard is located beneath the Osgood Aquitard. This aquitard is approximately 40 to 45 feet thick in the vicinity of the Facility (Figure 3-1). The Silurian-aged rocks comprising the Brassfield Aquitard consist of interbedded limestone and shale. Based on Townsend (2002), the

Brassfield Aquitard consists of the Dayton Formation (dolomite), and the upper, middle, and lower zone of the Brassfield Formation (limestone and shale). Townsend (2002) has defined these units as a "carbonate aquitard" (Figure 3-1). Visual and microscopic examination of core from this zone shows very low (about 1%) porosity with no observable interconnections, which indicates that the hydraulic conductivity in this unit is near zero except at joints (Townsend, 2002). Frost (1977) indicates that there is some evidence of limited water movement along clay seams in this zone. Frost and Townsend also document that the production potential to water wells from this zone is very poor. The Brassfield Formation also exhibits a northeasterly joint trend in southwestern Ohio. Site-specific data currently does not exist for the Brassfield Aquitard.

3.6 Brassfield Aquifer (Lower Aquifer)

The Brassfield Aquifer, the lowermost aquifer beneath the Facility and vicinity, is situated beneath the Brassfield Aquitard (Figure 3-1). The Osgood Aquitard and the Brassfield Aquitard (consisting of approximately 65 to 80 feet of lower permeability geologic units) separate the Brassfield Aquifer from the base of the Cedarville Aquifer above. The Brassfield Aquifer consists of the portion of the Brassfield Formation known locally as the "sugar rock." The sugar rock zone of the Brassfield Formation is identified as being four feet thick in a boring drilled at Antioch College, located approximately one mile east of the Facility (Townsend, 2002). Frost (1977) notes that the rock in this zone is generally dense near the base and develops an intergranular and vugular porosity and increased crystal size. As a result, this zone exhibits prominent intergranular openings, producing interconnected intercrystalline porosity, ranging from 10% to 30% (Townsend, 2002).

<u>Hydrogeology</u>

The flow of ground water in the Brassfield Aquifer is controlled by the vugular porosity of the sugar rock, and joints and fractures. The capacity of the aquifer to transmit water to wells depends on the size, number, and interconnection of water yielding joints. The average ground water yield from wells in the Brassfield Aquifer is about 16 gpm (Maxfield, 1975). Currently, there is no site-specific data for the Brassfield Aquifer.

3.7 Elkhorn Aquiclude

The Brassfield Aquitard is underlain by a thick (greater than 1,000 feet) succession of non-water bearing shale and limestone bedrock of lower Silurian and upper Ordovician age. These units have been defined as an aquiclude (Frost, 1977), acting as the base of the hydrogeological system beneath the Facility and the surrounding area (Figure 3-1). An aquiclude is a low-permeable unit that forms either the upper or lower boundary of a ground water flow system (Fetter, 1994). This unit is referred to as the Elkhorn Aquiclude in this report. Site-specific data for the Elkhorn Aquiclude has not been collected at this point.

4.0 MONITORING WELL NETWORK

This section describes the monitoring well network that existed prior to the RCRA Correction Action at the Facility, and the objectives of the monitoring well installation program that was completed in 2003 as part of the RCRA Corrective Action. A detailed description of the well installation methodology is presented in this section.

4.1 Monitoring Well Network Prior to RCRA Corrective Action

Monitoring wells were installed at and in the vicinity of the Facility prior to 2003 as part of the Ohio VAP investigation (Pre-RCRA CA monitoring wells). Prior to installing permanent monitoring wells, a number of Geoprobe® borings were drilled to the top of the Cedarville Aquifer for the purpose of collecting ground water samples from within the Geoprobe® borehole. These ground water boring locations are presented on Figure 4-4. The results of the Geoprobe® ground water samples assisted in determining the optimum location for the permanent monitoring wells on the Facility and on Omar Circle and Wright Street.

The Pre-RCRA CA monitoring wells were installed on and in the vicinity of the Facility between 1998 and 2000. These monitoring wells are screened in the upper, middle, and lower portions of the Cedarville Aquifer, and within sewer backfill. At the Facility, 12 of these monitoring wells (MW01-01 through MW01-11, and MW01-14) are screened within the upper portion, four of these wells are screened within the middle portion (MW01-02CD through MW01-05 CD), and one well (MW01-02SE) is screened in the lower portion of the Cedarville Aquifer (Figure 4-2). Two monitoring wells (MW01-12 and MW01-13) are screened in the sanitary and storm sewer backfill, respectively. In addition, four additional monitoring wells (RW01-02 through RW01-05) are located in the central portion of the Facility between Plant 2 and Plant 3 (Figure 4-2). These monitoring wells are also screened in the upper portion of the Cedarville Aquifer, and were used to monitor the ground water in this area during an in situ pilot study conducted in 1999 during the Ohio VAP investigation (CCR, Section 4.1.3). Seven additional monitoring wells (MW02-01 through MW02-07) screened in the upper portion of the Cedarville Aquifer are located south of the Facility on Omar Circle and east of the Facility on Wright Street (Figure 4-2). Figure 4-2 presents the locations of the entire pre-RCRA corrective action monitoring well network.

The monitoring wells screened in the middle portion of the Cedarville Aquifer are designated with a "CD" after the well identification (i.e. MW01-2CD), which indicates that the well is screened in the Cedarville Dolomite. The monitoring well screened in the lower portion of the Cedarville Aquifer is designated with a "SE" after the well identification (i.e. MW01-02SE), which indicates that the well is screened in the Springfield and Euphemia formations within the Cedarville Aquifer. The Pre-RCRA CA well logs are presented in Appendix VI of the CCR, and Table 3-2 presents the well construction information.

4.2 Objectives of the RCRA Corrective Action Monitoring Well Installation Program

As required by Section VI. Paragraph 13. of the AOC, additional Cedarville Aquifer and storm sewer backfill monitoring wells were installed before September 30, 2003. The work was performed within portions of the 825 Dayton Street property and the Village of Yellow Springs Right-of-Way along Dayton Street, Omar Circle, Wright Street, Suncrest Drive, Green Street, Limestone Street, College Street and Lawson Place (Figure 4-3). The primary objectives of the monitoring well installation program were:

- To collect Geoprobe® ground water screening samples from the upper portion of the Cedarville Aquifer and storm sewer backfill to determine the optimum locations for permanent shallow Cedarville Aquifer and storm sewer backfill monitoring wells.
- To install monitoring wells into the upper, middle, and lower portions of the Cedarville Aquifer and into storm sewer backfill to assist in determining the nature and extent of contaminants in ground water and sewer backfill.
- To record the potentiometric surfaces in the monitoring wells installed in the upper, middle, and lower portions of the Cedarville Aquifer to determine the vertical hydraulic gradient at well cluster locations and generate potentiometric surface maps.
- To collect Geoprobe® water samples from discontinuous sand seams within the Unconsolidated Unit to support evaluation of human exposure during the risk assessment.
- To gather additional information on the nature of the conceptual site hydrogeologic model.

4.3 Cedarville Aquifer Well Installation Process

As required by Section VI.13 of the AOC, Vernay, in consultation with the US EPA, installed additional ground water monitoring wells in the Cedarville Aquifer and storm sewer backfill following a Geoprobe® ground water sampling event. This work was completed between August 21 and September 11, 2003.

In order to determine optimum monitoring well locations, a Geoprobe® ground water sampling event was conducted prior to selecting the locations for additional monitoring wells. The analytical ground water data collected from the Geoprobe® investigation is comparable to data collected from a monitoring well (Section 5.3.4) at the same location. Since a Geoprobe® rig cannot usually penetrate very deep into rock, one limitation is that ground water samples can only be collected from either water from sand lenses within the Unconsolidated Unit, or from the top portion of the Cedarville Aquifer. Ground water samples from the middle or lower portions of the Cedarville Aquifer cannot be collected with a Geoprobe®.

A Payne Firm geologist coordinated sample collection, quality assurance/quality control procedures, employment of data quality objectives, and containment of drilling waste in accordance with the Payne Firm's SOPs and site-specific Corrective Action QAPP. A second Geoprobe® ground water sampling event was also conducted in November 2003.

4.3.1 Geoprobe® Ground Water Sampling Methodology and Results

Initial Geoprobe® Sampling

Ground water samples were collected from 21 locations at the top of the Cedarville Aquifer at the 825 Dayton Street property, Wright Street, Suncrest Drive, and Green Street using a Geoprobe® during the third quarter of 2003 (Figure 4-3). Results from this investigation provided information for optimum monitoring well placement into the Cedarville Aquifer. Once the top of the Cedarville Aquifer was encountered, a water sample was collected directly from within the borehole (if saturated); the hole was then abandoned to the ground surface in accordance with state guidelines. Ground water sampling forms are included in Appendix III.

The following steps were taken at each Geoprobe® direct-push sampling location.

- The boring was initiated by driving the probe rods and sampling device down to the top of the Cedarville Aquifer. The drillers stopped driving at the inferred top of the Cedarville Aquifer based on probe driving resistance and lithologic data from available nearby locations. A stainless steel screen at depth was then exposed by retracting the protective outer drilling sleeve approximately 0.5 feet.
- Prior to sample collection, the ground water was purged with a peristaltic pump and dedicated Teflon® tubing at each depth prior to sampling to minimize fine sediment and turbidity in the water sample based on visual observation. The purging volume usually consisted of 0.5 to two gallons prior to sampling. In cases where recharge was abundant, a stainless steel bailer was used to collect the ground water sample. Where low yields were encountered, the ground water samples were collected from Teflon® tubing and a check valve ball or peristaltic pump.
- Samples were labeled and then packaged into an ice-packed cooler prior to shipment to the laboratory in conformance with Payne Firm SOPs.
- Upon completion of the sampling and removal of the drilling rods, the boring was backfilled with bentonite chips and the surface location patched following Payne Firm SOPs. Purge water was transferred to a holding tank for proper disposal.
- The direct-push stainless steel screen and other drilling rods were decontaminated in accordance with the Payne Firm SOPs. Rinsate samples were periodically collected over the sampling equipment as specified in the project QAPP for quality control. Other quality control samples included trip blanks, duplicates, field blanks, and matrix spike/matrix spike duplicates as specified in the RCRA CA QAPP.

The water samples that were collected from the borehole were analyzed for volatile organic compounds (VOCs). Figure 4-4 presents a summary of VOCs that were detected in Geoprobe® boring locations from this investigation above the analytical laboratory reporting limit. Figure 4-4 does not present estimated concentrations that were detected below the laboratory reporting limit. However, estimated concentrations detected below the laboratory reporting limit are presented on Table 4-1 (shown with a “J” qualifier) along with a complete list of VOCs that were analyzed by the laboratory.

Two north-south transects of five Geoprobe® borings each were drilled on the 825 Dayton Street property (Figure 4-3). The highest concentrations of VOCs in ground water samples were detected from the borings located on the southern portion of the western transect (GP02-32 and GP02-33). Concentrations of PCE up to 200 ug/L were detected in GP02-32. Freon-113 was the only VOC concentration that was detected above the laboratory reporting limit from the eastern transect borings. Only a very low concentration of cis-1,2-DCE was detected above the reporting limit in one of the northern transect borings (GP02-36). A summary of the data is presented on Table 4-1. The analytical data indicated that

VOCs detected in the upper portion of the Cedarville Aquifer decrease in the eastern (downgradient) direction from the Facility.

A total of 12 Geoprobe® borings (GP02-20 through GP02-31) were drilled on Wright Street, Suncrest Drive, and Green Street to determine the optimum location of a well that would monitor the downgradient edge of the VOC ground water plume. The highest concentrations of VOCs were detected at GP02-25 on Suncrest Drive (Figure 4-4). Concentrations of VOCs such as PCE (6.3 ug/L), TCE (7.6 ug/l), cis-1,2-DCE (1.4 ug/L), and Freon-113 (14 ug/L) were detected in the ground water sample collected from this boring. Concentrations of PCE (1.2 ug/L) and Freon-113 (2.4 ug/L) were also detected in boring GP02-21 on Green Street.

This data was used to determine additional monitoring well locations in the upper Cedarville Aquifer. The rationale for the additional monitoring well locations based on the analytical data is presented in Section 4.3.2.

<u>Second Geoprobe® Sampling Event</u>

A second round of ground water samples were collected from 21 Geoprobe® locations on the north side of Dayton Street, on the 825 Dayton Street Property, Limestone Street, Green Street, the property located at 1 Lawson Place, Omar Circle, College Street, and Wright Street (Figure 4-3). The purpose of this sampling event was to collect additional ground water data to determine the extent of VOC contamination in the upper portion of the Cedarville Aquifer, and to determine the optimum locations for additional monitoring wells to be installed in 2004. Ground water sampling forms are included in Appendix III.

The water samples that were collected from the borehole were analyzed for VOCs. Figure 4-4 presents a summary of VOCs that were detected at Geoprobe® boring locations. Figure 4-4 does not present estimated concentrations that were detected below the laboratory reporting limit. However, estimated concentrations detected below the laboratory reporting limit are presented on Table 4-1 (shown with a "J" qualifier) along with a complete list of VOCs that were analyzed by the laboratory.

VOCs were not detected above the laboratory reporting limits in ground water samples collected from Geoprobe® borings drilled along Dayton Street, Limestone Street, Green Street, the property at 1 Lawson Place, the southern portion of Green Street, and West South College Street (Figure 4-4). The only exception is a detection of a very low concentration (1.1 ug/L) of Freon-113 slightly above the reporting limit on Omar Circle (GP02-79). A summary of the data is presented on Table 4-1. This analytical data will be used to make decisions regarding proposed additional monitoring wells in the upper Cedarville Aquifer, as discussed in Section 8.2.1.

4.3.2 Well Installation Methodology and Locations

Following analyses of the initial Geoprobe® VOC results, eight ground water monitoring wells were installed into the Cedarville Aquifer at locations on the 825 Dayton Street property, Omar Circle, Suncrest Drive, and Green Street using sonic drilling (Figure 4-5). The subsurface stratigraphy was cored and logged by a Payne Firm geologist. The monitoring wells are constructed of two inch diameter PVC with ten foot screen lengths placed within the upper, middle, or lower portions of the Cedarville Aquifer. Boring logs and well construction diagrams are presented in Appendix I.

At Omar Circle, a well screened in the lower portion of the Cedarville Aquifer (MW02-03SE) was installed adjacent to an existing shallow Cedarville Aquifer monitoring well (MW02-03, Figure 4-5). The well screen at MW02-03SE also intersects the upper one foot of the Osgood Aquitard.

At the 825 Dayton Street property, a cluster of two wells (one shallow [MW02-11] and one deep well [MW02-11SE]) were installed downgradient of the Facility in the Cedarville Aquifer. At a separate location on the 825 Dayton Street property, a cluster of three Cedarville Aquifer wells (shallow [MW02-08], middle [MW02-08CD], and deep [MW02-08SE]) were constructed downgradient of wells on the Facility that contain elevated concentrations of VOCs. As indicated on Figure 4-5, this cluster of three wells is positioned near the eastern portion of the 825 Dayton Street property and is near the central axis of ground water contamination. As with monitoring well MW02-03SE on Omar Circle, the deep well screens for these monitoring wells (MW02-08SE and MW02-11SE) also intersect the top one foot of the Osgood Aquitard.

Shallow monitoring wells at Suncrest Drive (MW02-09) and Green Street (MW02-10) were installed in the upper portion of the Cedarville Aquifer at the approximate areas of highest VOC detections previously identified by the Geoprobe® investigation (Figure 4-5). These monitoring wells were installed to further characterize ground water conditions downgradient from the Facility.

The additional Cedarville Aquifer monitoring wells located in streets are completed flush with the surface consistent with the existing wells located on Wright Street and Omar Circle. The top of the monitoring well PVC casing is completed below the road grade protected by a steel road guard. The Cedarville Aquifer monitoring wells at the 825 Dayton Street property are completed above ground with steel guard post protection. Well development was completed in accordance with Payne Firm SOPs. Copies of the field well development logs are presented in Appendix IV. A licensed surveyor located the coordinates and elevations of the Geoprobe® and well locations following completion. Survey data for the new monitoring wells are included on Table 3-2.

4.4 Off-Property Storm Sewer Well Installation Process

4.4.1 Geoprobe® Investigation and Results

Geoprobe® borings were drilled along Dayton Street between the Facility and Limestone Street (GP02-42 through GP02-52), and east of Plant 3 where sanitary sewers exit the Facility (GP01-109 and GP01-110), to determine the optimum location to install a monitoring well into the sewer backfill and to determine the extent of VOC contamination in the sewer backfill water. A Geoprobe® was used to drill borings into the backfill material surrounding the sewer.

A private underground utility contractor, Underground Detective of Cincinnati, Ohio, marked on the ground surface the approximate outer limits of the sewers in the study area. This was necessary to locate the sewer backfill in the borings immediately adjacent to the sewer and without striking the utility during drilling. Once the sewer backfill was identified by logging, a water sample was collected directly from within the borehole (if saturated); the hole was then abandoned to the ground surface in accordance with state guidelines. Ground water sampling forms are included in Appendix III.

The boring installation and water sampling methodology conducted was consistent with the methods described in Section 4.3.1. The only difference is that the boring was initiated by driving the probe rods and sampling device down to the bottom of the sewer backfill. The drillers stopped driving at the inferred base of the sewer backfill based lithologic data described by a Payne Firm geologist.

The water samples that were collected from the borehole were analyzed for VOCs. The highest concentrations of VOCs in the sewer backfill were detected at GP02-49, located immediately north of MW01-13 on the Vernay property (Figure 4-7). The concentrations of VOCs detected at GP02-49 are very similar to VOC concentrations detected at MW01-13. Since MW01-13 is already located in the area of highest concentration of VOCs in the storm sewer backfill, a permanent well at GP02-49 is not needed.

VOCs were detected by several orders of magnitude lower to the east in the adjacent downgradient sewer water sample collected at GP02-48. This analytical data was used to make decisions regarding proposed additional monitoring wells in the sewer backfill, as discussed in Section 4.4.2. The laboratory data are summarized on Table 4-2.

4.4.2 Well Installation Methodology

Following analyses of VOC results from the water within the storm sewer backfill, one monitoring well (MW02-12) was installed into the storm sewer backfill along Dayton Street (Figure 4-6). The monitoring well is located in an area of low VOC concentration based on the Geoprobe® sample data and therefore is providing information on the extent of VOC contamination in the storm sewer backfill water. Consistent with the existing storm sewer monitoring well on the Facility (MW01-13), the additional well on Dayton Street (MW02-12) was constructed of two inch diameter PVC with a five foot screen length (Appendix I). Well development was completed in accordance with Payne Firm SOPs. A copy of the field well development logs are presented in Appendix IV. A licensed surveyor obtained the coordinates and elevations of the well location following completion. Survey data for the new monitoring well is included on Table 3-2.

4.5 Water Sampling from Sand Seams in the Unconsolidated Unit

During the Geoprobe® investigations on and off of the Facility in 2003, water samples were collected from discontinuous sand seams in the Unconsolidated Unit, if they were encountered in the borehole. The purpose of these water samples is to provide information for the evaluation of potential receptors during the risk assessment. During the 2003 Geoprobe® investigation, a total of 42 borings were installed on and off of the Facility; out of the 42 total borings, 22 boring locations either did not encounter a sand seam or encountered a dry sand seam, and 20 borings encountered a sand seam where a water sample was collected (Figure 4-8).

The boring installation and water sampling methodology was conducted consistent with the methods described in Section 4.3.1. The only difference is that a new boring was drilled adjacent to the original boring location for each separate sand seam identified by a Payne Firm geologist. Each sand seam boring was initiated by driving the probe rods and sampling device down to the bottom of the identified sand seam.

4.5.1 On Property Sand Seam Water Sample Results

On the Facility property, 6 of 13 boreholes encountered water in sand seams during the 2003 Geoprobe® investigation. A summary of the concentrations detected above the laboratory reporting limit in these borings is presented on Figure 4-9. These results support the conclusion that the saturated sand seams are disconnected and the presence of water in these sand seams within the Unconsolidated Unit is variable. The maximum concentrations of VOCs in the water samples collected in sand seams beneath the Facility were detected at boring GP01-115, located immediately south of Plant 2 located at the northeast corner of the Facility. At boring GP01-115, the water was sampled from 10.5 to 11 feet below the ground surface. TCE was detected in this sample at a concentration of 1,200 ug/L, and cis-1,2-DCE at 35 ug/L.

Concentrations of PCE and TCE were detected in water sampled from a sand seam at boring GP01-111, located at the northeast corner of the Facility (Figure 4-9). At this location, two separate sand seams (from 8 to 9.5 feet and 12.5 to 13 feet below the ground surface) were encountered and sampled. Concentrations of PCE decreased from 740 ug/L in the upper sand seam water sample (8-9.5 feet), to 54 ug/L in the lower sand seam water sample (12.5-13 feet). A concentration of 240 ug/L of TCE was also detected in the lower sand seam water sample at this location. Water samples were also collected at these intervals from other Geoprobe® borings (GP02-73) in the vicinity of GP01-111 (Figure 4-9 and Table 4-3).

Concentrations of PCE, TCE, cis-1,2-DCE, and 1,2-DCP were also detected in the water sampled from sand seams located at boring GP01-112 (8-11 feet, and 14-16 feet) located near the northern property boundary. Lower concentrations of some of these chemicals were also detected at GP01-114 and GP01-121 (Figure 4-9, Table 4-3).

A summary of the concentrations of VOCs from saturated sand seams within the Unconsolidated Unit from Geoprobes®.

4.5.2 Off-Property Sand Seam Water Sample Results

Twenty-nine Geoprobe® borings were drilled off of the Facility on Dayton Street, the property on 825 Dayton Street, Limestone Street, Green Street, the property at 1 Lawson Place, Wright Street, West South College Street, and Omar Circle (Figure 4-8). Of these 29 boring locations, 15 borings either did not encounter a sand seam, or no water was present in the sand seam (Figure 4-8). These results further support the conclusion that the saturated sand lenses are disconnected and the presence of water in sand seams within the Unconsolidated Unit is variable.

The off Facility sand seam Geoprobe® borings are divided into three main areas for discussion purposes. These areas include: 1) Dayton Street area; 2) the area east and downgradient from the Facility (borings on Limestone, Green Street and the property at 1 Lawson Place); and 3) the area southeast and downgradient from the Facility (borings on Omar Circle, Wright Street, and West South College Street)(Figure 4-8).

Dayton Street Area

Six borings along the Dayton Street area encountered water in sand seams (Figure 4-8). Four of the six borings (GP02-76, GP02-74, GP02-73, and GP02-71) had concentrations of VOCs detected above the laboratory reporting limits. A summary of these concentrations is presented on Figure 4-9, and a complete summary is presented on Table 4-3. In general, relatively low concentrations of VOCs were detected in these samples, except for PCE (39 ug/L) detected from the sample collected at GP02-74 (7.5 to 11.5 feet below the ground surface).

Area East of the Facility

Only two of seven borings drilled in this area encountered water in sand seams. The borings where water was sampled are borings GP02-61 and GP02-59. No VOCs were detected in the water sampled at these locations.

Area Southeast of the Facility

Water in sand seams was not encountered in the seven borings drilled in this area. Locations where water samples have been collected since 1998 are shown on Figure 4-10.

5.0 SUMMARY OF QUARTERLY GROUND WATER MONITORING EVENTS

In accordance with Section VI. Paragraph 13. of the AOC, Vernay implemented a quarterly ground water monitoring program in 2003. This section presents a discussion of the ground water monitoring objectives, the ground water sampling protocol used during the monitoring events, and a summary of the ground water analytical laboratory data. The current ground water monitoring well network consists of the wells shown on Figure 5-1.

5.1 Objectives of the Quarterly Ground Water Monitoring Program

Section VI. of the AOC and Section 2.2 of the QAPP requires that the following ground water data objectives be satisfied during the Corrective Action Facility investigation to minimize the uncertainty of the US EPA's Statement of Basis, which details the justification for the US EPA's proposed final corrective measure for the Facility: 1) determine the nature and extent of contamination; 2) demonstrate that the migration of contaminated ground water from the Facility has stabilized; 3) demonstrate that all current human exposures to ground water contamination at or from the Facility are under control; 4) continue to demonstrate the efficacy of existing ground water interim actions; and, 5) collect sufficient data to evaluate current and potential risks to human health and the environment, and to evaluate corrective measures.

As stated in Paragraph 18. of Section VI., the critical demonstrations that are needed to meet the ground water objectives include:

- Determine any current unacceptable risks to human health and the environment, and control any unacceptable current human exposures.
- Stabilize the migration of contaminated ground water, including implementing any corrective measures necessary.
- Conduct ground water monitoring to confirm that any contaminated ground water remains within the original area of contamination.

Before each quarterly sampling event, the following critical factors were evaluated (listed from higher priority to lower priority) to determine the sufficiency of data needed to meet the overall objectives of the quarterly monitoring program:

1. Confirmation that there is no significant or unacceptable exposures of COCs above appropriate risk-based levels for which there are complete pathways between ground water contamination and human receptors.
2. Confirmation that concentrations on the fringes of the area of contamination are not significantly increasing overtime, especially at well locations that are critical for demonstrating stability of ground water contaminant migration.
3. Confirmation that concentrations of COCs within the existing area of contamination are not increasing or decreasing significantly overtime.
4. The Corrective Action project schedule including the stage of completion of the iterative ground water well installation program for the Cedarville Aquifer, and possibly the Brassfield Aquifer.
5. Potential influence of seasonal variations in ground water elevation in the Cedarville Aquifer beneath the Facility and the surrounding area.
6. Evaluation of existing analytical database with the project risk assessor and project hydrogeologist to ensure that sufficient data is available to conduct the risk assessment including contaminant fate and transport modeling, if necessary.
7. Data needs to confirm that the existing ground water interim actions are effectively performing.
8. Confirmation that COCs are not migrating on to the Facility from an upgradient source.

These factors are important to understanding concentrations of COCs over time, to confirm that contaminant migration pathways identified in the conceptual site model have not changed, to confirm that there is no current unacceptable risk to human health, and to assist in determining if any additional ground water interim actions are necessary.

5.2 Quarterly Ground Water Monitoring Well Sampling Methodology

The field activities associated with the quarterly ground water monitoring events followed the project QAPP and the Payne Firm's SOPs for Well Purging (SOP 6-3), Ground Water Sampling (SOP 6-4), and Decontamination of Water Sampling Equipment (SOP 6-1). The Payne Firm's SOPs are consistent with the May 2002 US EPA guidance document "Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers" (US EPA, 2002) and are located in the Project QAPP. The ground water sampling methodology consisted of the following primary elements:

- Prior to sampling a monitoring well, appropriate measurements such as the static water level, total well depth, and volume of water in the well are made.
- A submersible pump (QED Well Wizard® Bladder Pump, or Grundfos® Redi-Flow II submersible pump) with dedicated Teflon®-lined tubing is slowly lowered into the well to a point within the well screen interval.
- Each well is purged following the low flow purging methods described in SOP 6-3. During well purging, water quality parameters (temperature, pH, specific conductance, oxidation-reduction potential [ORP], dissolved oxygen, and turbidity) are recorded from an in line flow-through cell every 3 to 5 minutes after a minimum of one tubing volume of water has been removed. Purging may cease when measurements for all parameters have stabilized for three consecutive measurements. Stabilization criteria for the water quality parameters is as follows (US EPA 2002):

  i. pH: +/- 0.1
  ii. specific conductance: +/- 3% S/cm
  iii. dissolved oxygen: +/- 0.3 milligrams per liter
  iv. oxidation-reduction potential: +/- 10 millivolts
  v. turbidity: +/- 10% (when turbidity is > 10 NTUs).

  The flow rate during purging is initially low (0.2 to 0.5 liter per minute); the flow rate may be increased as long as the drawdown in the well does not exceed 0.33 feet.

- Once sufficient ground water is purged, ground water is carefully transferred to laboratory supplied containers for analysis of chemicals of concern for each sampling event. Appropriate sample preservation is immediately added to the ground water samples, according to the particular analysis to be conducted. Samples are collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell.
- The ground water samples are appropriately packaged and shipped to the project laboratory, Severn Trent Laboratories in North Canton, Ohio.
- Ground water sampling information is recorded on a ground water sampling form and/or in the project field logbook.

Ground water samples were collected from all monitoring wells during the First Quarter Monitoring Event, and they were analyzed for VOCs by US EPA Method SW846 8260, SVOCs by US EPA

Method SW846 8270, and metals (copper, chromium, zinc) by US EPA Method SW846 6010. Ground water samples collected during the 2nd Quarter Monitoring Event were analyzed for VOCs and SVOCs. Ground water samples collected from all monitoring wells during the Third and Fourth Quarter Monitoring Events were analyzed for VOCs. Tables 5-1 through 5-4 summarize the analytical results of the quarterly ground water monitoring events. All ground water samples were analyzed following the methods described in the RCRA CA QAPP.

Sampling Documentation

Ground water samples are labeled immediately after collection. The information on the sample label included the project name, sample identification, sample date and time, and the analyses requested. The ground water samples are labeled as **MW01-01/[date]**, where:

MW01-01/[date], MW01=On-property monitoring well (MW02=Off-property monitoring well);
MW01-01/[date], 01=Well identification;
MW01-01/[date], [date]=Date of sample collection.

A field logbook and a field ground water sampling form are used to record facts and circumstances of the sampling event. Information recorded in the logbook/field form may include the following:

- Name of sampling personnel;
- Sample location;
- Time and date;
- Weather conditions;
- Sample type (i.e. grab, composite, etc.); and
- Pertinent sample data.

Copies of the ground water sampling forms for each quarterly ground water monitoring event are presented in Appendix III.

Chain-of-custody documentation accompanied each sample shipment. The chain-of-custody record includes the project name, type of sample collected, date of sample collection, name(s) of the person(s) responsible for sample collection, date of custody transfer, signature of the person relinquishing and accepting sample custody, and other pertinent information.

Decontamination of Sampling Equipment

The ground water sampling pump is decontaminated prior to use at each monitoring well location. Decontamination procedures include:

- Disconnect internal pump parts, including Teflon® bladder and pump fittings.
- Scrub the exterior of the pump and associated internal pump fittings and Teflon® bladder in a non-phosphate detergent solution;

- Rinse with distilled water;
- Allow to air dry.

Dedicated tubing is used at each monitoring well location; therefore, it is not necessary to decontaminate pump tubing between monitoring well sampling locations. New decontamination solutions were used periodically during each day of sampling. All decontamination solutions are contained and properly disposed.

Quality Control Samples

Sample collection, quality assurance/quality control procedures, and employment of data quality objectives were conducted by the Payne Firm in accordance with the Payne Firm's SOPs and Corrective Action QAPP. During the monitoring events, the following QC samples were collected at a minimum:

- One trip blank sample was shipped with each sample cooler containing samples for VOC analysis. The trip blank samples were identified as: TB01-[date]. The trip blank sample was analyzed for VOCs.
- One duplicate sample was collected for every 20 sample. The duplicate samples were identified prior to each sampling event and were analyzed for the same constituents that were analyzed for the duplicate monitoring well.
- One equipment rinsate sample was collected for every 20 samples. The rinsate samples were collected after the ground water sample pump has been properly decontaminated at the end of the day. The sample will be collected by pouring laboratory grade water over the sample pump, and collecting the rinsate off of the pump into the appropriate sample containers. The laboratory grade water was provided by the project laboratory.
- One matrix spike/matrix spike duplicate (MS/MSD) sample was collected for every 20 samples.
- One field blank sample was collected for every 20 samples during the sampling events by filling laboratory grade water directly into the appropriate sample containers.

5.3 Summary of 2003 Ground Water Analytical Results from Monitoring Wells

This section provides a summary of the analytical laboratory ground water data that was collected during the quarterly ground water monitoring events in 2003. A comparison of the ground water samples collected from the Geoprobe® and monitoring wells is discussed in Section 5.3.4. Consistent with the Corrective Action QAPP, the analytical reports submitted by the laboratory are CLP-like in that they contain the same information that would be presented in a CLP laboratory report (i.e. including raw calibration data, etc.).

All laboratory data for the quarterly ground water sampling events were validated by the Payne Firm consistent with the Corrective Action QAPP. Any data that was qualified by the Payne Firm project data validator was incorporated into the project analytical database.

A summary of the laboratory data, as well as the laboratory reports, from the first, second, and third quarter ground water monitoring events were presented in the respective quarterly progress reports submitted to the US EPA. This GWMTM also includes ground water data collected from the fourth quarter ground water monitoring event. As required by Section VI, Paragraph 24 of the AOC, copies of the analytical reports will be provided to the US EPA by January 15, 2004 in the Fourth Quarter Progress Report.

5.3.1 Summary of Concentrations of VOCs in the Upper, Middle, and Lower Portions of the Cedarville Aquifer

Based on the ground water data collected to date, several VOCs are considered to be chemicals of interest (COIs) for the purposes of this technical memorandum. These VOC COIs include the following chemicals: PCE, TCE, cis-1,2-DCE, 1,2-DCP, and Freon-113. The VOC COIs were considered to be the most important to focus on within this technical memorandum because: 1) they are detected the most frequent in ground water beneath and in the vicinity of the Facility; and 2) their historical use at the Facility.

5.3.1.1 Upper Cedarville Aquifer

Ground water samples collected in 2003 from the upper portion of the Cedarville Aquifer include the samples collected from monitoring wells during the quarterly ground water monitoring events, and the ground water samples collected from 42 Geoprobe® boring locations (Section 4.3.1). A summary of the analytical data from these sampling events is presented on Table 5-1 and 5-2 for the monitoring wells and Table 4-1 for the Geoprobes®.

A summary of VOC COIs detected above the laboratory reporting limit in monitoring wells at and in the vicinity of the Facility is presented on Sheet 1. The maximum concentration of the VOC COIs in the upper portion of the Cedarville Aquifer and the location where the chemical was detected during the 2003 sampling events is presented below:

Chemical	Concentration	Sample Location	Date Sampled in 2003
PCE	9,700 ug/L	RW01-05	2/18/03
TCE	1,400 ug/L	MW01-06	2/14/03
cis-1,2-DCE	110 ug/L	MW01-10	9/15/03
1,2-DCP	610 ug/L	MW01-02	9/11/03
Freon-113	820 ug/L	MW01-04CD	9/15/03

As expected, the maximum concentrations of these VOC COIs occur in ground water beneath the Facility. Concentrations of these VOC COIs decrease with distance from the Facility (Sheet 1). As indicated in Section 4.3.1, concentrations of VOC COIs are not detected above the laboratory reporting limit approximately 1,700 feet in the downgradient direction (east) of the Facility.

A discussion of the VOC concentration distributions in the Cedarville Aquifer is presented in Section 5.4.

5.3.1.2 Middle Cedarville Aquifer

Five monitoring wells are screened in the middle portion of the Cedarville Aquifer. These monitoring wells include four wells on the Facility (MW01-02CD, MW01-03CD, MW01-04CD, and MW01-05CD), and one well located on the 825 Dayton Street property (MW02-08CD) (Figure 5-1).

VOCs were not detected above the laboratory reporting limit in samples collected from MW01-02CD and MW01-03CD. Very low concentrations of cis-1,2-DCE (0.55 ug/L), 1,2-DCP (1.3 ug/L), and TCE (1.2 ug/L) were detected at monitoring well MW01-05CD. Concentrations of PCE, TCE, and Freon-113 are detected in monitoring well MW01-04CD. The maximum concentrations of these chemicals detected in MW01-04CD in samples collected in 2003 are 680 ug/L (PCE), 26 J (TCE), and 920 (Freon-113).

On 825 Dayton Street property, ground water samples collected in 2003 from monitoring well MW02-08CD have maximum concentrations of PCE (73 ug/L), TCE (35 ug/L), cis-1,2-DCE (7.9 ug/L), and Freon-113 (140 ug/L) detected above the laboratory's reporting limit.

5.3.1.3 Lower Cedarville Aquifer

Four monitoring wells are screened in the lower portion of the Cedarville Aquifer. These monitoring wells include one well on the Facility (MW01-02SE), and three wells off the Facility (MW02-03SE, MW02-08SE, MW02-11SE) (Figure 5-1). VOCs were not detected above the laboratory's reporting limit in any of the lower Cedarville Aquifer monitoring wells.

5.3.2 Summary of Concentrations of SVOCs and Metals in the Cedarville Aquifer

During the first quarter 2003 ground water monitoring event, all monitoring wells were sampled for SVOCs and metals (copper, chromium, and zinc). On June 30, 2003, Vernay prepared Technical Memorandum No. 1 (Payne Firm, 2003) presenting the sampling list of chemicals for the Facility Investigation. The technical memorandum documents the methodology and rational in developing the site-specific sampling list of chemicals. The SVOCs and metals were identified as possible chemicals of concern in ground water.

<u>Metals</u>
Concentrations of the three metals were not detected above the laboratory reporting limit in any monitoring wells. Given the lack of detections of metals from the ground water samples collected from the same monitoring wells prior to the RCRA corrective action (four separate sampling events), and the lack of detection during the first quarter ground water monitoring event, ground water samples were not analyzed for metals during the subsequent ground water monitoring events. A summary of the analytical results for metals is included on Table 5-3.

<u>SVOCs</u>
One SVOC, bis(2-ethylhexyl)phthalate, was detected above the laboratory reporting limit in four monitoring wells (MW01-03, MW01-05CD, MW01-08, RW01-05) during the first quarter ground water

monitoring event. Two additional monitoring wells (MW01-09, MW01-12) had estimated concentrations of bis(2-ethylhexyl)phthalate detected below the reporting limit (qualified with a "J"). During that sampling event, the maximum concentration of bis(2-ethylhexyl)phthalate was 61 ug/L detected at upgradient monitoring well MW01-08. No other SVOCs were detected above the laboratory's reporting limit.

During the second quarter ground water monitoring event, the six monitoring wells that detected bis(2-ethylhexyl)phthalate during the first quarter event were sampled again for SVOCs. These monitoring wells were selected to confirm the concentrations of bis(2-ethylhexyl)phthalate that were detected in these wells during the first quarter ground water monitoring event in 2003. The second quarter sampling results from these monitoring wells did not have any detections above the laboratory reporting limit for any SVOC, including bis(2-ethylhexyl)phthalate.

The detections of bis(2-ethylhexyl)phthalate during the first quarter sampling event may have been related to the tubing used to sample the monitoring wells. Flexible polyvinyl chloride (PVC) tubing was utilized during the first quarter sampling event. Bis(2-ethylhexyl)phthalate is widely used as a plasticizer, and may be a compound in the sample tubing that was used. During the subsequent ground water sampling events, Teflon® lined tubing was used. Given the lack of detections of SVOCs from the ground water samples collected from the first and second quarter in 2003, and the lack of detections of SVOCs from the ground water samples collected from the same monitoring wells prior to the RCRA corrective action (4 separate sampling events) ground water samples were not analyzed for SVOCs during the third and fourth quarter ground water monitoring events. A summary of the analytical results for SVOCs is included on Table 5-4.

5.3.3 Summary of Concentrations of VOCs in the Storm and Sanitary Sewer Backfill

The storm and sanitary sewer backfill monitoring wells consist of MW01-12, MW01-13, and MW02-12. Monitoring well MW01-12 is screened into sanitary sewer backfill near the north-central portion of the Facility where the Vernay-owned sanitary sewer taps into the Village of Yellow Springs sanitary sewer located on Dayton Street (Figure 5-1). Monitoring wells MW01-13 and MW02-12 are both screened into storm sewer backfill; MW01-13 is located at the northeastern corner of the Facility where the storm sewer on the Facility discharges into the storm sewer on Dayton Street, and MW02-12 is located approximately 500 feet east of the Facility on Dayton Street.

Low concentrations of TCE (up to 4.4 ug/L) were detected in sanitary sewer backfill water above the laboratory reporting limit in samples collected from MW01-12 in 2003. Very low estimated (J) concentrations of PCE (less than 0.51 ug/L) detected below the laboratory reporting limit were also detected in MW01-12 in 2003.

In storm sewer backfill, concentrations of PCE up to 1,100 ug/L were detected above the laboratory reporting limit in water samples collected at MW01-13 in 2003. In addition, concentrations of 1,2-DCE (up to 44 ug/L) and estimated (J) concentrations of TCE (up to 34 ug/L) were detected in MW01-13. The observed elevated concentrations of these VOCs are significantly reduced in the sewer backfill 500 feet from the Facility, as observed by the very low concentrations of VOCs detected in MW02-12. Water samples in 2003 collected from MW02-12 indicate PCE (up to 2.0 ug/L), and estimated (J) concentrations detected below the laboratory reporting limit of cis-1,2-DCE (up to 0.42 ug/L) and TCE (up to 0.97 ug/L).

5.3.4 Comparability of Geoprobe® Sampling and Monitoring Well Analytical Data

Eleven monitoring wells have been installed off the Facility in the upper Cedarville Aquifer and one monitoring well was installed in the storm sewer backfill following an analysis of Geoprobe® ground water samples. Results from Geoprobe® ground water samples have also been used to assist in determining the extent of VOCs in the upper Cedarville Aquifer and sewer backfill off the Facility. Therefore, it is important to determine if the Geoprobe® ground water sampling data are comparable to monitoring wells at the same location. Ground water data were compared among all twelve monitoring well locations off-Facility. In general, the comparisons showed a good correlation between VOC data obtained from Geoprobe® boring and monitoring well samples (Table 5-5). No more than a difference of about 20 ug/L has been observed in these samples. The following example shows the similarity in data taken at Geoprobe® boring locations and monitoring wells at the same location.

Location	Sample Date	PCE	TCE	cis-1,2-DCE
GP02-16	3/1/1999	8.6 ug/L	7.9 ug/L	2.6 ug/L
MW02-06	3/25/1999	6.2 ug/L	5.8 ug/L	2.0 ug/L
GP02-21	7/29/2003	1.2 ug/L	<1 ug/L	<0.5 ug/L
MW02-10	9/11/2003	1.6 ug/L	0.99 J ug/L	<0.5 ug/L

5.4 VOC COI Distributions in the Cedarville Aquifer

As described in Section 5.3.1, the most frequently detected VOC COIs in the Cedarville Aquifer are PCE TCE, cis-1,2-DCE, 1,2-DCP, and Freon-113. The lateral and vertical distributions of these contaminants are dependent on in-situ processes such as dispersion, volatilization, adsorption and chemical and biological degradation in the aquifer. The movement of these dissolved chemicals downgradient tends to be slower in comparison to the rate of ground water flow since these types of contaminants adsorb to the bedrock surfaces and degrade chemically or biologically. As dissolved contaminants are carried by ground water they tend to spread out both laterally and vertically, thereby lowering the average contaminant plume concentrations. Additionally, the capture of VOCs along the eastern property boundary of the Facility (Section 7.1.2) leads to a reduction in chemical flux in the aquifer downgradient of the Facility. Ultimately, a steady-state condition will be reached in the aquifer and the VOC plume will contract at some point downgradient of the Facility because the degree of chemical degradation exceeds the degree of downgradient chemical flux.

The current understanding of the distribution of VOC COCs in the Cedarville Aquifer was determined utilizing the analytical data obtained from the quarterly ground water monitoring events (32 wells), and the ground water analytical data obtained from 44 Geoprobe® borings drilled during the third and fourth quarters of 2003. A geospatial analysis using a sophisticated contouring package (earthVision®) together with scientific interpretations has produced a conceptual horizontal depiction of the maximum detections of the COI VOCs, shown on Figure 5-2 through 5-6.

5.4.1 Distribution VOCs in the Cedarville Aquifer

The current horizontal distribution VOCs in the Cedarville Aquifer is summarized below:

<u>PCE and Freon-113</u>

1. The geometries in plan view of these two constituents are very similar in that they tend to originate from the Plant 3 area (Figures 5-2 and 5-3). The capture zone produced by the two extraction wells at the Facility has mitigated the downgradient movement of these constituents beyond the eastern property boundary of the Facility.
2. Downgradient of the two extraction wells, two lobes of the plumes are apparent: (1) east of the Facility beyond Wright Street, and (2) between the southeastern portion of Omar Circle and West South College Street. This current distribution of these constituents is the result of pre-pumping ground water flow through these areas (Figure 7-1).
3. The extent of contamination in the upper portion of the Cedarville Aquifer has initially been defined by the non-detect results from Geoprobe® ground water samples on the streets of Dayton, Green, 1 Lawson Place, South Wright and West South College (Figure 4-4). Additional monitoring wells will need to be installed to confirm this.

<u>TCE and cis-1,2-DCE</u>

1. The horizontal extent of these two VOCs appears to originate at the Plant 2 area and upgradient of the Plant 2 area (Figures 5-4 and 5-5). The appearance of cis-1,2-DCE is most likely a chemical breakdown of TCE, and PCE.
2. The same two disconnected lobes are also apparent in the pre-pumping downgradient directions, similar to PCE and Freon-113.
3. Also similar to PCE and TCE, the extent of contamination has initially been identified.

<u>1,2-DCP</u>

1. The horizontal extent and origination of the 1,2-DCP plume is different than the VOCs previously discussed (Figure 5-6). This distribution originates in the vicinity of MW01-02 at the Facility and extends due east along the northern property line. Detections of 1,2-DCP extend to at least the GP02-66 area off-property. The distribution of 1,2-DCP may be less apparent in areas where other VOCs are detected in higher concentrations due to elevated detection limits. More work is planned in 2004 to identify the northern and eastern extent of this contaminant (Section 8.0).
2. Also the decrease in concentrations of 1,2-DCP downgradient of the Facility is more than likely the result of pumping at extraction well CW01-02.

6.0 MONTHLY WATER LEVEL MEASUREMENTS

Water levels are measured from the monitoring well network on a monthly basis (Figures 5-1). During each month, the water levels are recorded in the field logbook, incorporated into the project database, and the ground water potentiometric surface is determined for each monitoring well location through numeric modeling (Appendix IX). Table 6-1 presents the potentiometric surface for each monitoring well. A figure depicting the potentiometric surface for the Facility and vicinity for each month in 2003 is presented in Appendix V.

Based on the potentiometric surface at and in the vicinity of the Facility, the following observations can be made:

- The potentiometric surface is highest near the western portion of the Facility. It appears that this area is also located near the potentiometric surface high in the general area.
- The potentiometric surface is significantly changed on the eastern portion of the Facility, as well as to the northeast, east, and southeast of the Facility due to the pumping at the two capture wells located along the eastern property boundary (Section 7.0). Ground water in these areas flows toward the two ground water extraction wells located on the northeast (CW01-02) and southeast portions of the Facility (CW01-01).
- Approximately 900 feet east of the Facility (near Wright Street), the potentiometric surface appears to be affected less by the ground water interim measure, and ground water in this area flows generally to the east.
- Very small differences in hydraulic head are measured in the Cedarville Aquifer as indicated from the shallow, middle, and deep well clusters (Table 6-2).
- The potentiometric surface is relatively smooth, and does not exhibit any jaggedness or areas of extreme differences that might be indicative of a karstic environment.

Ground water hydrographs from monitoring well clusters in the Cedarville Aquifer are presented in Appendix VI. The hydrographs were constructed from the monthly water level measurements that were obtained from November 1998 through December 2003 (Table 6-1). The following observations are made based on the ground water hydrographs:

- The seasonal high and low potentiometric surface for the Cedarville Aquifer exists during the second and fourth quarter, respectively. This trend is observed irrespective of depth of the well (upper, middle, or deep). This observation is attributable to seasonal precipitation events, which are more frequent in the spring than in the fall/winter.
- There is very little difference in the potentiometric surface from monitoring wells screened in the upper, middle, or lower portions of the Cedarville Aquifer as indicated on Table 6-2 and shown in the example below.

Location	Screen Interval	Date	Potentiometric Surface
MW02-08	Upper	12/3/03	1019.17 (ft. msl)
MW02-08CD	Middle	12/3/03	1019.07 (ft. msl)
MW02-08SE	Lower	12/3/03	1019.24 (ft. msl)

7.0 EVALUATION OF THE EFFICACY OF EXISTING GROUND WATER INTERIM MEASURES

A ground water interim measure commenced at the Facility in March 2000 with the operation of a ground water extraction well (CW01-01) at the southeastern portion of the Facility. A detailed description of this system was presented in Section 4.1.3 in the CCR. In January 2003, a second extraction well (CW01-02) was installed and began operation at that time. Information regarding the second extraction well was described in detail in the First Quarter Progress Report to the US EPA (www.epa.gov/region5/sites/vernay). This section describes the objectives and evaluates the efficacy of the ground water interim measures. A description of the components and operation and the maintenance and monitoring of the GWCTS is presented in Appendix VIII.

7.1 Ground Water Capture Treatment System

7.1.1 Objective of the Ground Water Capture Treatment System

The ongoing ground water interim measure that is operating at the eastern portion of the Facility is referenced as the Ground Water Capture Treatment System (GWCTS). The GWCTS consists of two individual six-inch diameter stainless steel extraction wells (CW01-01 and CW01-02) located near the eastern property boundary of the Facility (Figure 5-1). The objective of the GWCTS is to capture VOC-contaminated ground water beneath the eastern and southeastern portions of the Facility, and then treat the captured water with activated carbon before it is discharged to the Yellow Springs Publicly Owned Treatment Works (POTW).

7.1.2 Capture Zone Evaluation

A Capture Zone Analysis was conducted to determine whether additional ground water capture well(s) would be required at the Facility "to prevent the migration of contaminated ground water off of the Facility in the Cedarville Aquifer" as identified in Paragraph 11 of the AOC. The results of the Capture Zone Analysis indicated that one additional ground water extraction well was needed near the northeast corner of the Facility to satisfy the objective identified in Paragraph 11 of the AOC. Based on this, extraction well CW01-02 was installed by the Payne Firm in January 2003. This extraction well has been operational since January 21, 2003, and together with an existing extraction well (CW01-01) prevent the migration of contaminated ground water off the Facility in the Cedarville Aquifer as indicated on the validated potentiometric surfaces presented in Appendix V. A summary of the methodology that was used to conduct the capture zone analysis is presented in Appendix IX.

7.1.3 Effects of Pumping on Hydrogeologic System

An example potentiometric surface of the Cedarville Aquifer before the implementation of the GWCTS is presented in Figure 7-1. As shown in the Figure7-1, the potentiometric surface beneath the Facility prior to pumping activities decreases in general from west to east measured during September 1999. Figure 7-2 presents a recent depiction of the potentiometric surface measured during September 2003 showing the localized area of ground water capture that has been active since pumping began at CW01-01 in

March 2000 and at CW01-02 in January 2003. Appendix V presents monthly potentiometric surfaces and capture zones of the Cedarville Aquifer since January 2003. Depictions of other monthly potentiometric surfaces prior to 2003 are presented in the CCR. Depictions of the capture zones presented in Appendix V, indicate that the dimensions of the capture zone created by the two extraction wells are very consistent through time.

Along the eastern boundary of the Facility, ground water is captured over a distance of approximately 1,000 feet in the north-south direction. Downgradient of the Facility (to the east) the capture zone extends approximately 500 feet, and ground water flowing from the western property boundary (approximately 900 feet) will also ultimately be captured by the extraction wells.

Based upon the results of the particle tracking analysis, the capture zone extends at least to the base of the Cedarville Aquifer along the eastern boundary of the Facility. Downgradient (east) of the extraction wells, the vertical extent of the capture zone will decrease with distance. Although the vertical extent of the capture zone will also decrease with distance in the upgradient direction (west), ground water beneath the Facility in the Cedarville Aquifer will eventually flow to the eastern property boundary, at which point it will move upward and be captured by the extraction wells.

7.1.3.1 VOC Concentrations vs. Time

The effect of pumping at CW01-01 and CW01-02 has a measurable effect on the concentrations of VOCs detected in the Cedarville Aquifer. VOC concentrations in several monitoring wells screened in the upper portion of the Cedarville Aquifer show decreasing concentrations of VOCs over time. The most dramatic effect of this decrease is shown by examining the PCE concentrations over time at MW01-04 and MW01-04CD located at the southeast portion of the Facility (Figure 7-3). As presented on Figure 7-3 and the graphs in Appendix VII, concentrations of PCE have been reduced from 4,600 ug/L (sampled in November 1998) to 76 ug/L (sampled in September 2003) in the upper Cedarville Aquifer. Other monitoring wells in the shallow portion of the Cedarville Aquifer that have exhibited decreasing concentrations of VOCs (since pumping commenced at the Facility) include MW01-05, MW01-09, and MW02-02 and MW02-03 located on Omar Circle. Appendix VII includes a graph of VOCs over time since the initial monitoring event for each monitoring well installed by Vernay.

Decreases of VOCs are also observed in monitoring wells screened in the middle portion of the Cedarville Aquifer. The effects of VOC reduction are not as pronounced as some of the monitoring wells screened in the shallow portion of the Cedarville Aquifer, but nonetheless have been reduced. Examples of this reduction in the middle portion of the aquifer are shown on the graphs of MW01-04CD and MW01-05CD. As shown on Figure 7-3, PCE has decreased in MW01-04 CD from 1,200 ug/L (detected in May 1999) to 480 ug/L (detected in November 2003).

Some monitoring wells on the Facility have exhibited an increase in VOCs since pumping commenced at the Facility. As the ground water extraction wells are operating, VOCs in the ground water are redistributed. Ground water and its dissolved contaminants will respond to pumping by moving toward the extraction wells. As ground water and its dissolved contaminants move toward the extraction wells, measured concentrations of VOCs with time may increase in any particular well, depending on its proximity to be capture zone. As a result, the monitoring wells at the Facility that exhibit and increasing trend of VOCs include MW01-02 west of the capture zone and MW01-05 and MW01-10 within the capture zone.

7.1.3.2 Conclusions of Capture Zone Evaluation

After CW01-02 was placed into operation, a series of water level measurements were collected from the monitoring and extraction wells in February 2003. Based on those data, a confirmatory particle tracking analysis was conducted to ensure that the new recovery well was performing as predicted. As shown in Figure 7-2, the results of the confirmatory particle tracking analysis are in agreement with the analysis completed during the remedial design. As shown in Appendix V all of the particles are captured by the recovery wells[2]. As a result, it is concluded that the two existing capture wells at the Facility are preventing the migration of ground water contamination off of the Facility in the upper, middle, and lower portions of the Cedarville Aquifer.

7.2 Utility Tunnel Sump Water Treatment System

7.2.1 Objectives of the Utility Tunnel Sump Water Treatment System

Vernay is also currently operating a Utility Tunnel Sump Water Treatment System (UTSWTS) for a sump located at the northeast corner of Plant 2. The sump collects water that drains around the perimeter of the concrete utility tunnel. On July 18, 2000, the Payne firm collected a water sample from the utility tunnel sump. Analytical results indicated that detectable concentrations of VOCs were present in the sump water. In response, Vernay installed an activated carbon treatment system to treat the sump water that was being discharged. Approximately 8,000 gallons of water is treated per month by the UTSWTS. The main objective of the UTSWTS is to collect VOC-contaminated water in the utility tunnel sump, and then treat the collected water with activated carbon before it is discharged to the Yellow Springs POTW. A description of the components and operation and the maintenance and monitoring of the UTSWTS is presented in Appendix VIII.

8.0 ADDITIONAL DATA NEEDS FOR THE PHASE I FACILITY INVESTIGATION

8.1 Sewer Backfill

The extent of VOC contamination in the storm sewer backfill has been defined with Geoprobe® ground water data collected from the borings on Dayton Street, and the addition of monitoring well MW02-12 in

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[2] The extraction well CW01-01 was off-line for periodic maintenance during the water level measurement event of March 2003. As a result, full capture along the eastern property line still existed as demonstrated by the confirmatory particle tracking although; a particle of water on the southern boundary may not have been included within the capture zone during the temporary shutdown of the extraction well.

the storm sewer east of the Facility on Dayton Street. The sewer monitoring wells will continue to be evaluated during the quarterly ground water monitoring events.

8.2 Cedarville Aquifer

Section 4.2 described the objectives of the monitoring well installation program that commenced in 2003, and Section 5.3 described the activities and analytical data that were collected from the Cedarville Aquifer in 2003. Based on the data collected to date from the Cedarville Aquifer, additional data needs have been identified for the Phase I Facility Investigation. These additional Cedarville Aquifer data needs are described below.

8.2.1 Shallow Cedarville Aquifer

Additional data is needed to determine the extent of VOCs in the shallow portion of the Cedarville Aquifer. At least five additional monitoring wells need to be installed into the shallow Cedarville Aquifer: an additional monitoring well downgradient of MW02-09 along Green Street; a monitoring well installed at the southeast corner of Omar Circle (at GP02-55); and downgradient of this location on West South College Street. Figure 8-1 shows the proposed locations of these additional shallow Cedarville Aquifer monitoring wells. These shallow monitoring wells are located in the downgradient central axis of the VOC plumes that emanated from the Facility.

At lease one shallow Cedarville Aquifer monitoring well needs to be installed north of the Facility to determine if recently detected soil contamination located at the northern portion of the Facility in the vicinity of MW01-02 has impacted the Cedarville Aquifer. To determine the most appropriate monitoring well location, ground water samples need to be initially collected from Geoprobe® boreholes and then a permanent monitoring well installed after reviewing the Geoprobe® analytical data. The locations of the proposed Geoprobe® borings are shown on Figure 8-1.

At least one shallow Cedarville Aquifer monitoring well needs to be installed east of the Facility on the 825 Dayton Street property to evaluate the extent of VOCs detected at GP02-66. In order to determine the most appropriate monitoring well location, ground water samples will be initially collected from Geoprobe® boreholes, and then a permanent monitoring well installed after reviewing the Geoprobe® analytical data. The locations of the proposed Geoprobe® borings are shown on Figure 8-1.

8.2.2 Middle Cedarville Aquifer

The extent of VOCs in ground water in the middle portion of the Cedarville Aquifer has not been determined. In order to determine the extent of VOCs in the middle portion of the Cedarville Aquifer, at least four additional monitoring wells need to be installed into the middle Cedarville Aquifer. The proposed middle Cedarville Aquifer wells are shown on Figure 8-1, and are each located adjacent to a shallow Cedarville Aquifer monitoring well. The middle Cedarville Aquifer monitoring wells proposed on Green Street and West South College Street should define the extent of contamination in this portion of the aquifer. The wells proposed on Wright Street and Omar Circle will assist in determining the nature of the VOC concentration gradient between the Facility and the additional well locations on Green Street and West South College Street.

8.2.3 Deep Cedarville Aquifer

The extent of VOC contamination in the lower portion of the Cedarville Aquifer off of the Facility has been determined with the monitoring wells installed in 2003 (MW02-03SE, MW02-08SE, MW02-11SE). However, the nature of VOCs (if any) in the deep portion of the Cedarville Aquifer has not been determined beneath the Facility. As a result, one monitoring well will need to be installed into the deep portion of the Cedarville Aquifer at the southeast corner of the Facility near the existing MW01-04 upper and middle well cluster (Figure 8-1). This location is immediately downgradient from the area of highest ground water contamination in the shallow portion of the Cedarville Aquifer. Ground water analytical data from this monitoring well will also be used to evaluate whether or not an investigation into the Brassfield Aquifer is necessary.

8.3 Surface Water and Sediment

During the Ohio VAP investigations from 1999 through 2001, samples of surface water and sediment were collected at several locations along the unnamed creek northeast of the Facility between Dayton Street and Fairfield Pike (Figure 8-2). A limited number of surface water and sediment samples were collected in 2003 from the unnamed creek. Results from the surface water and sediment sampling have been and will be included in the quarterly progress reports submitted to the US EPA. Samples will be collected from the same locations shown on Figure 8-2 during the first quarter 2004 ground water monitoring event. The purpose of this sampling will be to determine the current conditions of surface water and sediment in the unnamed creek, and to assist in the preparation of the Human Health Environmental Indicator report.

8.4 Quarterly Ground Water Monitoring

Quarterly ground water monitoring will continue in 2004. During the first and second quarter of 2004, ground water samples will be collected from all monitoring wells, including the new wells to be installed in early 2004. These ground water samples will be analyzed for VOCs. After the second quarter monitoring event, the Phase I Facility Investigation report will be prepared and submitted to the US EPA. The quarterly ground water monitoring program will be re-evaluated at that time, and a modified quarterly ground water monitoring program may be proposed.

8.5 Private Well Abandonment/Sampling

A well survey is currently being conducted in the vicinity of the Facility. Results of the survey will be incorporated in the First Quarter 2004 Progress Report, as well as the Phase I Facility Investigation report. The results of any private well sampling and/or well abandonment information will also be incorporated in the quarterly progress reports and the Phase I Facility Investigation report.

8.6 Confirmation Soil Sampling

Some soil samples were collected from the Facility and vicinity during 2003. However, as documented in the "Historic Data Ground Water Technical Memorandum No. 2" dated December 12, 2003 (Payne Firm, 2003), additional soil sampling is needed to confirm the Ohio VAP soil data. The soil sampling will occur during the first quarter of 2004. The analytical results from this event, as well as a comparison of the data to the Ohio VAP data will be provided to the US EPA in the quarterly progress reports.

9.0 SUMMARY

Based on the information presented in this GWMTM, the following observations can be made at this time based on data and information collected to date:

1. Upper sand seams within the Unconsolidated Unit are laterally discontinuous, and water contained in these upper sand seams are not hydraulically connected with the Cedarville Aquifer.

Water is present in a few laterally discontinuous sand seams within the Unconsolidated Unit. Water samples collected from sand seams situated beneath the Facility indicate that some contain detectable concentrations of VOCs. Water samples collected from sand seams off of the Facility indicate either no VOCs or very low concentrations of VOCs are present. Evidence to support that the sand seams are laterally discontinuous and are not hydraulically connected to the Cedarville Aquifer include: 1) water level measurements in the sand seams are significantly different than the water level measurements of the Cedarville Aquifer at the same locations; 2) detailed cross sections prepared from the boring logs indicate that these sand seams are laterally discontinuous; and 3) variability in the distribution of detectable VOCs are observed in water samples collected from encountered sand seams.

2. The Cedarville Aquifer can be represented as an equivalent porous medium at the scale of the Facility and vicinity.

This is supported by the following: 1) the results of the aquifer pumping test performed on CW01-01shows little evidence of anisotropy or delayed yield characteristics typical of discrete fracture systems; 2) there is very little vertical hydraulic head present in wells screened in the upper, middle and lower portions of the aquifer; 3) the potentiometric surfaces of the Cedarville Aquifer exhibit a smooth and continuous surface without areas of rapidly changing or anomalous hydraulic head values; 4) the measurement of natural ground water geochemical parameters such as temperature, pH, and specific conductivity are relatively constant on a quarterly basis; and 5) site specific geophysical and rock core inspection indicates that ground water flow is predominantly controlled by horizontal bedding plane partings.

3. **The ground water interim measures are operating as designed by preventing the migration of contaminated ground water off of the Facility in the upper, middle, and lower portions of the Cedarville Aquifer.**

Based upon the results of the particle tracking analysis, the capture zone of the GWCTS extends at least to the base of the Cedarville Aquifer along the eastern boundary of the Facility. Downgradient (east) of the extraction wells, the vertical extent of the capture zone will decrease with distance. Although the vertical extent of the capture zone will also decrease with distance in the upgradient direction (west), ground water beneath the Facility in the Cedarville Aquifer will eventually flow to the eastern property boundary, at which point it will move upward and be captured by the extraction wells.

4. **Ground water flow velocities in the Cedarville Aquifer range from approximately 5 to 30 feet per year.**

Prior to commencing the ground water interim measures, ground water flow in the Cedarville Aquifer at the Facility was towards the east-northeast at an estimated gradient of 0.005 ft/ft. Based on the capture zone analysis, the hydraulic conductivity of the Cedarville Aquifer ranges from 1 to 4 feet per day. Downgradient of the Facility, the primary components of ground water flow are toward the northeast and southeast in the Cedarville Aquifer.

5. **SVOCs and metals are not chemicals of concern in ground water.**

Quarterly ground water sampling results from monitoring wells screened with the upper, middle, and lower portions of the Cedarville Aquifer, and monitoring wells screened in sewer backfill, exhibited very little variability in contaminant concentrations during quarterly monitoring in 2003. SVOCs and metals (copper, chromium, and zinc) were not detected above laboratory reporting limits in all monitoring wells sampled during the first or second quarter monitoring events. Therefore, there is no need to sample SVOCs and metals during future quarterly ground water monitoring.

6. **PCE, TCE, cis-1,2-DCE, 1,2-DCP, and Freon-113 are detected most frequently at the Facility.**

Based on the quarterly ground water sampling results for VOCs, PCE, TCE, cis-1,2-DCE, 1,2-DCP, and Freon-113 are detected most frequently. All VOCs will being assessed during the RCRA corrective action, are currently being monitored on a quarterly basis.

7. **The existing monitoring well network in the sewer backfill on and off of the Facility is sufficient to determine the nature and extent of contamination within this media.**

Based on the results of the Geoprobe® water samples collected in the sewer backfill, the existing well network in sewer backfill is sufficient to determine the nature and extent of contamination. These monitoring wells will continue to be sampled on a quarterly basis for at least the remainder of the Phase I Facility Investigation.

8. The VOC COI distributions appear to be "cut-off" in all pre-pumping downgradient directions off the Facility and the "hot-spots" are within the capture zone of the extraction wells of the interim measure.

Beyond the limits of the capture zone, the presence of separate lobes has been identified which are remnant plumes prior to pumping. The centerlines of these two lobes extend from the Facility (1) east of Wright Street to Green Street and (2) southeast of MW02-03 at Omar Circle to West South College Street.

The extent of PCE, TCE, cis-1,2-DCE and Freon-113 have been identified within the upper Cedarville Aquifer in all downgradient directions from the Facility. More work is planned to investigate the middle portions of the aquifer. VOCs have not been detected in the lower Cedarville Aquifer in all downgradient directions from the Facility.

Given the source control provided by the interim measures at the Facility, plume stability and plume contraction farther downgradient of the Facility should be observed in the future.

9. Additional ground water monitoring wells are needed in the upper, middle, and lower portions of the Cedarville Aquifer to complete the Phase I Facility Investigation.

The existing monitoring well network in the Cedarville Aquifer is not currently sufficient to determine the nature and extent of contamination within this aquifer. Therefore, additional ground water monitoring wells are needed in the upper, middle, and lower portions of the Cedarville Aquifer to complete the Phase I Facility Investigation. These monitoring wells are proposed to be installed in January/February 2004.

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