U.S. EPA RCRA CORRECTIVE ACTION FACILITY INVESTIGATION PHASE I REPORT

VERNAY LABORATORIES, INC.
PLANT 2/3 FACILITY
Yellow Springs, Ohio

Volume 1
Text, Tables, Figures

Project No. 0292.11.31

June 29, 2004

Prepared For

VERNAY LABORATORIES, INC.
Yellow Springs, Ohio

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in collaboration with

ENVIRON International Corporation

and

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Hydrogeologist

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Volume 2
Sheets and Appendices

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EXECUTIVE SUMMARY

In the September 27, 2002 Administrative Order on Consent (Corrective Action Order) between the United States Environmental Protection Agency (U.S. EPA) and Vernay Laboratories, Inc. (Vernay), it was agreed that Vernay would conduct a Resource Conservation and Recovery Act (RCRA) Corrective Action Facility Investigation (RFI) to determine the nature and extent of any releases of hazardous waste and hazardous constituents at or from its facility located at 875 Dayton Street, Yellow Springs, Ohio (Facility), which may pose an unacceptable risk to human health and the environment. The Corrective Action Order also requires Vernay to take corrective remedial measures necessary to protect human health and the environment from all current and future unacceptable risks due to releases of hazardous waste or hazardous constituents at or from the Facility.

This report documents the results of Phase I of the RFI that Vernay conducted at the Facility. The RFI is being conducted and reported in two phases (Phase I and Phase II). The Phase I and Phase II RFI are needed to identify the presence, stabilization, fate, and risks associated with contamination at and emanating from the Facility and vicinity, and to determine the chemical and physical properties likely to influence contaminant migration. This information will be used to evaluate corrective measures needed to remediate the contamination.

Phase I of the RFI was completed between September 2002 and June 2004. The primary objective of Phase I of the RFI was to determine the extent of ground water contamination in the Cedarville Aquifer (the uppermost aquifer beneath the Facility and the surrounding area) and storm sewer backfill, and to determine if a deeper aquifer beneath the Facility (Brassfield Aquifer) needs to be investigated during Phase II of the RFI. The Phase I RFI also involved determining the nature and extent of contamination at or from the Facility in soil, sediment, surface water and indoor air; and, construction and operation of a second ground water extraction well on the Facility.

Another objective of the Phase I RFI was to collect sufficient information to complete the RCRA Corrective Action Environmental Indicator (EI) for Current Human Exposures Under Control (CA725) report. This activity included the completion of a water well survey in the vicinity of the Facility to determine the usage of ground water in the area, and to obtain human health exposure information needed to complete the CA725 EI report. Ground water data collected during the Phase I RFI will also be used to complete the RCRA Corrective Action Migration of Contaminated Ground Water Under Control (CA750) EI report.

Phase II of the RFI will consist of completing the determination of the nature and extent of contamination in soil beneath the Facility, an assessment of the fate and transport of contaminants from the Facility, quarterly ground water monitoring, and completion of the baseline human health and ecological risk assessments. The Phase II RFI report will be submitted to the U.S. EPA by December 31, 2004.

Based on the results of the investigation of the nature and extent of contamination of the Cedarville Aquifer during the Phase I RFI, it is recommended that an investigation of the Brassfield Aquifer during Phase II of the RFI is not needed to meet the objectives of the CA750 EI and the Corrective Action Order. Final determination concerning the investigation of the Brassfield Aquifer during the Phase II RFI will be made by the U.S. EPA.

Phase I RFI Scope of Work

The U.S. EPA's data quality objectives process was used to prepare detailed scopes of work for the RFI, and to ensure that the overall goals and objectives of the RFI are met during the corrective action. The Phase I RFI tasks were conducted in iterative steps, and involved the sampling and analysis of soil, sediment, ground water, subsurface water, surface water, and indoor air. The initial steps of field work concentrated on developing a RFI sampling list, conducting interim measures for ground water, and installing additional monitoring wells into the Cedarville Aquifer and storm sewer backfill. These initial steps allowed for an understanding of the extent of contamination in the Cedarville Aquifer and storm sewer backfill, as well as providing additional information for conceptual site model and the evaluation of the efficacy of existing interim measures.

Subsequent work tasks during the Phase I RFI were focused on completing the determination of the extent of contamination in the Cedarville Aquifer, defining the nature and extent of contamination in soil on and off of the Facility, completing focused sampling of indoor air, surface water, and sediment, developing a ground water flow model, and completion of a water well survey.

Twenty-six new monitoring wells were added to the existing well network, which consisted of 27 wells at the time the Phase I RFI was initiated. Seven quarters of ground water monitoring were conducted during the Phase I RFI to determine the extent of contamination in the Cedarville Aquifer and storm sewer backfill, monitor existing ground water extraction wells, and to assess if there were seasonal variations in contaminant concentrations in ground water beneath the Facility and vicinity.

Phase RFI Results

The site hydrogeological model (SHM) consists of two aquifers, the Cedarville Aquifer and the Brassfield Aquifer. The two aquifers provide potable and non-potable water to a limited number of users in the vicinity of the Facility, and are separated from one another by less permeable geologic units that act as aquitards. Within the conceptual SHM, the Cedarville Aquifer and the deeper Brassfield Aquifer have the most capability of transporting hazardous waste or hazardous constituents that have been released at or from the Facility. Potential vertical migration of contamination from the Cedarville Aquifer to the Brassfield Aquifer is restricted by the regional occurrence of the low-permeability Osgood and Brassfield Aquitards.

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 75 feet per year. An unconsolidated unit lies above the Cedarville Aquifer, and consists of very firm, slightly moist silt and clay deposit; and, isolated and laterally discontinuous poorly to well sorted discontinuous sand lenses within the clay matrix that are at or near the bedrock surface and discontinuous sand seams in the upper and middle portions of the unit.

During the Phase I RFI, a ground water flow model for the Cedarville Aquifer was developed to assist in characterizing the hydrogeology and contaminant migration pathways beneath the Facility and the surrounding area. The ground water model assisted in the prediction of the movement of ground water in the subsurface, and will also be used as a component in the prediction of the fate and transport of contamination in the ground water during Phase II of the RFI. The results indicate that the model is well calibrated with actual ground water data that were collected during the Phase I RFI, and that the ongoing ground water capture system is effective in capturing hazardous constituents in the Cedarville Aquifer emanating from the Facility.

A site-specific sampling list of chemicals was developed for the RFI to investigate a number of medium and high release potential solid waste management units (SWMUs) and areas of concern (AOCs) identified at the Facility by the U.S. EPA. Given the past uses of these units and areas, the most frequently detected contaminants during the Phase I RFI were VOCs. SVOCs and a few metals were detected, but less frequently than VOCs. A direct-push boring program was performed to collect soil samples in the immediate vicinity of SWMUs and AOCs, and water samples from discontinuous sand seams and sewer backfill material.

To determine the nature and extent of contamination of past data and RFI data, and to assess if any additional data are needed for the Phase II RFI, "Contaminants of Interest" (COIs) were identified. COIs are VOC, SVOC, and metal constituents that exceed generic risk based screening criteria; and, are the lowest exceedance of generic risk-based screening criteria, or migration to ground water screening criteria. This was conducted as a conservative evaluation to determine the nature and extent of contamination, and to make initial judgments about whether or not the past and Phase I RFI data were sufficient to meet the objectives of the RFI.

Conclusions

The following are conclusions based on the results of the Phase I RFI:

- The nature and extent of contamination has been determined for surface water (including storm sewer water), sediment, saturated sand seams and sewer backfill at the Facility and vicinity.
- The nature and extent of contamination in soil has not fully been delineated on and off the Facility; full definition will be completed during Phase II of the RFI.
- The horizontal and vertical extent of ground water contamination in the Cedarville Aquifer (upper, middle and lower) has been determined.

Based on the following, it is judged that an investigation of the lower Brassfield Aquifer is not needed during the Phase II RFI:

- The horizontal and vertical extent of contamination in the upper aquifer (Cedarville Aquifer) on and off the Facility has been determined.
- A sufficient monitoring well network currently exists at the base of the Cedarville Aquifer to detect the presence of VOCs and evidence for potential DNAPL migration.
- A lack of vertical hydraulic gradient over most of the aquifer, and slight upward hydraulic gradient over portions of the aquifer was measured consistently over time in the Cedarville Aquifer, therefore inhibiting downward migration of VOCs to the base of the Cedarville Aquifer and beyond.
- Locally, the upper and lower aquifers are separated by 70 to 100 feet of dense, low permeable carbonate and shale lithology (Osgood and Brassfield Aquitards). The presence of these low permeable formations of the aquitards, in concert with the upward hydraulic gradient measured in the Cedarville Aquifer above, would further inhibit the downward migration of VOCs (if present). The confined Brassfield Aquifer is located approximately 200 feet below the surface in the vicinity of the Facility.
- A recent hydrogeologic characterization of the Brassfield Aquifer was conducted by YSI, Inc. at its Facility, which is located less than one mile downgradient of the Vernay Facility. Data from six monitoring wells in the Brassfield Aquifer, clustered adjacent to Cedarville Aquifer monitoring wells, confirmed: 1) the thickness and low permeability nature of the aquitards; 2) the apparent confined nature of the Brassfield Aquifer; 3) a nearly flat to slight southeasterly flow direction in the Brassfield Aquifer; 4) no observed hydraulic communication between aquifers; and, 5) no detections of the COIs identified at the Vernay Facility.
- Within the limits of the well survey conducted by Vernay during the Phase I RFI, water wells were not identified in the Brassfield Aquifer.

1.0 INTRODUCTION

This report documents the results of Phase I of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) that Vernay Laboratories, Inc. (Vernay) is conducting at its facility located at 875 Dayton Street, Yellow Springs, Ohio (Facility). The RFI is required by Section VI (Work to be Performed) of the September 27, 2002, RCRA Section 3008(h) Administrative Order on Consent (Corrective Action Order) agreed to by Vernay and the United States Environmental Protection Agency (U.S. EPA). The Corrective Action Order is a streamlined RCRA order that requires Vernay to take corrective remedial measures necessary to protect human health and the environment from all current and future unacceptable risks due to releases of hazardous waste or hazardous constituents at or from the Facility. A flow chart describing the U.S. EPA RCRA CA process is presented on the following page.

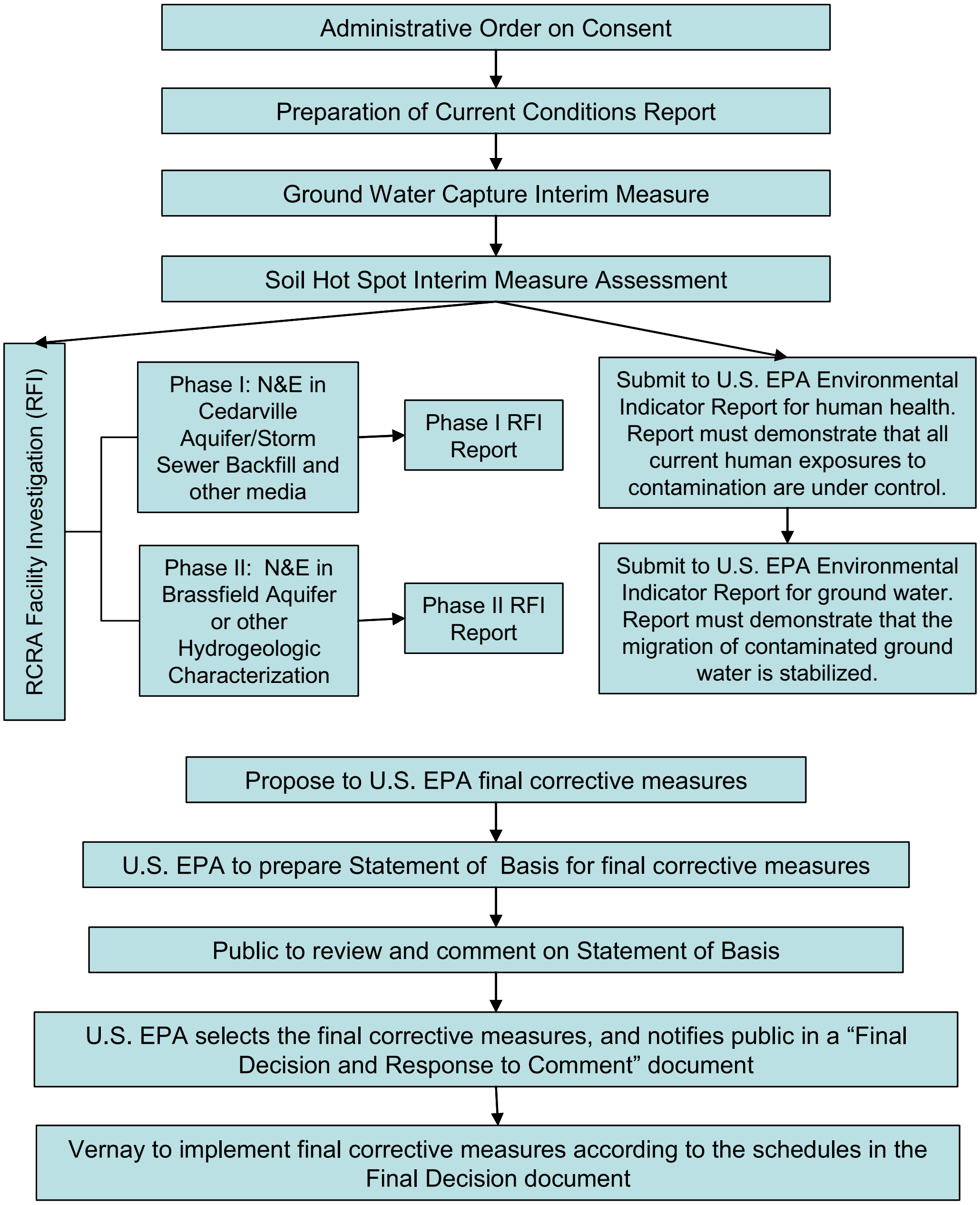
Prior to the Corrective Action Order, Vernay voluntarily conducted environmental investigation and remediation activities at the Facility. From 1998 to 2000, this work was done following the Ohio EPA's Voluntary Action Program (VAP) rules (Ohio Revised Code 3745-300). These activities led to the:
1) preliminary determination of the nature and extent of contaminant source areas at the Facility; 2) initial determination of the nature and extent of ground water contamination at areas on and off the Facility; and, 3) construction and operation of a ground water extraction and treatment system to control contaminants migrating off of Vernay's property.

Phase I of the RFI has focused on completing the investigation of the nature and extent of contamination on and off of the Facility, and has included the sampling and analysis of indoor air, soil, sediment, surface water, storm sewer water, and ground water media. On the behalf Vernay, Phase I of the RFI was completed by The Payne Firm, Inc. (Payne Firm), in collaboration with ENVIRON International Corporation (ENVIRON) and David Back, P.G., Hydrogeologist, between September 2002 and June 2004.

1.1 RFI Objectives

The primary objective of the RFI is to determine the nature and extent of any releases of hazardous waste or hazardous constituents at or from the Facility that pose an unacceptable risk to human health and the environment. The RFI is being conducted and reported in two phases (Phase I and Phase II). The Phase I and Phase II RFI are needed to identify the presence, stabilization, fate, and risks associated with contamination at, or emanating from the Facility, and to determine the chemical and physical properties likely to influence contaminant migration. The information will also be used to evaluate corrective measures needed to remediate the contamination. Both phases of the RFI are intended to support the Corrective Measures Proposal that will follow the completion of Phase II of the RFI. The Corrective Measures Proposal, which is currently scheduled to be submitted to the U.S. EPA in 2006, will evaluate a

Vernay Laboratories, Inc.
U.S. EPA RCRA Corrective Action Process



Administrative Order on Consent

Preparation of Current Conditions Report

Ground Water Capture Interim Measure

Soil Hot Spot Interim Measure Assessment

RCRA Facility Investigation (RFI)

Phase I: N&E in Cedarville Aquifer/Storm Sewer Backfill and other media

Phase I RFI Report

Phase II: N&E in Brassfield Aquifer or other Hydrogeologic Characterization

Phase II RFI Report

Submit to U.S. EPA Environmental Indicator Report for human health. Report must demonstrate that all current human exposures to contamination are under control.

Submit to U.S. EPA Environmental Indicator Report for ground water. Report must demonstrate that the migration of contaminated ground water is stabilized.

Propose to U.S. EPA final corrective measures

U.S. EPA to prepare Statement of Basis for final corrective measures

Public to review and comment on Statement of Basis

U.S. EPA selects the final corrective measures, and notifies public in a “Final Decision and Response to Comment” document

Vernay to implement final corrective measures according to the schedules in the Final Decision document range of corrective remedial measures appropriate to protect human health and the environment from any unacceptable current or future risks associated with contamination on and off the Facility.

The primary objective of Phase I of the RFI (Phase I RFI) was to determine the extent of ground water contamination in the Cedarville Aquifer and storm sewer backfill, and to determine if a deeper aquifer beneath the Facility (Brassfield Aquifer) or other hydrogeologic investigation needs to be investigated during Phase II of the RFI. The Phase I RFI also involved investigating the nature and extent of contamination at or from the Facility in soil, sediment, surface water, storm sewer water, and indoor air; and, construction and operation of a second ground water extraction well on the Facility.

Another objective of the Phase I RFI was to collect sufficient information for Vernay to complete the RCRA Corrective Action Environmental Indicator (EI) for Current Human Exposures Under Control (CA725) report. This activity included the completion of a water well survey in the vicinity of the Facility to determine the usage of ground water in the area, and to obtain human health exposure information needed to complete the CA725 EI report. At the request of the U.S. EPA, a draft CA725 EI report was submitted to the U.S. EPA on April 9, 2004 under a separate cover. Based on comments from the U.S. EPA (2004), the final CA725 EI report will be submitted on or before July 15, 2004.

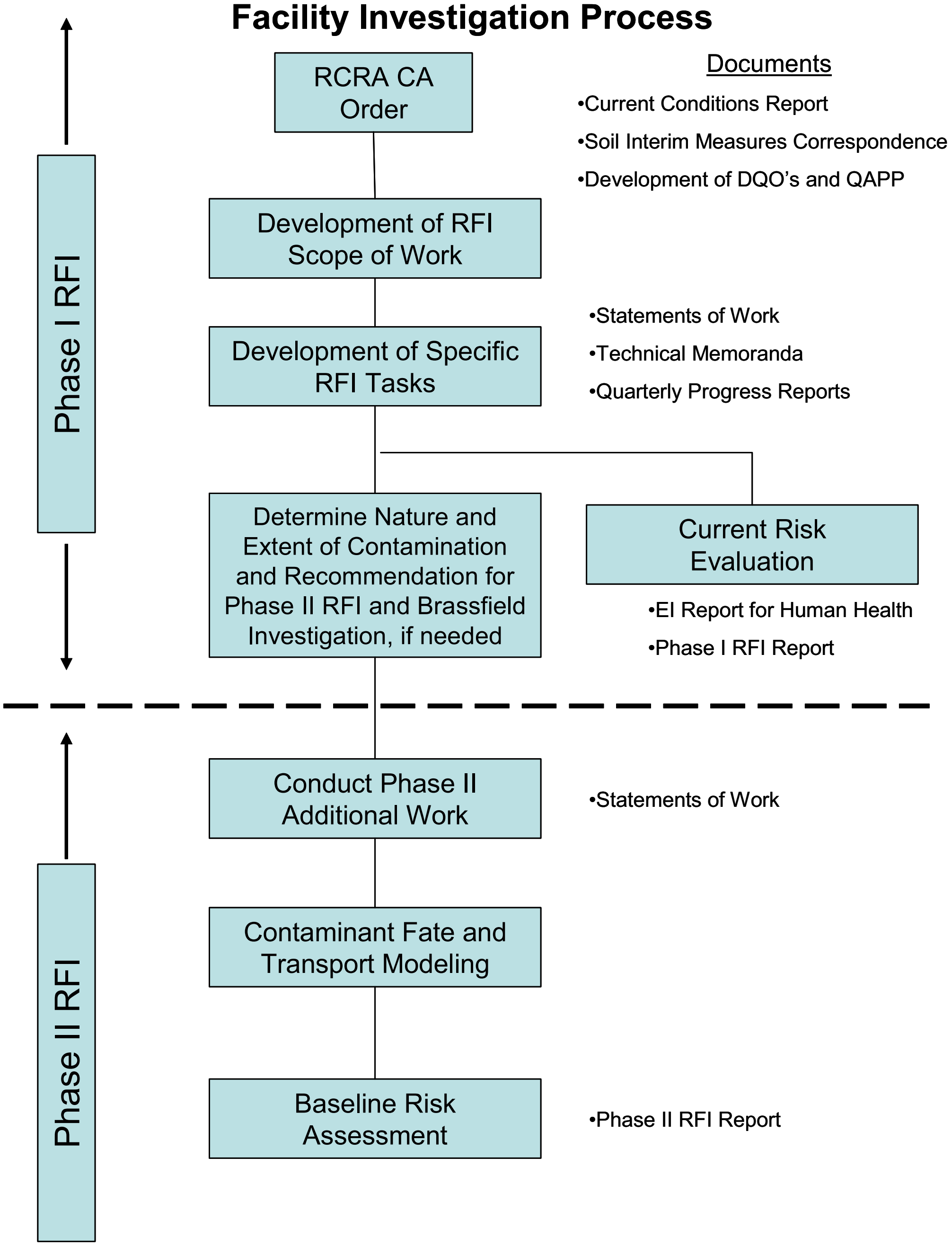
Ground water data collected during the Phase I RFI will also be used to complete the RCRA Corrective Action EI for Migration of Contaminated Ground Water Under Control (CA750) report. The CA750 EI report will be submitted to the U.S. EPA within 180 days following the approval of the Phase II RFI report. Additional ground water data needed to complete the CA750 EI report will be collected during the Phase II RFI.

The two EI reports are measures developed by the RCRA Corrective Action program to track changes in environmental quality with respect to the impacts from releases of hazardous waste and hazardous constituents. While a final remedy remains the long-term objective of the Corrective Action Order, the EI reports assist the U.S. EPA and Vernay in making sure that near-term objectives and decisions concerning the need for interim remedial measures are made in a timely manner.

Phase II of the RFI will consist of completing the determination of the nature and extent of contamination in soil beneath the Facility, an assessment of the fate and transport of contaminants from the Facility, quarterly ground water monitoring, and completion of the baseline human health and ecological risk assessments. The Phase II RFI report will be submitted to the U.S. EPA by December 31, 2004. A flow chart describing the U.S. EPA RCRA Facility Investigation Process is presented on the following page.

Based on the results of the investigation of the nature and extent of contamination of the Cedarville Aquifer during the Phase I RFI, it is judged that an investigation of the Brassfield Aquifer during Phase II

Vernay Laboratories, Inc.
U.S. EPA RCRA Corrective Action
Facility Investigation Process



of the RFI is not needed to meet the objectives of the CA750 EI and the Corrective Action Order. Final determination concerning the investigation of the Brassfield Aquifer during the Phase II RFI will be made by the U.S. EPA.

1.2 Format of the Report

The primary objective of this report (Phase I RFI Report) is to present the results and conclusions of the Phase I RFI. This report consists of an assessment of the nature and extent of contamination beneath the Facility and surrounding area, including a summary of the sampling locations, field sampling procedures, analytical methods and results, and quality assurance/quality control (QA/QC) protocols that were used to complete Phase I of the RFI.

The Phase I RFI Report consists of an Executive Summary, Sections 1 through 8, and several tables, figures, sheets, and appendices. The entire Phase I RFI report is included electronically in Appendix VIII. Each section has subsections that present the topics of discussion. Summaries of the primary issues discussed in each section are presented below:

Section 1 – Introduction
The remaining portion of Section 1 provides a description of the Facility and the surrounding area, the development and operation of the Facility, a summary of pre-RFI investigations, current operating ground water extraction interim measures, as well as a review of Phase I RFI reports and technical memoranda.

Section 2 – Phase I RCRA Facility Investigation
Section 2 opens with an overview of the objectives and data needs of the RFI, and summarizes the specific tasks that were conducted to satisfy the data needs during the Phase I RFI. Each phase of work that was undertaken during the Phase I RFI is reviewed along with the QA/QC and data validation procedures that were implemented during the investigation.

Section 3 – Environmental Setting
Section 3 provides a description of the environmental setting of the Facility and the regional area. A Site Hydrogeological Model (SHM) is presented that provides the framework for the determination of the nature and extent of soil and ground water contamination beneath the Facility and surrounding area. A summary of the land use and demographics in the area of the Facility is also discussed. Section 3 concludes with a summary of results of a water well survey and a ground water flow model for the Cedarville Aquifer.

Section 4 – Source Characterization

Section 4 describes solid waste management units (SWMUs) and areas of concern (AOCs) identified at the Facility by the U.S. EPA. A general description of the physical and chemical characteristics of the hazardous constituents released at the Facility is also discussed.

Section 5 – Nature and Extent of Contamination

This section presents the nature and extent of contamination in affected media on or off of the Facility. Additionally, a review of background concentrations of metals in soil determined for the Facility is presented.

Section 6 – Phase I RFI Risk Evaluations

This section summarizes the results of the CA725 EI Report. A preliminary Conceptual Site Model (CSM) for human exposures is also presented.

Section 7 – Phase I RFI Summary and Recommendations

This section summarizes the results, evaluations, and conclusions of the Phase I RFI and the remaining data and tasks needed to complete the RFI during Phase II.

Section 8 – References

Section 8 includes a list of references cited in this report.

1.3 Description of the Facility and Vicinity

The Facility is located at 875 Dayton Street in the Village of Yellow Springs, Ohio at latitude 39°48’10” and longitude 84°54’19” (Figure 1). Yellow Springs is located in the north-central portion of Greene County (Miami Township), which is located in the southwestern portion of Ohio (Figure 1). 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 10 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).

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 and 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. A number of underground utilities, including sanitary and storm sewers, hydraulic oil pipe system, utility tunnel between Plant 2 and Plant 3, municipal water, fire lines, and natural gas exist at the Facility. A detailed description of the underground utilities was provided in the *Current Conditions Report* (Payne Firm, 2002).

Plant 2 is currently used for the manufacturing of specialty small-scale rubber components, primarily for the medical industry, and covers approximately 9,000 square feet. Plant 3, which is approximately 100,000 square feet in area, was used in the past for rubber manufacturing operations and maintenance activities. Manufacturing operations in Plant 3 were discontinued by Vernay in stages during 2003 and will be completed by early 2005. A detailed description of the manufacturing areas and processes conducted by Vernay in Plant 3 prior to the discontinuation of operations are discussed in the June 1, 2001 TechLaw, Inc. (TechLaw) report entitled *Final Preliminary Assessment/Visual Site Inspection Report for Vernay Laboratories, Inc., 875 Dayton Street, Yellow Springs, Ohio, EPA ID No. OHD004243002* (Techlaw, 2001). Operations in Plant 2 are also being phased out by Vernay. Complete discontinuation of operations at the Facility is expected by the end of 2004.

1.4 Property Development

The development of the Facility was summarized in detail in previous reports (TechLaw, 2001; Payne Firm, 2002). Relevant information from these two reports is presented below.

The Facility has manufactured specialty rubber components for the automotive and medical industries since the early 1950s. Prior to that time, the property was used for agricultural purposes. A vacant farmhouse and three agricultural support buildings were located along the northern property boundary during the early stages of property development; these structures were removed from the property by Vernay during the mid-1960s. A small building located on the north central portion of the Facility was built by Vernay in 1948 and leased to a design studio from 1948 to the mid-1960s, and then to a local dentist from the mid-1960s to 1995 (Figure 2). This building was vacant from 1995 until 2001, when it was razed by Vernay.

Vernay started the industrial development at the Facility in 1951 by constructing Plant 2 (Figure 2). The Plant 3 building was built by Vernay in 1957. Reportedly, Plant 3 is built on timber piers that are extended to the top of bedrock. A number of expansions were constructed on the original Plant 2 and Plant 3 buildings over the years that increased the size and capacity of Vernay's operations (Payne Firm, 2002). The expansions occurred between 1956 and 1986.

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[1] The aerial photographs displayed on figures in this report were obtained from the Greene County Auditors Office, dated 1998.

1.5 Current and Past Uses of Surrounding Properties

Adjoining properties were primarily used for agricultural and residential purpose prior to the industrial development of the Facility. Residential development occurred to the northeast, east, and south of the Facility in the 1950s, with increasing development in these areas until the 1980s. The area to the north- northwest was agricultural until approximately 1973, at which time Antioch Publishing developed the land on the north side of Dayton Street. Areas to the west were used as agricultural land until Yellow Springs High School and other Village of Yellow Springs buildings were constructed southwest of the Property in the late 1960s.

The adjoining properties, as they currently exist, are shown on Figure 2. Antioch Publishing and residential houses are located on the north; a recording studio and agricultural land are located on the east side of the Facility; residential homes are located to the south; and a high school including athletic fields, is located on the west.

The surrounding area was primarily agricultural in nature prior to development. Extensive residential development began on the western and southern portions of Yellow Springs in the 1940s and 1950s along with commercial/industrial development along Dayton Street. The Village of Yellow Springs has a population of approximately 4,000. The community is currently predominantly residential and commercial in nature along with small businesses focused towards supporting the Village and Antioch College, which is located approximately 1.5 miles southeast of the Facility.

1.6 History of Operations and Waste Activities

A detailed summary was presented of the history of the operations and waste activities at the Facility in the TechLaw report (TechLaw, 2001), and the Payne Firm's *Current Conditions Report* (Payne Firm, 2002). A general summary of the information in these reports is provided below.

The manufacturing processes of specialty rubber components for the automotive and medical industries occurred at the Facility since the early 1950s. These manufacturing processes included mixing, pre-form, finishing, warehousing, and molding. In addition, administrative offices, maintenance departments, tool and equipment rooms, central stores, and shipping and receiving were located at the Facility.

The original manufacturing operations were conducted in Plant 2 and then expanded into Plant 3 when it was built in the late 1950s. Chemical storage and chemical usage areas at the Facility include, or have included in the past, solvent degreasers, stills, and caustic and acid baths used for parts cleaning, outdoor and indoor waste and empty product drum storage areas, rubber cement bonding spray booths, outdoor perchloroethene (PCE) aboveground storage tank (AST) areas, and indoor maintenance areas. In addition, petroleum products have been used in maintenance areas and in a network of hydraulic oil piping located in reinforced concrete trench systems beneath the floor slabs in both Plants 2 and 3. The only underground storage tanks (USTs) used on the Facility were two 20,000 gallon heating oil tanks. The tanks were removed by Vernay in November 1997, and the Facility obtained a No Further Action Letter from BUSTR on May 26, 2000.

Reportedly, PCE ASTs were located outdoors on the west side of Plant 3 during different time periods. The ASTs were used to store PCE that was used for indoor vapor degreasers located at two areas along the west side of Plant 3. One 500-gallon AST is believed to have been used outside the Sandblast Room during the 1970s and early 1980s (Figure 6). Reportedly, this AST was removed from the Facility in the early 1980s. A second 500-gallon PCE AST was used from the early 1980s to the mid 1990s before it was taken out of service. The former location of this PCE AST is presently covered by the Plant 3 heating, ventilation, and air conditioning (HVAC) system (Figure 6). Both tanks were situated on concrete and PCE product was fed to containers located indoors via piping through the building wall.

The types of wastes generated at the Facility did not change significantly over the years because the manufacturing processes and chemical usage did not change significantly since operations began in the early 1950s. The Facility is a small quantity generator (SQG) of hazardous waste. Prior to 2002, the Facility was a large quantity generator (LQG).

The chemicals and petroleum products used most frequently at the Facility since the 1950s include trichloroethene (TCE), PCE, methyl ethyl ketone (MEK, aka 2-butanone), toluene, isopropyl alcohol, mineral spirits, freon-113, machine coolants, kerosene, hydraulic oils, organic and inorganic dyes, and caustics and acids. The quantity of solvents and oils decreased over the years as Vernay improved its operations to reduce the use of chemicals and waste generation. For example, TCE was used more extensively during the 1950s, and the Facility discontinued using it in the early 1960s. As indicated in Section 1.3, the operations at the Facility have diminished significantly over the past few years, which has resulted in a significant reduction of chemical usage by Vernay. The Facility discontinued using PCE in 2001. Vernay also changed the composition of rubber in one of its products such that waste dust (ball grinding dust) generated from this process is no longer considered a characteristic hazardous waste.

The following wastes were generated at the Facility in the past (TechLaw, 2001):

- Waste PCE (F001, F002); discontinued in 2001.
- Spent PCE still bottoms (F001, F009); discontinued in 2001.
- Needle grinding dust (D006, D008); discontinued in 2002.
- Ball grinding dust (D006, D008); discontinued in 2001.
- Cement bonding wastes (D001, F003, F005, D035).
- Waste oil from preventive maintenance on machinery and other used oils, such as used lubrication oil.

- Freon-113, used as a degreaser and carrier (F001); discontinued in 1999.
- Chlorinated fluorocarbons and flammables, from bonding and cleaning spray guns (D001).
- Solid waste, such as rubber and metal remnants.
- Non-contact cooling waters.

1.7 Previous Investigations

Three limited sampling events were previously conducted by the Ohio EPA at the Facility to preliminary assess current risks to human health and the environment. These focused investigations were discussed in detail in previous reports (TechLaw, 2001; Payne Firm, 2002), and the results did not have a bearing on the scope of work for the RFI. Therefore, these investigations are not discussed in this report. The U.S. EPA contracted TechLaw to conduct a preliminary assessment/visual inspection (PA/VSI) at the property in 2001. The results of this inspection assisted in preparing the scope of work for the RFI and are summarized below.

1.7.1 U.S. EPA Preliminary Assessment/Visual Site Inspection

In 2001, TechLaw was contracted by the U.S. EPA to perform a PA/VSI at the Facility. The PA/VSI was conducted by TechLaw on February 22, 2001 to identify and characterize solid waste management units (SWMUs) and areas of concern (AOCs). A SWMU is a discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste (U.S. EPA, 1994). An Area of Concern is a release that warrants investigation or remediation regardless of whether they are associated with a specific SWMU (U.S. EPA, 1994).

The PA/VSI was conducted by TechLaw to identify past compliance history, evidence of past releases, potential migration pathways, potential exposure to any released hazardous constituents, closure methods and dates, citizen complaints, manufacturing processes, and waste management practices at the Facility. In June 2001, a "Final Preliminary Assessment/Visual Site Inspection Report" was prepared by TechLaw for the U.S. EPA (TechLaw, 2001). TechLaw utilized data and other information collected by Vernay during its voluntary investigation to complete its PA/VSI report, as well as information from regulatory files and interviews with Vernay representatives (TechLaw, 2001).

Based on information obtained during the PA/VSI, TechLaw concluded that further investigation and remediation appear to be warranted at the Facility and, also concluded that: *"The Facility has done significant work in characterizing soil, ground water, surface water, and sediment contamination while participating in Ohio's Voluntary Action Program. This work confirms onsite soil and ground water contamination as well as offsite ground water, surface water, and sediment contamination. Several solid waste management units and other areas of concern are known or probable contributors to the contamination"* (TechLaw, 2001).

A total of 39 SWMUs and four AOCs were identified by TechLaw during the PA/VSI. TechLaw identified the potential for each SWMU and AOC to release hazardous waste or hazardous constituents to the environment. The categories for the release potential as presented in the report were low, moderate, or high. Thirty-one of the SWMUs and AOCs were defined as having a low release potential (TechLaw, 2001). Six SWMUs and/or AOCs as possessing a moderate release potential, and seven as a high release potential. TechLaw's rationale for characterizing these areas as moderate or high was based on information known about the past uses of the areas, and soil boring and ground water contamination data collected by Vernay during a pre-RFI voluntary investigation. Each of the SWMUs and AOCs defined as a moderate or high release potential are discussed in detail in Section 4.0 and presented in Figures 5 through 7.

1.7.2 Vernay Pre-RFI Voluntary Investigation

Vernay voluntarily conducted an environmental investigation at the Facility to determine the nature and extent of hazardous waste and hazardous constituents beneath the Facility and the surrounding area, and to evaluate the need for interim remedial measures. This investigation followed the Ohio VAP investigation rules. Vernay also completed an underground storage tank (UST) closure following Ohio Bureau of Underground Storage Tank Regulations (BUSTR) regulations; a detailed storm and sanitary sewer mapping effort; a soil boring investigation along Dayton Street east of the Facility to support construction activities undertaken by the Village of Yellow Springs; and the abandonment of an inactive septic tank (Payne Firm, 2002). The results of the voluntary investigation and sewer mapping effort were also used to assist in preparing the scope of work for the RFI; a brief description of these activities is described below.

Vernay Voluntary Investigation

Beginning in 1998, Vernay initiated an environmental investigation at the Facility following the Ohio VAP rules in OAC 3745-300 (voluntary investigation). The voluntary investigation provided information regarding releases or suspected releases of hazardous constituents and petroleum products to the subsurface at the Facility. Based upon the results of the investigation, four areas where contamination was known or suspected to be located on the Facility were identified (Payne Firm, 2002).

Vernay investigated the four identified areas and the ground water beneath the Facility and surrounding area in iterative phases from 1998 through 2000. During this period, samples of soil, ground water, surface water, storm sewer water, storm sewer backfill, sediment, and indoor air were collected in accordance with Ohio VAP sampling procedures, and analyzed by an Ohio VAP-certified analytical laboratory (Severn Trent Laboratories, Inc., STL). In addition, a ground water extraction well and treatment system was installed to capture the migration of VOCs beneath the eastern boundary of the Facility. Detailed discussions of the data collected during the VAP Phase I are presented in the CCR.

Facility Sewer Identification Assessment

A detailed investigation of the existing sewer system at the Facility was conducted by the Payne Firm between April 2000 and September 2000 to assist in: 1) the identification of possible contaminant migration pathways beneath the Facility; and, 2) determining if certain unused sewer structures should be permanently closed (Payne Firm, 2001a; Payne Firm, 2002). During the assessment, sanitary and storm sewers and related discharge structures on and beneath the Facility were identified by reviewing available sewer information, discussing pertinent issues and questions with current and past Vernay employees to confirm field observations, conducting visual inspections, employing dye and running water tests, and video inspections. A detailed depiction of the sewer system at the Facility was determined, and is presented in Figures 2 through 4. The Payne Firm's April 2001 report summarizing the finding of the investigation is presented in Appendix IV of the CCR.

1.8 Interim Measures

1.8.1 Extraction Wells

In March 2000, a ground water extraction interim remedial measure commenced at the southeastern portion of the Facility with the operation of a pumping well (CW01-01) that was constructed in the Cedarville Aquifer. A detailed description of the construction and operation of CW01-01 was presented in the CCR.

In December 2002, a Capture Zone Analysis was completed by the Payne Firm to determine if additional ground water extraction well(s) were required to control the migration of contaminated ground water off of the Facility in the Cedarville Aquifer (as required by Paragraph 11 of the Corrective Action Order). The results of the Capture Zone Analysis indicated that one additional ground water extraction well was needed near the northeast corner of the Facility. As a result, extraction well CW01-02 was installed by the Payne Firm in January 2003. Extraction well CW01-02 has been operational since January 21, 2003.

The results of the Capture Zone Analysis, and a detailed description of the components and operation and the maintenance and monitoring of the ground water extraction wells was provided to the U.S. EPA in *Technical Memorandum No. 3: Ground Water Monitoring* (TM-3) (Payne Firm, 2003c).

The ground water interim measure is referred to 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 southeastern and northeastern property boundary of the Facility, respectively. The GWCTS is controlling VOC-contaminated ground water migrating beneath the eastern and southeastern portions of the Facility, and is then treating the water with activated carbon (Figure 2) before it is discharged to the Yellow Springs Publicly Owned Treatment Works (POTW).

1.8.2 Utility Tunnel Sump Water Treatment System

Vernay is also operating a Utility Tunnel Sump Water Treatment System (UTSWTS) for a sump located at the northeast corner of Plant 2 (Figure 2). The sump collects water that drains around the perimeter of the concrete underground tunnel that connects utility lines between Plants 2 and 3 (Figure 2). Approximately 8,000 gallons of water is treated per month by the UTSWTS. The UTSWTS treats 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 was presented in TM-3.

1.9 RFI Reports and Technical Memoranda

During the RFI, interim documents such as quarterly reports, Technical Memoranda, and other reports are prepared by Vernay and submitted to the U.S. EPA to report on the progress of the RCRA Corrective Action (Table 1). A brief summary of these documents is provided below.

1.9.1 Current Conditions Report

The *Current Conditions Report* dated November 25, 2002, was prepared as required by Paragraph 10 of the Corrective Action Order (Payne Firm, 2002). The purpose of this report was to provide a description of the Vernay facility and the surrounding regional area, the results of past environmental investigations, and available information relevant to the presence or release of hazardous waste and hazardous constituents at the Facility. The information in the report assisted in preparing in the scope of work for the RFI.

1.9.2 Project QAPP

A Quality Assurance Project Plan (QAPP) dated February 11, 2003 was prepared to present the organization, objectives, functional activities and specific QA/QC activities of the RFI, and to ensure the representativeness and accuracy of collected data (Payne Firm, 2003d). In addition, the QAPP presented the data quality objectives (DQOs) for the RFI (Table 3).

1.9.3 Quarterly Progress Reports

Quarterly progress reports are submitted to the U.S. EPA by the 15th day of the month following the end of each quarter. The elements contained in the quarterly progress reports include the work performed to date, data collected, problems encountered, project schedule, and percent work completed.

1.9.4 Public Repository

In accordance with Paragraph 24 of the Corrective Action Order, Vernay in conjunction with the U.S. EPA established the Village of Yellow Springs Library as the publicly accessible repository for information regarding the progress and results of the RCRA Corrective Action. Documents submitted to the U.S. EPA (Technical Memoranda, Quarterly Progress Reports, etc.) are also submitted to the Village of Yellow Sprigs Library. In addition, the U.S. EPA established a web page that posts all or portions of these documents at www.epa.gov/region5/sites/vernay.

1.9.5 Technical Memoranda

During the Phase I RFI, technical memoranda were prepared so that the U.S. EPA and Vernay were in agreement on the scope and progress of the RFI. Four technical memoranda were prepared during the Phase I RFI, as summarized below:

Technical Memorandum No. 1: Facility Investigation Sampling List

Technical Memorandum No. 1: Facility Investigation Sampling List (TM-1) was prepared on June 30, 2003 (Payne Firm, 2003a). TM-1 presented the list of chemicals of concern to be analyzed for during the RFI, including the methodology and rational used in developing the site-specific list.

Technical Memorandum No. 2: Historic Data Usage in the RCRA Corrective Action

Technical Memorandum No. 2: Historic Data Usage in the RCRA Corrective Action (TM-2) was prepared on December 12, 2003 (Payne Firm, 2003b). TM-2 provided the justification for the use of the past data for its intended uses in the RFI and requested the U.S. EPA to review this justification. The U.S. EPA (2004a) provided comments to TM-2 on January 21, 2004.

Technical Memorandum No. 3: Ground Water Monitoring

Technical Memorandum No. 3: Ground Water Monitoring (TM-3), was prepared on December 22, 2003 (Payne Firm, 2003c). TM-3 was required by the Corrective Action Order to be a component of the Phase I RFI Corrective Action Order. The TM-3 included the following information: 1) the results of four quarterly 2003 ground water sampling events; 2) an evaluation of the efficacy of the GWCTS; 3) well construction documentation; 4) ground water potentiometric surface depictions; and, 5) additional information as it relates to the ground water and hydrogeological system at and in the vicinity of the Facility. The U.S. EPA (2004b) provided comments to TM-3 on February 17, 2004.

Technical Memorandum No. 4: Soil Confirmation

Technical Memorandum No. 4: Soil Confirmation (TM-4), was prepared on March 18, 2004 (Payne Firm, 2004) to demonstrate to the U.S. EPA that RFI soil data confirmed the past soil data. The U.S. EPA (2004c) provided comments to TM-4 on May 4, 2004.

1.9.6 Soil Interim Measure Report

On May 20, 2003, Vernay submitted a report (Payne Firm, 2003e) to the U.S. EPA that presented an assessment of implementing an effective in-situ treatment technology as an early interim measure to remediate soils beneath the Facility exhibiting the highest concentrations of soil contamination. The assessment and report were required by the Corrective Action Order as an initial RFI task. The assessment focused on a feasibility evaluation of the effectiveness, implementability, and cost of several in-situ soil treatment technologies. The assessment concluded that there was not a potential viable in-situ technology that could be easily and cost-effectively implemented to effectively reduce contaminant concentrations in the soil over a short term period (1-2 years).

1.9.7 Human Health Environmental Indicator (CA725)

At the U.S. EPA's request, Vernay submitted a draft CA725 EI report to the U.S. EPA on April 9, 2004. Based on comments from the U.S. EPA, the final CA725 EI report will be submitted to the U.S. EPA on or before July 15, 2004. The draft CA725 EI report demonstrated that all current human exposures to contamination at or from the Facility are under control. The draft CA725 EI report was prepared by ENVIRON Corporation in collaboration with the Payne Firm (ENVIRON, 2004).

2.0 RCRA FACILITY INVESTIGATION

This section presents the goals, objectives and tasks of the RFI, and discusses the procedures and protocols used to document that collected RFI field and analytical data are of sufficient quality and quantity to meet project data quality objectives. Tasks completed during Phase I of the RFI are also discussed in detail. The Phase I RFI tasks were completed between October 2002 and June 2004.

2.1 RFI Scope of Work

2.1.1 Objectives of the RFI Scope of Work

During the negotiation of the Corrective Action Order, discussions were held with the U.S. EPA concerning the scope of work necessary to conduct and complete the RFI. The data gaps, and the data needed to satisfy the objectives of the Corrective Action Order, were easily identifiable because of the extensive amount of information and data obtained by Vernay during its past voluntary investigation, and the results of the U.S. EPA's PA/VSI report (TechLaw, 2001).

The goals and objectives of the RFI scope of work are based on four primary components: 1) past soil, ground water, surface water, sediment, and indoor air sampling data for on and off of the Facility, 2) the SWMUs and AOCs identified in the PA/VSI report; 3) the results of the operation of extraction well CW01-01 at the Facility; and, 4) relevant U.S. EPA corrective action guidance as appropriate to the Facility including, but not limited to, Documentation of Indicator Determination Guidance (U.S. EPA, 1999); model scopes of work for RCRA Corrective Action; RCRA Region 5 Quality Assurance Project Plan Policy (U.S. EPA, 1998); and, U.S. EPA risk assessment guidance (U.S. EPA, 1989).

Based upon these components, the following goals for the RFI scope of work were agreed upon by the U.S. EPA and Vernay:

- Target investigations and assessments to the current conditions that warranted the most attention in the near term.
- Control any unacceptable current risks to human health and the environment.
- Stabilize the migration of contaminated ground water in the Cedarville Aquifer.
- Conduct quarterly ground water monitoring to confirm that contaminated ground water remains with the original area of contamination.
- Prioritize investigations to determine known or potential unacceptable risks; and then modify the scopes of work iteratively using gathered data and information to make informed decisions.
- Implement interim remedial measures at any time to mitigate unacceptable current risks.

- Make progress towards the ultimate goal of implementing corrective remedial measures that will protect human health and the environment from all current and future unacceptable risks.
- Communicate frequently to ensure that the corrective action process is conducted efficiently and properly.

Based upon these goals, the overall objectives of the RFI scope of work are:

- Determine the nature and extent of contamination of any releases of hazardous waste and hazardous constituents on or off of the Facility that may pose an unacceptable risk to human health and the environment.
- Collect and analyze data that is of sufficient quality to allow comparison with established action levels or regulatory standards (e.g. risk-based screening levels).
- Collect the information that Vernay needs to meet all of the criteria required by the CA725 and CA750 EI reports.
- Collect sufficient data for all contaminated media and biota necessary to perform an evaluation of the fate and transport of contaminants released at the Facility, and to determine the potential risks to human health and the environment.
- Collect sufficient data to the support the development and evaluation of corrective remedial measures for the Facility. This evaluation will be conducted after the RFI is completed.

To assist in identifying data needs necessary to meet these objectives, the results of past investigations at the Facility were extensively documented in the *Current Conditions Report* (Payne Firm, 2002). The purpose of the *Current Conditions Report* (CCR) was to provide a representative description of what is currently known about the release and presence of hazardous waste and hazardous constituents at the Facility. Presenting past data in the CCR provided the foundation for identifying the objectives of the RFI and, in particular, the data needs.

The CCR included a summary of all past sampling data, a preliminary conceptual site model, and a summary of past operations and the physical setting of the Facility and the surrounding area. The CCR also described the conditions at all SWMUs and AOCs identified in the U.S. EPA's PA/VSI (TechLaw, 2001), and any other locations at the Facility where the past treatment, storage, or disposal of hazardous waste or hazardous constituents occurred. The CCR was the first task completed during the RFI, and was used extensively to develop the detailed scope of work for Phase I of the RFI. A RCRA Corrective Action project schedule is presented on Table 2.

2.1.2 RFI Scope of Work

The U.S. EPA's data quality objectives (DQOs) process was used to prepare the detailed scope of work for the RFI, and to ensure that the overall goals and objectives of the RFI are met during the corrective action. The DQO process is a series of planning steps that are designed to ensure that the type, quantity, and quality of the environmental data used in decision making are appropriate for the intended application or use (USEPA, 2000). The DQO process was developed by the U.S. EPA to assist agency personnel and environmental consultants with identifying the data needs that are important to decision making.

Implementing the DQO process resulted in an identification of the data needs and acceptable levels of data quality for the RFI before any data were collected, and to discuss these requirements and levels with the U.S. EPA. Application of the DQO process also resulted in a detailed RFI scope work, and the tasks necessary to obtain laboratory and environmental field data of appropriate quality. The results of the DQO process and the RFI scope of work are presented on Table 3. This table includes outputs (e.g. documents, decision diagrams, statements of work, etc.) that are necessary to support RFI planning decisions (e.g. assessing unacceptable risks to human health and the environment, and evaluating corrective remedial measures). During the Phase I RFI, the scope of work shown on Table 3 was modified during the iterative facility investigation process as information was gathered and assessed. The RFI scope of work will continue to be modified during Phase II of the RFI as additional information is collected.

The Corrective Action Order did not require the preparation of a comprehensive work plan document that presented the detailed scope of work tasks for the RFI. One of the objectives of the U.S. EPA's streamlined RCRA corrective action process is to encourage the responsible party to implement corrective remedial measures as soon as practical. As a result, it was agreed that the RFI scope of work presented on the project DQO table (Table 3), which is more of a global overview, needed to be detailed in task specific statement of works (project SOWs) prepared by Vernay and reviewed by the U.S. EPA. During the Phase I RFI eleven SOWs were prepared and reviewed by the U.S. EPA. Table 4 shows the project SOWs that were prepared during each step of the Phase I RFI, the data needs that were addressed by the tasks associated with each project SOW, and documents and other outputs that were prepared to present the results of the tasks.

To ensure that the environmental field and laboratory data collected during the RFI are of sufficient quality to meet the project DQOs and the goals and objectives of the RFI scope of work, a quality assurance project plan (QAPP) was prepared following the U.S. EPA's Region 5 RCRA QAPP Policy (U.S. EPA, 1998). A draft QAPP was submitted and discussed with the U.S. EPA prior to initiating the RFI. The QAPP presents the organization, objectives, and functional quality assurance (QA) and quality control (QC) activities associated with the RFI. Specific procedures and protocols for sampling, sample handling and storage, chain-of-custody, and field and laboratory analyses are described in the QAPP (Payne Firm, 2003d).

2.1.3 Phase I RFI Tasks

During the Phase I RFI, soil borings were drilled to collect samples for analytical or geotechnical laboratory analyses, or to assess the geology beneath the Facility and vicinity. Twenty-six new monitoring wells were added to the existing well network which consisted of 27 wells at the time the Phase I RFI was initiated. Monitoring wells were sampled during seven quarterly monitoring events. Analytical data collected during the RFI are validated following procedures in the project QAPP.

As shown on Table 4, the Phase I RFI tasks were conducted in iterative steps, and involved the sampling and analysis of soil, sediment, ground water, storm sewer water, subsurface water, surface water, and indoor air. The initial steps of field work concentrated on developing a RFI sampling list, implementing additional interim measures for ground water, and installing additional monitoring wells into the Cedarville Aquifer and storm sewer backfill. These initial steps allowed for determining the extent of contamination in the Cedarville Aquifer and storm sewer backfill, as well as providing additional information for the Site Hydrogeologic Model (SHM) conceptual site model and the evaluation of the efficacy of existing interim measures.

Other work tasks implemented during the Phase I RFI focused on determining the nature and extent of contamination in soil on and off of the Facility, sampling of indoor air, determining the nature and extent of contamination in surface water and sediments and in discontinuous sand seams in the vadose zone, developing a ground water flow model, and completion of a water well survey. Seven quarters of ground water monitoring were conducted during the Phase I RFI to determine the extent of contamination in the Cedarville Aquifer and storm sewer backfill, monitor existing ground water extraction wells, and to assess if there were seasonal variations in contaminant concentrations in ground water beneath the Facility and vicinity.

During the Phase I RFI, data needs and data quality objectives were also focused on obtaining sufficient information for the preparation of the CA725 and CA750 EI reports. More emphasis was placed on collecting data for completing the CA725 because Vernay needed to demonstrate that all current human exposures to contamination at or from the Facility are under control by June 30, 2004, as agreed to in the Corrective Action Order. At the request of the U.S. EPA, the CA725 report was prepared by ENVIRON (2004) and the Payne Firm and was submitted draft to the U.S. EPA on April 9, 2004 under separate cover.

Analytical data from ground water, sediments, and surface water were also collected during the Phase I RFI to meet the criteria required by the CA750 EI report. The purpose of the CA750 EI report is to confirm that the migration of “contaminated” ground water has stabilized, and that monitoring will be conducted to confirm that contaminated ground water remains within the original “area of contamination.” The CA750 report will be prepared after the completion of the Phase II RFI. Vernay needs to meet all of the criteria required CA750 EI criteria within 180 days of the approval of this Phase I RFI report, or approval of the Phase II RFI report (if further ground water investigation is deemed necessary by the U.S. EPA during Phase II).

2.2 RFI Procedures and Protocols

2.2.1 Project Management

The U.S. EPA and Vernay have each identified project managers for the RCRA corrective action, including the RFI. Frequent communication occurred during the Phase I RFI between the project managers: Doug Fisher of Vernay, and Patricia Polston of the U.S. EPA. The U.S. EPA is frequently kept informed of the progress and findings of the field work through quarterly progress reports, field SOWs, project schedules, several technical meetings with the U.S. EPA project manager and other technical staff of the U.S. EPA, technical memoranda, and conference calls. These communications with the U.S. EPA assisted in the development and refinement of the RFI scope of work, and the Phase I RFI tasks.

All RFI field sampling activities are managed and conducted by professional and field geologists, and field technicians from the Payne Firm following the SOPs presented in the project QAPP. Sonic drilling services during the Phase I RFI were provided by Bowser-Morner of Dayton, Ohio, Enviro Core, Ltd. of Columbus, Ohio provided direct-push drilling. Woolpert, Inc., of Dayton, Ohio, provided licensed surveying services. All geological property laboratory services were provided by Bowser-Morner.

All chemical laboratory procedures and protocols conducted during the RFI follow the methodologies and criteria presented in the project QAPP. The project chemical laboratory is Severn Trent Laboratories (STL), North Canton, Ohio. All chemical analyses during the Phase I RFI were conducted by STL at two of its affiliated laboratories: organic and inorganic analyses were conducted at the North Canton, Ohio laboratory; and the analyses of air samples were conducted at the Knoxville, Tennessee facility. All chemical soil and water samples were shipped directly to the North Canton laboratory. All indoor air samples were shipped directly to the Knoxville laboratory. Water samples collected from the existing ground water extraction systems were submitted to DataChem Laboratories (DataChem), Cincinnati, Ohio.

<u>Statements of Work</u>
As indicated above, a task specific Statement of Work (SOW) is prepared prior to the commencement of each step of the RFI field work as required by the project QAPP. The purpose of the SOW is to document important elements associated with each task so that the field sampling team is fully aware of the objectives and sampling procedures required by the task. The SOW is prepared by the Payne Firm's Field Coordinator/Quality Assurance Officer and reviewed by the Project Manager, and summarizes the

sample collection and identification procedures unique to the task such as QA/QC sampling locations, constituent analysis list, and changes or additions to identified work scopes. The draft SOWs are submitted to the U.S. EPA prior to initiating the field work to ensure that the project managers agree with the scope of work. The SOWs include the following information:

- Sampling objectives and purpose;
- Sample locations;
- Sample numbering and labeling;
- Pertinent SOPs to follow;
- QC samples;
- Any specific holding time requirements; and
- And task-specific QAPP or QA/QC procedures to follow.

During the Phase I RFI, eleven SOWs were prepared and implemented (Table 4).

2.2.2 Project Surveying

During the field activities, the northing and easting grid coordinates of sampling location and monitoring wells were determined by the project surveyor (using professional surveying techniques) and transferred to a base map. Survey data are presented on Table 5. The base map is shown on Sheet 1, which is a comprehensive map of the Facility and vicinity showing buildings and structures as they existed in 1998. Locations of monitoring wells, soil borings, and other sampling location are depicted using this base map.

In addition to the above activities, the top of well casing elevations for all existing and new monitoring wells constructed during the Phase I RFI were determined by the project surveyor. This was done to determine the elevation of the potentiometric water level in each well. The surveyed elevations are accurate to the nearest 0.01 foot. The top of casing reference elevations for the pre-RFI monitoring well network were established by the project surveyor and reported in the CCR. Therefore, the top of casing elevations in the existing wells were not re-surveyed during the Phase I RFI. The top of casing elevations for the new and existing wells were used in the determination of potentiometric surfaces and ground water flow directions.

2.2.3 Field Documentation

Task-specific Field Logbooks are used to record field activities, observations, and measurements during the course of the RFI. The Field Logbooks are used by each field member or team to document a specific field task such as ground water level measurements, ground water sampling, or soil boring or well installation and include relevant information specific to the task such as alternate procedures used, unanticipated observations or occurrences, health and safety information, monitoring equipment readings, etc.

Following the requirements of the Payne Firm SOPs, other logs and checklists that are used to document specific field activities include: daily calibration logs for organic vapor analyzers, pH meters and turbidity meters, geological boring logs, monitoring well construction detail logs, well development forms, sample chain-of-custody forms, soil and ground water sample collection logs, ground water sampling form, and field QA/QC data validation checklist. The primary purpose of the field documentation is to verify that all soil, sediment, ground water, subsurface water, surface water, indoor air and geotechnical samples collected for laboratory analyses were properly managed, labeled, recorded, and packaged prior to shipment to the project laboratory.

After each step of work was completed during the Phase I RFI, all field documents, Field Logbooks, sampling and equipment logs, and QA/QC checklists were placed in task-specific notebooks and retained in the project file.

2.2.4 Sample Identification

A unique numbering system is used to identify each field sample collected during the RFI as shown below and as depicted on database tables and appendices presented in this report:

Soil

For soil samples, the field sample identification incorporated whether the boring was drilled on or off of the Facility property, the boring identification, the depth of sample collection, and the date of sample collection as shown in the following example:

GP01-017/14-16/[date], where,

- GP01-017/14-16/[date] indicates that the boring was installed using a direct push drill rig (a B indicates that the boring was installed with a hollow-stem auger drill rig);
- GP01-017/14-16/[date] indicates that the boring was installed on the Facility property (02 indicates that the boring was installed off of the Facility property);
- GP01-017/14-16/[date] indicates the soil boring identification;
- GP01-017/14-16/[date] indicates the depth the soil sample was collected below the surface (or in the case of inside a building, the depth below the floor grade);
- GP01-017/14-16/[date] indicates the date the soil sample was collected.

Ground Water

For ground water samples collected from monitoring wells, the field sample identification method is:

MW01-04/[date] where,

- MW01-04/[date] indicates that the sample was collected from a monitoring well (RW indicates that the sample was collected from a remediation observation well); and CW indicates a ground water extraction well;
- MW01-04/[date] indicates that the sample was collected on the Facility property (02 indicates that the sample was collected off of the Facility property);
- MW01-04/[date] indicates the ground water well identification; and
- MW01-04/[date] indicates the date the water sample was collected.

For ground water samples collected from water wells, the field sample identification method is:

WELL/[address] A/[date] where,

- WELL/[address] A/[date] indicates that the sample was collected from a water well;
- WELL/[address] A/[date] indicates the address of the property where the sample was collected;
- WELL/[address] A/[date] indicates that the sample was immediately collected from the well, and a B indicates that the sample was collected after 10 minutes of purging the water well;
- WELL/[address] A/[date] indicates the date the water sample was collected.

Surface Water/Storm Sewer Water

For surface water samples and samples collected from the storm sewer system, the field sample identification method is:

ST01-04/[date] where,

- ST01-04/[date] indicates that the sample was collected from a surface water body (from within a storm sewer or from an open surface water body);
- ST01-04/[date] indicates that the sample was collected on the Facility property (02 indicates that the sample was collected off of the Facility property);
- ST01-04/[date] indicates the surface water sample station identification; and
- ST01-04/[date] indicates the date the water sample was collected.

Sediment

For sediment samples, the field sample identification method used was:

SED01-04/[date] where,

- SED01-04/[date] indicates that the sample was collected from sediment within a surface water body;
- SED01-04/[date] indicates that the sample was collected on the Facility property (02 indicates that the sample was collected off of the Facility property);
- SED01-04/[date] indicates the sediment sample station identification; and
- SED01-04/[date] indicates the date the sediment sample was collected.

Indoor Air

For indoor air samples collected inside Plant 2 and Plant 3, the field sample identification is:

AIR01-07/[date] where,

- AIR-0107/[date] indicates that the sample collected is an air matrix;
- AIR-0107/[date] indicates on-property air sample;
- AIR-0107/[date] indicates the air sample station identification; and
- AIR-0107/[date] indicates the date the air sample was collected.

QC Samples

For QC samples, the following sample identification method is:

- Field duplicates, trip blanks, field blanks, and rinsate samples were numbered sequentially per sampling event, and labeled as DUP01/[date], TB01/[date], FB01/[date], and RIN01/[date], respectively; and
- MS/MSD samples were noted on the chain-of-custody comments section, but a separate sample identification was not required by STL.

The sample locations for field duplicate samples are recorded on the sample log sheet and/or Field Logbook but kept out of the sample identification number to prevent laboratory bias. Sample identification labels for all samples are completed at the time of collection and included the data and time of collection and the Payne Firm's project number, following SOP 1-3 (Labeling and Custody of Samples).

2.2.5 Analytical Methods

Soil, ground water, subsurface water, surface water, sediment and indoor air samples are analyzed by the project laboratory following the standard analytical methods presented in Section 8.0 (Analytical Procedures), Table 10 (Summary of Analytical Methods), and Appendix III (Laboratory SOPs) of the QAPP. The analytical methods and procedures used during the Phase I RFI are shown on Table 6. All organic and inorganic chemical analyses followed U.S. EPA SW-846 methods and all geological property analyses followed American Society for Testing Materials (ASTM) methods.

2.2.6 Drilling Methodologies

Depending on the data needed to meet RFI objectives, different methods of drilling were used during the Phase I RFI. The drilling methods included direct-push probing (Geoprobe®), sonic drilling (also referred to as rotosonic, rotasonic, or sonicore), continuous flight hollow stem auger drilling, and air rotary drilling. Sonic drilling, air rotary, or hollow stem augers were used for monitoring well and extraction well installation on and off of the Facility. The majority of the direct-push borings were advanced for soil and sand seam water sampling at the Facility and vicinity. All borings and monitoring well locations are shown on Sheet 1. All boring and well construction logs from the Phase I RFI and Vernay's past voluntary investigation are presented in Appendix VIII.-B.

All drilling activities were performed by qualified drilling contractors with project management and project-specific input from a Payne Firm geologist. During drilling activities, field boring logs were prepared at the time of sample collection by the Payne Firm geologist following the procedures and criteria presented in the Payne Firm SOPs.

All soil sampling conducted by Payne Firm personnel was performed in conformance with Payne Firm SOPs. During each soil sampling event, drilling and sampling equipment was decontaminated in accordance with Payne Firm SOPs. Soil cuttings and water generated during drilling were containerized and properly disposed at a permitted disposal facility.

2.2.7 Quality Control Sampling

In conformance with the project QAPP, field blank, trip blank, equipment rinseate samples, duplicate samples, and MS/MSD samples are collected and analyzed to assess the quality of field and analytical procedures conducted during the RFI (Table 7). The QC sampling procedures and frequency are summarized below:

- Field blank samples are prepared for every 20 investigative samples and analyzed for the same analytes specified for the investigative samples collected during the sampling event. A field blank sample is prepared by pouring laboratory grade water into appropriate sample containers. The field blank samples are analyzed for the constituents being analyzed during the sampling event by the project laboratory. Field blank samples are also collected from the source of potable water used in the drilling process.

- Trip blanks are utilized to assess the potential for contamination of investigative samples due to VOC contaminant migration during sample shipment and storage. Trip blanks are prepared by the project laboratory using laboratory grade water. A trip blank is included in each sample cooler shipped to the project laboratory which contained investigative samples for VOC analysis.
- An equipment rinseate sample is used to assess the effectiveness of the field decontamination of non-dedicated soil or ground water sampling devices (e.g. split-spoon samplers, sample pumps). If non-dedicated sampling equipment was use, at least one rinseate sample was collected for every 20 investigative samples by pouring laboratory grade water over the decontaminated sampling device and collecting the rinseate water. The rinseate samples are analyzed by the project laboratory for the constituents being analyzed during the sampling event.
- A duplicate field sample is collected for every 20 investigative samples and analyzed for the same constituents as the associated investigative sample. Duplicate samples are collected at sampling locations which were known or suspected of being contaminated. The duplicate samples are assigned a unique sample number and sent to the project laboratory to assess analytical reproducibility.
- MS/MSD samples are collected to evaluate analytical accuracy and precision. Two categories of MS/MSD samples are designated for analysis during the RFI: 1) MS/MSD samples designated for analysis by the Payne Firm; and, 2) samples selected for MS/MSD analysis by the project laboratory. MS/MSD samples are selected by the project laboratory to comply with QC requirements of the methods which specify that each analytical batch include MS/MSD samples for analysis. Since the number of MS/MSD samples designated by the Payne Firm (one MS/MSD sample per 20 analytical samples) may not be sufficient at times to comply with this QC requirement on an analytical batch basis, additional samples can be selected for MS/MSD analysis by the laboratory if they believe that it is warranted.

2.2.8 Data Quality and Validation

Data validation is an independent process of confirming that analytical data are of sufficient technical quality to meet the intended uses. All inorganic and organic data received from the project laboratory were validated by the Data Validation Coordinator according to the protocols presented in Section 10.0 (Data Reduction, Validation, and Reporting) of the project QAPP.

The level of data quality required for the RFI depends on the intended use of the data, which in turn dictates the appropriate level or extent of validation. The intended uses of the data were established by the project DQOs shown on Table 3. As such, different data uses may require different levels of data quality. During the RFI, specific analytical support levels (ASLs) are assigned to each sample collected. The ASLs used during the Phase I RFI are shown on Table 8; all analytical laboratory data reported by the project laboratory during the Phase I RFI consisted of “CLP-like” data reports (i.e. Level IV), consistent with U.S. EPA guidance (U.S. EPA, 1998).

To verify that the analytical data met the DQOs and to determine compliance with applicable protocols, the validation process for the RFI includes an independent review and check of: laboratory adherence to QA procedures and accuracy and precision criteria; laboratory analysis and reporting; the presence of laboratory contamination; and any nonconformities or discrepancies in the analytical database. After each task of the field work is completed and the data validated, Payne Firm data qualifiers are assigned to the analytical database to notify the user of any nonconformities to the QA/QC requirements set forth in the QAPP. The list of STL and Payne Firm qualifiers and definitions is provided in Table 9. Data validation memorandum are included in Appendix V.

To further assess the quality of the data received from the project chemical laboratory, STL’s North Canton, Ohio laboratory was independently audited by the Payne Firm’s Data Validation Coordinator and a Project Manager to evaluate the laboratory’s internal performance and sample management activities. The audit was conducted on May 7, 2004 and, in conformance with Section 11.0 (Performance and System Audits) of the project QAPP, the audit included, but was not limited to: an examination of laboratory documentation of sample receipt, sample log-in, sample storage, chain-of-custody procedures, sample preparation and analysis instrument operating records.

2.2.9 Data Management

Completed laboratory analytical reports are submitted to the Payne Firm by the project laboratory in pdf format and in an electronic database format to facilitate data validation, management and review. All laboratory reports are received by the Project Field Coordinator and logged into the project file. The manner in which the analytical data are managed by the Payne Firm once received from the project laboratory is summarized on Figure 8.

After each step of work, the laboratory data are validated by the project Data Validation Coordinator and validation memorandums are generated and reviewed by the Project Field Coordinator and the Project Manager. All validation data qualifiers are added to the electronic analytical database. All Payne Firm personnel involved in data management, data evaluation, and data interpretation activities access the controlled qualified database.

2.2.10 Areas of Interest

To assist in focusing the RFI scope of work, the Facility and vicinity were divided into four Area’s of Interest (AOIs) based on: 1) physical location and current conditions; or, 2) the type of SWMU or AOC; or, 3) the type of human or ecological receptor that may be present under current and likely future conditions (ENVIRON, 2004). Figure 23 shows AOI-1 through AOI-4. AOI-1 and AOI-2 are located on the Facility, and AOI-3 and AOI-4 are located off of the Facility property. AOI-1 consists of the undeveloped portion of the Facility, primarily the western fill area. AOI-2 includes the balance of the Facility, including all developed portions of the property. The sewers beneath the Facility are identified as a subset of this area (AOI-2A). AOI-3 includes the off-Facility area that was investigated during the Phase I RFI. The sewers located on Dayton Street between the Facility and the unnamed creek and between Omar Circle and the Facility are identified as a subset of this area (AOI-3A). AOI-4 includes the unnamed creek between Dayton Street and Fairfield Pike. These AOIs were also used to assemble data for assessing the significance of current potential human exposures to hazardous constituents detected in soil, subsurface and ground water, and surface water in each AOI as part of the CA725 (ENVIRON, 2004). The AOIs will be used to assess current and future risks to human and ecological receptors associated with each AOI for the baseline risk assessment, to be conducted during the Phase II RFI.

2.2.11 Waste Management

Purged water, soil and rock cuttings, and decontamination water derived during the RFI are containerized, managed and disposed of at a permitted disposal facility. Purged water and drilling water are collected into temporary containers (1,500 gallon aboveground storage vessels). After suspended solids settle out, water retained in these vessels is removed by Perma-Fix of Dayton, Ohio for disposal at its permitted wastewater disposal facility.

During the drilling activities, investigation derived waste soils and rock cuttings are placed into new 55-gallon drums and temporarily stored at the Facility. Composite waste solid samples are collected and analyzed for the waste characterization parameters, prior to drum removal from the Facility by Perma-Fix of Dayton.

2.3 Phase I RFI Sampling Methods

This subsection briefly summarizes the sampling methods used during the Phase I RFI. Detailed field sampling SOPs are presented in Appendix II of the QAPP (Payne Firm, 2003d), and can be reviewed if detailed information is required.

2.3.1 Soil Sampling Methods

A variety of soil sampling methodologies were used during the Phase I RFI depending on the data needs and objectives. These soil sampling methods are discussed below.

2.3.1.1 Field Screening

Field screening requirements were determined for each RFI task independently depending on the objectives of the task. Field screening was performed using either a photo-ionization detector (PID) and/or flame-ionization detector (FID).

2.3.1.2 Direct-Push Drilling

Direct-push drilling was implemented by the Payne Firm as an efficient technology to collect soil samples to characterize unconsolidated soils. Direct-push soil sampling using a Geoprobe® was performed by advancing the soil sampling equipment into the subsurface with a hydraulically-driven percussion hammer. Soil samples from borings were collected continuously through a dual tube soil sampling system, assuring the integrity of the sample and minimizing cross contamination. The direct-push sampling equipment consisted of a two-inch by three, four, or five-foot long dual cased steel rod and disposable plastic sleeve liner.

2.3.1.3 VOC Soil Sampling

During the Phase I RFI, soil samples analyzed for VOCs were collected using Method 5035 of Update III to SW-846. Consistent with the U.S. EPA memorandum entitled “Determination of Volatiles in Soil-Directive for Change” (U.S. EPA, 1998), all soil samples for VOC analysis were collected using the En-Core® sampler for subsequent sample preparation by Method 5035. For each interval to be sampled, three 5-gram En-Core® samplers were collected.

2.3.1.4 Sonic Drilling

The Payne Firm utilized sonic drilling to install monitoring wells to ensure the ability to drill through cobbles, sand, gravel, hard till, and bedrock materials without compromising sample volume or integrity and to overcome difficulties with heaving sand conditions. Temporary dual and triple steel casing capabilities provided the ability to continuously seal the borehole wall to minimize the potential for the vertical movement of chemical constituents during casing advancement into the borehole. Soil borings were advanced at locations on and off of the Facility using sonic drilling following the procedures and criteria presented in SOP 3-7 (Observation of Rotasonic Drilling Activities). Sonic borings were typically installed to depths of up to approximately 100 feet. Rock cores were collected, logged, placed into core boxes, and stored at the Facility.

2.3.1.5 Borehole Abandonment

Boreholes completed by the direct-push method were abandoned by filling the borehole with bentonite chips and sealing the surface with asphalt, concrete, or bentonite. Boreholes completed by sonic drilling and not completed as wells were abandoned by injecting a bentonite slurry with a tremie pipe from the bottom of the borehole upward, to ensure the entire borehole annulus was filled.

2.3.1.6 Geological Properties Laboratory Testing

Soil samples were collected for laboratory analyses of specific geological properties and total organic carbon (TOC). The soil samples were collected to assist in the evaluation of the geologic, hydrogeologic, and physical properties of the major geologic units encountered beneath the Facility and vicinity. At boring locations drilled by the sonic method, fine-grained samples were collected directly from the four inch diameter soil core barrel. To preserve in-situ moisture characteristics, the sonic core samples were securely wrapped in plastic and foil and sealed with tape. These fine-grained core samples were considered undisturbed, or “in-situ” samples by the project geological properties laboratory (Bowser-Morner, Inc., Dayton, Ohio). Where coarser-grained materials were encountered, samples were collected directly into six gallon plastic buckets with lids and were considered disturbed samples and were re-compacted by the laboratory.

Samples were analyzed for various physical parameters including porosity, bulk density, grain size distribution (sieve and hydrometer), USCS classification, moisture content, soil pH, and vertical hydraulic conductivity (falling head for undisturbed and constant head for disturbed samples). A visual description of the sample was also provided from the geological properties laboratory. Table 12 summarizes testing methods for geological property analyses.

TOC samples were also collected from the sample interval immediately above or below the undisturbed sampling interval or directly from the disturbed sampling interval and collected into four-ounce glass jars and placed on ice prior to shipment. Samples submitted to the project analytical laboratory (STL) were analyzed for TOC in accordance with U.S. EPA procedures (SW846-9060).

2.3.2 Monitoring Well Installation

The ground water monitoring network at the Facility consisted of 20 on-Facility and 7 off-Facility monitoring wells prior to the RFI. During the RFI, one on-Facility monitoring well and 25 off-Facility monitoring wells were added during the course of Phase I RFI (Figure 28). Pre-RFI monitoring wells and new monitoring wells were constructed following Payne Firm SOP 4-2 (installation of monitoring wells).

Monitoring wells were installed at and in the vicinity of the Facility prior to 2003 as part of the past voluntary investigation (Pre-RFI CA monitoring wells). The Pre-RFI 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. The Pre-RFI CA well logs are included in Appendix VIII-C, and Table 10 presents the well construction information.

During the Phase I RFI, additional monitoring wells were constructed by the Payne Firm within the upper, middle, and lower portions of the Cedarville Aquifer and within sewer backfill at 26 locations (MW01-04SE through MW02-18CD) on the Facility and vicinity using sonic drilling or hollow stem auger technology following the procedures and criteria presented in SOP 4-2 (Installation of Monitoring Wells). A Payne Firm geologist described the geologic and hydrostratigraphic units encountered while drilling. Monitoring wells were installed to depths ranging from 10 to 110 feet below ground surface (bgs) within the Cedarville Aquifer or sewer backfill. The well construction materials included two-inch ID Schedule 40 polyvinyl chloride (PVC) casing and two-inch ID, 0.010-inch slotted well screens. Ten-foot screens were used at al monitoring well locations.

Working from bottom to top, the open seven-inch inside diameter (ID) borehole was sealed with bentonite pellets to the base of the desired screen interval and allowed to hydrate. A sand pack was placed in the annular space around the screened interval by pouring sand through the six-inch ID drilling casing. The top of the sand pack was terminated approximately two to three feet above the screen. An annular seal was installed above the sand pack by pouring bentonite pellets through the drill casing to approximately three to ten feet above the sand pack, followed by hydration of the bentonite. The remainder of the annular space of the borehole was tremie-grouted with a cement-bentonite mixture within two to three feet from the surface and allowed to setup overnight. The wells were then covered with a nine-inch diameter, steel, protective manhole cover, encased in a concrete pad at the ground or pavement. For wells constructed in a field, stick up protective steel covers and steel guard posts were constructed. The top of the monitoring well casing was then permanently marked for subsequent surveying and water level measurements. A locking cap and Payne Firm lock secured the well at completion.

2.3.3 Monitoring Well Development

Following installation, each monitoring well was developed in accordance with the procedures and criteria presented in the Payne Firm’s SOPs. The development process was performed by the drilling contractor and directed by a Payne Firm geologist. Well development information was recorded in the Field Log Book and on a Well Development Form. Water removed from the well was containerized and properly disposed. At most monitoring well locations where sonic drilling was utilized, approximately 1.5 times the volume of water, introduced to the formation by drilling, was removed prior to the well construction and well development. Well Development Forms from the RFI are included in Appendix VIII-D.

2.3.4 Water Level Elevations

Water level elevations were collected during the RFI to assess ground water flow direction beneath the Facility and vicinity, and to monitor the effectiveness of the ground water capture systems. A complete summary of water elevation measurements is included in Appendix VIII-B. Hydrographs from the monitoring wells are included in Appendix I.

Measurements were recorded at each well location with an electrical water level indicator following Payne Firm SOP 2-5. Depths to the ground water surface in the well were measured by using a Solinst® water level tape indicator with depth markings every 0.01 feet. All measurements were recorded in a Field Log Book or Ground Water Measurement form to the nearest 0.01 feet. During each event, water level measurements were collected within a 24 to 36 hour period to minimize changes due to atmospheric and precipitation effects. In addition, water levels were recorded before well development and well purging occurred.

2.3.5 Subsurface Water Sampling Methods

2.3.5.1 Monitoring Well Sampling

The field activities associated with ground water and sewer backfill monitoring 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 follow the procedures and protocols presented in the May 2002 U.S. EPA guidance document "Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers," (U.S. EPA 2002) The monitoring well 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, volume of water in the well, and ground water elevation were collected.
- A submersible pump (QED Well Wizard® Bladder Pump) with dedicated Teflon tubing was slowly lowered into the well to a point within the well screen interval.
- Each well was 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) were recorded from an in line flow-through cell every 3 to 5 minutes after a minimum of one tubing volume of water was removed. Purging ceased when measurements for all parameters stabilized for three consecutive measurements. Stabilization criteria for the water quality parameters that was satisfied during well purging is listed below (U.S. 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 was initially low (0.2 to 0.5 liter per minute); as appropriate, the flow rate was increased in some wells as long as the drawdown in the well did not exceed 0.33 feet.

- Once sufficient water was purged, water was transferred to laboratory supplied containers for analysis of (VOCs, SVOCs, or metals). Appropriate sample preservation was added to the water samples, according to the particular analysis to be conducted (see Section 5). Samples were collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell.
- The water samples were appropriately packaged and shipped to the project laboratory.
- Water sampling information was recorded on a ground water sampling form and/or in the project field logbook.

Ground water sampling forms completed during the Phase I RFI are presented in Appendix VIII-E.

2.3.5.2 Direct-Push Water Sampling

Water samples were collected at the Facility and vicinity using direct-push drilling to assist in the preliminary identification of the vertical and horizontal extent of VOCs in the upper Cedarville Aquifer, in discontinuous saturated sand seams, and in sewer backfill shown on Figure 9. Results from these water samples were also used to assist in determining optimum monitoring well locations. A sampling device was used to collect water samples from various depths throughout the Unconsolidated Unit and ground water samples from the upper Cedarville Aquifer. The sampling interals were generally: 1) in saturated discontinuous sand seams; 2) in the storm and sanitary sewer backfill; and 3) in the upper portion of the Cedarville Aquifer.

The following steps were taken at each direct-push water sampling location:

- To collect a water sample from the upper Cedarville Aquifer, 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 top of the Cedarville Aquifer (based on probe driving resistance and lithologic data). Once the desired depth was reached, a stainless steel screen was exposed by retracting the protective outer drilling sleeve across saturated interval of interest.
- Prior to sample collection, the formation water was purged 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 most cases where recharge was abundant, a stainless steel bailer was used to collect the water sample. Where low yields were encountered, the water samples were collected using new 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 restored following Payne Firm SOPs. Purge water was transferred to a holding tank at the Facility 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 QAPP.

2.3.5.3 Water Well Sampling

During the Phase I RFI, water wells located off the Facility property were sampled. The purpose and objectives of this task, and locations of the water wells that were sampled is presented in more detail in Section 3.6 and Appendix VI. The water well sampling methodology consisted of the following primary elements:

- Prior to sampling a water well, appropriate measurements such as the static water level and total well depth were collected if the well head was accessible at the surface. A water level meter dedicated for potable use wells was used to measure the water level and total depth of the well, if accessible.
- The well pumping system was used to collect the water samples. The water sample was collected from the sampling point (i.e. spigot or faucet) closest to the well. Two samples were collected from each water well sampling point: A) one sample collected immediately when the spigot was turned on, and B) a second sample collected after 10 minutes of purging the well, or until sufficient volume was purged to remove all water standing in the distribution system (including pressure/holding tank, if present).
- If the water well did not have an operable pumping system and the well head was accessible, samples from the water well were collected with a submersible pump. New tubing was used at each water well that was sampled with the submersible pump. Two samples were collected from the water well as noted above (A and B).
- Water samples were transferred to laboratory supplied containers for analysis of VOCs.
- The water samples were appropriately packaged and shipped to the project laboratory.
- Water sampling information was recorded in the project field logbook.

2.3.6 Surface Water Sampling

Surface water samples were collected from the unnamed creek and the storm sewer along Dayton Street (Figures 30 and 31). Surface water sampling methodologies are described in SOW #10. These surface water samples were collected directly into the sample container. The samples were collected under the water surface by pointing the sample container upstream, avoiding any disturbance to the stream substrate.

A sample was collected from the storm sewer invert at locations ST02-03 (Figure 30) using a dip sampler. The surface water sample was collected by lowering the dip sampler into the storm sewer manhole to collect the sample. Once the dip sampler container was full, it was carefully brought to the surface and gently poured into the appropriate sample containers.

2.3.7 Sediment Sampling

During the Phase I RFI, sediment samples were collected at the storm sewer outfall to the unnamed creek (Figure 32). In general, the depth of water at this location is less than 1 foot. Sediment samples were collected using U.S. EPA Method 5035 for VOC analysis by collecting sediment from the upper 6 inches of the stream bed into a 5-gram Encore® sample container. The sediment samples contained greater than 30% silt and clay based on visual observations. Rocks, sticks, leaves, etc. were not included in the sample. Pertinent sampling information was recorded in the Field Logbook.

2.3.8 Indoor Air Sampling

Air samples were collected for VOC analysis inside Plant 2 and Plant 3 prior to and during the Phase I RFI at the locations shown on Figures 3 and 4. At each location, two air samples were collected into a Summa Passivated Canister (Summa Canister): one sample collected approximately one foot from the bottom of the structure, and a second sample collected approximately four feet from the bottom of the structure. The sample time interval for the samples was four hours, which was regulated by a laboratory-provided flow regulator attached to each Summa Canister. At the completion of sampling, each sample was labeled and returned to the project laboratory under proper chain-of-custody procedures.

3.0 ENVIRONMENTAL SETTING

This section summarizes the environmental setting of the Facility and regional area. The characterization of the physical environments in and around the Facility is important to the RFI process to assist in the evaluation of the nature, extent and migration of contamination, and the evaluation of unacceptable risks to human health and the environment. The primary objectives of this section are to:

- Summarize the regional hydrogeological characteristics in the vicinity of the Facility including the regional physical setting and geological history, the identification and usage of regional aquifers, and a characterization of near surface soils and climatic conditions.
- Characterize the geologic units beneath the Facility, and a presentation of a conceptual Site Hydrogeological Model (SHM) for the area.
- Characterize the properties of the ground water system beneath the Facility including ground water flow direction and rates, temporal fluctuations in ground water levels, and interconnection between saturated zones and units.
- Identify the demographics (populations and sensitive subpopulations) of the area surrounding the Facility including information regarding land use and potential receptor identification.

Information and data used to prepare the conceptual SHM were derived from the CCR, deep sonic drilling that occurred during the Phase I RFI, and the comprehensive array of ground water monitoring wells distributed across the Facility and vicinity (Table 11). Within the conceptual SHM, the Cedarville Aquifer and the deeper Brassfield Aquifer have the most capability of transporting hazardous waste or hazardous constituents that have been released at or from the Facility. Potential vertical migration pathways from the Cedarville Aquifer to the Brassfield Aquifer are restricted by the regional occurrence of the Osgood and Brassfield Aquitards.

The discussion below begins with an overview of the regional environmental setting, and then focuses on the properties of the geologic units within the conceptual SHM. After the conceptual SHM is discussed, other environmental setting aspects important for the RFI are presented (e.g. population distributions, and the utilization of land in close proximity to the Facility).

3.1 Regional Environmental Setting

This section describes the regional environmental setting of the area surrounding the Facility. It begins with a review of the physiographic characteristics of the area and then reviews the geological processes responsible for the sequence of unconsolidated and consolidated deposits beneath the region. Finally, the meteorological characteristics of the area are defined. Information for this section was primarily derived from the CCR, as well as published documents, maps and information.

3.1.1 Topography

Regional topography was obtained from the 1968 (photorevised in 1975) United States Geologic Survey (USGS) *7.5 Minute Topographic Quadrangle Map for Yellow Springs, Ohio* (USGS 1975). The Yellow Springs area is located at an elevation that is generally more elevated than the land surrounding the Village. The elevation in and around the Facility is generally at or above 1,000 feet mean sea level (MSL). The Facility is geographically located in the central portion of the regional elevated topographic area shown on Figure 14. In general, the areas west and south of the Facility are slightly higher in elevation; the relief within this area is generally 30 to 40 feet. The typical relief in the gorge is 60 to 70 feet in elevation.

The topography of the Facility is relatively flat (Figure 15). The eastern two/thirds of the Facility occupied by Plant 2, Plant 3, parking areas, and limited grass areas ranges in topography from about 1,023 feet MSL to 1,028 feet MSL. The open grass area on the western portion of the Facility is somewhat mounded, ranging in elevation from approximately 1,028 feet MSL to 1,032 feet MSL. This represents the highest area of the Facility. The lowest area at the Facility is located at the northeastern corner of the property. The floor grade inside Plant 2 and Plant 3 is approximately four feet above the outside ground surface.

3.1.2 Surface Water Drainage

The vicinity of the Facility is drained by the Yellow Springs Creek to the east, the Little Miami River to the south, the Jacoby Branch Creek to the west, and the Clear Creek to the north (Figure 14). The presence of these streams create topographic relief at these areas, with the most pronounced being the Yellow Springs gorge created by the Yellow Springs Creek located approximately one mile east of the Facility at the Glen Helen Nature Preserve.

Surface water drainage at the Facility flows to several on-property storm sewer drains and lines, which are connected to a 54-inch Village of Yellow Springs storm sewer located below Dayton Street (Figure 2). The connection to the 54-inch Village of Yellow Springs storm sewer is located near the northeast corner of the Facility. No surface bodies of water are located on the Facility.

The Village of Yellow Springs storm sewer located beneath Dayton Street discharges into a small unnamed creek on the north side of Dayton Street approximately 0.3 miles east of the Facility (Figure 14). The unnamed creek travels approximately one mile to the north-northeast where it discharges to the Yellow Spring Creek near the intersection of Yellow Springs Creek and Polecat Road. Yellow Springs Creek is a tributary of the Little Miami River located approximately 2.5 miles south of the Property. The Little Miami River is the regional discharge point for surface water in the vicinity of Yellow Springs.

3.1.3 Geomorphology

The majority of Greene County, including the Facility, is located in the Southern Ohio Loamy Till Plains physiographic region of Ohio (Brockman, 1998). Most of the topography and unconsolidated sediments of this area are the result of one or more of the four continental glaciers during the Pleistocene Epoch. All glacial drift exposed at the surface in Greene County was deposited by the advances and retreats of the latest ice sheet during the Wisconsinan stage 14,000 to 24,000 years ago (Norris, 1956). The farthest advance of the Wisconsin ice sheet was to within a few miles of Cincinnati, Ohio.

The primary type of glacial deposit in the vicinity of the Facility consists of till that was deposited directly by the glacier (ODNR, 1999). Glacial till typically contains a heterogeneous mixture of unstratified materials in which the individual grain size can range from clay to boulders. Soil borings drilled at and in the vicinity of the Facility indicates that the thickness of the till deposits range from approximately 14 to 22 feet.

Approximately 1.5 miles north of the Facility, another type of glacial deposit known as outwash is present (Figure 12). In this area, outwash has been deposited in unconsolidated stratified layers by meltwater from the ice sheet, forming a group of hummocks or high valley-side terraces known as kames. Kame deposits typically contain sand and gravel sized particles that are poorly sorted and bedded. There are no kame deposits located beneath the Facility or in the immediate surrounding area.

A second type of outwash deposit, known as a buried valley, is located approximately 2.5 miles south of the Facility (Figure 12 and 13). When a glacier ends in a region that slopes away from the ice, the sediment-laden meltwaters are transported down the nearest valley. The resulting thick and elongated bodies of outwash sand and gravel are called buried valleys or valley train deposits. The northern (up valley) extent of this buried valley begins near the intersection of the Yellow Springs Creek and Grinnell Road two miles southeast of the Facility (Figure 13). The buried valley roughly follows the course of the Little Miami River in Greene County. The Yellow Springs well field is located within this buried valley. The buried valley at the well field is approximately 150 feet thick at its deepest point (Panterra, 1998) as presented on Sheet 2. The buried valley deposits consist of an upper and lower sand and gravel zone that is separated by a laterally-variable, fine-grained till layer.

3.1.4 Soils and Clay Till Unit

In the vicinity of the Facility, the soils generally consist of silt and clay loams to a depth of 5 to 10 feet below ground surface and are poorly drained with low permeability. The loams are exposure surfaces that have formed on a thin sequence of silty clay glacial till deposits that overlie Silurian dolomite bedrock consisting of the Cedarville Dolomite. The unconsolidated clay till is a poor source of ground water because it has a very low permeability. Wells screened in the clay till rarely yield more than three gallons per minute (gpm) according to Schmidt (ODNR 1991). Water bearing zones in the clay till are generally restricted to thin discontinuous silt or sand seams.

3.1.5 Bedrock Units

Southwestern Ohio is characterized by nearly flat-lying Silurian-age and Ordovician-age bedrock that is overlain by Quaternary glacial and fluvioglacial deposits. The Silurian-age bedrock consists of carbonate rocks (limestone and dolomite), and shale. The Ordovician-age bedrock consists of interbedded limestone and shale. These rock units were deposited as marine sediments a little over 400 million years ago during a time when this portion of Ohio was located in tropical latitudes south of the Equator.

The stratigraphy of the bedrock units in the area have been described by various researchers in the past, and the nomenclature has evolved through time. The nomenclature of Horvath and Sparling (1967) is used herein, as this represents the more commonly followed scheme used by local and state geologists. A bedrock geology map of the area is presented on Sheet 2. A detailed stratigraphic column and hydrogeologic classifications of the SHM are presented on Figure 11.

Starting at the base, the oldest rock units comprising the conceptual SHM beneath the area of the Facility are late Ordovician shale and limestone known as the Elkhorn Formation of the Richmond Group, Cincinnatian Series. The lithologic contrast between the Elkhorn Formation and the overlying Brassfield Formation suggest the presence of a regional unconformity between the Ordovician and Silurian systems. Provided on Sheet 2 is summary of the thickness of the Silurian bedrock units in the area (Panterra, 1998).

The oldest rocks of the Silurian system in the area consist of the Brassfield Formation (19 to 44 feet thick), and its basal member, the Belfast Member (2 to 6 feet thick). A detailed study of the Brassfield Formation in the area of the Facility was conducted by Frost (1977). Frost identified five distinct lithologic zones (upper zone, middle zone, lower zone, sugar rock zone, and the Belfast member) of limestone and shale (Figure 11). A regional unconformity exists at the top of Brassfield Formation, distinguishing it from the overlying Dayton Formation.

The Dayton Formation consists of dolomite and is relatively thin (2 to 6 feet thick) in the Yellow Springs area. The Dayton Formation grades into interbedded shale and limestone known as the Osgood Shale (20 to 25 feet thick). Shale predominates over limestone in the middle and lower portions of the Osgood Shale; the upper portion is typically composed of equal portions of limestone and shale. The Osgood Shale is a relatively thick bedrock unit. The Osgood grades upward into the Laurel Limestone (4 to 6 feet thick), which is actually a dense dolomite. The Massie Shale (5 feet thick) overlies the Laurel Limestone, and is a dark-colored calcareous shale and relatively thin in the area.

The relatively thin Euphemia Dolomite (6 feet), a vuggy-weathering dolomite, and Springfield Dolomite (6 to 14 feet thick), a crystalline dolomite, are present above the Massie Shale. The uppermost bedrock unit consists of the massive Cedarville Dolomite. The Cedarville Dolomite represents the thickest (approximately 65 feet) Silurian bedrock unit in the area. The Cedarville Dolomite is the primary stratigraphic unit that is responsible for the massive, steep cliffs that are observed in the Yellow Springs gorge located one mile east of the Facility.

3.1.6 Structural Geology

Collision between the North American and European continents during the Middle Ordovician formed a series of island arcs and mountains to the east of Ohio (Baranoski, 2002). This event, the Taconic Orogeny, which culminated in the Late Ordovician, is recorded in rocks stretching from Newfoundland to Alabama. The Cincinnati Arch, a north-south-oriented, positive structural feature in southwest Ohio and adjacent areas to the south, began to form sometime after the Late Ordovician. Detailed stratigraphic and paleontologic work by Kolata et al. (2001) indicates the Cincinnati Arch did not have a significant presence during Middle and Late Ordovician time (Baranoski, 2002). The axis of the arch is east of Cincinnati and continues northward until it splits into the Findlay Arch to the North and the Kankakee Arch to the west. The broad area formed by the three arches is called the Indiana-Ohio Platform.

Normal faults have been mapped in the vicinity of the Cincinnati Arch in Tennessee and Kentucky, but no major faults have been documented in southwestern Ohio (Waren, 1988). Studies in southwestern Ohio have been conducted regarding the presence of fractures in the Paleozoic limestones and dolomites. Waren (1988) notes that the fracture orientations of the Silurian formations in southwestern Ohio are geometrically related to the development of the Cincinnati Arch. Waren (1988) and Porges (1998) also indicate that the Cedarville, Springfield, and Brassfield formations exhibit a strong northeasterly fracture trend in southwestern Ohio.

3.1.7 Bedrock Topography

According to the “Bedrock Topography of the Yellow Springs, Ohio Quadrangle” map (ODNR, 2000), the two most prominent features of the bedrock surface in the area appear as topographic highs (Figure 17), located beneath the Village of Yellow Springs (eastern bedrock high) and to the west in the vicinity of the intersection of West Enon and Dayton-Yellow Springs Roads (western bedrock high). These two areas of regional high bedrock elevation are divided by the north-south trending Jacoby Branch Creek and the Clear Creek.

The Facility is located above the eastern bedrock topographic high. Based on work performed by Frost (1977), the Facility is located on the east-northeastern flank of this bedrock high. Above the eastern bedrock high, the first bedrock formation encountered beneath the unconsolidated clay till deposits is the Cedarville Formation.

The general trend of bedrock topography beneath the Facility is to the northeast. The bedrock topographic elevation beneath the Facility rises from approximately 1,000 feet MSL at the northeast corner of the property, to approximately 1,016 feet MSL at the southwest portion of the property (Figure 18). This trend corresponds with the regional bedrock topography work conducted by Frost (1977).

3.1.8 Hydrogeologic Setting

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 containing 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 13). Municipal water and private water use are described in Sections 3.6.

The second type of unconsolidated deposit found in Greene County, and beneath the Facility, is glacial clay till. Where present, the clay till typically contains a heterogeneous mixture of unstratified materials that range in size from clay to boulders. The vertical hydraulic conductivity of the clay till is predominantly very low (around 1×10^{-7} cm/s). Discontinuous silty sand seams may be present within clay 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. Useable ground water is present in the Cedarville, Springfield and Euphemia Formations (Cedarville Aquifer) and within the Sugar Rock member of the Brassfield Formation (Brassfield Aquifer). Ground water within these two aquifers moves laterally through horizontal bedding planes and vertical (or near vertical) joint sets. Ground water yields from these two aquifers are relatively low (5 to 15 gpm) in the vicinity of the Facility.

Most properties in the Village of Yellow Springs are connected to the municipal water supply. A few properties (less than ten) in the vicinity of the Facility have private water wells screened within the upper or middle portions of the Cedarville Aquifer, and use the Cedarville Aquifer ground water for potable and/or non-potable purposes. Some of the private wells are not currently being used for any purpose. A water well survey was conducted in late 2003/early 2004 in the vicinity of the Facility to identify wells that are being used, or could be used. Within the survey area, water wells were not identified in the lower aquifer (Brassfield Aquifer). Section 3.6 presents a summary of the water well survey. The Village of Yellow Springs does not derive its public water supply from the Cedarville or Brassfield Aquifers, as indicated above. Neither of the bedrock aquifers outcrop into the buried valley aquifer, which is used by the Village of Yellow Springs (Sheet 2). Both aquifers outcrop at the Yellow Springs gorge located approximately two miles east of the Facility.

3.1.9 Climate

The regional climate in the vicinity of the Facility is defined as moist continental (Strahler, 1987), characterized by well-defined winter and summer seasons that are accompanied by large annual temperature variations. This climatic type affects the mid-eastern United States which is located within the polar front zone where polar and tropical air masses generally meet. Precipitation occurs throughout the year and is usually increased in the summer months due to the invading air masses from the Gulf of Mexico. Hot summers and mild to cold winters are characteristic of this type of climate.

The mean annual temperature in the area of the Facility ranges from 49° Fahrenheit (F) to 55° F; the mean monthly temperature ranges from 68° to 77° F in the summer and from 26° o to 33° F during the winter (USGS 2000). Precipitation for the region ranges from less then 36 to more than 42 inches per year; annual snowfall ranges from 11 to 30 inches. Wind direction is prevailing from the southwest. A wind rose diagram for the wind speed and wind direction for the region is presented in Figure 10.

3.2 Site Hydrogeologic Model

A conceptual SHM was developed and presents the current understanding of the hydrogeologic system beneath the Facility and the surrounding area. The purpose of the SHM is to identify features that affect the ability of each geologic unit to transmit ground water, ground water quality, and contaminant migration and transport. It is an assimilation of general regional information presented in Section 3.1, and Facility-specific geological data into a description of where contaminants are expected to move in the subsurface. The conceptual SHM is not a mathematical or computer model, although computer modeling of ground water flow was used in confirming certain aspects of the SHM, as discussed below.

The conceptual SHM provides: 1) a description of the physical parameters needed to determine the nature and extent of soil and ground water contamination addressed in Section 5 of this report; 2) an identification of the potential contaminant migration pathways that need to be assessed from a human health risk perspective; and, 3) the geologic and hydrogeologic data needed to support the evaluation of remedial alternatives during the corrective measures evaluation.

3.2.1 Development of the Site Hydrogeologic Model

The conceptual SHM described below was developed using the available published literature, site-specific geological boring and geophysical data obtained during Vernay's voluntary investigation and the RFI, and ground water modeling. A preliminary SHM was presented in the CCR and was updated in *Technical Memorandum (TM) No. 3 Ground Water Monitoring* (Payne Firm, 2003c). The information presented in the CCR and TM-3, along with information acquired during Phase I of the RFI, is used to summarize the characteristics and properties of the hydrogeologic units within the SHM. A number of cross sections depicting the subsurface beneath the Facility were presented in Appendix XI of the CCR. Additional cross-sections were presented in Appendix II of TM-3 from additional data collected during the RFI through December 2003. Additional refined cross sections (A-G) from additional data collected during the RFI through March 2004 are included in Appendix IV of this RFI Phase I report, and assisted with the development of the SHM.

As presented on Figure 11, the conceptual SHM consists of the following six hydrogeologic units:

(1) Unconsolidated Unit (vadose zone)
(2) Cedarville Aquifer (uppermost aquifer)
(3) Osgood Aquitard
(4) Brassfield Aquitard
(5) Brassfield Aquifer (lowermost aquifer)
(6) Elkhorn Aquiclude.

The six hydrogeologic units that define the SHM are consistent with other work that researchers have completed in the Yellow Springs area (e.g. Frost, 1977; Shrake, 1994; Townsend, 2002). To date, Vernay has collected site-specific data from the Facility to characterize the first three units in the SHM. Data from the remaining units has been evaluated during a recent hydrogeologic characterization at the YSI Facility, less than one mile south of Vernay (BHE, 2004b). Based on determinations made by the U.S. EPA, other units may be characterized during the RFI to satisfy the project DQOs and the requirements of the Corrective Action Order. Data collected during past investigations, the RFI, and previous research (Table 11) have contributed to the current version of the SHM presented on Figure 11 and described in the following subsections.

3.2.2 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 Figure 12; (ODNR, 1999). The Unconsolidated Unit is also referred to as the vadose zone.

The Unconsolidated Unit consists of a very firm, slightly moist silt and clay deposit according to borehole logs drilled on and off of the Facility (Appendix VIII-C), and laboratory grain size analyses (Table12). The unit contains isolated and laterally discontinuous poorly to well sorted sand lenses within the clay matrix that are at or near the bedrock surface, and sand seams in the upper and middle portions of the unit. The discontinuous sand seams vary in thickness (six inches to four feet) and vary in moisture content (dry to saturated). According to geological property laboratory results from samples collected from the Unconsolidated Unit (Figure 24; Table 12), 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; and, for samples collected from isolated discontinuous sand seams the results are 18%, 52%, and 6.5×10^{-5} cm/s, respectively. As shown on the cross sections in the CCR and TM-3, the discontinuous sand seams are not encountered in boreholes until depths of approximately 10 feet below grade.

The thickness of the Unconsolidated Unit ranges from approximately 11 to 26 feet. An isopach (thickness) map of the Unconsolidated Unit thickness that was prepared from soil boring log information is presented on Figure 16. As depicted on 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 north-south trending linear area beneath the properties just east of the Facility. As described in the Section 3.1.6, 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 all the cross sections A through G (Appendix IV).

Hydrogeology

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 surface of the zone of saturation, which in the top of the Cedarville Aquifer (i.e. uppermost aquifer). 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.

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 15.

Most of the isolated and discontinuous sand seams that were encountered 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 non-equivalent 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, TM-3). 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 water level difference was measured between a saturated sand seam within the Unconsolidated Unit and the Cedarville Aquifer potentiometric surface at the same area.

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

Some isolated and discontinuous sand lenses were also encountered at or near the surface of the underlying bedrock unit (Cedarville Dolomite). These sand lenses were typically saturated and are 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, TM-3). In the example below, less than 0.2 feet of water level difference was measured between the saturated sand lens near the bedrock surface and the potentiometric surface in the underlying Cedarville Dolomite at the same area.

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

The same observations have been made during the YSI Facility investigation where the bedrock aquifer is in communication with the base of the unconsolidated unit at several nested well pairs (BHE, 2004b).

3.2.3 Cedarville Aquifer

Beneath the Unconsolidated Unit, two consolidated bedrock aquifers, the Cedarville Aquifer and the deeper Brassfield Aquifer, are present beneath the Facility and the surrounding area. The horizontal limits of the two aquifers regionally are presented on Sheet 2; neither aquifer outcrops into the buried valley aquifer where the Village of Yellow Springs well field is located. The aquifers are separated by two aquitards (Osgood and Brassfield aquitards). An aquifer is a geologic unit or formation that is saturated, and sufficiently permeable to transmit economic quantities of water to wells and springs (Fetter, 1994). An aquitard is a low-permeability unit or formation that can store ground water, but transmits it slowly from one aquifer to another (Fetter, 1994).

As described in Section 3.1.8, both aquifers are used by some private well users for potable and non-potable purposes. During the RFI, boring log information was obtained from BHE Environmental, Inc. (BHE) who is conducting an environmental investigation for YSI, Inc., located less than one mile southeast of the Facility. BHE has drilled several borings into the aquifers and aquitards to depths up to 120 feet. The information was used to refine the regional cross-sections presented in the CCR; the refined cross-sections (A-G) are shown in Appendix IV.

The Cedarville Aquifer consists of Silurian-aged carbonate bedrock (dolomite and some shale). The isolated and discontinuous sand lenses that occur on the top of the bedrock unit are very likely to be in hydraulic communication with the Cedarville Aquifer, based on the water elevations presented in Section 3.2.2 above. As a result, the lenses are a component of the Cedarville Aquifer within the conceptual SHM.

The Cedarville Aquifer is approximately 74 to 89 feet in thickness beneath the Facility and vicinity. As shown on Figure 11, 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 VIII-C), the bottom elevation of the Cedarville Aquifer has been identified at 11 locations (MW01-02SE, MW01-04SE, CW01-02, MW02-03SE, MW02-06CD, MW02-08SE, MW02-11SE, MW02-14CD, MW02-15CD, MW02-16CD, and MW02-18CD). From the boreholes listed above, the average thicknesses of the three geologic formations are 66 feet, 7 feet, and 7.5 feet, respectively, for an average Cedarville Aquifer thickness of 80.5 feet (Table 11 and Figure 19).

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, which underlies the Cedarville Aquifer. As shown on Sheet 2, these units extend to the Yellow Springs gorge to the east where they outcrop. To the south-southeast towards the Yellow Springs well field, these units outcrop into the overlying Unconsolidated Unit before they reach the well field. As a result, there is a very low probability that the Cedarville Aquifer is in hydraulic communication with the Little Miami River buried valley aquifer system, which is used by the Village of Yellow Springs as a potable water supply.

At the Facility and vicinity, the depth to the top of the of the Cedarville Dolomite ranges from 11 to 26 feet below the surface (Table 11). As shown on Figure 17, contours of the regional bedrock topography indicate the Facility is located near the bedrock high for the region (ODNR, 2000). Contour intervals of site-specific bedrock topography data of the Cedarville, Springfield, and Euphemia formations are shown on Figures 18, 20, and 21. In general, contouring of the bedrock surface (Cedarville Formation) indicates: (1) there is a general decrease in elevation to the northeast beneath the Facility; (2) topographic lows and highs exist beneath Plant 3; (3) an erosional surface (topographic low) with over three feet of relief 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).

Beneath the Cedarville Formation, contouring of the bedrock surfaces of the Springfield and Euphemia Formations indicates: (1) there is a general decrease in elevation to the northeast beneath the Facility; (2) a north-south trending topographic low exists directly east of the Facility and (3) the localized dip of the bedrock surfaces is approximately one foot in elevation per 70 feet in distance to the northeast, which is consistent with the reported dip for the region (Evers, 1991).

Hydrogeology

As presented in detail in the CCR, geological property analyses were performed on six bedrock core samples collected from the Cedarville Aquifer to gain a general understanding of the hydraulic characteristics of the aquifer (Figure 24). Four samples were collected from the Cedarville Formation and one sample was collected from the Springfield and Euphemia formations, respectively. The geological property results are presented on Table 12.

In general, the Cedarville and Euphemia formations exhibit a coarse grained texture with a vuggy porosity. Stylolites and clay partings are common. Iron-stained intervals were also commonly observed throughout most of these formations. The Springfield Formation exhibited a mostly fine-grained texture with fewer vugs. Horizontal breaks in the retrieved core samples were common; a few near-vertical breaks were also observed.

The drilling of bedrock boring BSB-1 (now MW01-02SE) to a depth of 121 feet at the western upgradient portion of the Facility during Vernay's voluntary investigation aided in the characterization of the hydrogeology of Cedarville Aquifer and the upper portion of the Osgood Aquitard beneath the Facility (see Sheet 2), and assisted with the completion of the ground water flow model for the Cedarville Aquifer.

Borehole geophysical techniques (natural gamma, neutron porosity, caliper, high resolution density, spontaneous potential, single point resistance, acoustic televiewer, and down-hole video survey) were utilized in this deep boring to assist with the characterization (Marshall Miller & Associates, 1999). The results of the borehole geophysical survey indicated the following:

- No significant differences of the lithology were observed from the interpretation of the geophyscial logs compared to the Payne Firm geologist's log of the core recovered from borehole BSB-1 (now MW01-02SE).

- The high resolution density delineates the significant fracturing in the dolomite rock. The low density "spikes" are very good indicators of fractures or bedding planes occurring in the Cedarville Aquifer. In addition, the neutron porosity log, which is an indicator of relative porosity in the rock, indicates two zones of higher porosity in the Cedarville Aquifer: one at a depth of approximately 30 feet; and, the other at approximately 73 to 79 feet at the base of the Cedarville Formation (Sheet 2). These two zones correlate well with the observations made with the Acoustic Televiewer in the same borehole. This observation was interpreted in the CCR to be a vuggy porosity present in these zones as opposed to secondary fracture porosity.
- Resistivity curves also showed the relatively lower resistivity of the shale deposits of the Osgood Aquitard, and the higher resistivity of the Cedarville Aquifer units.
- Fractures and bedding plane location and orientation are two of the most common uses of the acoustic televiewer (ATV) geophysical technology. As depicted on Sheet 2, the section of borehole BSB-1 below 96 feet BGS is predominantly shale (Osgood Aquitard) with some dolomitic beds and exhibited very few fractures or other anomalies on the ATV. The dolomitic zones above the Osgood Aquitard, in the units of the Cedarville Aquifer, however, have several fractures, bedding contacts, and porosity zones.
- A rose diagram was produced from an identification of fracture dip directions in the Cedarville Aquifer units over the interval from 44 feet to 94 feet and presented on Sheet 2. The diagram indicates that the primary fracture strike direction of all noted fractures greater than a 10 degree dip is to the northeast/southwest. This closely correlates with data obtained by other workers in the Yellow Springs area (e.g. Porges, 1998; as shown on Sheet 2).

Because of the lack of ground water in the Unconsolidated Unit, most of the known private water wells in the vicinity of the Facility are drilled into the upper and middle portion of the Cedarville Aquifer. Vernay has also installed a total of 60 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 7 to 10 gpm. Portions of the 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). The site-specific data from geophysical logging and core inspection discussed above support these findings indicating these 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 Unconsolidated Unit. 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 is more than likely confined or semi-confined 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 a confined aquifer beneath the Facility and vicinity (Table 3-3, TM-3). In the examples below, over eight to twelve feet of potential 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.

Based on ground water elevations measured on September 10, 1999 before the pumping began for the ground water capture interim measure, ground water flow in the Cedarville Aquifer at the Facility was towards the east-northeast at an estimated gradient of 0.005 ft/ft (Payne Firm, 2002). As discussed in the Ground Water Flow Model (Section 3.4), the calibrated hydraulic conductivities of the Cedarville Aquifer tend to fall between 60 to 5500 feet per year and ranges from 1 to 15 feet per day. Therefore, the ground water flow velocity ranges from approximately 5 to 75 feet per year (ft\yr) (if an effective porosity of 25 percent is assumed). The higher hydraulic conductivities are generally between 1000 and 5500 ft/yr, and form a band that trends from the southwest of the Facility to the northeast towards Dayton Street. This zone of increased hydraulic conductivity is not only consistent with the northeast trending hydraulic gradients, but it is also aligned with the general shape of the VOC plumes (Section 5.0). Lithologic logs (Appendix VIII-C) 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 (Appendix VIII-B and Table 3-3, TM-3). 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. Based on the Ground Water Flow Model (Section 3.4) an areal recharge rate of seven inches per year is expected for the Cedarville Aquifer.

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)

3.2.4 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 11. 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 11, 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 to 6 feet thick). The Massie Shale overlies the Laurel Limestone, and is a dark-colored, argillaceous shale and relatively thin in the area (approximately 6 feet thick). Site-specific borehole data has encountered the Massie Shale at 11 locations in the vicinity of the Facility (Table 11). When the Laurel Limestone was also encountered, the average thickness of the Massie Shale was determined to be 6.2 feet. The top of the Laurel Limestone has been encountered at five locations 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 was terminated after drilling 20 feet into the shale. As discussed above and in the CCR, 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; 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 86 to 109 feet (Table 11). Using site-specific data, 2.5 foot contour intervals of the top of the Massie Shale are shown on Figure 22. In general, the contouring of the top of the Massie Shale indicates: (1) there is a general decrease in elevation to the northeast beneath the Facility; (2) a north-south trending topographic low exists directly east of the Facility; and, (3) 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). The geometry of the bedrock surface of the Massie Shale is propagated through to the overlying units of the Cedarville Aquifer discussed in Section 3.2.3, indicating the Massie Shale controlled areal distribution for the sedimentation of the Cedarville Aquifer bedrock units.

3.2.5 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 11) according to Frost (1977) and Townsend (2002). 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 11). 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 at the Vernay Facility does not exist for the Brassfield Aquitard, although data are available from the YSI Facility less than one mile to the southeast. Six boreholes were installed through the Brassfield Aquitard and into the underlying Brassfield Aquifer (BHE, 2004). Site-specific data from these boreholes indicates the presence of up to 100 feet of non-porous carbonate rocks, shales and other mixed lithologies between the upper and lower aquifers. According to the observations made during the description of these units, the upper and middle portions of the Brassfield Formation, in series with the shale/carbonate aquitard, would be expected to further inhibit the vertical migration of ground water into the lower Brassfield Aquifer (BHE, 2004b).

3.2.6 Brassfield Aquifer

The Brassfield Aquifer, the lowermost aquifer beneath the Facility and vicinity, is situated beneath the Brassfield Aquitard (Figure 11). The Osgood Aquitard and the Brassfield Aquitard (consisting of approximately 65 to 100 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). At the YSI Facility less than one mile from the Vernay Facility, this unit is approximately ten feet thick (BHE, 2004a). 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).

Hydrogeology

The flow of ground water in the Brassfield Aquifer is controlled by the vugular porosity of the sugar rock, and joints and/or 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).

Site-specific data at the Vernay Facility does not exist for the Brassfield Aquifer, although information is available from the YSI Facility (BHE, 2004a). Based on six monitoring wells installed into the Brassfield Aquifer, the general flow direction is to the southeast of the YSI Facility, consistent with the bedrock topography of the area. In addition to the Brassfield Aquifer monitoring wells, YSI has installed eight monitoring wells into the Cedarville Aquifer. According to the investigation at the YSI Facility, the lower carbonate aquifer (or Sugar Rock zone) appears to be a confined aquifer with the potentiometric surface above the aquifer surface (BHE, 2004), with water levels significantly below those in the upper Cedarville Aquifer. A map of this potentiometric surface exhibits a nearly flat to slightly easterly direction of ground water flow in the Brassfield Aquifer. Approximately 70 to 100 feet of potential head difference has been measured in monitoring wells installed in the Cedarville Aquifer above and the Brassfield Aquifer below. This separation in potential head elevation indicates that it is unlikely that these two aquifers are hydraulically connected in the Yellow Springs area, which is consistent with the observations of Norris (1956) where he indicated pumping from one aquifer does not immediately affect the other. Based on data from six monitoring wells completed in the Brassfield Aquifer at YSI, it does not appear that contaminants are migrating vertically from the Cedarville Aquifer (BHE, 2004).

3.2.7 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 11). 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 the conceptual SHM. At the YSI Facility, over 20 feet of impermeable lower Brassfield limestone, shaley limestone/dolomite of the Belfast Transition zone, and massive Ordovician-age shales has been observed (BHE, 2004b). Site-specific data for the Elkhorn Aquiclude does not exist beneath the Facility or vicinity.

3.3 Ground Water Elevation

Ground water elevations are measured from the Cedarville Aquifer on a monthly basis (Appendix VIII-B). 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 VII). Appendix I presents hydrographs of the potentiometric surface for each monitoring well since the time of installation. A figure depicting the potentiometric surface for the Cedarville Aquifer for each month from January 2003 through June 2004 is presented in Appendix II. Based on the potentiometric surface at and in the vicinity of the Facility, the following observations can be made:

- The potentiometric surface for the Cedarville Aquifer is highest near the western portion of the Facility. This area is also located near the surface topographic and bedrock topographic highs 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 interim measure extraction wells located along the eastern property boundary. The potentiometric surface in the Cedarville Aquifer at these areas slopes 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 influenced by the ground water capture systems, 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 (Appendix I) indicating there is little affect of upward and downward hydraulic gradients in these portions of the Cedarville Aquifer.
- 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 for the Cedarville Aquifer are presented in Appendix I. The hydrographs were constructed from the monthly water level measurements that were obtained from November 1998 through June 2004. The following observations are made about the monitoring well 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, indicating some hydraulic communication between the overlying Unconsolidated Unit and the Cedarville Aquifer.
- As discussed above, 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 from well clusters in Appendix I 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)

3.4 Ground Water Flow Model

During the Phase I RFI, a ground water flow model was developed to assist in characterizing the hydrogeology and contaminant migration pathways beneath the Facility and the surrounding area. A ground water flow model is a mathematical computer model that simulates ground water flow in the subsurface. The ground water flow model assisted in the prediction of the movement of ground water in the subsurface, and will also be used as a component in the prediction of the fate and transport of contamination in the ground water during Phase II of the RFI. A detailed description of the ground water flow model, including the modeling objectives, computer code selection, model construction, model calibration, and particle tracking analysis is presented in a separate report in Appendix VII.

A properly calibrated numerical model that simulates ground water flow provides investigators a means to predict the system behavior to natural and manmade stresses placed upon the system. Hydrologic analysis is being conducted using MODFLOW, PEST and MODPATH software programs. The use of PEST has allowed the model to be well calibrated, and subsequent results of capture zone analysis indicate that the two extraction wells are effectively capturing contaminated water emanating from the Vernay Facility.

The modeling objectives are to understand the ground water flow field in the vicinity of the Vernay Facility and to determine the effectiveness of the two capture wells on controlling the continued migration of contamination off the Facility. These objectives were achieved using the following model simulations:

1. A three-dimensional ground water model that generates a flow field (array of head values) representing average conditions in the Vernay area.

2. A ‘particle tracking analysis’ that evaluates how the average flow field, along with other transport parameters, is affected by the pumping at the extraction wells.

Steps completed in creating the numerical model included the following:

- Adopting a conceptual model to guide the creation of model.
- Choosing appropriate computer code(s) for the analysis.
- Establishing the time period represented by the model and the duration of subdivisions of this period (time steps) required for modeling.

- Selecting a suitable model domain, including determining the dimensional (horizontal and vertical) limits of the analysis.
- Establishing the model structure, including determining the number of model layers and the grid spacing requirements.
- Incorporating hydraulic boundaries and features, including determining the shape and characteristics of constant-head boundaries, rivers, precipitation (or other) recharge sources, and pumping wells.
- Assigning hydraulic parameters consisting of hydraulic conductivity, total porosity, effective porosity, storativity, and initial head (ground water surface elevation) values.
- Selecting hydraulic calibration targets.
- Evaluating and assigning appropriate model computational characteristics, for example, solution method, iteration limits and convergence criteria, to enhance model stability, computational efficiency, and solution accuracy.
- Running the model and adjusting assigned model parameters within predetermined limits to achieve the closest fit between model results and calibration targets.

The results of the ground water flow modeling indicate that the model is well calibrated with actual ground water data that are collected during the Phase I RFI.

Capture Zone Evaluation

During the Phase I RFI, the ground water flow model was used to assist in the capture zone evaluation of the existing ground water interim measure at the Facility. The capture zone evaluation was presented in TM-3 (Payne Firm, 2003c). 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 Corrective Action Order. The results of the capture zone analysis indicated that one additional ground water extraction well was needed near the northeast corner of the Facility.

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) control the migration of contaminated ground water off the Facility in the Cedarville Aquifer as indicated. A summary of the methodology that was used to conduct the capture zone analysis is presented in Appendix IX of TM-3 (Payne Firm, 2003c).

3.5 Potential Contaminant Migration Routes

The purpose of this section is to review the potential migration routes within the conceptual SHM. This review will assist with the discussions of the nature and extent of contamination presented in Section 5.0, and with the future evaluation of the fate and transport of contaminants to be conducted during the

Phase II RFI. The data and information presented in the Environmental Setting sections above indicate that:

- Horizontal contaminant migration within the conceptual SHM has the potential to occur in: 1) man-made conduits within sewer backfill in the Unconsolidated Unit; 2) isolated and discontinuous sand seams located within the Unconsolidated Unit; and, 3) bedding planes and vugular porosity in the Cedarville Aquifer. Horizontal contaminant migration is inhibited by the silty clay matrix of the Unconsolidated Unit. The horizontal migration of contaminants in the Cedarville Aquifer is influenced by the two ground water capture wells located along the eastern property boundary of the Facility.

- Vertical contaminant migration within the conceptual SHM has the potential to occur within the Unconsolidated Unit, and within vertical or near vertical joints in the aquifers and aquitards within the SHM. Vertical contaminated migration is inhibited by the: 1) low permeability silt and clay rich nature of the Unconsolidated Unit; and, 2) the 70-100 feet of fine grained low-permeability consolidated bedrock that comprise the Osgood and Brassfield aquitards.

The Phase I RFI focused on determining the nature and extent of contamination in the Unconsolidated Unit and the Cedarville Aquifer. As a result, potential contaminant migration routes in these portions of the conceptual SHM are described in more detail below.

3.5.1 Unconsolidated Unit

Contaminant migration is occurring in the Unconsolidated Unit soil. Possible factors that can affect rate of contaminant transport and the distribution of chemicals includes the presence or absence of asphalt, concrete, or building foundations (which affect water infiltration rates and occurrences), the presence of preferential flow paths (e.g. micro-fractures in soil, discontinuous sand seams, below ground structures, etc.), vertical hydraulic conductivity of the soil, the presence or absence of dense non-aqueous phase liquids (DNAPLs), and the amount of moisture and total organic carbon within the soil. Contaminant transport within the unit is predominantly vertical towards the underlying Cedarville Aquifer or into permeable subsurface backfill materials beneath sewer lines where horizontal migration can occur along the base of the sewer construction (Figure 9), and into discontinuous sand seams located within the Unconsolidated Unit. In addition, there is the potential for VOC vapors that exhibit the highest levels of VOC contamination to migrate from soil beneath the Facility to the surface, or into belowground and aboveground structures.

3.5.2 Cedarville Aquifer

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 CW01-01 shows 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.

Based on the hydrogeologic parameters of the Cedarville Aquifer, contaminant migration in the Cedarville Aquifer is influenced by the regional direction of ground water flow, the existing ground water capture interim measure located along the eastern property boundary, vertical and horizontal hydraulic gradients, the permeability of the rock matrix, and by joints and fractures in the bedrock. Concentrations of VOCs, such as PCE and TCE, are also affected by dilution, attenuation, dispersion, and degradation, which tend to dissipate concentrations over time.

Ground water in the Cedarville Aquifer primarily migrates horizontally to the east-northeast based on ground water elevation measurements in different depths of the aquifer and zones of higher hydraulic conductivities. However, ground water may also migrate vertically based on the presence of local fracture patterns in the form of vertical or near-vertical joints.

Contaminants detected in the Cedarville Aquifer have the potential to migrate to lower geologic units within the conceptual SHM (e.g. the Osgood Aquitard, Brassfield Aquitard, or the Brassfield Aquifer). However, this potential is very limited due to the regional presence, thickness, and geologic properties of the aquitard systems present between the two aquifers. Contaminant concentrations in the Cedarville Aquifer decrease significantly with depth, as evident by the sharply decreasing contaminant gradient in the center of the contaminant plume at the southeast corner of the Facility (MW01-04 well cluster), indicating that it is unlikely that contamination has migrated through the Osgood and Brassfield Aquitards and into the Brassfield Aquifer. This is discussed in more detail in Section 5.0.

Ground water flow in areas east-southeast of the Facility continues to flow in the same direction, where it discharges at springs at downgradient locations where the bedrock outcrops along the west side of the Yellow Springs gorge, or where the bedrock outcrops into overlying glacial deposits (Sheet 2). Ground water flow at the YSI Facility, less than 1 mile from the Vernay Facility is also to the south-southeast

(BHE, 2004b). The ground water modeling performed for this Phase I RFI report (Appendix VII) also confirms the southerly to southeastern flow direction following regional bedrock topography of the area.

As depicted on Sheet 2, the Cedarville Aquifer, Osgood Aquitard, Brassfield Aquitard, and the Brassfield Aquifer outcrop at the Yellow Springs gorge or into overlying glacial deposits south-southeast of the Facility. This significantly reduces the possibility that contaminants emanating from the Facility will impact the Village of Yellow Springs well field located approximately 2.5 miles southeast of the Facility.

3.6 Local Ground Water Use

This section describes the current and potential future uses of ground water in the vicinity of the Facility, in addition to a demographic profile of the people and land use. These data are needed to support an evaluation of potential receptors in the CA725 EI report, and in the baseline risk assessment during the Phase II RFI.

Since the 1960s, The Village of Yellow Springs has obtained its potable water from a well field located approximately 2.5 miles south of the Facility within the valley of the Little Miami River (Figure 13). A detailed description of the municipal water use in the Village was described in the CCR (Payne Firm, 2002).

Currently, no publicly available database identifying the current use of water wells within Yellow Springs exists. There are some available records from the Ohio Department of Natural Resources (ODNR) well logs, the Greene County Auditor property tax records; Yellow Springs water records; and an Ohio EPA 1999 site investigation report. Information from these sources was presented in the CCR, and indicated that there are some water wells located in the vicinity of the Facility.

As a result, a water well survey was conducted during the Phase I RFI for a defined area in Yellow Springs to confirm the informational sources listed above, and to compile a complete list of known well locations. The purpose of the water well survey was to: 1) support the completion of the CA725 EI report; 2) determine if any short-term interim measures where necessary to protect unacceptable risks at potentially affected well locations (such as installation of a water treatment system, abandonment of well, connection to the Village's water supply); and, 3) to support the baseline risk assessment.

The water well survey was conducted by the Payne Firm and the Greene County Combined Health Department (GCCHD) between December 2003 and March 2004. The objective of the water well survey was to identify water wells or other subsurface structures that may collect ground water used for potable and/or non-potable purposes within a designated well survey area located in the vicinity of the Facility. The water well survey methodology and results are presented in detail in a separate report presented in

Appendix VI. In general, the scope of the survey included a survey mailing process, followed by door-to-door interviews (which generated a response rate over 91 percent).

Results from the water well survey identified operational water wells located within the well survey area in the Cedarville Aquifer; water wells were not identified in the lower Brassfield Aquifer within the survey area. A total of 20 water wells and two monitoring wells (other than the Vernay monitoring wells) were identified; eleven water wells were reported by the property owner as not currently being used, and nine were reported as currently being used. Of the nine water wells currently being used, five were reported as being used for potable purposes (e.g. drinking, cooking, showering, bathing), and four were being used for non-potable purposes (specifically used for crop or lawn watering; other non-potable examples include car washing, swimming pool use, manufacturing/industrial use, and landscaping fountains).

In March 2004, all currently used water wells identified during the survey were sampled following the sampling methodology described in Section 2.3.5.3. A summary of the water well sampling results is presented in Appendix VI. The results indicated that the five water wells currently used for potable purposes did not have any detection of VOCs above U.S. EPA maximum contaminant levels (U.S. EPA MCLs) for drinking water. Concentrations of VOCs above MCLs were detected in two of the four water wells that were reported by property owners as being used for non-potable purposes. According to the CA725 EI report (Section 6.5), the concentrations of VOCs detected in the water wells used for non-potable purposes do not pose an unacceptable risk to human health (ENVIRON, 2004). Vernay presented the sampling results to the respective property owners and the GCHD in letters sent in May 2004.

3.7 Demography

Information on the demographics of the Village of Yellow Springs was obtained from the Village of Yellow Springs Comprehensive Plan (Village Plan, Village of Yellow Springs, 2002). The Village of Yellow Springs (Yellow Springs) covers an area of 1.79 square miles (755 acres) with a population of approximately 3,761 (2000 census data) and an average age of 41.1 years. The approximate number of families in Yellow Springs is 1,587, and the average persons per household are 2.11. Yellow Springs is predominantly residential and commercial along with small businesses focused towards supporting Antioch College, which is located approximately 1.5 miles southeast of the Facility. Vernay Laboratories, Antioch Publishing, YSI, Inc. (YSI), and Morris-Bean & Company (MBC) are the largest manufacturing companies in the Yellow Springs area.

3.7.1 Land Use

Information on the general land use of the area was obtained from the Village Plan (Village of Yellow Springs, 2002). According to the records of the Greene County Auditor for 2002, 608 acres within the Village are coded for residential development. Additionally, 36 acres are coded for industrial activities, 59 acres for retail uses, and 52 acres for agricultural activities. The dominant residential land use is single-family residences. The next highest use of land falls in the category of quasi-public, which includes Antioch College, churches and local government facilities. Parks and open areas are the next largest land use.

Within the general category of residential development, single-family housing occurs primarily in the south and north portions of the Village. Homes in the central portion of the Village are a mixture of one-family units, duplexes, and multi-family developments.

The area surrounding the Village is sparsely developed, mostly occupied by single-family residences and farms. Some significant residential development has occurred west of the Village. About 1000 acres of predominately farmland that adjoins almost the entire northern boundary of the Village will not be developed, since in 1999 the Village contributed to the purchase of an easement on this land that will perpetuate its use as a farm.

The anticipated future land in the Village is presented in the Village Plan on a figure entitled “Yellow Springs Future Land Use and Thoroughfare Plan, 2002.” According to this figure, the Facility and the property to the north (Antioch Publishing) is labeled as “light industrial”. The high school property to the west of the Facility is labeled as “educational/public institution”, and the properties to the east and south are labeled as “low to medium density residences,” thus reflecting little planned change to the current conditions.

3.8 Ecological Setting

At present, the Facility currently consists of paved parking lots and walkways, office and manufacturing buildings, and landscaped grounds. Landscaping includes grass lawns and perennial shrubbery. There is no surface water on the Facility property. There is no evidence of small and large mammal or avian forage or habitat.

Ground water from the Facility enters a subsurface roadside storm water pipe beneath Dayton Street. The storm sewer extends east and discharges into an unnamed creek. The unnamed creek flows intermittently through agricultural and residential lands. The unnamed creek discharges into Yellow Spring Creek, located approximately one-mile downstream from the storm water outfall (Figure 23). There is no other surface water in the area. At creek monitoring locations, the depth of the creek is less than approximately four inches and water flow is perceptable, but generally slow (approximately 1 foot per 10 seconds). The creek bed and banks contain some small gravel cobble and silty muds. Pioneer trees, fruiting vines, and short-stem leafy vegetation grows along both creek banks and generally reaches the water line.

There is some evidence of small and large mammal and avian forage and habitat along the unnamed stream, but no evidence of small and large mammal activity along the banks of the creek. A common species of frog inhabits the creek. Small fish (approximately 1 to 2 inches in length) are found only at the furthest creek monitoring location (Figure 31) where the depth of water in pools adjacent to a roadway is less than approximately 6 to 10 inches.

As part of the assessment of the ecological setting, Vernay submitted a written request to the ODNR Division of Natural Areas and Preserves for a Natural Heritage Data Search regarding endangered species information for an area within a one-mile radius from the Facility. The response from ODNR (2003) indicated that several potentially threatened or threatened species are located within one mile of the Facility listed on the table below.

Scientific Name	Common Name	Status
Verbesina helianthoides	Hairy Wingstem	Potentially Threatened
Asplenium ruta-muraria	Wall-Rue	Threatened
Arabis hirsuta var. adpressipilis	Southern Hairy Rock Cress	Threatened
Oryzopsis racemosa	Mountain Rice	Threatened
Carex retroflexa var. retroflexa	Reflexed Sedge	Threatened
Spiranthes ovalis	Lesser Ladies Tresses	Potentially Threatened

ODNR also indicated that there are no existing or proposed state nature preserves at the Facility, and that they are unaware of any unique ecological sites, geologic features, breeding or non-breeding animal concentrations, state parks, state forests, scenic rivers, or wildlife areas within the project area.

3.9 Conceptual Site Model

Based on the land use and ecological setting information presented above, a conceptual site model (CSM) for human and ecological exposures was prepared by ENVIRON, and is summarized on Tables 16 and 17. The objective of these CSMs is to identify actual or potential exposure pathways on and off of the Facility. The CSM for human exposures presented on Table 16 includes a description of receptor population, exposure route, exposure medium, whether the potential exposure is possible now or in the future, and general comments related to the receptor population.

Similarly, a CSM for ecological exposures is summarized on Table 17, and includes a description of exposure medium, potential ecological receptors, potential exposure routes, and whether the potential exposure is possible now or in the future, and general comments related to the receptor population. As noted above, while, sensitive, threatened, or endangered (ESA) species listed by both federal and Ohio EPA have been identified in the region; however, habitat conditions both on-site and off-site do not support critical habitats and do not appear to support any ESA species.

4.0 CONTAMINANT SOURCE AREAS

Section 3.0 defined the conceptual SHM for the Facility, including the definition of the primary hydrostratigraphic units beneath the Facility and the surrounding area, the identification of the potential vertical and horizontal contaminant migration pathways within the SHM, and a summary of potential receptors based on current and reasonably likely future land and ground water use.

Potential sources of hazardous waste and hazardous constituents have been identified at the Facility during previous site inspections or investigations. This section summarizes the characteristics of these sources and the contaminants that may have been released from these areas. A summary of the closure of potential sources is also discussed. This information will assist in the assessment of the nature and extent of contamination beneath the Facility and surrounding area (Section 5.0) including the scope of work that was undertaken to characterize the sources.

4.1 Potential Sources of Contamination

In 2001, TechLaw Inc. (TechLaw) was contracted by the U.S. EPA to perform a Preliminary Assessment/Visual Site Inspection (PA/VSI) of the Facility. The PA/VSI was conducted by TechLaw (2001) on February 22, 2001 to identify and characterize solid waste management units (SWMUs) and areas of concern (AOCs). A SWMU is a discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste (U.S. EPA, 1994). An AOC is a release that warrants investigation or remediation regardless of whether they are associated with a specific SWMU (U.S. EPA, 1994).

The PA/VSI was conducted by TechLaw to identify past compliance history, evidence of past releases, potential migration pathways, potential exposure to any released hazardous constituents, closure methods and dates, citizen complaints, manufacturing processes, and waste management practices at the Facility. In June 2001, a "Final Preliminary Assessment/Visual Site Inspection Report" was prepared by TechLaw for the U.S. EPA (TechLaw, 2001). TechLaw utilized environmental investigation data and other information collected by Vernay during its Ohio VAP Phase I and Phase II assessments to complete its PA/VSI report, as well as information from regulatory files and interviews with Vernay representatives (TechLaw, 2001).

Based on information obtained during the PA/VSI, TechLaw concluded that further investigation and remediation appear to be warranted at the Facility and, also concluded that: *"The Facility has done significant work in characterizing soil, ground water, surface water, and sediment contamination while participating in Ohio's Voluntary Action Program. This work confirms onsite soil and ground water contamination as well as offsite ground water, surface water, and sediment contamination. Several solid* *waste management units and other areas of concern are known or probable contributors to the contamination"* (TechLaw, 2001).

A total of 39 SWMUs and four AOCs were identified by TechLaw during the PA/VSI. Figures 5 through 7 present the locations of the SWMUs and AOCs as identified in the PA/VSI report.

In the PA/VSI report, TechLaw identified the potential for each SWMU and AOC to release hazardous waste or hazardous constituents to the environment. The categories for the release potential as presented in the report were low, moderate, or high. Thirty-one of the 39 SWMUs were defined as having a low release potential (TechLaw, 2001). TechLaw's justification for determining which SWMUs were identified as low release potential is identified on Table 13.

The PA/VSI report identified six SWMUs and/or AOCs as possessing a moderate release potential, and seven as a high release potential. TechLaw's rationale for characterizing these areas as moderate or high was based primarily on information known about the past uses of the areas, and soil boring and ground water contamination data collected by Vernay during the Ohio EPA VAP investigation. A summary of the moderate and high release potential SWMUs and AOCs is presented on Table 14.

Each of the SWMUs and AOCs defined as a moderate or high release potential are discussed in detail below. Detailed discussions of the low release potential areas are not discussed since the contamination beneath the Facility is predominantly derived from the moderate and high release potential SWMUs and AOCs (TechLaw, 2001).

4.1.1 Solid Waste Management Units

SWMU 1 and SWMU 2 – Sewer Lines and Floor Drains

SWMU 1 (Process Sewer Lines and Floor Drains) and SWMU 2 (Storm Sewer System) were designated as high release potential areas by TechLaw. In 1957, the Facility was connected to the Yellow Springs POTW sanitary sewer system located beneath Dayton Street and east of the Facility (Figure 2). Modifications to the sewer system were conducted over the years as the Plant 3 building was expanded. The Payne Firm conducted a comprehensive assessment to identify and depict all sanitary and storm sewers and related discharge structures on and beneath the Facility in 2000 (Payne Firm, 2001a). As a result of this assessment, the location of the existing sewers and structures is known beneath the Facility.

The materials of construction of sanitary sewers beneath the Facility are reported to be vitrified clay. The sanitary sewer system also contains four concrete sedimentation structures located on the east and west sides of Plant 3 (Figure 2). The purpose of the sedimentation structures is to capture solid materials (i.e. rubber pieces) so that they are not included in the materials discharged to the Village of Yellow Springs sanitary sewer system.

The storm sewer system beneath the Facility was originally constructed in the late 1950s, and is comprised of a collection of storm water drains and sewer lines which receives storm water from the Facility grounds and roof drains (Payne Firm, 2001a). In the past, some floor drains located in Plant 3 were connected to the storm sewer system. However, all floor drains in Plant 3 are currently connected to sanitary sewer lines. The materials of construction of the storm sewer lines at the Facility vary from extra heavy cast iron, vitrified clay, concrete, or PVC. The existing storm sewer system at the Facility discharges into the Village of Yellow Springs storm sewer located on Dayton Street. The Village of Yellow Springs storm sewer located beneath Dayton Street discharges into an unnamed creek on the north side of Dayton Street approximately 0.3 miles east of the Facility (Figure 14).

Waste liquids used in Plant 2 and Plant 3 reportedly entered into the sewer system beneath the facility via floor drains located inside the two buildings (TechLaw, 2001). These wastes were reported to have included waste solvents and waste oils from the vapor degreaser areas, bonding spray booths, and the maintenance areas located primarily along the western portion of Plant 3, and the southern portion of Plant 2 (TechLaw, 2001). These processes included cooling water baths, the Carbon Filtration Ground Water Treatment System, the Utility Tunnel Water Treatment System, the Maintenance Room Wash Pits, and the water discharge from the Oil/Water Separators. Samples are collected from the Carbon Filtration Ground Water Capture Treatment System (GWCTS) and the Utility Tunnel Water Treatment System (UTWTS) on a monthly basis to verify that no contaminants are being discharged from these sources. Vernay received an indirect discharge permit (permit-by-rule status) from the Ohio EPA in April 2001 for the discharge of these wastewaters to the Village of Yellow Springs POTW.

Soil and ground water samples collected near floor drains and sewer lines and within sewer backfill during the Ohio EPA VAP investigation contain elevated concentrations of VOCs, especially in the central portion of the Facility where vapor degreasers were used in close proximity to floor drains (e.g. the Bonding Room). As a result, sewer lines and sewer backfill beneath the Facility are considered to be a primary contributor to contamination beneath the Facility. Soil samples collected on Dayton Street northeast of the Facility during the Phase I RFI indicate that the soil beneath a portion of the storm sewer on Dayton Street has also been impacted (Section 4.1.2-AOC F).

SWMU 4 – Former Hazardous Waste Drum Storage Area

This area was used to store drums of waste prior to the drums being stored in the former Hazardous Waste Storage Trailer. This area was located outdoors near the southeast corner of Plant 2 (Figure 7). Reportedly, drums of spent PCE, still bottoms, and bonding wastes may have been stored at this area (TechLaw, 2001). Reportedly the area was initially paved with gravel, then paved with asphalt in the late 1960s or early 1970s.

Although no specific spills or releases are reported for drums stored at this area, it is located immediately adjacent to the location where VOC-contaminated ground water was first encountered at the Facility. Soil samples collected during the past voluntary investigation contained elevated concentrations of VOCs in the subsurface in the immediate vicinity of SWMU 4 (TechLaw, 2001). The past storage of drums on unpaved surfaces within an area of elevated VOC concentrations in soil and ground water suggests that releases may have occurred at this SWMU, and therefore, it was identified as a high potential area for the past release of hazardous waste or hazardous constituents release (TechLaw, 2001).

SWMU 5 – Dust Suppression and Weed Control Areas

Reportedly, Vernay applied waste oils and solvents, potentially including PCE and TCE, for dust and weed control on gravel driveways and parking lots in the late 1950s and the 1960s (TechLaw, 2001). These areas are located outdoors along former driveways and parking lots, and extended throughout the area between Plants 2 and 3 (Figure 7). This practice reportedly ceased in the late 1960s when the area was asphalted (TechLaw, 2001).

Soil borings and monitoring wells drilled within the area of SWMU 5 during the past voluntary investigation contained elevated concentrations of VOCs. As a result, this area was identified as a high potential for the past release of hazardous waste or hazardous constituents (TechLaw, 2001).

SWMU 6 – Former Waste Accumulation Area (Needle Inspection Area)

Vernay operated a former waste accumulation area and loading dock outside the western side of the original Plant 3 building (Figure 6). The former waste accumulation area stored wastes generated from the Plant 3 manufacturing process; however, the specific waste types or volumes staged in this area is unknown (TechLaw, 2001). A dumpster and trash compactor were also located at this area. There is no knowledge of drums of materials stored at this location. The base of the area was initially gravel, and was subsequently paved with asphalt. The Facility ceased storing wastes in this area when an addition to Plant 3 was constructed in 1968 (TechLaw, 2001). This location is now occupied by the former Needle Inspection Room (Figure 6).

The former waste accumulation area was identified as a moderate potential for the past release of hazardous waste or hazardous constituents to the ground surface based on the reported storage of wastes over a gravel base and the close proximity of the area to soil and ground water contamination (TechLaw, 2001).

SWMU 7 – Storm Water Catch Basin

During the late 1950s to the mid-1970s, a linear storm sewer catch basin was reported to be located on the south side of Plant 2 near a former loading dock (Figure 7; TechLaw, 2001). The former catch basin was designed to divert storm water which collected in the depression at the base of the sloped loading dock, and was equipped with a pump. The pump may have discharged to a former Plant 2 septic system, to sewers beneath the Facility, or both (TechLaw, 2001). The estimated length of the former catch basin is 10 feet. The catch basin was reportedly filled in with concrete in the mid-1970s when the existing loading ramp was constructed over it.

Reportedly, waste liquids were released from a former maintenance area inside Plant 2 and collected in the basin. The types and quantities of waste potentially managed at this SWMU are unknown. Since a former vapor degreaser was also located near this area in Plant 2, it is considered to be a potential source of liquid wastes to the catch basin (TechLaw, 2001).

This catch basin may have been a contributor to the soil and ground water contamination at the Facility, given it is in an area of ground water contamination, and spent degreasers and other wastes may have been discharged to this unit. As a result, the unit was identified as a moderate potential for the past release of hazardous waste or hazardous constituents (TechLaw, 2001).

SWMU 16B – Former Plant 2 Septic System

A former septic system was reportedly located on the north side of the original Plant 2 building (Figure 5; TechLaw, 2001). The expansion of Plant 2 is thought to be built over the former septic system. No additional information on the septic system, its design, materials of construction and capacity are available. However, during the third addition to Plant 2 in 1977, stacked and butted terra cotta pieces thought to be a part of the former septic system were reportedly encountered near the northeast portion of the existing Plant 2 building.

It was reported that floor drains in Plant 2 may have flowed to the unit from the time that it was constructed in 1951, to the time that Plant 3 was constructed in 1957. During that period, it was reported that wastes entered into sewer lines via floor drains inside the building, which at one time may have been associated with the former septic system (TechLaw, 2001). It is reported that the use of the septic system was discontinued when the Facility was connected to the Village's POTW in the late 1950s.

The potential for the past release of hazardous waste or hazardous constituents from the former Plant 2 septic system was concluded to be high based on the reported discharge of wastes into the system, and the close proximity of soil and ground water contamination identified during the past voluntary investigation (TechLaw, 2001).

SWMU 29 – Hydraulic Oil Trench Systems

An array of hydraulic oil piping and concrete containment pipe trenches exist beneath both plants. The pipes transport hydraulic oil in three and six inch diameter steel pipes to and from press machines in a closed loop system. The containment trenches, ranging from three to seven feet below the grade of the plant floors (the floors are up to approximately four feet above the grade of the outside ground surface), are constructed of concrete and are designed to collect any oils that may incidentally leak from the pipes. A weekly leak inspection program was conducted by Vernay to monitor hydraulic oil inventories, and piping and concrete trench integrity. Any observed defects are repaired by Vernay maintenance personnel.

During weekly inspections in June 1998, it was reported that a pipe in Plant 3 had leaked hydraulic oil into a localized portion of the trench system known as the former V-Ball pit area. Several hundred gallons of oil were pumped out of the concrete trench by Vernay after the release was discovered. After the oil was pumped out, an observed defect in the concrete trench system was repaired by Vernay at a point where the former V-Ball Pit was tied into the system. Soil sampling conducted during the Ohio EPA VAP investigation in the V-Ball Pit area showed TPH levels exceeding 1,000 mg/kg.

Based on Vernay's inspection program, the integrity of the hydraulic oil trench system is very good. There have been no significant releases of hydraulic oil since the 1998 event. However, since the 1998 event likely resulted in a localized area of subsurface TPH contamination in the V-Ball Pit area, the release potential for existing hydraulic oil trench system was identified as moderate (TechLaw, 2001).

SWMU 39 – West Fill Area

Fill material from a road construction project on Dayton Street in the 1960s was placed by the Village on the western portion of the Facility (Figure 7). Soil data collected from this area during the Ohio EPA VAP investigation indicated elevated concentrations of a few polynuclear aromatic hydrocarbons (PAHs). No VOCs were detected in the soil samples; and, no PAHs were detected in any monitoring wells during the VAP. As a result, it is likely that the PAH detections are the result of road materials (e.g. asphalt) within the fill. There is no known documentation or information that the West Fill area was ever used by Vernay for waste storage or placement. Based on past soil analytical results, however, the potential for the past release of hazardous waste or hazardous constituents from this area was considered to be high (TechLaw, 2001).

4.1.2 Areas of Concern

AOC A – Vapor Degreaser Areas

Five vapor degreasers were used to clean the metal parts with solvents throughout the Facility beginning in the late 1960s (Figures 5 and 6). Four vapor degreasers were located in Plant 3: one along the southern wall of the Mold Cleaning Room, one along the southern wall of the Sandblast Room, one in the Stock Room, and one in the southeastern corner of the New Product Development Area (TechLaw, 2001). There was also one former vapor degreaser located in Plant 2 along the southern wall of the main manufacturing room. Currently no vapor degreaser exists at the Facility; the last vapor degreaser was taken out of service by Vernay in 2001.

The areas surrounding the degreasers are considered areas of concern because liquid solvents may have drained or spilled to the floor and potentially migrated to sewer lines and soils beneath the floor, and elevated concentrations of VOCs were detected in soil samples collected at former degreasing areas during the Ohio EPA VAP investigation (TechLaw, 2001). Based on this, the potential for the past release of hazardous waste or hazardous constituents from these areas was considered to be moderate (TechLaw, 2001).

AOC B – PCE Aboveground Storage Tanks

In the past there were two former PCE ASTs located outdoors along the outer west wall of Plant 3 (Figure 7). These tanks are no longer present at the Facility. The ASTs were used to store PCE for use in the vapor degreasers located along the west side of Plant 3 (TechLaw, 2001). One AST had a 500-gallon capacity and was located outside the Sandblast Room in Plant 3. It was used during the 1970s until its removal in the early 1980s. The second AST also had a 500-gallon capacity and was used from the early 1980s to the mid 1990s when it was removed. The second unit was located along the outside of the Stock Room at the southwestern corner of Plant 3. The area is now completely covered by the HVAC system. Both units reportedly were situated on concrete. The PCE was transported by piping through the wall for use inside Plant 3. There was no reported history of release for either tank (TechLaw, 2001).

The ASTs were considered to be a moderate release potential due to their storage of PCE, and the detection of VOCs in soil samples collected in close proximity to the tanks during the VAP investigation (TechLaw, 2001).

AOC C – Empty Product Drum Storage Area

An empty product drum storage area was located on the southern side of the southwest corner of Plant 3 (Figure 7). Empty drums, which may have contained residual amounts of product, were reportedly stored at this area from the 1960s to the 1990s (TechLaw, 2001). The approximate dimensions of the area are ten feet by fifty feet. The previous contents of these product drums are not known. The area had a gravel base until the 1990s when the current elevated loading dock was constructed. Due to the outside location of this former storage area and its gravel base, the area has a moderate potential for the past release of hazardous waste or hazardous constituents (TechLaw, 2001).

AOC D – 1,2-DCP Plume

1,2-dichloropropane (1,2-DCP) exists in ground water beneath the northwest portion of the Facility, trending west to east (Figure 7). 1,2-DCP was detected at concentrations ranging from 5 to 500 µg/L in monitoring wells MW-2 and MW-5 during the past voluntary investigation. According to Facility representatives, the source of the 1,2-DCP detections is unknown (TechLaw, 2001). 1,2-DCP was also detected in soil boring GP01-024 at a depth of 8 to 10 feet (32 ug/kg). 1,2-DCP has never been used in facility operations (TechLaw, 2001).

The 1,2-DCP plume is considered to be an AOC due to the lack of information regarding the source of this constituent (TechLaw, 2001).

AOC E-Former Agricultural Support Buildings

Recent soil samples collected at the Facility during the Phase I RFI detected concentrations of PCE and 1,2-DCP on the western portion of the Facility near a location where three small agricultural support buildings were located on the property (Figure 7, Section 1.4). The Phase I RFI has identified a potential source area in the vicinity of GP01-149 on the western portion of the Facility. This area will be further delineated during the Phase II RFI.

AOC F-Off Facility Storm Sewer

Soil samples collected on Dayton Street northeast of the Facility during the Phase I RFI indicate that the soil beneath a portion of the storm sewer on Dayton Street has also been impacted. As documented in Section 4.1.1, the storm sewer from the Facility connects to the storm sewer along the southern portion of Dayton Street (Figure 2). This area of soil contamination will be further delineated during the Phase II RFI.

4.2 Closure of Potential Sources of Contamination

Former Hazardous Waste Storage Trailer

In November 2000, Vernay ceased storing drums of hazardous waste in an on-property storage trailer located along the south side of the Storage Building in the central portion of the Facility (Figure 2). The less than 90-day hazardous waste storage area was decontaminated and closed following OAC 3745-66-11 (A) and (B) and 3745-66-14 hazardous waste rules. Closure activities for the trailer were conducted by the Payne Firm on March 2, 2001. The closure activities consisted of decontaminating the secondary containment floor inside the trailer with a power washer, and confirmatory sampling of the wash rinse. Confirmatory sampling indicated that concentrations of VOCs, SVOCs, RCRA metals and PCBs were not detected in the rinsate sample that was collected after the secondary containment floor was decontaminated. A closure report documenting the closure activities was prepared by the Payne Firm (The Payne Firm, 2001b). The location of the former hazardous waste trailer is not considered to be a contaminant source area.

Potential Class V Injection Well Structures

In 2000, five structures were identified by Vernay as potential Class V injection wells at the Facility. Vernay notified the Ohio EPA, Division of Drinking and Ground Waters, Underground Injection Control (UIC) in a letter dated August 2, 2000 of the existence of these possible Class V structures. Four of the structures were located in Plant 3, and one structure was located outdoors near the southeast corner of Plant 2. All four structures located in Plant 3 were identified as a hole in the floor, and did not appear to be connected to either a storm or sanitary sewer. Two of the structures in Plant 3 were located in the warehouse area of the plant, and the other two structures were located inside electrical transformer rooms. The structures inside the transformer rooms served to collect any water or other liquids that may have accumulated near the plant's large transformers presenting an electrical hazard. These four structures are classified by the UIC as Class V Industrial Drainage Wells. No documented spills or leaks have been reported at or near these four potential Class V injection well structures.

The fifth potential Class V well identified at the Facility was located at the former ground water treatment system at the southeast corner of Plant 2. This structure consisted of a PVC stand pipe that was positioned several feet into the ground. This structure was used in 1991 as an injection well for treated ground water during a pilot test of the initial ground water treatment system installed at this location. After the pilot study, the structure was reportedly not used again.

On August 10, 2000 all five of the potential Class V structures were permanently closed. The structures were sealed by filling them with grout and concrete. Closure documentation of these structures was provided to the Ohio EPA and UIC in a September 14, 2000 letter. As a result, the wells are not considered to be contaminant sources.

Concrete Trench Abandonment

On October 31, 2001, the Payne Firm conducted a visual inspection of three decontaminated hydraulic oil trench systems associated with the former Strip Cure operations, and a trench located in the Bonding Department inside the Plant 3 building. The hydraulic oil trenches were a part of the hydraulic oil system identified as a SWMU by TechLaw (TechLaw, 2001).

The Strip Cure operations ceased at Plant 3 in September 2001. The Strip Cure operations at Plant 3 were conducted at the southeast corner of the building. Hydraulic oil piping associated with the Strip Cure operations was located below grade at each of the three Strip Cure units. The hydraulic piping below grade was located within concrete trenches that served as secondary containment. During operation of the Strip Cure units, oil that accumulated in the trench sumps was removed by Vernay personnel and properly disposed.

In October 2001, Vernay's maintenance department removed the Strip Cure equipment, as well as the hydraulic oil piping located within the trench system. The Payne Firm visually inspected the trenches on October 31, 2001 and observed that the concrete trenches were in good condition and that no residual oil or cracks were present in any of the trenches. The trenches were filled with sand and capped with concrete to return the upper portion of the trenches to surface grade in late 2001. As a result, the oil trench system is not considered to be a source of contamination.

The trench in the Bonding Department is located along the southern wall of the southernmost Bonding Room. The trench system in the Bonding Room is approximately 20 feet in length and one foot in width, and several inches in depth. The trench is constructed of concrete, and gently slopes to a former drain in the center portion of the trench. This trench was connected to a sanitary sewer, but the drain in the trench was plugged with concrete in the late 1990s. The trench was filled with concrete in late 2001. The trench in the Bonding Room is a part of AOC A-Vapor Degreaser Areas and is therefore considered to be a high potential for the past release of hazardous waste or hazardous constituents.

UST Closure

Section 1.7.2 described the heating oil UST removal and closure assessment that was conducted at the Facility. Based on the soil and ground water samples collected from this area, the USTs are not a source of contamination at the Facility.

4.3 Waste Characteristics

Section 1.6 provided a list of wastes that have been generated at the Facility in the past. Section 4.1 described the types and approximate quantities of waste that were associated with the medium and high release potential SWMSs and AOCs. This section presents a summary of the hazardous waste generated at the Facility, and the physical and chemical properties of these wastes.

4.3.1 Hazardous Waste Generated at the Facility

U.S. EPA has separated hazardous wastes into two categories: 1) listed hazardous waste, and 2) characteristic hazardous waste. Listed hazardous waste contains specific chemicals which appear on specific lists (F, P, K, and U) as identified in Subpart D of RCRA in the Code of Federal Regulations (CFR) Part 261. Characteristic hazardous wastes contain generic properties that are defined as hazardous (ignitibility, corrosivity, reactivity, or toxicity) as identified in Subpart C of RCRA in 40 CFR Part 261. Both types of hazardous waste were generated at the Facility.

F-listed hazardous wastes were generated at the Facility. F-listed wastes are those wastes that are derived from non-specific sources. The F-listed waste that were generated at the Facility included the following:

- F001: spent halogenated solvents used in degreasing (such as PCE, TCE);
- F002: spent halogenated solvents (such as PCE, TCE);
- F003: spent non-halogenated solvents (such as xylene, ethylbenzene);
- F005: spent non-halogenated solvents (such as toluene, MEK, benzene); and
- F009: spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process.

Characteristic hazardous wastes have also been generated at the Facility. These characteristic wastes include the following:

- D001: solid waste exhibiting the characteristics of ignitability, but is not listed as a hazardous waste in Subpart D;
- D006: solid waste exhibiting the characteristic of toxicity for cadmium;
- D008: solid waste exhibiting the characteristic of toxicity for lead; and
- D035: solid waste exhibiting the characteristic of toxicity for methyl ethyl ketone.
- D009: solid waste exhibiting the characteristic of toxicity for mercury.
- D039: solid waste exhibiting the characteristic of toxicity for PCE.

Other non-hazardous wastes, such as waste oils, solid waste, and cooling wastewater were also generated at the Facility.

4.3.2 Physical and Chemical Characteristics of Hazardous Constituents

General chemical characteristics of hazardous constituents sampled for during the RFI are presented on Table 15. These characteristics include physical form, boiling point, molecular mass, density, solubility in water, vapor pressure and viscosity.

The two primary pathways of removal of contaminants from a medium are degradation and physical movement. These pathways will be included in the assessment of the fate and transport of contamination at the Facility during the Phase II RFI.

5.0 NATURE AND EXTENT OF CONTAMINATION

Sections 1.0 and 2.0 provided an overview of the Facility and the methodologies that that were used to collect the data required for the RFI. Section 3.0 reviewed the physical features of the Facility and presented the conceptual SHM and the human health and ecological receptor CSM, and Section 4.0 summarized the presence and characteristics of potential sources of hazardous waste and hazardous waste constituents at the Facility.

This section provides a detailed discussion of the nature and extent of contamination beneath the Facility and vicinity, focusing on those contaminants found to be contaminants of interest (COIs) as defined later in this section. This section begins with a discussion of the process that was undertaken to evaluate data collected during the Phase I RFI. The nature and extent of contamination is then discussed within the context of the potential significance of hazardous constituent concentrations (relative to background levels, and/or U.S. EPA risk-based screening criteria or drinking water standards) detected in indoor air, surface water, storm sewer water, sediment, water in discontinuous sand seams and in sewer backfill, and Cedarville Aquifer ground water. A number of figures and tables presented in this section were prepared to facilitate the determination of the nature and extent of contamination, and to identify data needs for the Phase II RFI.

As summarized below, the Phase I RFI: 1) characterized the potential for unacceptable risks from vapors intruding into indoor air at the Facility; 2) determined the extent of contamination in soil, surface water, sediment; and, water in the Unconsolidated Unit (in discontinuous sand seams and sewer backfill); and, 3) determined the vertical and horizontal extent of contamination in the Cedarville Aquifer on and off the Facility.

For soil within the Unconsolidated Unit beneath the Facility and vicinity, the results of the Phase I RFI have identified four primary areas of VOC contamination and three areas of SVOC contamination. For ground water of the Cedarville Aquifer beneath the Facility and vicinity, VOCs are present from Dayton Street to the north, East Enon Street to the west, Lawson Place to the east, and West South College Street to the south. In addition, the vertical limits of VOCs in ground water have been defined to concentrations below the laboratory reporting limit in all wells screened at the base of the Cedarville Aquifer on and off the Facility.

As identified in Section 2.0, the media that were sampled to meet the objectives of the Phase I RFI included the following (Figure 3):

- Surface Water
- Sediment

- Storm Sewer Water
- Soil (0 to 2 feet; and at selected intervals down to the top of the Cedarville Aquifer).
- Vadose Zone Water
    - Sewer Backfill Water
    - Discontinuous Sand Seam Water

Cedarville Aquifer Ground Water

- Upper Cedarville Aquifer Ground Water
    - Including sand lenses at or near the surface of the bedrock aquifer
- Middle Cedarville Aquifer Ground Water
- Lower Cedarville Aquifer Ground Water

5.1 RFI Data Evaluation Process

The overall goal of the RFI is to determine whether unacceptable risks to human health and the environment associated with hazardous waste or constituents released from SWMUs and/or AOCs at the Facility warrant interim or corrective measures. Data were collected during the Phase I RFI investigation to meet the DQOs defined in Section 2.0 and the project QAPP (Payne Firm, 2003d).

During the Phase I RFI investigation, data collection was conducted in iterative phases. After each phase of data collection, the adequacy of the data to meet the DQOs was evaluated to determine whether additional data collection was warranted. In evaluating the sufficiency of data relative to determining the nature and extent of contamination at and from the Facility and quantifying the potential risks associated with this contamination, a number of elements were considered during the Phase I RFI. These elements include:

- Review of past data collected from the Facility and vicinity and the preparation of the Current Conditions Report (Payne Firm, 2002);
- risk-based screening of past site investigation data;
- development of an RFI sampling list;
- confirmation sampling;
- development of Areas of Interest (AOIs); and
- development of Contaminants of Interest (COIs).

A discussion of each of these elements is presented below.

5.1.1 Review of Past Data

As discussed in Sections 1.0 and 2.0, Vernay implemented a voluntary investigation in 1998 to begin the process of determining the nature and extent of contamination beneath the Facility and off of the Facility. Data that were collected during the voluntary investigation (past data) were used by TechLaw in the completion of the PA/VSI (TechLaw, 2001), in risk-based screening, and to develop the scope of work for the RFI. The past data were summarized in the CCR, including the documentation supporting the quality of data (i.e. data validation memoranda, analytical reports, data summary tables, and data collection objectives).

The amount of past data collected at the Facility and vicinity assisted in the identification, development, and refinement of the data needs and tasks needed for the RFI. Once the data needs were identified, Statements of Work (SOWs) were prepared for each field task during the RFI, as discussed in Section 2.0. The quality of the past data, and the usability of the data in the RFI, were documented in the CCR, and TM-2 (Payne Firm, 2003b), and TM-4 (Payne Firm, 2004).

5.1.2 Risk-Based Screening of Past RFI Data

In February 2003, ENVIRON conducted an initial risk-based screening of past soil, sediment, surface water, subsurface water and Cedarville Aquifer ground water data (ENVIRON, 2003). The purpose of this risk-based screening was to identify potential data gaps, data needs, and scope of work for the RFI and the CA725 EI report.

Generic human health risk-based screening levels were used to identify locations where hazardous constituents are present at concentrations where additional investigation was needed. As described below, the screening criteria utilized for the evaluation of the data included risk-based screening levels and methodologies published by U.S. EPA, and for pathways not addressed in U.S. EPA generic criteria, other readily available and relevant criteria.

5.1.2.1 Risk-Based Data Screening Criteria

Risk-based screening criteria appropriate for each environmental medium and potential receptor identified by the conceptual site model for human exposures (Section 3.0) were assembled for use in identifying potential data needs for additional sampling during the RFI, to identify chemicals of interest (COI), and to support a reliable estimate of exposure concentrations.

Soil and Sediment
Based on the CSM for human exposures, the following screening criteria were selected to evaluate past soil and sediment:

- Risk-based screening levels calculated using the methodology and conservative exposure factors for deriving U.S. EPA Region 9 risk-based Preliminary Remediation Goals (PRGs) for residential land use (set at a target cancer risk level (TCRL) of 10^{-6} for carcinogenic constituents and a target hazard quotient (HQ) of 1 for non-carcinogenic constituents).
- Risk-based screening levels calculated using the methodology and conservative exposure factors for deriving U.S. EPA Region 9 PRGs for industrial land use (set at a TCRL of 10^{-5} for carcinogenic constituents and a target HQ of 1 for non-carcinogenic constituents).
- U.S. EPA's Soil Screening Guidance values for soil contamination migrating to ground water with a dilution-attenuation factor of 20 (derived by U.S. EPA under the assumption that ground water is a drinking water source).
- Risk-based screening levels calculated for evaluating vapor intrusion from soil for industrial land use (set at a TCRL of 10^{-5} for carcinogenic constituents and a target HQ of 1 for non-carcinogenic constituents).

Samples exhibiting concentrations exceeding screening criteria were evaluated further to determine the need for additional investigation that considered the following:

- likely exposures scenarios at the SWMU or AOC;
- concentrations of the constituent at other locations and depths;
- distribution of the constituent in other environmental media;
- background levels;
- field observations; and
- potential impacts from adjacent SWMUs or AOCs.

Cedarville Aquifer Ground Water/Subsurface Water

In the past, ground water samples were collected from the Cedarville Aquifer on and off of the Facility and subsurface water samples were collected from sewer backfill and saturated sand seams on and off of the Facility. Based on the conceptual site model for human exposures, the following screening criteria were selected to evaluate the past ground water data:

- Federal and Ohio Maximum Contaminant Levels (MCLs) for drinking water, or in the absence of an MCL, equivalent drinking water standards (EDWLs; set at a TCRL of 10^{-5} for carcinogenic constituents and a target HQ of 1 for non-carcinogenic constituents).
- Risk-based criteria calculated for assessing direct contact exposures to ground water during routine utility excavation activities (set at a TCRL of 10^{-5} for carcinogenic constituents and a target HQ of 1 for non-carcinogenic constituents).

- Risk-based screening levels calculated for evaluating the ground water to indoor air pathway for both industrial and residential land use (set at a TCRL of 10^{-5} for carcinogenic constituents and a target HQ of 1 for non-carcinogenic constituents).

Based on the constituents identified as having maximum concentrations exceeding the above-defined screening criteria, the results for each ground water sample were screened to identify specific sample locations where these screening criteria were exceeded, and to identify COIs. These data were then evaluated further to determine the need for additional investigation. Specifically, data were further evaluated relative to:

- likely exposures scenarios at the SWMU or AOC,
- concentrations of the constituent at other locations and depths,
- distribution of the constituent in other environmental media,
- background levels, and
- field observations.

Surface Water

Surface water samples were collected from the unnamed creek during the past voluntary investigation. Based on the conceptual site model for human exposures, the following screening criteria were selected to evaluate the past surface water data:

- Federal and Ohio Maximum Contaminant Levels (MCLs) for drinking water, or in the absence of an MCL, equivalent drinking water standards (EDWLs; set at a TCRL of 10^{-5} for carcinogenic constituents and a target HQ of 1 for non-carcinogenic constituents).
- Site-specific non-potable criteria based on direct contact and inhalation associated with use of ground water in a residential “kiddie pool” scenario.

Storm Sewer Water

In the past, storm sewer water samples were collected from the storm sewer system on and off of the Facility. Based on the conceptual site model for human exposures, the following conservative screening criteria were selected to evaluate past storm sewer water data:

- Risk-based criteria for assessing direct contact exposures to ground water during routine utility excavation activities (set at a TCRL of 10^{-5} for carcinogenic constituents and a target HQ of 1 for non-carcinogenic constituents).

An evaluation of the maximum detected concentration for each constituent was compared against each of the above screening criteria for surface water and storm sewer water. Detected concentrations of a specific constituent exceeding the screening criteria were evaluated further. Specifically, based on the constituents identified as having maximum concentrations exceeding the above-defined conservative screening criteria, the surface water results were screened to identify specific sample locations where these screening criteria were exceeded.

5.1.2.2 Results of the Risk-Based Screening Evaluation

The results of the risk-based screening evaluation of past data indicated that the following additional data were needed to meet the objectives of the RFI:

- Arsenic, copper, and zinc needed to be evaluated in soil to establish representative background concentrations.
- Additional soil delineation needed to be evaluated at SMWUs and AOCs.
- Deeper soil samples needed to be collected from some boring locations where the concentrations exceeding the screening criteria occur at the deepest sampling interval.
- Additional monitoring wells were needed in the Cedarville Aquifer and sewer backfill to determine the nature and extent of contamination.
- Additional surface water, storm sewer water, sediment and indoor air samples needed to be collected to verify that no significant changes have occurred in these media since previous data sets.

5.1.3 Development of RFI Sampling List

TM-1 (Payne Firm, 2003a) presented the sampling list of chemicals to be sampled for during the RFI (Table 18). The methodology and rational in developing the site-specific sampling list was described in TM-1, and is summarized below. The sampling list is sufficient to support the DQOs for the RFI, and the development and evaluation of potential corrective measures for the Facility.

5.1.3.1 Methodology

In order to meet the DQOs and to develop a representative sampling list for the RFI, the following two regulatory lists of chemicals were reviewed for their applicability:

- 40 CFR 264, Appendix IX List (Appendix IX)
- U.S. EPA Target Compound List/Target Analyte List (TCL/TAL)

The Appendix IX list a comprehensive list of all chemicals hazardous waste constituents that can be reliably detected utilizing U.S. EPA analytical methods. The TCL/TAL list of constituents is a list generated by the U.S. EPA's Contract Laboratory Program that includes the most frequently detected chemicals at hazardous waste facilities. The Appendix IX and TCL/TAL lists were determined to be the "base list" of chemicals from which decisions can be made regarding the appropriateness for inclusion on the RFI sampling list. Based on the extensive amount of past analytical data generated at the Facility, the information known about the wastes that were handled at the Facility, and the primary chemicals used in manufacturing processes over the years at the Facility, it was determined that the base list of chemicals can be reduced to a more representative site-specific list of chemicals. This was also based on the fact that the PA/VSI conducted at the Facility confirmed that the chemical groups of potential concern at the Facility included VOCs, SVOCs, and metals (Table 18; TechLaw, 2001).

The Appendix IX and TCL/TAL base lists of chemicals include the following common chemical groups.

- VOCs
- SVOCs (both base/neutral compounds and acid extractable compounds)
- Pesticides/PCBs
- Metals and cyanide

In addition, the Appendix IX list also contains dioxins/furans, herbicides, and sulfide.

As previously discussed in Section 2.0, sampling results from the past voluntary investigation at the Facility are documented in detail in Section 4.5 of the CCR (Payne Firm, 2002). In addition, interviews were conducted during the RFI with Vernay personnel knowledgeable of the chemical groups and specific chemicals that were used in the Facility's manufacturing processes over the years. Based on the lack of detection during the past voluntary investigation (Payne Firm, 2002), the lack of use or reported release at the Facility (TechLaw, 2001), and discussions with Vernay personnel knowledgeable of the chemicals used at the Facility, it was determined that pesticides/PCBs, dioxins/furans, herbicides, cyanide, and sulfide did not need to be included on the RFI sampling list. As a result, the site-specific sampling list for the RFI was reduced to the following chemical groups: VOCs; SVOCs; and metals.

The Appendix IX list and the TCL/TAL list of chemicals of VOCs, SVOCs, and metals are not identical. To determine the appropriate list of specific chemicals to be included for each chemical group on the RFI sampling list, the VOCs, SVOCs, and metals listed in the Appendix IX and the TCL/TAL lists were compared to: 1) the frequency and concentrations of constituents previously detected in environmental media at and adjacent to the Facility; 2) the materials reasonably known to be used or have been used at the Facility; and 3) U.S. EPA published data for releases associated with similar manufacturing processes. In addition, an evaluation of the availability of toxicity data for constituents on the TCL/TAL and Appendix IX lists was conducted since ultimately data generated during the RFI will be used to support risk-based decisions regarding the need for corrective measures. Based on this evaluation, the TCL/TAL list was selected as the point-of-departure for developing the site-specific analyte list (Table 18) since there are a larger number chemicals on the Appendix IX list that do not have U.S. EPA published toxicity data.

As an additional step, an assessment was conducted to determine if any VOCs, SVOCs, or metals other than those on the TCL/TAL list should be added to the Facility investigation sampling list. This assessment was performed by comparing the Appendix IX list of VOCs, SVOCs, and metals to the toxic release inventory (TRI) data compiled for rubber and miscellaneous plastics products industry (U.S. EPA, 1995). The TRI list was compiled by the U.S. EPA and includes chemicals that are generally used in the rubber and plastics industry. Chemicals that are identified on the TRI list and the Appendix IX list were considered for inclusion on the RFI sampling list. A summary of the issues that were considered is presented on Table 19 and discussed below.

5.1.3.2 VOCs

No VOCs were used at the Facility that are on the Appendix IX and TRI lists and not analyzed in previous investigations. Vernay indicated that trace amounts (less than ten parts per million [ppm]) of acrylonitrile were present as an unreacted reactant in some of the nitrile rubber compounds that were used by Vernay; however, Vernay never used acrylonitrile at the Facility. Since acrylonitrile has not been used at the Facility, it is not appropriate to include acrylonitrile on the RFI sampling list. Therefore, it was judged that the appropriate list of VOCs for the RFI sampling list is the TCL/TAL list. A complete list of the chemicals on the RFI investigation sampling list was presented in TM-1, as shown on Table 18.

5.1.3.3 SVOCs

The only SVOC that has not been analyzed for in previous investigations, but is identified on both the TRI and Appendix IX lists is methylphenol (total). This compound has not been used at the Facility, and therefore does not warrant being included on the RFI sampling list. Therefore, the appropriate list of SVOCs constituents for the RFI sampling list is those on the TCL/TAL list. A complete list of the chemicals on the RFI investigation sampling list was presented in TM-1, as shown on Table 18.

5.1.3.4 Metals

The TCL/TAL list includes a total of 24 metals (including cyanide). During the past site investigation at the Facility, only the eight RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver) were analyzed (Payne Firm, 2002). A list of the metals on the TCL/TAL and rational for retaining or removing the metals for the RFI sampling list was presented in TM-1 and summarized on Table 20. The metals to be included on the sampling list included arsenic (soil only), copper, chromium (ground water only), and zinc. A complete list of the chemicals on the RFI investigation sampling list was presented in TM-1, as shown on Table 18.

5.1.3.5 Refinement of the RFI Sampling List

As the Phase I RFI was being conducted and additional analytical data were generated, certain chemical groups or specific metals were removed from the RFI sampling list, as described below:

Metals

Concentrations of the three metals were not detected above the laboratory reporting limit in any monitoring wells during the first quarter 2003 monitoring event. 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 monitoring event, monitoring well samples were not analyzed for metals during the subsequent quarterly monitoring events.

SVOCs

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 2003 monitoring event. Two additional monitoring wells (MW01-09, MW01-12) had estimated concentrations of bis(2-ethylhexyl)phthalate detected below the reporting limit (data qualified with a “J”). During that sampling event, the maximum concentration of bis(2-ethylhexyl)phthalate was 61 µg/L detected at an upgradient monitoring well MW01-08. No other SVOCs were detected above the laboratory’s reporting limit.

During the second quarter 2003 monitoring event, the six monitoring wells with detected concentrations of bis(2-ethylhexyl)phthalate during the first quarter 2003 event were sampled again for SVOCs. These monitoring wells were selected to confirm the first quarter 2003 concentrations of bis(2-ethylhexyl)phthalate. The second quarter 2003 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 2003 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 quarterly sampling events, Teflon® lined tubing was used. Given the lack of detections of SVOCs from the water samples collected from the first and second quarter in 2003, and the lack of detections of SVOCs from the water samples collected from the same monitoring wells prior to the RCRA corrective action (four separate sampling events), monitoring wells were not analyzed for SVOCs during subsequent quarterly monitoring events.

5.1.4 Confirmation Soil Sampling

In an October 2, 2003 letter to Vernay (U.S. EPA, 2003), the U.S. EPA indicated that Vernay needed to submit a data package consistent with the requirements of the U.S. EPA guidance document entitled "Region 5 Policy and Guidelines Regarding Historical Data Usage in the RCRA Facility Investigation" (U.S. EPA, 1998) for considering the use of past data (including soil, sediment, surface water, ground water, and air) in the RFI. On December 12, 2003, Vernay submitted the data package in the form of a technical memorandum (TM-2, Payne Firm, 2003b) and requested the U.S. EPA to complete a Quality Assurance Project Plan review of the past data and its intended use in the RFI. The U.S. EPA provided comments to TM-2 in a January 21, 2004 letter, indicating that Vernay can use the past data to establish trend analysis in ground water, sediments, and surface water (U.S. EPA, 2004a). The U.S. EPA indicated that past soil data could not be used in the RFI until RFI soil data were collected and confirmation between the past and RFI data was demonstrated following U.S. EPA guidance (U.S. EPA, 1998).

As a result, confirmation soil samples were collected at the Facility in January and February, 2004 to address the U.S. EPA comment stated above. Prior to conducting this work, a conference call was held on January 22, 2004 between the U.S. EPA and the Payne Firm to discuss the additional RFI soil confirmation data needs. Based on the call, the appropriate location and number of confirmation soil samples and chemical groups to analyze were agreed, as well as the scope of work for the soil confirmation boring program.

The samples were collected in January and February 2004, following the procedures presented in the project QAPP and SOW #7 (see Figure 25 for locations). Confirmation sample analysis was conducted for all constituents identified in the project QAPP including VOCs, SVOCs (including PAHs), and metals. The metals identified in the project QAPP for soil include arsenic, copper, and zinc. Since the past soil data were analyzed for the eight RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), the confirmation soil samples were analyzed for the RCRA metals.

The methods for comparing past and confirmatory soil data were conducted following U.S. EPA guidance (U.S. EPA, 1998). The results of this assessment were presented in detail to the U.S. EPA in TM-4 (Payne Firm, 2004). The results documented in TM-4 indicated there is no significant variability between the method detection limits (MDLs) and in the sample concentrations for the past soil data and the confirmatory soil data. It was judged by the Payne Firm in TM-4 that the past soil data could be used for its intended uses for the RFI and the corrective action.

The U.S. EPA provided comments to TM No. 4 on May 4, 2004 (U.S. EPA, 2004c), and indicated that they did not accept all of the intended uses of the past soil data. Specifically, U.S. EPA did not accept the use of past non-Update III soil VOC data for use in quantitative risk assessments. The U.S. EPA indicated that past non-Update III soil VOC data can be used for the following qualitative purposes:

- Assist in providing rationale for sampling design;
- Assist in the indication of "hot spot" zones of contamination; and
- Use in Environmental Indicator determinations.

5.1.5 Areas of Interest (AOIs)

As described in Section 2.2.10, the Facility and vicinity were divided into four Areas of Interest (AOIs) by ENVIRON (Figure 23). The AOIs were defined based on: 1) physical location and current conditions; 2) type of SMWU or AOC, and 3) type of human or ecological receptor that may be present under current and likely future conditions as identified on the conceptual human health and ecological conceptual site models (Tables 16 and 17). The AOIs were initially prepared during the evaluation of the CA725 EI, and were used to focus the determination of the nature and extent of contamination at the Facility and off of the Facility.

5.1.6 Contaminants of Interest (COI)

For the Phase I RFI and the CA725 EI Report, "contamination" and "contaminated" describes media containing contaminants (in any form, NAPL and/or dissolved, vapors, or solids, that are subject to RCRA) in concentrations in excess of appropriately protective risk-based "levels" (for the media, that identify risks within acceptable range.

After the initial risk-based screening evaluation described above was completed, ENVIRON conducted a second risk-based screening evaluation using data collected during the past voluntary investigation and the Phase I RFI to determine the presence, and current unacceptable risks, of contamination at or emanating from the Facility. The methodology and results of the second screening evaluation were presented in a draft of the CA725 EI report, submitted to the U.S. EPA under a separate cover on April 9, 2004 (ENVIRON, 2004). Table 23 provides a sampling summary of all media, AOIs, SWMUs, and AOCs.

The second screening evaluation conducted by ENVIRON consisted of a comparison of Phase I RFI data with media specific generic risk-based screening criteria for potential exposure pathways identified in the conceptual site model for current human exposures (Table 16). The list of screening criteria selected by ENVIRON is presented in the draft CA725 report. This second screening resulted in the identification of "contamination" for each of the Phase I RFI media, and a determination that there were no current unacceptable risks to human health on and off of the Facility (ENVIRON, 2004).

To determine the nature and extent of contamination of past data and RFI data, and to assess if any additional data are needed for the Phase II RFI, "Contaminants of Interest" (COIs) were identified by the Payne Firm. Summarized on Table 22, COIs are VOC, SVOC, and metal constituents that were identified by ENVIRON as exceeding the generic risk based screening criteria; and, are the lowest exceedance of either the generic risk-based screening criteria presented in the draft CA725 EI report, or the migration to ground water screening criteria (U.S. EPA's Soil Screening Guidance values for soil contamination migrating to ground water with a dilution-attenuation factor of 20; derived by U.S. EPA under the assumption that ground water is a drinking water source). This was conducted as a conservative evaluation to determine the nature and extent of contamination, and to make initial judgments about whether or not the past and Phase I RFI data were sufficient to meet the objectives of the RFI.

Determinations and depictions of the nature and extent of contamination for all affected media beneath the Facility and the surrounding area are presented in this section. During the Phase II RFI, and more specifically during the site specific baseline risk assessment and soil leaching contaminant transport modeling, additional refinement of the depiction of the nature and extent of contamination will be prepared. The AOIs, COIs and potential media of interest are presented on Table 21.

The COIs in each media listed on Table 22 are summarized below:

<u>VOC-COIs in Soil</u>

- Tetrachloroethene
  - Exceeds migration to ground water > 60 µg/kg (On/Off-Facility)
- Trichloroethene
  - Exceeds migration to ground water > 60 µg/kg (On/Off-Facility)
  - Exceeds residential exposure > 53 µg/kg (Off-Facility)
- Vinyl Chloride
  - Exceeds migration to ground water > 10 µg/kg (On-Facility)
- Methylene Chloride
  - Exceeds migration to ground water > 20 µg/kg (On-Facility)
- Bromomethane
  - Exceeds migration to ground water > 200 µg/kg (On-Facility)
- 1,2-Dichloropropane
  - Exceeds migration to ground water > 30 µg/kg (On-Facility)

<u>SVOC-COIs in Soil</u>

- Benzo(a)pyrene
  - Exceeds migration to ground water > 2100 µg/kg (On/Off-Facility)
  - Exceeds migration to ground water > 62 µg/kg (Off-Facility)
- Benzo(a)anthracene
  - Exceeds migration to ground water > 2000 µg/kg (On-Facility)

- Dibenz(a,h)anthracene
    - Exceeds migration to ground water > 2000 µg/kg (On-Facility)
- Benzo(b)fluoranthene
    - Exceeds migration to ground water > 5000 µg/kg (On-Facility)

<u>VOC-COIs in Storm Sewer Backfill Water</u>

- Tetrachloroethene
    - Exceeds excavation worker exposure > 6138 µg/L (On-Facility)

<u>VOC-COIs in Cedarville Aquifer Ground Water</u>

- Tetrachloroethene
    - Exceeds drinking water exposure > 5 µg/L (Off-Facility)
    - Exceeds excavation worker exposure > 6138 µg/L (On-Facility)
- Trichloroethene
    - Exceeds drinking water exposure > 5 µg/L (Off-Facility)
- Vinyl Chloride
    - Exceeds excavation worker exposure > 708 µg/L (On-Facility)
    - Did not exceed the drinking water exposure > 2 µg/L (Off-Facility)

*The off-Facility drinking water exposure was used as the COI for the depiction of the nature and extent of contamination in this Phase I RFI report.

<u>Indoor Air, Sediment, Surface Water, and Storm Sewer Water</u>

No COIs were identified in these media during the Phase I RFI because none of the risk-based screening criteria were exceeded identified in the draft CA725 EI report (ENVIRON, 2004).

Although other constituents were detected during the Phase I RFI, they did not exceed the CA725 risk-based screening criteria or the migration to ground water criteria. As a result, they are not on the list of COIs that are needed to describe the Phase I RFI nature and extent of contamination. Results of all chemical constituents analyzed during the Phase I RFI are presented in the pertinent tables and appendices within this report, and will be considered during the baseline risk assessment and evaluation of contaminant fate and transport during Phase II of the RFI. Table 24 provides a summary of all constituents and the maximum detected values and frequency of detections.

5.2 Indoor Air Sampling

Based on the CSM for human exposures (Table 16), one potential exposure at the Facility is vapor intrusion to indoor air from soil, subsurface water and/or Cedarville Aquifer ground water. As a result of this potential exposure, an indoor air sampling was conducted during the RFI to characterize the indoor air quality at the Facility. Indoor air samples were collected on the Facility at locations closest to the highest concentrations of contamination.

Three subsurface structures were identified at the Facility that could be entered by workers where vapors may tend to accumulate. These subsurface structures were greater than five feet below the surface grade of the Plant 2 or Plant 3 buildings and include: 1) the Plant 2 hydraulic oil pit, 2) the Plant 3 hydraulic oil pit, and 3) the underground concrete utility tunnel connecting Plant 2 and Plant 3 (Figures 3 and 4). These structures are located in close proximity to elevated concentrations of VOCs in soil, subsurface water, and Cedarville Aquifer ground water.

Indoor air samples were sampled from each of these areas during the Phase I RFI. The indoor air samples at each location were collected at the bottom of each structure, as well as approximately four feet above the bottom of the structure, following the sampling methodology described in Section 2.3.8.

Indoor Air Sampling Results

The results of the indoor air sampling program are summarized on Table 26 and Figure 29. As presented on Table 26, very low concentrations of VOCs were detected in the air samples. However, the direct measurement of indoor air constituent concentrations are all below the occupational screening criteria as presented in the draft CA725 EI report (ENVIRON, 2004). As a result, no COIs were identified because there is not a current unacceptable risk associated with indoor vapor intrusion at the Facility.

5.3 Nature and Extent of Contamination in the Unconsolidated Unit

As discussed in Section 4.0, a number of medium and high release potential SWMUs and AOCs were identified at the Facility by TechLaw during the PA/VSI (TechLaw, 2001). The locations of these SWMUs and AOCs are presented on Figures 5, 6 and 7 and summarized on Tables 13 and 14. Given the past uses of these areas, the most frequently detected contaminants in the Unconsolidated Unit during the Phase I RFI were VOCs. SVOCs were also detected in the Unconsolidated Unit, but less frequently than VOCs. As presented in Section 3.2.2, the Unconsolidated Unit consists of the following: soil, storm sewer water, and water in discontinuous sand seams and sewer backfill (Figure 9). A direct-push boring program and soil sampling methodology following U.S. EPA Method 5035 ("Encore Sampling") were used to collect Update III VOC soil samples from the Unconsolidated Unit. Direct push borings were also used to collect water samples from discontinuous sand seams, and sewer backfill material situated within the Unconsolidated Unit.

The data needed to determine the nature and extent of contamination in the Unconsolidated Unit included:

- A soil background data set for arsenic, copper, and zinc.
- A determination of the physical characteristics and geotechnical properties of the Unconsolidated Unit beneath the Facility and vicinity.
- The horizontal and vertical extent of contamination of all affected media within the Unconsolidated Unit, and confirmation that no other contaminant source areas existed at the Facility.
- A sufficient amount of quantitative analytical data to chemically and physically characterize contaminant source areas, and to support the CA725 EI report and the baseline risk assessment.

The primary data needs of the borings drilled at the Facility included: 1) a background soil sampling investigation for arsenic, copper, and zinc; 2) a soil boring investigation at, in the vicinity of, medium and high potential SWMU and AOC locations; 3) the collection of water samples within discontinuous sand seams, sewer backfill and the upper Cedarville Aquifer on and off of the Facility.

The primary data needs and objectives of the off-Facility boring program during the Phase I RFI were to: 1) determine the horizontal and vertical extent of contamination along Dayton Street within the Unconsolidated Unit, primarily associated with sewer lines emanating from the Facility; 2) characterize the quality of water encountered in discontinuous sand seams within the Unconsolidated Unit; 3) collect a sufficient amount of quantitative analytical data to physically characterize off-Facility Unconsolidated Unit conditions; and, 4) collect upper Cedarville Aquifer ground water samples from direct-push boreholes to assist in the evaluation of the extent of ground water contamination and in the selection of upper Cedarville Aquifer monitoring well locations.

The detailed scope of work that was used to collect the data identified above were defined in SOW #4B (Additional Monitoring Wells in the Cedarville Aquifer and Sewer Backfill), SOW #6 (Additional Geoprobe Sampling in the Cedarville Aquifer and Unconsolidated Unit on and off the Vernay Plant 2/3 Facility), and SOW No. 7 (Additional Geoprobe Sampling in the Cedarville Aquifer and Unconsolidated Unit on and off the Vernay Plant 2/3 Facility).

5.3.1 Background Soil Sampling

Background soil samples were collected during the Phase I RFI to characterize naturally occurring levels of inorganics in soil at the Facility. The main objective of the background soil sampling investigation was to establish a statistically representative background metals (arsenic, copper, and zinc) data set for assistance in assessing the nature and extent of these metals at the Facility. The detailed scope of work for the background soil sampling was described in SOW No. 7. ENVIRON discussed the results of the background soil sampling in Appendix B of the draft CA725 EI report (ENVIRON, 2004).

Background soil samples were collected at ten locations from a property (825 Dayton Street) located approximately 200 feet east of the Facility (Figure 35). The adjacent property was selected based on: 1) its close proximity to the Facility; and, 2) its similar land use to the Facility prior to both properties being developed (i.e. agricultural use). The background sampling locations on the adjacent property were from an undisturbed and unused grassy area judged to be representative of natural soil conditions. The background soil samples were collected from similar horizons vertically within the Unconsolidated Unit corresponding to the majority of source area characterization samples collected on the Facility. The background soil borings were drilled during January and February 2004 using direct-push drilling methods. The boring logs for the background soil borings are included in Appendix VIII-C. The locations and results are presented on Figure 35.

Background Soil Sampling Results

At each location, one sample was collected from 0 to 2 feet bgs. Deeper samples, from 6 to 8 feet bgs, were collected at these locations but are not included in the calculations because they represent soil that would be rarely, if ever, encountered as part of background exposures to metals in soil. The concentrations of inorganics in the samples from the 0 to 2 feet bgs interval are the most representative of background exposures to inorganics in soil because the general population encounters soil from this interval more often than deeper soil. The inorganic concentrations in background soil from this interval are summarized in Appendix B of the draft CA725 EI report which also includes summary statistics describing the concentration distributions and the 95% upper confidence limits (UCLs) on the means for site-specific background inorganics.

The UCLs presented are nonparametric bootstrap confidence limits on the mean (Efron and Tibshirani 1998) calculated from 4,000 bootstrap replications and at a 0.05 level of significance. Nonparametric bootstrap statistical limits are more reliable than parametric statistical limits because, unlike parametric limits, they do not rely on assumptions about distribution shapes that are often difficult to justify. Appendix B of the draft CA725 EI Report summarizes the UCLs on the mean background levels of inorganics in the Off-Facility area. Concentrations of inorganics in soil at an AOI that are below these levels are considered to be within background and not site-related; concentrations higher than these levels are considered site-related. The nature and extent of metals detected in soil is presented on Figure 35. A determination will be made during the scoping of Phase II of RFI as to whether or not additional data is needed for soil to determine the nature and extent of contamination at the Facility.

5.3.2 Soil Sampling

During the Phase I RFI, 54 direct-push borings were drilled into the Unconsolidated Unit at the Facility between August 2003 and February 2004, in addition to the 108 borings drilled during the past investigation (Figure 25). All boring locations are shown on the project base map labeled Sheet 1. Media sampled from the Unconsolidated Unit during the Phase I RFI included soil, and water encountered in discontinuous sand seams and sewer backfill. Soil samples collected from the Unconsolidated Unit beneath the Facility were analyzed for a combination of VOCs, SVOCs (including PAHs), and/or metals (arsenic, copper and zinc). If a saturated discontinuous sand seam or sewer backfill was encountered, a separate borehole was installed adjacent to the original boring location to collect a water sample for VOC analysis. In addition, geologic borings were completed in the undeveloped area on the western portion of the Facility to determine the nature and extent of fill material in this area. Sampling intervals were dependent on the purpose and location of the soil boring.

During the Phase I RFI, 80 direct-push borings were drill into the Unconsolidated Unit off of the Facility between July 2003 and February 2004, in addition to the 19 borings drilled during the past investigation (Sheet 1 and Figure 26). Media that were sampled included soil, water present in sand seams and sewer backfill, and ground water from the upper portion of the Cedarville Aquifer. Soil samples from the Unconsolidated Unit off-Facility were collected and analyzed for VOCs. If a saturated sand seam was encountered, a separate borehole was installed adjacent to the original boring location to collect a water sample for VOC analysis. Sampling intervals were dependent on the purpose of the soil boring.

During the off-Facility boring program, soil samples were also collected for laboratory analyses of geological properties and total organic carbon (TOC) following the procedures described in Section 2.3.1.6. Boring logs from the past investigations and Phase I RFI are included in Appendix VIII-C.

Soil Sampling Results

A total of 430 VOC samples, 251 SVOC samples and 253 metals samples were collected from soil on and off of the Facility during the past investigation and the Phase I RFI. The VOC-COIs in soil were determined to consist of PCE, TCE, vinyl chloride, methylene chloride, bromomethane and 1,2-DCP. Only Update III soil VOC data were used to determine the extent of soil COIs. The SVOC-COIs in soil were determined to consist of benzo(a)pyrene, benzo(a)anthracene, benzo(a)fluoranthene, and dibenz(a,h)anthracene. As presented in Section 5.3.1, there are no metals in soil that exceeded a screening criteria. The analytical results for VOCs, SVOCs and metals in soil are presented on Tables 29, 30 and 31, respectively. Figures 36 and 37 present the distribution of COIs in soil that exceed a screening criteria for VOCs and SVOCs, respectively. Although metals are not considered a COI in soil, the nature and extent of metals detected in soil is presented on Figure 35. The nature and extent of COIs in soil has the following characteristics:

- The conceptual distribution of VOC-COIs (PCE, TCE, methylene chloride, bromomethane, vinyl chloride, and 1,2-DCP) in soil is presented on Figure 36 using U.S. EPA Update III data only. The major areas that exceed a risk screening criteria are located: 1) beneath and between Plants 2 and 3; 2) near the southwestern portion of Plant 3; 3) east of Plant 3; 4) adjacent to the storm sewer north of

Plant 3; and, 5) on the northwestern portion of the Facility. These areas of VOC-COIs distribution coincide with SWMUs and AOCs described in Section 4.0. The highest concentration of these VOC-COIs is presented on Table 23. As indicated on Figure 36, a portion of these VOC-COIs will need additional delineation during the Phase II RFI to complete the determination of the nature and extent of contamination in the Unconsolidated Unit.

- The conceptual distribution of SVOC-COIs (benzo(a)pyrene, benzo(a)anthracene, benzo(a)fluoranthene, and dibenz(a,h)anthracene) is presented on Figure 37. Three areas on the Facility exceed screening criteria are located: 1) on the northwestern portion of the Facility; 2) on the southwestern portion of the Facility; and, 3) beneath the east-central portion of Plant 3. These areas of SVOC-COIs distribution coincide with SWMUs and AOCs described in Section 4.0. The highest concentration of these SVOC-COIs is presented on Table 23. As indicated on Figure 37, a portion of these SVOC-COIs will also need additional delineation during the Phase II RFI.
- As indicated on Table 24, the maximum detected concentrations for some VOC and SVOC-COIs in soil exceed the potential for residual amounts of NAPL in soil. These locations in soil are generally limited to the interior of the Facility and isolated within horizons of the silt and clay matrix of the Unconsolidated Unit. Although these constituents do exceed the generic migration to ground water criteria, an effective interim measure is operating at the Facility which is controlling the migration of contaminated ground water off the Facility. As indicated below, COIs have not been identified in a NAPL phase in any water (ground water, sand seams, sewer backfill) beneath the Facility or off the Facility.

5.3.3 Unconsolidated Unit Water Sampling

As described above, water samples were collected from storm sewer backfill and discontinuous sand seams in the Unconsolidated Unit collected during the Phase I RFI. The water sampling results are discussed below.

Sewer Backfill Water Results

A total of 45 VOC samples and seven SVOC samples were collected from sewer backfill monitoring wells on and off of the Facility during the past investigation and the Phase I RFI. In addition, a total of 14 VOC samples were collected from sewer backfill water from direct-push borings on and off the Facility during the RFI Phase I. As presented above and on Table 22, PCE was identified as a COI for an excavation worker exposure to storm sewer backfill on the Facility only. Three monitoring wells are screened in sewer backfill. Two monitoring wells are located on the Facility (MW01-12 screened in the sanitary sewer backfill, and MW01-13 screened in the storm sewer backfill) and one well is located off of the Facility along Dayton Street (MW02-13 screened in the storm sewer backfill). During the Phase I RFI, water samples were collected on a quarterly basis from these monitoring wells.

Additionally, seven remediation injection wells are screened into the storm sewer backfill on the Facility. These wells were utilized for a remediation pilot study conducted during the past voluntary investigation and are therefore not appropriate monitoring wells for the RFI although, water level measurements are recorded on a monthly basis (see hydrographs, Appendix I).

There are no SVOCs in sewer backfill that exceeded a risk-based screening criteria. The analytical results for VOCs and SVOCs in sewer backfill are presented on Tables 32 and 37, respectively. Figure 33 presents the nature and extent of VOCs in sewer backfill; PCE is the only COI that exceed a screening criteria. The nature and extent of PCE in sewer backfill water has the following characteristics:

- Sewer backfill water has the highest concentrations of PCE at MW01-13 located at the northeast corner on the Facility. The maximum detected concentrations of PCE at MW01-13 was 9000 µg/L (February 2000) which is greater than 1 percent of the aqueous phase solubility of PCE although, no recent evidence exists for mobile NAPL in sewer backfill as indicated by the April 2004 sampling event which detected concentrations of PCE at 580 µg/L at MW01-13. This area of contamination in storm sewer backfill water corresponds with an isolated “hot spot” of PCE in soil at the same location identified during the Phase I RFI (Figure 36), and will be further delineated in soil during the Phase II RFI.
- Direct-push water samples collected on Dayton Street indicated that concentrations of VOCs decrease significantly off of the Facility towards the storm sewer outfall at the unnamed creek. The extent of VOCs in the sewer backfill off the Facility was determined by data collected from MW02-12 (Second Quarter 2004), where very low concentrations (2.3 µg/L PCE and 1.0 µg/L TCE) were detected, and with the direct-push water samples collected farther downgradient to the east where no VOCs were detected above the laboratory reporting limit in sewer backfill water (Figure 33).

<u>Discontinuous Sand Seam Water</u>

A total of 55 VOC samples were collected from discontinuous sand seams within the Unconsolidated Unit on and off of the Facility during the past investigation and the Phase I RFI. As presented in Section 5.1.3.6, no COIs were identified in water samples collected from the discontinuous sand seams since risk-based screening criteria for this medium were not exceeded as identified in the draft CA725 EI Report (ENVIRON, 2004). The nature and extent of detected VOCs in discontinuous sand seams on and off of the Facility was defined by water samples collected from direct-push borings (Figure 34). As presented in the conceptual SHM (Section 3.2), sand seams located within the Unconsolidated Unit are discontinuous laterally and are generally no more than six inches to four feet thick (Figure 9). Many of these sand seams were slightly moist to dry. The analytical results for VOCs in saturated sand seams are presented on Table 33. The nature and extent of VOCs in the discontinuous sand seams has the following characteristics:

- The variation in concentrations of VOCs detected in sand seams, and the distribution of sand seams that were encountered support the conclusion that the sand seams are discontinuous and the presence of water is variable in these isolated zones within the Unconsolidated Unit.
- On the Facility, maximum concentrations of PCE were detected at GP01-111 (740 µg/L in a sand seam located in the upper portion of the Unconsolidated Unit, and 54 µg/L in a lower sand seam encountered at this location) at the northeast corner of the Facility. Off the Facility, the maximum concentration of PCE was detected on Dayton Street at GP02-74 (39 µg/L). No VOCs were detected above 1 percent of the aqueous phase solubility limits indicating that NAPL is not expected to be present in sand seams.
- Locations where concentrations of VOCs are detected above the laboratory reporting limit in sand seams are bounded by data that indicates either: 1) no saturated sand seam is present laterally from this location (i.e. GP02-69, GP01-125, GP01-13); or, 2) no concentrations of PCE are detected above the reporting limit in borings adjacent and side-gradient from these locations (i.e. GP02-68, GP02-67, GP02-88, GP02-89, GP02-77, GP02-85, GP01-123).

5.4 Surface Water Sampling

During the Phase I RFI, surface water samples were collected from the unnamed creek located 0.3 miles northeast of the Facility (AOI-4, Figure 23). Surface water at the Facility drains to storm sewers that connect with a main storm sewer line that runs beneath Dayton Street. The Dayton Street storm sewer discharges into the unnamed creek at a concrete outfall (Figure 23). During the past voluntary investigation (Section 1.7.2), surface water samples were collected at the outfall (ST02-05), and at three sampling locations in the unnamed creek shown on Figure 31 (ST02-06, ST02-07, ST02-09). Surface water samples were collected from these locations on a semi-annual basis between January 1999 and November 2001.

During the Phase I RFI, surface water samples were collected from the storm sewer outfall (ST02-05) to confirm the past surface water data. Samples were collected following the methodology described in Section 2.3.6. The results of the confirmation samples were described in TM-2 (Payne Firm, 2003b). The surface water sampling results confirmed the past data (U.S. EPA, 2004a).

Surface Water Sampling Results

A total of 32 samples were collected from surface water of the unnamed creek off of the Facility during the past investigation and Phase I of the RFI. As presented in Section 5.1.3.6, no COIs were identified in surface water. The nature and extent of VOCs in surface water of the unnamed creek (AOI-4), located 0.3 miles northeast of the Facility, was defined by samples collected from the surface water sampling station locations ST02-05 through ST02-07 and ST02-09. The presence of VOC concentrations in the surface water is likely the result of VOC concentrations present in storm sewer water discharging into the unnamed creek (Section 5.3.2.3). The analytical results for VOCs in surface water are presented on

Table 27. The nature and extent of detected VOCs in surface water of the unnamed creek has the following characteristics:

- The extent of VOCs in surface water has been defined by the samples collected during the past investigations, and was confirmed by the samples collected during the Phase I RFI.
- PCE is the primary VOC that is detected most frequently in surface water.
- The maximum concentration of PCE was detected at 75 µg/L in surface water at the storm sewer outfall (ST02-05) to the unnamed creek, and decreased with distance from this location. The most recent detection of PCE at the outfall was 15 µg/L during the First Quarter of 2004. The concentrations of VOCs in surface water are summarized on Table 27. No VOCs were detected above one percent of the aqueous phase solubility limits indicating that NAPL is not expected to be present in surface water.

5.5 Storm Sewer Water Sampling

During the Phase I RFI, water samples were collected from inside the storm sewer beneath Dayton Street (AOI-3A, Figure 30). Samples were collected following the methodology described in Section 2.3.6. During the past voluntary investigation (Section 1.7.2), samples were collected from the storm sewer located on the Facility property, on Dayton Street, and on Omar Circle on a semi-annual basis between January 1999 and November 2001(Figure 30). During the Phase I RFI, storm sewer water samples were collected from the connecting manhole near the northeast corner of the Facility (ST02-03) to confirm the past storm sewer water data. The results of the confirmation samples were described in TM-2 (Payne Firm, 2003b). The storm sewer sampling results confirmed the past data (U.S. EPA, 2004a).

Storm Sewer Water Sampling Results

A total of 25 samples were collected from storm sewer water on and off of the Facility during the past investigation and the Phase I RFI. All storm sewer water samples were collected from the water located inside the storm sewer pipe. As presented in Section 5.1.3.6, no COIs were identified in water samples collected from the storm sewer system. The nature and extent of VOCs in storm sewer water on and off of the Facility (AOI-2A and AOI-3A) was defined by samples collected from the sampling locations ST01-01 through ST01-07 on the Facility, and sampling locations ST02-01 through ST02-04 and ST02-08 off of the Facility (Figure 30). The analytical results for VOCs in storm sewer water are presented on Table 27. The nature and extent of VOCs in the storm sewer water has the following characteristics:

- The presence of VOCs in storm sewer water has been defined by the samples collected during the past investigations, and was confirmed by the samples collected during the Phase I RFI.
- The primary VOCs that are detected in storm sewer water include: PCE, TCE, and cis-1,2-DCE.
- The maximum concentration of PCE, TCE and cis-1,2-DCE were detected at 560 µg/L, 6.9 µg/L and 23 µg/L, respectively in storm sewer water at the location of the connecting storm sewer manhole

near the northeast corner of the Facility (ST02-03), and decreased with distance from this location towards the outfall to the unnamed creek. The most recent detections of First Quarter of 2004 PCE, TCE and cis-1,2-DCE at the connecting storm sewer manhole were 170 µg/L, 6.4B µg/L, and 12 µg/L, respectively. The concentrations of VOCs in storm sewer water are summarized on Table 27. No VOCs were detected above one percent of the aqueous phase solubility limits indicating that NAPL is not expected to be present in storm sewer water.

5.6 Sediment Sampling

During the Phase I RFI, sediment samples were collected from the unnamed creek located 0.3 miles northeast of the Facility (AOI-4, Figure 23). Samples were collected following the methodology described in Section 2.3.7. During the past voluntary investigation (Section 1.7.2), samples were collected from the six sediment sampling locations in the unnamed creek on a semi-annual basis between May 1999 and November 2001 (Figure 32). During that period, two of the five events (May 1999 and December 1999) utilized sample preparation U.S. EPA Method 5035 (Update III) for VOC analysis.

During the Phase I RFI, a sediment sample was collected from the storm sewer outfall (SED02-01) to confirm the past sediment data. The results of the confirmation sample were described in TM-2 (Payne Firm, 2003b). The results of the confirmation sediment sampling confirmed the past sediment data at the storm sewer outfall (U.S. EPA, 2004a).

Sediment Sampling Results

A total of 34 samples were collected from sediment of the unnamed creek off of the Facility during the past investigation and during the Phase I RFI. As presented in Section 5.1.3.6, no COIs were identified in sediment because all detected concentrations were below generic risk-based screening values presented in the draft CA725 EI report. The nature and extent of VOCs within sediment of the unnamed creek (AOI-4) located 0.3 miles northeast of the Facility was defined by samples collected from the sediment sampling station locations SED02-01 through SED02-06 (Figure 32). Concentrations in sediment are likely the result of VOCs detected in surface water form the storm sewer outfall discharging to the unnamed creek (Section 5.3.2.2). The analytical results for VOCs in sediment are presented on Table 28. The nature and extent of VOCs in the sediment of the unnamed creek has the following characteristics:

- The extent of VOCs in sediment has been defined by the sediment samples collected using U.S. EPA Update III methodology for VOC analysis, and was confirmed by the samples collected during the Phase I RFI.
- The primary VOCs that are detected most frequently in sediment include: PCE and cis-1,2-DCE.
- The maximum concentrations of PCE and cis-1,2-DCE were 31 µg/L and 270 µg/L, respectively detected at the storm sewer outfall to the unnamed creek (SED02-01), and decreased with distance from this location. The most recent detections First Quarter of 2004of PCE and cis-1,2-DCE at the

outfall were 3J µg/L and <3.2 µg/L, respectively. The concentrations of VOCs in sediment at the unnamed creek are summarized on Table 24. No VOCs were detected above one percent of the aqueous phase solubility limits indicating that NAPL is not expected to be present in sediment at the unnamed creek.

- The downstream extent of VOCs in sediment has been defined by location SED02-06 (Figure 32).

5.7 Nature and Extent of Ground Water Contamination

Additional Cedarville Aquifer and storm sewer backfill monitoring wells were installed during two phases of the Phase I RFI. 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, West North College Street, West South College Street, and Lawson Place. The entire monitoring well network is presented on Figure 28. The primary objectives of the monitoring well installation program were:

- Collect direct-push ground water samples from the upper portion of the Cedarville Aquifer and water samples from the storm sewer backfill to determine the optimum locations for permanent shallow Cedarville Aquifer and storm sewer backfill monitoring wells, and to assist in the determination of the extent of contamination in the upper Cedarville Aquifer.
- Install monitoring wells into the upper, middle, and lower portions of the Cedarville Aquifer and into storm sewer backfill to determine the nature and extent of contaminants in ground water and sewer backfill.
- Locate monitoring wells immediately downgradient from contaminant source areas identified on the Facility and in the down-dip direction of the bedrock surfaces at: 1) the Unconsolidated Unit/top of the Cedarville bedrock formation; and, 2) the lower Cedarville Aquifer/Osgood Aquitard bedrock surface to provide a sufficient monitoring well network to identify the potential presence and/or extent of ground water contamination in the NAPL phase, if present.
- Determined the potentiometric surfaces in monitoring wells installed in the upper, middle, and lower portions of the Cedarville Aquifer to determine the vertical hydraulic gradient at well cluster locations, generate potentiometric surface maps (i.e. ground water flow direction maps), and to complete a ground water flow model for the Facility.
- Gather additional information to support and/or refine the site hydrogeologic model, and to determine the effectiveness of the two existing ground water extraction wells on the Facility.

5.7.1 Rationale and Scope of Work

During the Phase I RFI, two phases of monitoring well installation were completed. The first phase of well installation occurred between August and September 2003. This initial phase included the installation of eight monitoring wells in the upper, middle, and lower portion of the Cedarville Aquifer and one monitoring well into storm sewer backfill. Upon completion of the first phase of monitoring well installation and subsequent sampling events, additional Cedarville Aquifer monitoring wells were needed to determine the nature and extent of ground water contamination (Payne Firm, 2003c). The location of the additional monitoring wells was proposed to the U.S. EPA in TM-3 (Payne Firm, 2003c) and subsequently refined on a call with the U.S. EPA on February 6, 2004. The second phase of monitoring well installation occurred between January and February 2004, and included the installation of 17 additional monitoring wells in the upper, middle, and lower portions of the Cedarville Aquifer.

Results from direct-push water samples were used to evaluate the optimum locations of sewer backfill monitoring wells and upper Cedarville Aquifer monitoring wells. Boring logs and well construction diagrams are presented in Appendix VIII-C. Well development was completed in accordance with Payne Firm SOPs. Well development forms are presented in Appendix VIII-D. Upon completion, a licensed surveyor located the coordinates and elevations of the well locations (Table 5).

5.7.1.1 RFI Quarterly Monitoring

In accordance with Section VI. Paragraph 13. of the Corrective Action Order, Vernay implemented a quarterly monitoring program in 2003. The current monitoring well network includes 47 monitoring wells and two extraction wells in the Cedarville Aquifer and three monitoring wells in sewer backfill (Figure 28). During the Phase I RFI, a total of seven quarterly monitoring events were conducted. Results of each quarterly monitoring event were presented to the U.S. EPA in quarterly progress reports (Table 1). In addition, TM-3 (Payne Firm, 2003) summarized the results of the quarterly monitoring events conducted in 2003. Laboratory analytical reports from the Phase I RFI are included in Appendix VIII-F.

Before each quarterly sampling event, the following factors were evaluated to determine the sufficiency[2] of data and ground water monitoring wells needed to meet the overall objectives of the RFI:

1. Confirmation that there are no unacceptable risks above appropriate generic risk-based screening levels for which there are complete pathways between “contamination” and human receptors.
2. Confirmation that VOCs in ground water on the fringes of the area of “contamination” are not moving beyond the three-dimensional extent of the plumes, especially at well locations that are critical for demonstrating stability of ground water contaminant migration.
3. Potential influence of seasonal variations in ground water elevation in the Cedarville Aquifer beneath the Facility and the surrounding area.

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[2] “Sufficiency” of data refers to meeting the data quality objectives outlined in Table 3 to define the nature and extent of contamination, support the Human Health and Ground Water Indicator Determinations, Risk Assessment, and the Corrective Measures Evaluation.

4. 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.
5. Data needs to confirm that the existing ground water extraction wells are effectively performing.
6. Confirmation that VOCs, SVOCs, and metals are not migrating onto the Facility from an upgradient source.
7. Determining if Non-Aqueous Phase Liquids (NAPLs) are present in the Cedarville Aquifer, as either evidenced by concentrations above one percent of the aqueous phase solubility limit for the contaminant; or, visual evidence.

These factors are important to understanding concentrations of contaminants 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. Graphs of the results from COIs detected in monitoring wells on and off the Facility are presented in Appendix III.

All monitoring wells in the well network (Figure 28) were sampled for VOCs for all quarterly monitoring events, with the exception of the second quarter in 2003. In addition, SVOCs and metals (arsenic, copper, and chromium) were sampled in all monitoring wells during the first quarter 2003 event. SVOCs were also sampled in select monitoring wells during the second quarter 2003 monitoring event. After the first and second quarter 2003 monitoring events, it was determined there was sufficient data for SVOCs and metals to be excluded in future monitoring events. As a result, discussions and depictions of the nature and extent of contamination in the following sections only addresses VOCs, and more specifically, VOC COIs that were developed following the methodology described in Section 5.1.6.

5.7.2 Cedarville Aquifer Sampling Results

COIs identified in the Cedarville Aquifer include PCE, TCE, and vinyl chloride. Although 1,2-DCP is not identified as a COI in the Cedarville Aquifer, the results of 1,2-DCP are described in this section since it has been identified as an AOC at the Facility (TechLaw, 2001). Graphs of these COIs over time are presented in Appendix III. A summary of Cedarville Aquifer sampling results are described on Sheet 3.

Upper Cedarville Aquifer data were also collected from direct-push borings to assist in the evaluation of the distribution of VOCs and monitoring well placement (Figure 27; Table 34). Based on the quarterly monitoring results and the spatial distribution of monitoring wells horizontally and vertically in the Cedarville Aquifer, and the direct-push ground water results, the vertical and horizontal extent of VOCs have been defined to the laboratory reporting limits in the upper, middle, and lower portion of the Cedarville Aquifer on and off the Facility. Furthermore, no evidence exists at the base of the Cedarville Aquifer for ground water contamination in the DNAPL phase.

A geospatial analysis using sophisticated contouring software (earthVision™) together with professional interpretations have produced three-dimensional nature and extent depictions of COIs in the Cedarville Aquifer, as presented in Figures 38 through 41 and cross sections presented in Appendix IV. Based on ground water flow modeling completed for the RFI (Section 3.0 Appendix VII), the calibrated hydraulic conductivities of the Cedarville Aquifer tend to fall between 60 to 5,500 ft\yr. The higher hydraulic conductivities (shown in warmer colors on Figures 38-41) are generally between 1,000 and 5,500 ft/yr, and form a band that trends from the southwest to the northeast, possibly corresponding with the trend of fracture joints in the area (Warren, 1988; Porges, 1998). This zone of higher hydraulic conductivity is not only consistent with the northeast trending hydraulic gradients, but it is also aligned with the general shape of the contaminant plumes in the Cedarville Aquifer described below.

5.7.2.1 Upper Cedarville Aquifer Sampling Results

A total of 30 monitoring wells are located on and off the Facility in the upper portion of the Cedarville Aquifer. The horizontal extent of COIs has been defined within an area bounded by Dayton Street to the north, Lawson Place to the east, West South College Street to the south, and East Enon Street to the west (Figures 38 through 41). The vertical extent of COIs from the most recent monitoring event (Second Quarter 2004) are plotted for each well on the geologic cross sections included in Appendix IV.

The maximum concentration of COIs and 1,2-DCP detected in the upper Cedarville Aquifer on the Facility, historically and during the most recent quarterly ground water monitoring event (Second Quarter 2004), are listed below with the conservative risk-based screening criteria:

VOCs in the Upper Cedarville Aquifer	Exceedence Criteria On-Facility (µg/L)	Historic Maximum Detected Concentration (µg/L)	(Q2-2004) Maximum Concentration (µg/L)
PCE	5	44,000 (RW01-05)	6,100 (RW01-05)
TCE	5	4,700 (GP01-071/19’)	420 (MW01-06)
Vinyl chloride	2	760 (GP01-068/22’)	23 (MW01-10)
1,2-DCP	5	810 (MW01-02)	360 (MW01-02)

The maximum concentration of COIs and 1,2-DCP detected in the upper Cedarville Aquifer off the Facility, historically and during the most recent quarterly ground water monitoring event (Second Quarter 2004), are listed below:

VOCs in the Upper Cedarville Aquifer	Exceedence Criteria Off-Facility (µg/L)	Historic Maximum Detected Concentration (µg/L)	(Q2-2004) Maximum Concentration (µg/L)
PCE	5	21 (MW02-06)	21 (MW02-06)
TCE	5	26 (GP02-033/24')	6.9 (MW02-09)
Vinyl chloride	2	Below Reporting Limit	Below Reporting Limit
1,2-DCP	5	2.3 (GP02-066/24')	1.5 (MW02-17)

A description of the nature and extent of the COIs and 1,2-DCP in the upper portion of the Cedarville Aquifer is discussed below:

PCE and TCE

- As shown on Figure 38, PCE originates generally from the Plant 3 area, which is consistent with the majority of the soil source of PCE (Section 5.3.2.4, Figure 36). As shown on Figure 39, TCE originates beneath the central portion of the Facility, also consistent with the majority of the soil source of TCE.
- The concentration gradient sharply decreases (one order of magnitude) east of the Facility's eastern property boundary in the downgradient ground water flow direction (Figures 38 and 39). The operation of the two ground water extraction wells on the Facility are creating a capture zone effectively controlling the migration of PCE and TCE off the Facility, as demonstrated by the particle tracking analysis and ground water flow modeling (Appendix VII).
- Approximately 400 feet east and southeast of the Facility, two lobes of PCE and TCE are apparent: 1) east of the Facility, an elongated lobe is oriented northeast beyond Wright Street; and, 2) southeast of the Facility, another elongated lobe exists between the southeast side of Omar Circle and West South College Street. This current distribution of PCE is judged to be the result of pre-pumping ground water flow along a zone of higher hydraulic conductivity in the aquifer (Figures 38 and 39).
- The horizontal extent of PCE and TCE in the upper Cedarville Aquifer has been defined to the laboratory reporting limit (1.0 µg/L) by the existing monitoring well network and the direct-push ground water samples collected beyond the limits of the plume on the One Lawson Place property, Dayton Street and Limestone Street. These plumes have been entirely defined by the existing monitoring well network below a level of concern off the Facility (5.0 µg/L) (see Figures 38 and 39).
- No concentrations above one percent of the aqueous phase solubility limit of TCE have ever been detected, indicating that DNAPL is not expected to be present in the upper Cedarville Aquifer.
- Concentrations above one percent of the aqueous phase solubility limit of PCE have been detected, indicating that DNAPL may exist in the upper Cedarville Aquifer at locations within soil source areas in the central portion of the Facility. Although, detections above the aqueous phase solubility limit of PCE have never been observed in any monitoring well on or off the Facility.

Vinyl Chloride

- The distribution of vinyl chloride at detectable concentrations is much more confined to the Facility (Figure 40). Approximately half of the vinyl chloride distribution is beneath Plant 3, and the other half is located in close proximity to the east of the Facility.
- The contouring of vinyl chloride concentrations from the Fourth Quarter 2004 indicates the entire plume is well within the capture zone produced by the ongoing interim measure at the eastern Facility boundary. The generally circular shape of the vinyl chloride contours closely approximate the shape of the capture zone contours.
- The horizontal extent of vinyl chloride in the upper Cedarville Aquifer has been entirely defined by the existing monitoring well network to the laboratory reporting limit (1.0 µg/L) and below a level of concern (2.0 µg/L) off the Facility.
- No concentrations above one percent of the aqueous phase solubility limit of vinyl chloride have ever been detected, indicating that DNAPL is not expected to be present in the upper Cedarville Aquifer.

1,2-DCP

- The horizontal extent of 1,2-DCP is much different than the other VOC-COIs given the different location of the soil source area on the Facility. The distribution 1,2-DCP in soil (Figure 36) and ground water (Figure 41) originate on the western half of the Facility.
- The concentration gradient sharply decreases (one order of magnitude) east of the Facility's eastern property boundary in the downgradient ground water flow direction from 360 µg/L to 1.5 µg/L and then less than the reporting (Figure 41). The operation of the two ground water extraction wells on the Facility are creating a capture zone effectively controlling the migration of 1,2-DCP off the Facility, as demonstrated by the particle tracking analysis and ground water flow modeling (Appendix VII).
- The horizontal extent of 1,2-DCP in the upper Cedarville Aquifer has been defined to the laboratory reporting limit (1.0 µg/L) by the existing monitoring well network and the direct-push ground water samples collected along Dayton Street to the north and on the eastern boundary of the 825 Dayton Street property (Figure 41). The 1,2-DCP plume has been entirely defined by the existing monitoring well network below a level of concern (5.0 µg/L) off the Facility (see Figures 38 and 39).
- No concentrations above one percent of the aqueous phase solubility limit of 1,2-DCP have ever been detected, indicating that DNAPL is not expected to be present in the upper Cedarville Aquifer.

5.7.2.2 Middle Cedarville Aquifer Sampling Results

A total of 15 monitoring wells are located on and off of the Facility in the middle portion of the Cedarville Aquifer and are paired with an upper Cedarville Aquifer monitoring well. Additionally, the two extraction wells on the Facility are screened across the middle portion of the Cedarville Aquifer. Vinyl chloride and 1,2-DCP were not detected in any of the middle Cedarville Aquifer monitoring wells.

The vertical extent of COIs from the most recent monitoring event (Second Quarter 2004) are plotted for each well on the geologic cross sections included in Appendix IV. The horizontal extent of PCE and TCE has been entirely defined by the existing middle Cedarville Aquifer monitoring well network to the laboratory reporting limit (1.0 µg/L) and below the level of concern (5.0 µg/L) off the Facility (Figures 38 and 39). The geometry of this distribution is circular and bounded horizontally by Dayton Street, Wright Street, and the southern portion of Omar Circle. These circular distributions appear to follow the general shape of the capture zone opposed to following the northeast trending zone of higher hydraulic conductivity in the aquifer.

The maximum concentration of COIs and 1,2-DCP detected in the middle Cedarville Aquifer on the Facility, historically and during the most recent quarterly ground water monitoring event (Second Quarter 2004), are listed below with the conservative risk-based screening criteria:

VOCs in the Middle Cedarville Aquifer	Exceedence Criteria On-Facility (µg/L)	Historic Maximum Detected Concentration (µg/L)	(Q2-2004) Maximum Concentration (µg/L)
PCE	5	2300 (MW01-04CD)	330 (MW01-04CD)
TCE	5	31 (MW01-04CD)	Below Reporting Limit
Vinyl chloride	2	Below Reporting Limit	Below Reporting Limit
1,2-DCP	5	11 (MW01-05CD)	Below Reporting Limit

The maximum concentration of COIs and 1,2-DCP detected in the middle Cedarville Aquifer off the Facility, historically and during the most recent quarterly ground water monitoring event (Second Quarter 2004), are listed below with the conservative risk-based screening criteria:

VOCs in the Middle Cedarville Aquifer	Exceedence Criteria Off-Facility (µg/L)	Historic Maximum Detected Concentration (µg/L)	(Q2-2004) Maximum Concentration (µg/L)
PCE	5	120 (MW02-08CD)	120 (MW02-08CD)
TCE	5	44 (MW02-08CD)	44 (MW02-08CD)
Vinyl chloride	2	Below Reporting Limit	Below Reporting Limit
1,2-DCP	5	Below Reporting Limit	Below Reporting Limit

The maximum concentrations of PCE and TCE detected in the middle Cedarville Aquifer monitoring wells during the most recent quarterly ground water monitoring event (Second Quarter 2004) are much less than those detected in the upper portion of the Cedarville Aquifer (Table 35), with the exception of the MW02-08 cluster located along the approximate centerline of the plumes where a slight increasing trend is observed (Figures 38 and 39). This indicates a decreasing concentration gradient between the upper and middle portion of the Cedarville Aquifer as presented graphically on cross sections in Appendix IV.

As indicated on the tables above, PCE was detected in one monitoring well on the Facility (MW01-04CD) at concentrations slightly above one percent of the aqueous phase solubility for PCE. This location is the approximate centerline of the PCE plume in the downgradient direction of impacted soils. Similar to the upper Cedarville Aquifer, detections above the aqueous phase solubility limit of PCE have never been observed in any monitoring well in the middle Cedarville Aquifer on or off the Facility. Detections of the remaining COIs have been far below one percent of the DNAPL phase solubility limits, indicating that DNAPLs are not expected to be present in the middle Cedarville Aquifer.

5.7.2.3 Lower Cedarville Aquifer Sampling Results

A total of five monitoring wells are located on and off the Facility in the lower portion of the Cedarville Aquifer. During the most recent sampling events from the Second Quarter 2004 (April and May), no concentrations of COIs were detected above the laboratory reporting limit (1.0 µg/L). These recent sampling events indicate the vertical extent of contamination throughout the entire Cedarville Aquifer at and in the vicinity of the Facility has been determined to the laboratory reporting limit (1.0 µg/L). As a general rule, the plume concentrations in the vicinity of DNAPL will be at least one percent of the solubility of the constituent. If DNAPL were present for PCE, TCE, vinyl chloride or 1,2-DCP, this would result in monitoring well concentrations in excess of 1,503 µg/L, 11,000 µg/L, 27,600 µg/L and 35,000 µg/L, respectively. As shown on the tables below, TCE, vinyl chloride and 1,2-DCP were all below the laboratory reporting limit and the maximum PCE detected was 3 µg/L.

The maximum concentration of COIs and 1,2-DCP detected in the lower Cedarville Aquifer on the Facility, historically and during the most recent quarterly ground water monitoring event (Second Quarter 2004), are listed below with the conservative risk-based screening criteria:

VOCs in the Lower Cedarville Aquifer	Exceedence Criteria On-Facility (µg/L)	(Q1-2004) Maximum Detected Concentration (µg/L)	(Q2-2004) Maximum Concentration (µg/L)
PCE	5	3 (MW01-04SE)	Below Reporting Limit
TCE	5	Below Reporting Limit	Below Reporting Limit
Vinyl chloride	2	Below Reporting Limit	Below Reporting Limit
1,2-DCP	5	Below Reporting Limit	Below Reporting Limit

The maximum concentration of COIs and 1,2-DCP detected in the lower Cedarville Aquifer off the Facility, historically and during the most recent quarterly ground water monitoring event (Second Quarter 2004), are listed below with the conservative risk-based screening criteria:

VOCs in the Lower Cedarville Aquifer	Exceedence Criteria Off-Facility (µg/L)	Historic Maximum Detected Concentration (µg/L)	(Q2-2004) Maximum Concentration (µg/L)
PCE	5	2.7 (MW02-03SE)	Below Reporting Limit
TCE	5	Below Reporting Limit	Below Reporting Limit
Vinyl chloride	2	Below Reporting Limit	Below Reporting Limit
1,2-DCP	5	Below Reporting Limit	Below Reporting Limit

As indicated above, historic maximum detected concentrations of PCE in the lower Cedarville Aquifer were reported slightly above the laboratory reporting limit at MW01-04SE (3.0 µg/L) and MW02-03SE (2.7 µg/L). This may be the result of sample collection and analysis within the same one-month period as the drilling and installation of MW01-04SE. The location of MW01-04SE is at the southeast corner of the Facility where elevated concentrations (>1000 µg/L) of PCE have been detected in the past within the upper and middle Cedarville Aquifer. It is interpreted the short term detections in these two lower Cedarville Aquifer monitoring wells were a direct result of disturbing the rock matrix during the drilling and well installation of MW01-04SE. When these wells were sampled on a more frequent basis (monthly), the results showed no PCE (or VOCs) detected above a laboratory reporting limit (see Table 35 and Appendix IV), indicating the initial detections were a most likely a representation of the short-term disturbance of the in-situ formation ground water. All five lower Cedarville Aquifer monitoring wells are being sampled on a monthly schedule to confirm this trend of no VOC detections in the lower Cedarville Aquifer.

5.7.3 Summary Nature and Extent of Contamination in the Cedarville Aquifer

The lateral and vertical distributions of are VOCs detected in the Cedarville Aquifer 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 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(s) will contract at some point downgradient of the Facility because the degree of chemical degradation exceeds the degree of downgradient chemical flux.

The following conclusions have been made regarding the nature and extent of contamination in the Cedarville Aquifer:

- The horizontal and vertical extent of contamination in the Cedarville Aquifer (upper, middle and lower) has been determined during the Phase I RFI from the existing monitoring well network and direct-push water samples.

- The nature and extent determination was supported using sophisticated contouring software in conjunction with ground water flow modeling and scientific interpretations.
- The horizontal distribution of contamination is bounded by Dayton Street, Lawson Place, West South College Street, and East Enon Street. The shape of the distribution of VOCs in the upper portion of the Cedarville Aquifer is narrowed due to the ongoing pumping from the two ground water extraction wells on the Facility and the preferential pathway caused by the northeast trending zone of higher hydraulic conductivity of the aquifer.
- In general, VOC concentrations decrease from the upper to the lower portion of the aquifer to the laboratory reporting limit. The lack of vertical hydraulic gradient (Section 3.2.3), and slight upward hydraulic gradient, is likely causing reducing VOC concentrations with depth in the Cedarville Aquifer.
- Evidence from the existing monitoring well network indicates that DNAPLs are not expected to be present in the middle and lower portions of the Cedarville Aquifer. DNAPLs are likely to be present in the upper portion of the Cedarville Aquifer in the central portion of the Facility near RW-5.

6.0 PHASE I RFI RISK EVALUATIONS

As presented in Section 1.1, the primary objective of the Vernay RFI is to identify the nature and extent of any releases of hazardous waste or hazardous constituents at or from the Facility which may pose an unacceptable risk to human health and the environment. The information collected during the RFI will identify the presence, movement, fate, and risks associated with contamination from the Facility and will determine the chemical and physical properties of the Facility likely to influence contaminant migration and cleanup. A baseline risk assessment will be conducted during the Phase II RFI that will determine if corrective measures are necessary and provide the justification for performing remedial measures.

During the Phase I RFI, several tasks were conducted to support the baseline risk assessment and evaluations made during the RFI, as documented in this report. These tasks included the following:

- Development of a Conceptual Site Model (CSM) for Human Health and Ecological Exposures.
- Development of risk-screening criteria for current human exposures and/or contaminant migration to ground water.
- Completion of risk-based screening of past data.
- Development of the RFI sampling list.
- Completion of a water well survey and sampling event.
- Completion of the Human Health Environmental Indicator (CA725).

6.1 Conceptual Site Model for Human and Ecological Exposures

A conceptual site model (CSM) for human and ecological exposures was prepared by ENVIRON, and is summarized on Tables 16 and 17, and was discussed in Section 3.9.

6.2 Risk-Screening for Current Human Exposures and/or Contaminant Migration to Ground Water

Conservative risk-based screening criteria that are appropriate for each environmental medium and receptor identified for the Facility (Section 3.9) have been assembled for use in identifying a potential need for additional sampling in the RFI to support a reliable estimate of exposure concentration. In addition to human exposures, soil contamination migrating to ground water was initially evaluated. These risk-screening criteria were discussed in detail is Section 5.0

The results of the risk-based screening evaluation of the past data indicated that additional data was needed to complete the RFI. The additional data needed for the RFI as a result of the risk-based screening evaluation was described in Section 5.0. The results of the data that were collected during Phase I of the RFI were also presented in Section 5.0.

6.3 Development of a RFI Sampling List

In the early stages of the Phase I RFI, a Facility-specific RFI sampling list was developed. The Payne Firm (2003a) submitted TM-1 to the USEPA that presented the sampling list of chemicals for the RFI. The methodology and rational in developing the site-specific sampling list was described in TM-1, and is summarized in Section 5.0

6.4 Water Well Survey

A water well survey was conducted during the Phase I RFI. The main objective of the water well survey was to collect information to make the appropriate determinations required by the CA725 EI report. A summary of the water well survey is presented in Section 3.6, and the water well survey report is presented in Appendix VI. It was determined that current human exposures to identified water wells were under control.

6.5 CA725 Environmental Indicator Report

During the Phase I RFI, a draft CA725 EI report was completed in accordance with Paragraph 17 of the Corrective Action Order (ENVIRON, 2004). The CA725 EI is an assessment of actual current human risks and is in the form of a qualitative assessment of the completeness of exposure pathways. The purpose of the report is to support the conclusion that all current human exposures to contamination at or from the Facility are under control. The format and content of the draft CA725 EI report were based on the main sections of the U.S. EPA's CA725 form, including 1) information reviewed; 2) presence of contamination; 3) exposure pathways; and 4) significance of potential exposures.

ENVIRON (2004) concluded that concentrations of constituents in the following media are considered to meet the CA725 EI definition of "contaminated" when the highest constituent concentrations in these media are compared with generic risk-based screening criteria:

- Soil in several on-Facility areas.
- Soil in off-Facility sewer line areas.
- Surface water in the off-Facility Unnamed Creek.
- Unconsolidated Unit subsurface water (sewer backfill) and Cedarville Aquifer ground water in on-Facility areas.
- Cedarville Aquifer ground water in off-Facility areas.

However, taking into consideration the likelihood of complete exposure pathways, current site-specific conditions, and cumulative cancer risk and non-cancer HI values compared to U.S. EPA's established acceptable risk goals, it was determined that current human exposures to constituent concentrations in these media are under control according to the provisions of CA725.

6.6 Additional Risk Evaluation Needs

During Phase II of the RFI, additional evaluations will be conducted to support the baseline risk assessment. These evaluations will include fate and transport modeling of ground water concentrations, and site-specific leach-based modeling of VOCs in the Unconsolidated Unit migrating to ground water. The fate and transport modeling of ground water VOC concentrations in the Cedarville Aquifer will be conducted to predict future distributions of these compounds in the Cedarville Aquifer, including degradation of ground water plumes. Leach-based modeling will be conducted to support the assessment of the potential significance of contaminant migration from soil to ground water, and the evaluation of corrective measures.

7.0 PHASE I RFI SUMMARY AND RECOMMENDATIONS

7.1 Phase I RFI Summary

The primary objectives of the Phase I RFI were to determine the nature and extent of any releases of hazardous waste or hazardous constituents at or from the Facility posing an unacceptable risk to human health and the environment for: 1) ground water in the Cedarville Aquifer; and, 2) water in storm sewer backfill. During the Phase I RFI eleven task specific statement of works were prepared and reviewed by the U.S. EPA. Table 4 shows the project SOWs that were prepared during each step of the Phase I RFI, the data needs that were addressed by the tasks associated with each project SOW, and documents and other outputs that were prepared to present the results of the tasks.

Other objectives of the Phase I RFI included:

- Determining the nature and extent of contamination at or from the Facility in soil, surface water and sediment, storm sewer water, discontinuous sand seams and indoor air.
- Completion of an evaluation of potential soil interim measures on the Facility.
- Construction and operation of a second ground water extraction well on the Facility; and, an evaluation of the effectiveness of the two extraction wells located on the Facility.
- Quarterly ground water sampling.
- Completion of a water well survey in the vicinity of the Facility.
- Completion of a ground water flow model.
- Collection of information for the RCRA Corrective Action Environmental Indicator (EI) for Current Human Exposures Under Control (CA725).
- Determining if an investigation of the Brassfield Aquifer is necessary during Phase II of the RFI.

Based on the Phase I RFI results, recommendations are provided to the U.S. EPA regarding data needs for Phase II of the RFI including: 1) the investigation of a deeper aquifer beneath the Facility (Brassfield Aquifer); and, 2) additional soil borings to determine the nature and extent of soil contamination; along with completion of contaminant fate and transport modeling, the baseline risk assessment, quarterly ground water monitoring, and any other hydrogeologic characterizations that the U.S. EPA believes is necessary.

7.1.1 Phase I RFI Tasks Completed

Several tasks were completed during the Phase I RFI (Section 2.0) to meet the objectives described above and to support evaluations made during the Phase I RFI, as well as to support the future baseline risk assessment and corrective measures evaluation. These tasks included:

- Completion of a Current Conditions Report;
- Installation and operation of ground water interim measures;
- Development of a Conceptual Site Model (CSM) for human health and ecological exposures;
- Completion of risk-based screening of past and Phase I RFI data;
- Determination of Contaminants of Interest (COIs);
- Development of the RFI sampling list;
- Confirmation sampling;
- Development of Areas of Interest (AOIs);
- Installation of additional monitoring wells into the Cedarville Aquifer and sewer backfill;
- Six quarterly monitoring events;
- Sampling of indoor air, surface water and sediment, storm sewer water, subsurface water (sewer backfill and discontinuous sand seams), Cedarville Aquifer ground water and collecting geologic properties data;
- Completion of a water well survey and sampling event; and
- Completion of the Human Health Environmental Indicator Determination (CA725).

Other interim documents were prepared during the Phase I RFI that reported activities completed during the Phase I RFI, including: quarterly progress reports, task-specific Statements of Work, a RCRA Project QAPP, four technical memoranda, and the draft CA725 EI Report. At the request of the U.S. EPA, a draft CA725 report was submitted on April 9, 2004 (ENVIRON, 2004). Consistent with recent comments from the U.S. EPA (June 2004), the final CA725 EI report will be submitted on or before July 15, 2004.

7.1.2 Phase I RFI Results

As discussed in Section 2.0, data collected during the Phase I RFI are consistent with the DQOs for the RFI and were collected following the project QAPP. A Conceptual Site Hydrogeologic Model (SHM) was presented in Section 3.0 identifying the physical properties and spatial orientation of the geologic units within the SHM, and the potential contaminant migration pathways within and out of the SHM. Limited pathways exist for contaminants to migrate via ground water out of the SHM, based on direct observations and regional information to the conceptual SHM.

The nature and extent of contaminants of contamination in soil, Cedarville Aquifer ground water and sewer backfill water were investigated during the Phase I RFI; the results and conclusions of these investigations were presented in Section 5.0. To determine the nature and extent of contamination of past data and RFI data, and to assess if any additional data are needed for the Phase II RFI, "Contaminants of Interest" (COIs) were developed based on the lowest exceedence of either the generic risk-based screening criteria presented in the draft CA725 EI report, or the migration to ground water screening criteria. This was conducted as a conservative method to make judgments about whether or not the determination of the nature and extent of contamination, particularly for soil and ground water, was sufficient to meet the objectives of the RFI; and, to depict the nature and extent of contamination.

Based on conservative risk-based screening criteria, the nature and extent of contamination in surface water and sediment, discontinuous sand seams, storm sewer water has been defined. The nature and extent of contamination has also been defined horizontally and vertically in the upper, middle and lower portions of the Cedarville Aquifer and in sewer backfill water on and off the Facility. All ground water COIs have been defined to the project laboratory's reporting limits (i.e. practical quantitation limit). The results of the CA725 evaluation concluded that current human exposures to contaminated media are under control, including potential exposure to indoor air at the Facility.

7.1.2.1 Nature and Extent of Contamination in Soil and Sewer Backfill

As a result of the Phase I RFI, the following conclusions have been made regarding the nature and extent of contamination in soil and sewer backfill:

- The nature and extent of contamination has been determined in storm sewer water, sewer backfill, sediment, and discontinuous sand seams with the Unconsolidated Unit.
- In addition, there are no current unacceptable risks to potential receptors on the Facility contaminant vapors.
- Based on sampling results through the Second Quarter 2004, the current 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.
- PCE was identified as a COI in storm sewer backfill on the Facility at levels exceeding the excavation worker exposure screening criteria. PCE in sewer backfill has been defined to the laboratory reporting limit both horizontally and vertically.
- Six VOC-COIs (PCE, TCE, bromomethane, methylene chloride, vinyl chloride, and 1,2-DCP) and four SVOC-COIs (benzo(a)pryrene , benzo(a)anthracene, benzo(a)fluoranthene, and dibenz(a,h)anthracene) were identified in soil based on comparison with conservative screening criteria.
- The primary areas of VOC and SVOC-COIs are located in the central portion of the Facility (between and beneath Plants 2 and 3), near the southwest corner of Plant 3, adjacent to the storm sewer located north of Plant 3, and on the western portion of the Facility near AOC E. The nature and extent of contamination in soil has not fully been delineated on and off the Facility.

7.1.2.2 Nature and Extent of Contamination in Cedarville Aquifer Ground Water

As a result of the Phase I RFI, the following conclusions have been made regarding the nature and extent of contamination in the Cedarville Aquifer:

- Based on sampling results through the Second Quarter 2004, the current monitoring well network in the Cedarville Aquifer is sufficient to determine the nature and extent of contamination within this media on and off of the Facility. The Cedarville Aquifer is contaminated with VOCs. The aquifer is not contaminated with SVOCs and metals.
- The horizontal and vertical extent of contamination in the Cedarville Aquifer (upper, middle and lower) has been determined during the Phase I RFI using the current monitoring well network and direct-push water samples. The nature and extent determination was supported using direct field measurements, and sophisticated contouring software in conjunction with calibrated ground water flow modeling and scientific interpretations.
- The horizontal distribution of VOCs in the Cedarville Aquifer is located within the limits of Dayton Street, Lawson Place, WS College Street, and East Enon Street. The shape of the distribution of VOCs in the upper portion of the Cedarville Aquifer has narrowed due to the pumping from the two Facility extraction wells and the preferential pathway caused by the northeast trending zone of higher hydraulic conductivity identified in the Cedarville Aquifer.
- In general, VOC concentrations decrease to the laboratory reporting limit from the upper to the lower portion of the aquifer. The lack of vertical hydraulic gradient over most of the aquifer, and slight upward hydraulic gradient over portions of the aquifer, may be influencing the reduction of VOC concentrations at depth in the Cedarville Aquifer.
- Evidence from the existing monitoring well network indicates that DNAPL is not expected to be present in the middle and lower portions of the Cedarville Aquifer. It is possible that DNAPL exists in the upper portion of the Cedarville Aquifer beneath the central portion of 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.

7.1.2.3 Efficacy of Ground Water Interim Measures

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

- Based on the results of the calibrated ground water flow model and particle tracking analysis completed during the Phase I RFI, the capture zone of the interim measure 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.

7.2 Phase II RFI Recommendations

As recommended below, Phase II of the RFI does not include an investigation of a deeper aquifer (Brassfield Aquifer) based on the lack of VOCs (nor evidence for DNAPL) in the lower Cedarville Aquifer, the presence of an upward hydraulic gradient from the lower to the upper Cedarville Aquifer, the presence low permeability rocks and thickness of the Osgood Aquitard (70 to 100 feet), and a recent hydrogeologic characterization completed at a nearby Facility (YSI, Inc.) downgradient of the Vernay Facility which confirmed the confined nature and lack of VOCs in the Brassfield Aquifer.

Also recommended below, other hydrogeologic characterization during Phase II of the RFI needs to consist of completing a determination of the nature and extent of contamination in soil on and off the Facility, an assessment of the fate and transport of contaminants from the Facility, quarterly monitoring, and completion of the human health and ecological baseline risk assessment. Consistent with the Corrective Action Order, a Phase II RFI report will be submitted to the U.S. EPA by December 31, 2004.

7.2.1 Cedarville Aquifer and Storm Sewer Backfill

During the Phase II RFI, additional quarterly ground water monitoring in the Cedarville Aquifer and sewer backfill should be conducted during the Phase II RFI. The ground water monitoring will be focused on gathering sufficient data to support the RCRA Migration of Contaminated Ground Water Under Control Environmental Indicator (CA750). Continued monitoring of the existing ground water extraction well interim measure efficacy will also be conducted during the Phase II RFI.

7.2.2 Brassfield Aquifer

Based on the following rationale, investigation of the lower Brassfield Aquifer is not recommended during the Phase II RFI for the following reasons:

- The horizontal and vertical extent of contamination in the upper aquifer (Cedarville Aquifer) on and off the Facility has been determined during the Phase I RFI using the existing monitoring well network and direct-push water samples.
- A sufficient monitoring well network currently exists at the base of the Cedarville Aquifer to detect the presence of VOCs and evidence for potential DNAPL migration. All five lower Cedarville Aquifer monitoring wells, and the second Facility extraction well (CW01-02), are located in the down-dip direction on the top of the aquitard bedrock surface, the wells are screened at least one foot into the underlying shale of the aquitard and are located in the downgradient flow directions away from any soil source area on the Facility.
- Analytical data from the existing monitoring well network confirm that DNAPL(s) are not present in the lower Cedarville Aquifer/Osgood Aquitard surface. In fact, VOCs have not been detected above

the laboratory reporting limit in any of the lower Cedarville Aquifer monitoring wells from multiple sampling events and most recently, the Second Quarter 2004.

- A lack of vertical hydraulic gradient, and slight upward hydraulic gradient was measured consistently over time in the Cedarville Aquifer, therefore inhibiting downward migration of VOCs to the base of the Cedarville Aquifer and beyond.
- Locally, the upper and lower aquifers are separated by 70 to 100 feet of dense, low permeable carbonate and shale lithology (Osgood and Brassfield Aquitards). The presence of these low permeable formations that comprise the aquitards, in concert with the upward hydraulic gradient measured in the Cedarville Aquifer above, would further inhibit the downward migration of VOCs (if present). The confined Brassfield Aquifer is located approximately 200 feet below the surface in the vicinity of the Facility.
- A recent hydrogeologic characterization of the Brassfield Aquifer was conducted by YSI, Inc. at its Facility, which is located less than one mile downgradient of the Vernay Facility. Data from six monitoring wells in the Brassfield Aquifer, clustered adjacent to Cedarville Aquifer monitoring wells, have confirmed: 1) the thickness and low permeability nature of the aquitard; 2) the apparent confined nature of the Brassfield Aquifer; 3) a nearly flat to slight southeasterly flow direction in the Brassfield Aquifer; 4) no observed hydraulic communication between aquifers; and, 5) no detections of the COIs identified at the Vernay Facility.
- Within the limits of the well survey conducted by Vernay during the Phase I RFI, water wells were not identified in the Brassfield Aquifer.
- As depicted on Sheet 2, the Cedarville Aquifer, Osgood Aquitard, Brassfield Aquitard, and the Brassfield Aquifer outcrop at the Yellow Springs gorge or into overlying glacial deposits south-southeast of the Facility. This significantly reduces the possibility that contaminants emanating from the Facility will impact the Village of Yellow Springs well field located approximately 2.5 miles southeast of the Facility.

7.2.3 Additional Hydrogeologic Characterization

The recommended activities are necessary to support the additional hydrogeologic characterization during the Phase II RFI:

- Given that the past Update II soil VOC analytical data can only be used for qualitative purposes (U.S. EPA, 2004c), additional soil VOC analytical data using Update III (Method 5035) must be obtained to determine the nature and extent of contamination in soil on and off the Facility. Additional soil SVOC data must also be collected during the Phase II RFI in order to complete the nature and extent characterization in soil on and off the Facility.
- Collect sufficient data of adequate technical quality for all contaminated media and biota necessary to perform an evaluation of the fate and transport of contaminants released at, and emanating from, the Facility.

On completion of the Phase II RFI field activities, an assessment of potential current and future risks to human and ecological receptors will be conducted as part of the baseline risk assessment. In support of the risk assessment, fate and transport of Cedarville Aquifer ground water modeling and vadose zone leaching modeling will be conducted as appropriate to support the CA750 and evaluation of corrective remedial measures for the Facility. Consistent with the Corrective Action Order, the CA750 EI report and corrective measures evaluation will be prepared after the RFI is complete.

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