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**VIA FEDERAL EXPRESS**

November 4, 2005

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

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

Reference: Facility Investigation Phase II Report  
Vernay Laboratories, Inc.  
Yellow Springs, Ohio  
Project No. 0292.11.39

Dear Ms. Polston:

The Payne Firm, Inc. is pleased to submit, on behalf of Vernay Laboratories, Inc., the attached Resource Conservation and Recovery Act Corrective Action Facility Investigation Phase II Report, Revision 1 (RFI Phase II Report, Revision 1), as agreed to by the Administrative Order on Consent journalized by the United States Environmental Protection Agency on September 27, 2002. An electronic version of this RFI Phase II Report is also included on a CD-Rom in Appendix VIII of the report.

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

Sincerely,

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Mr. David Back  
Mr. Mark Nielsen - Battelle Memorial Institute

**U.S. EPA RCRA CORRECTIVE ACTION  
FACILITY INVESTIGATION  
PHASE II REPORT**

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

**OHD 004 243 002**

**Volume 1  
Text, Tables, Figures**

Project No. 0292.11.39

December 20, 2004  
Revision 1 - October 13, 2005

Prepared For



**VERNAY LABORATORIES, INC.  
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Prepared By



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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 (U.S. EPA, 2002). 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.

The original Phase II RFI report (Revision 0) is dated December 20, 2004, and was submitted to the U.S. EPA on December 22, 2004. Between December 22, 2004 and October 11, 2005, the U.S. EPA provided to Vernay comments to the December 20, 2004 Phase II report. This revision (Revision 1) of the Phase II RFI report dated October 13, 2005 addresses the U.S. EPA comments. Substantive changes made to the December 20, 2004 Phase II RFI report include the following sections:

- Executive Summary
  - Baseline Risk Assessments
  - Overall Phase II RFI Conclusions
- Section 3.0-RFI Results and Evaluation
  - Introduction section
  - Section 3.1.2-Vapor Intrusion
  - Section 3.2.3-Vapor Intrusion
  - Section 3.3.2-Vapor Intrusion
  - Section 3.6-Indoor Air Screening Criteria
  - Section 3.7-Interpretation of Screening Results
- Section 5.0-Baseline Human Health Risk Assessment
  - Section 5.2.1-Data Collection
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  - Section 5.5.2.1-Indoor Air Exposures
  - Section 5.7-Summary and Conclusions
- Section 7.0-Phase II RFI Summary
  - Section 7.1.2.4-Baseline Risk Evaluations



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This report documents the results of Phase II of the RFI that Vernay conducted at the Facility and supplements the Phase I RFI (Payne Firm et al., 2004) that was completed on June 29, 2004. Phase I of the RFI focused on defining the nature and extent of hazardous waste and hazardous substances at the Facility and areas in the vicinity of the Facility, determining if there were any current risks to human health and the environment that needed to be mitigated in the short-term, as well as the development of a ground water flow model for the Cedarville Aquifer located beneath the Facility and the surrounding area. In a letter dated October 15, 2004, the U.S. EPA approved the RFI Phase I report and agreed the report addressed the nature and extent of contamination for surface water (including the storm sewer), sediment, saturated sand seams, sewer backfill, and ground water of the Cedarville Aquifer, but acknowledged full additional definition of soil contamination was needed during the Phase II RFI. Furthermore, the U.S. EPA agreed on a final determination concerning the potential investigation of the Brassfield Aquifer during the Phase II RFI. In the approval letter, the U.S. EPA stated that, “Based on the RFI Phase I Report, it appears an investigation of the deeper aquifer (Brassfield Aquifer) will not be required at this time.”

The approval of the Phase I RFI report was preceded by the U.S. EPA’s approval of the Current Human Exposures Under Control Environmental Indicator Report (CA725), on September 29, 2004, which demonstrated that adequate protective controls are in place to prevent unacceptable human exposures under current conditions. In the Phase I RFI approval letter, the U.S. EPA also agreed with Vernay’s recommendations for the Phase II scope of work to address the nature and extent of contamination in soil, complete an assessment of the fate and transport of contamination from the Facility in the Cedarville Aquifer, continuation of quarterly monitoring, continued monitoring of the effectiveness of the ground water capture zone and completion of the human health and ecological baseline risk assessment.

#### Phase II RFI Scope of Work

Phase II of the RFI focused on completing the characterization of the nature and extent of contamination in soil, assessing the fate and transport of contaminants detected in the Cedarville Aquifer, and assessing the potential site-related human health and the environment risks associated with current and reasonably likely exposures to contaminated media. Information presented in the Phase I and Phase II RFI reports will be used to complete the Migration of Contaminated Ground Water Under Control (CA750) report, and to evaluate corrective measures needed to mitigate potentially unacceptable risks associated with releases of hazardous waste and hazardous substances detected at and in the vicinity of the Facility.

Phase II of the RFI consisted of the following tasks:

- Field activities to support the determination of the nature and extent of contamination in soil beneath the Facility.



- Field activities to support continuation of quarterly ground water monitoring.
- Field and modeling activities to support the continued evaluation of the efficacy of ground water interim measures.
- Modeling activities to support an assessment of the fate and transport of contaminants in the Cedarville Aquifer from the Facility and the completion of the baseline human health and ecological risk assessments
- Evaluation of hypothetical human health and ecological risks associated with potential current and reasonably likely future exposures to environmental media contaminated by releases of hazardous waste and hazardous constituents from the Facility.

### Baseline Risk Assessments

The primary objective of the Vernay RFI is to characterize the nature and extent of any releases of hazardous waste or hazardous constituents at or from the Facility, and to assess the potential significance of hypothetical risks associated with potential current and reasonably likely future human and ecological exposures to these released hazardous wastes or hazardous constituents. To characterize the hypothetical risks associated with identified releases, human health and ecological risk assessments were conducted by ENVIRON International Corporation (ENVIRON) during the Phase II RFI.

The human health risk assessment discussed in this report uses the site characterization data that have been collected during the RFI field investigation to evaluate the potential significance of reasonable maximum exposures under current and reasonably expected future land use and ground water use at and around the Vernay Facility. As discussed in the *Resource Conservation and Recovery Act CA725 Environmental Indicators Report* (“CA725 EI Report”) ENVIRON and Payne Firm, 2004), based on data collected as part of the RFI, and considering potential exposure pathways and site-specific conditions, current human exposures were determined to be under control according to the provisions of the CA725. Therefore, the results of the risk assessment presented in this Phase II RFI Report are used to identify where a release of hazardous waste or constituents from the Facility may cause reasonable maximum exposures to be significant enough in the future to warrant corrective measures. The significance of potential human exposures is determined by comparing estimates of site-related cumulative cancer and noncancer risks with a cancer risk limit of  $10^{-4}$  and a Hazard Index (HI) limit of 1, respectively, which U.S. EPA has established as triggers for corrective measures under RCRA corrective action (U.S. EPA 1991b).

Based on the information regarding land use and ground water use at and around the Facility assembled during the RFI, the potentially exposed populations under reasonably expected future land use include on-Facility routine workers, construction workers and trespassers. Off-facility receptors include residents and construction workers. The significance of potential exposures to concentrations of constituents in soil, ground water, sediment, surface water and indoor air, is evaluated based on conservative estimates of reasonable maximum exposures under reasonably expected future land use and ground water use.



### **Routine Workers**

The risk assessment evaluated potential future exposures to outdoor soil at the Facility via incidental ingestion, dermal contact, and inhalation of vapors and particulates. Potential exposure via inhalation of soil and ground water constituents assuming that they volatilize and migrate through cracks in building foundations was also evaluated.

The conservative estimates of site-related cumulative cancer risk and HI for incidental ingestion, dermal contact, and inhalation of vapors and particulates by routine workers do not exceed the cancer risk limit of  $10^{-4}$  and the HI limit of 1, respectively, at any of the areas investigated. The lead concentrations in soil do not exceed the range of acceptable soil lead criteria for routine workers. However, risk estimates for hypothetical future exposures to vapors migrating to indoor air from soils underlying the building (based on predicted and measured air concentrations) do indicate the potential for unacceptable risks to routine workers. It is noted that the measured indoor air concentrations that contribute most significantly to these risk estimates do not appear to be related to releases subject to corrective action.

### **Construction Workers**

The risk assessment evaluated the significance of potential future exposures to on-Facility soil during occasional excavation/maintenance activities and one-time new building construction by using the risk estimates for routine workers, which is a conservative and streamlined approach. Similar risk estimates were prepared for off-Facility exposures during excavation/maintenance activities. These calculations show that constituent concentrations in on-Facility and off-Facility soil do not pose a significant risk to construction workers.

The risk assessment also evaluated the significance of potential exposures to constituents in on- and off-Facility subsurface water and sewer line backfill water via incidental ingestion, dermal contact, and vapor inhalation. The conservative estimates of cumulative cancer risk and HI do not exceed the cancer risk limit of  $10^{-4}$  or the HI limit of 1, respectively. Therefore, constituent concentrations in subsurface water do not pose a significant risk to construction workers. Potential exposures of construction workers to on- and off-Facility storm water in the storm sewers were evaluated and determined to be insignificant. The cancer and noncancer risk estimates for this exposure scenario do not exceed the limits of  $10^{-4}$  or 1, respectively.

Potential exposures of construction workers to surface water and sediments in the Unnamed Creek were evaluated and determined to be insignificant. The cancer and noncancer risk estimates for this exposure scenario do not exceed the limits of  $10^{-4}$  or 1, respectively.



### **Trespassers**

The risk assessment evaluated the significance of potential future exposures of trespassers to on-Facility soil by using the risk estimates for routine workers, which is a conservative and streamlined approach. Since the constituents in on-facility soil do not pose a significant risk to routine workers, they do not pose a significant risk to trespassers.

### **Off-Facility Residents**

The risk assessment evaluated potential exposures to off-Facility residents via potable and nonpotable use of Cedarville Aquifer ground water. As documented in the CA725 EI Report, no existing water wells have concentrations exceeding relevant use criteria, indicating that there are no current unacceptable exposures via these pathways. However, ground water concentrations exceeding potable criteria were detected in on-Facility and off-Facility monitoring wells. Therefore, the potential exists for unacceptable exposures in the future if ground water exceeding these criteria migrate to an existing water well, or a new water well is installed at a location where ground water concentrations exceed the relevant criteria.

In addition, potential exposures via vapor intrusion from ground water and subsurface water to indoor air was evaluated. As documented in the CA725 EI Report, the estimates of cumulative cancer risk and HI based on the highest concentrations in the off-Facility wells do not exceed the cancer risk limit of  $10^{-4}$  or the HI limit of 1, thus indicating that current off-Facility concentrations do not present an unacceptable risk via this pathway. However, conservative estimates of future off-Facility concentrations (based on current on-Facility ground water concentrations) exceed the cancer risk limit of  $10^{-4}$  or the HI limit of 1, thus indicating the potential for future off-Facility concentrations to present an unacceptable risk via this pathway.

### **Recreational Waders in Unnamed Creek**

The risk assessment evaluated potential future exposure to sediment and surface water in the Unnamed Creek via incidental ingestion and dermal contact by adolescent recreators. The estimates of cumulative cancer risk and HI based on the highest concentrations in sediment and surface water do not exceed the cancer risk limit of  $10^{-4}$  or the HI limit of 1.

In summary, the human health risk assessment documented in the CA725 EI Report determined that current potential exposures to constituents in on-Facility and off-Facility soil, subsurface water, storm water, indoor air, ground water, sediment and surface water do not pose a significant risk. However, the risk assessment presented in this Phase II RFI Report has determined that there is the potential for future exposures to constituents in on-site soil and ground water to present an unacceptable risk to on-site and off-site receptors. In addition, migration of constituents from on-Facility soils to ground water may continue to contribute to ground water concentrations exceeding potable use criteria.



The ecological risk assessment (ERA) conducted as part of the RFI is comprised of a screening level ecological risk assessment (SLERA), and as needed a baseline ecological risk assessment (BERA). The ERA uses the site characterization data that have been collected during the RFI to assess potential risks to ecological receptors that may be exposed to Facility-related constituents in the soil, sediment and surface water at and near the Facility. Ecological risks are calculated in the SLERA by dividing conservative chemical-specific exposure estimates by conservative chemical-specific ecotoxicity screening values. These unitless chemical-specific ratios are referred to as hazard quotients (HQs). HQs are considered a surrogate for the assessment endpoint, which is the protection of individual organisms and wildlife populations. An HQ equal to or less than a value of 1 (to one significant figure) indicates that adverse impacts to individual organisms are considered unlikely (U.S. EPA 1997; 2000a). An HQ greater than 1 is an indication that further evaluation may be necessary to evaluate the potential for adverse impacts to individual organisms, and ultimately wildlife populations.

The SLERA results indicate that a focused initial BERA analysis was warranted because the results of the screening-level risk calculation result in HQs greater than 1, and because this information is not adequate for decision-making. The BERA problem formulation is designed to more realistically identify the nature and extent of ecological risks in order to support informed environmental management decision-making (U.S. EPA, 1997; 2000a). This is in contrast to the SLERA, which is designed to conservatively rule out further evaluation of chemicals and media that clearly do not pose significant ecological risk.

The critical findings of this BERA are:

- Federally listed threatened and endangered species are not present at or in the vicinity of the Facility.
- Elevated HQs associated with soil, surface water, and sediment exposures are predicted, typically in areas with poor habitat characteristics, and/or of limited spatial extent.
- Adverse impacts are not considered likely for wildlife associated with soil, surface water, and sediment on-Facility and off-Facility.
- Population-level exposure pathways are not complete, and population-level exposures are not expected to occur.

Based on this information, adverse impacts predicted by HQs greater than 1 are not indicative of ecologically significant impacts to populations, communities, or ecosystems (a primary risk management consideration according to U.S. EPA [1999]). Therefore, it is concluded that the available information is adequate to decide that ecological risks are negligible at the Vernay Facility and, therefore, there is no need for further action on the basis of ecological risk.

#### Overall Phase II RFI Conclusions

As a result of the Phase II RFI, the following conclusions have been made:

- The nature and extent of contamination has been determined in soil within the Unconsolidated Unit.





- Based on data gathered for the RFI, the nature and extent of soil contamination has been adequately characterized for risk evaluation purposes.
- Based on the results of the calibrated ground water flow model and particle tracking analysis completed during the Phase I and Phase II RFI, the capture zone of the ground water interim measure extends at least to the base of the Cedarville Aquifer along the eastern boundary of the Facility.
- Based on the RFI sampling data and results of the fate and transport modeling for the Cedarville Aquifer, the results of these analyses indicate that both the PCE and TCE ground water plumes are stable and well contained within the existing monitoring well network.
- Based on the results of the human health risk assessment during the Phase II RFI, current potential exposures to constituents in on-Facility and off-Facility soil, subsurface water, storm water, indoor air, ground water, sediment and surface water do not pose a significant risk. However, the risk assessment determined that there is the potential for future exposures to constituents in some of these media to present an unacceptable risk. Specifically, future exposures via off-Facility potable and nonpotable ground water use downgradient of the Facility as well as hypothetical vapor intrusion from ground water to indoor air could pose an unacceptable risk if ground water exceeding acceptable levels migrates to locations where these exposures can occur, or if a new well or residence were constructed in an area where ground water concentrations currently exceed acceptable levels. Similarly, hypothetical vapor migration from soils to indoor air in on-Facility buildings could pose an unacceptable risk in the future. In addition, migration of constituents from on-Facility soils to ground water may continue to contribute to ground water concentrations exceeding potable use criteria.
- Based on the results of the ecological risk assessment, it was concluded that the available information obtained for the RFI was adequate to determine that potential ecological risks were negligible at the Vernay Facility and, therefore, no need for further action is warranted to assess potential ecological exposures.

#### RCRA Corrective Action Next Steps

Based on the results of the investigations conducted at the Facility and vicinity, Vernay has identified the nature and extent of any releases of hazardous waste and hazardous constituents at or from the Facility which have the potential to pose an unacceptable risk to human health. The results of these investigations are documented in the Phase I RFI report (Payne Firm et al., 2004), and in this Phase II RFI report. As a result of these investigations, Vernay has completed the RCRA Facility Investigation portion of the Corrective Action process.

As shown on the flow chart in Section 1.1, the next step in the Corrective Action process is to complete an Environmental Indicator Report for ground water (CA750). The CA750 report must demonstrate that the migration of contaminated ground water at or from the Facility is stabilized, and will remain within any existing areas of contamination as defined by monitoring locations designated at the time of the demonstration. Based on the Corrective Action Order (Section VI., paragraph 16), the CA750 report is required to be submitted to the U.S. EPA within 180 days of U.S. EPA's approval of this Phase II RFI report.



In addition to the CA750 report, Vernay must also propose to the U.S. EPA final corrective 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. Based on the Corrective Action Order (Section VI., paragraph 19), the Final Corrective Measures Proposal is required to be submitted to the U.S. EPA within 180 days of the positive U.S. EPA determination of the CA750 report. The U.S. EPA will then prepare a Statement of Basis document that proposes its final corrective measures based on the range of information provided in Vernay's Final Corrective Measures Proposal. The U.S. EPA will provide the public with an opportunity to review and comment on its proposed final corrective measure presented in its Statement of Basis. Based on the public comments, the U.S. EPA will then select its final corrective measure, and will notify Vernay and the public of its decision and rationale in a Final Decision and Response to Comments (Final Decision) document.

Based on the two tasks described above, additional ground water monitoring and performance of a corrective measures evaluation is needed to be completed. These two tasks are described below.

- In order to meet the post-RFI ground water monitoring data needs, future ground water monitoring events will occur on a semi-annual basis until the final corrective action is determined by the U.S. EPA.
- In order to demonstrate plume stability for the CA750, monitor the effectiveness of the existing ground water interim measure, and to support the calibration of the contaminant fate and transport ground water model and the risk assessment, a sufficient number of monitoring wells be sampled on a semi-annual frequency.
- In order to support the conclusions of the CA725 and the risk assessment, Vernay will follow up in 2005 with water well owners identified within the water well survey area. The purpose of the follow-up is to verify any change in water well use. In addition, Vernay will also resample in 2005 those water wells that are identified as currently being used for potable or non-potable purposes within the water well survey area that are downgradient from the Facility.

#### Corrective Measures Evaluation

A number of tasks will be conducted during the Corrective Measures Evaluation. These tasks will include:

- Determination of media cleanup standards (Preliminary Remediation Goals);
- Identification, screening, and development of Corrective Measures Alternatives; and
- Evaluation and recommendation of Final Corrective Measure Alternative.

In addition to the above tasks, a pilot study/treatability study may be conducted at the Facility to support the Corrective Measures Evaluation.



## 1.0 INTRODUCTION

This report documents the results of Phase II 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 U.S. EPA (U.S. EPA, 2002). 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 Corrective Action process is presented on page 3 of this section.

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 Environmental Protection Agency's (Ohio EPA) 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 (extraction well with carbon treatment prior to discharge to the Village of Yellow Springs sanitary sewer treatment system) to control the off-property migration of contaminants detected in the Cedarville Aquifer.

Phase I of the RFI focused on defining the nature and extent of hazardous waste and hazardous substances at the Facility and areas in the vicinity of the Facility, determining if there were any current unacceptable risks to human health and the environment that needed to be mitigated, as well as the development of a ground water flow model for the Cedarville Aquifer located beneath the Facility and the surrounding area. In a letter dated October 15, 2004, the U.S. EPA approved the RFI Phase I report and agreed the report determined the nature and extent of contamination for surface water (including the storm sewer), sediment, saturated sand seams, sewer backfill, and ground water of the Cedarville Aquifer, but acknowledged that additional investigation was needed during the Phase II RFI to fully define the extent of soil contamination beneath the Facility. Furthermore, the U.S. EPA agreed on a final determination concerning the potential investigation of the Brassfield Aquifer during the Phase II RFI. In the approval letter, the U.S. EPA stated that, "Based on the RFI Phase I Report, it appears an investigation of the deeper aquifer (Brassfield Aquifer) will not be required at this time."

The approval of the Phase I RFI report was preceded by the U.S. EPA's approval of the Current Human Exposures Under Control Environmental Indicator Report ("CA725 EI Report"), on September 29, 2004,



which demonstrated that adequate protective controls are in place to prevent unacceptable current exposures to human health.

In the Phase I RFI approval letter, the U.S. EPA also agreed with Vernay's recommendations for a Phase II scope of work to complete the nature and extent of contamination investigation for soil, complete an assessment of the fate and transport of ground water contamination in the Cedarville Aquifer, continuation of quarterly ground water monitoring, continued monitoring of the effectiveness of the ground water extraction wells and completion of the human health and ecological baseline risk assessment.

Phase II of the RFI focused on completing these tasks. On the behalf of Vernay, Phase II 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 July 2004 and December 2004. A flow chart summarizing the Phase I and Phase II RFI process is presented on page 4 of this section.

As shown on the flow chart on page 3 of this section, the next steps in the corrective action process is to conduct the corrective measures evaluation. The tasks that will be undertaken during the corrective measures evaluation are summarized in Section 7.2.

## **1.1 RFI Objectives**

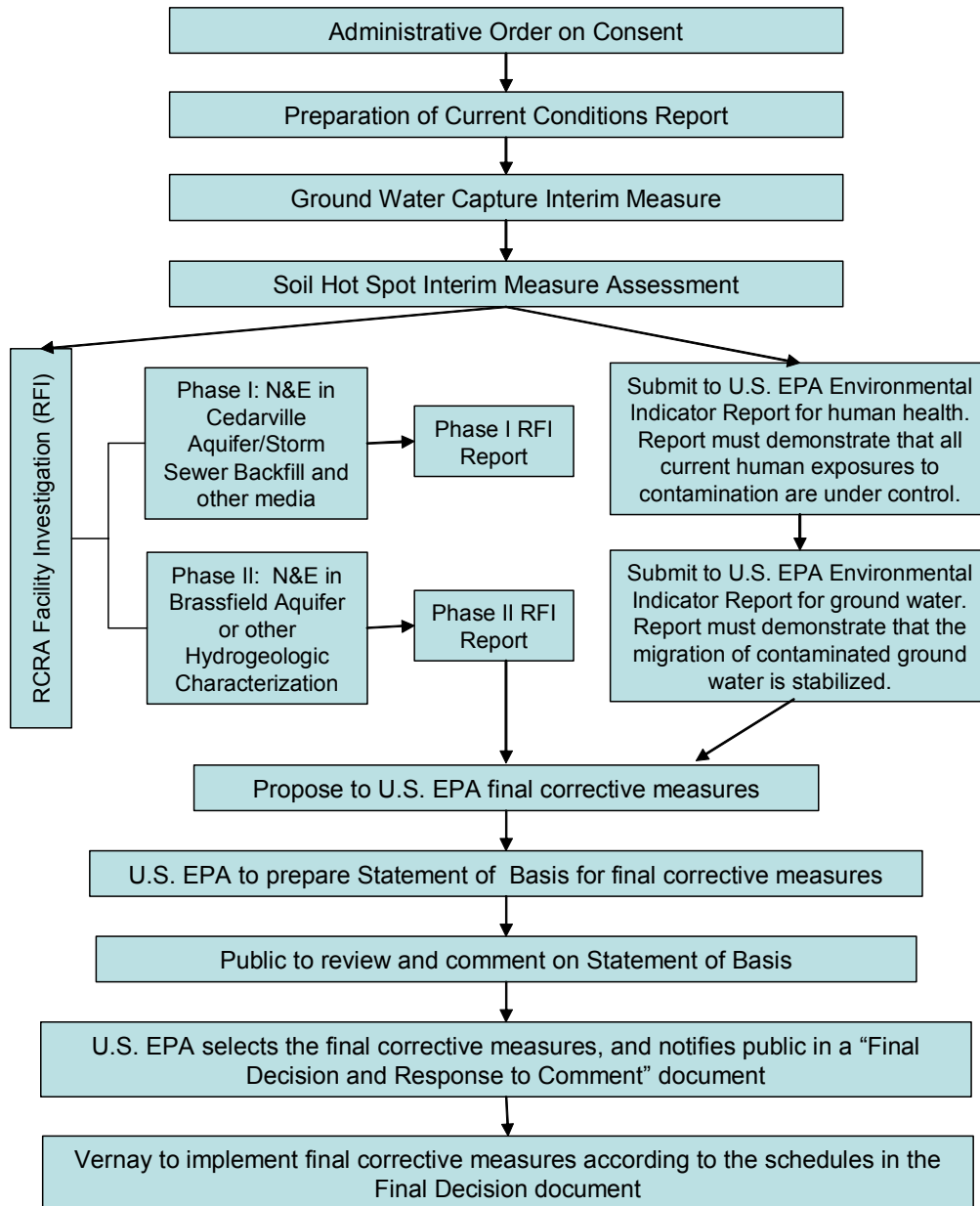
The primary objective of the RFI is to determine the nature and extent of any releases of hazardous waste or hazardous constituents at or from the Facility that pose an unacceptable risk to human health and the environment. As described above, the RFI is being conducted and reported in two phases (Phase I and Phase II). The Phase I and Phase II RFI data were used to determine the presence, stabilization, fate, and hypothetical 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 Phase II of the RFI and the Migration of Contaminated Ground Water Under Control Environmental Indicator report (CA750). The Corrective Measures Proposal, which is scheduled to be submitted to the U.S. EPA within 180 days of the positive U.S. EPA determination of the CA750 report, will evaluate a range of corrective remedial measures appropriate to protect human health and the environment from potentially unacceptable current or future risks associated with contamination on and off the Facility.

## **1.2 Format of the Report**

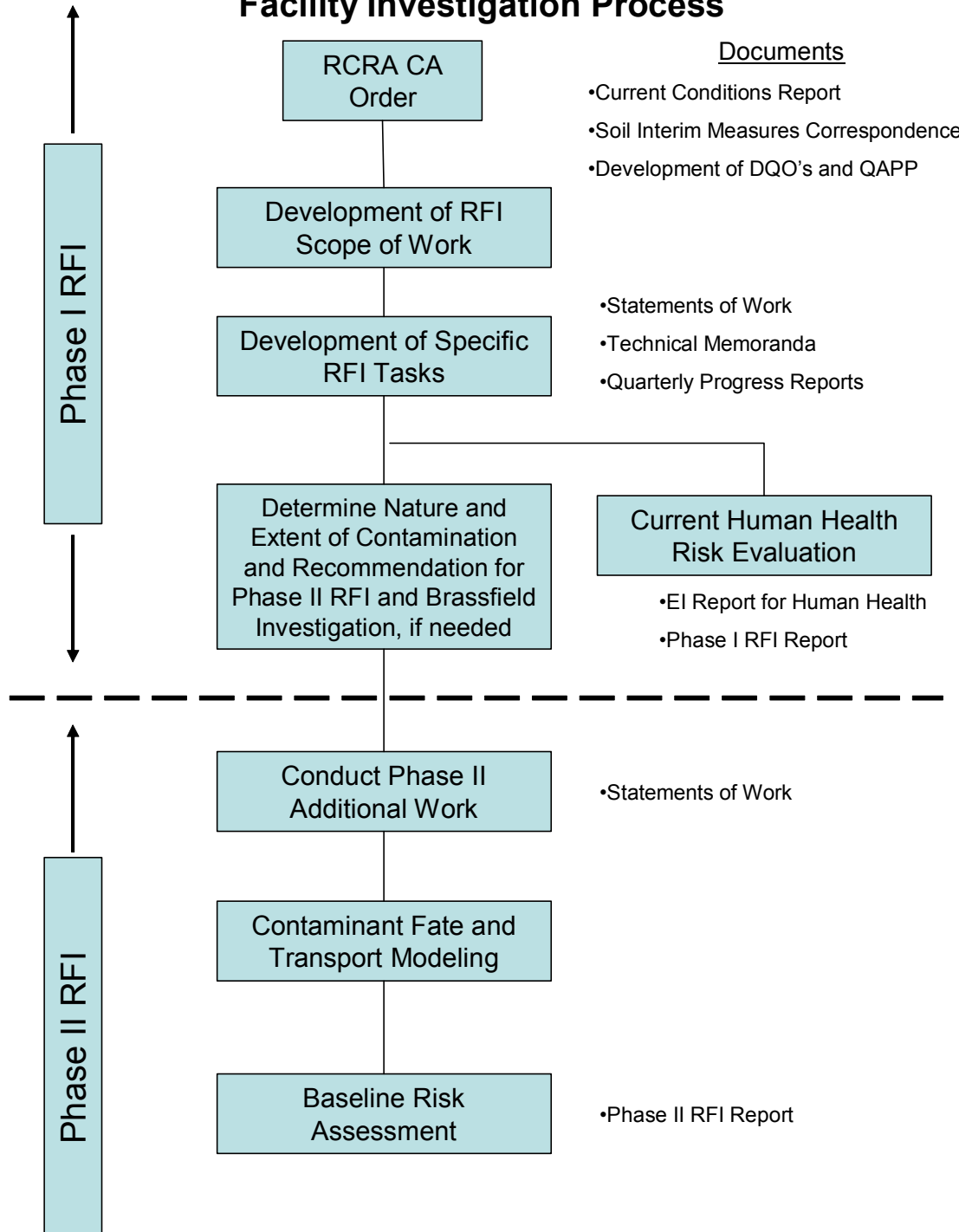
The primary objective of this report (RFI Phase II Report) is to present the results and conclusions of the Phase II RFI. This report consists of an assessment of the nature and extent of contamination in soil



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



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



beneath the Facility, an assessment of the fate and transport of contaminants from the Facility, results of quarterly ground water monitoring, evaluation of the efficacy of ground water interim measures, and completion of the baseline human health and ecological risk assessments, including a summary of the tasks that were used to complete Phase II of the RFI.

The RFI Phase II Report consists of an Executive Summary, Sections 1 through 8, and tables, figures, sheets, and appendices. The entire RFI Phase II 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 and a summary of the RFI Phase I investigation.

#### Section 2 – Phase II RCRA Facility Investigation Tasks

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 II RFI. Each phase of work that was undertaken during the Phase II RFI is reviewed.

#### Section 3 – RFI Results and Data Assessment

The results of the field investigations conducted during the RFI are discussed in Section 3.

#### Section 4 – Contaminant Fate and Transport in Ground Water

This section summarizes the contaminant fate and transport ground water model that was prepared for the Facility and vicinity. The fate and transport ground water flow model report is present in Appendix V.

#### Section 5 – Baseline Human Health Risk Evaluation

This section presents the human health risk assessment. The risk assessment was conducted to evaluate hypothetical risks to human health cause associated with reasonably likely future exposures to environmental media impacted by releases of hazardous substances or hazardous waste from the Facility.

#### Section 6 – Screening Level Ecological Risk Assessment

This section describes a screening level ecological risk assessment, and as needed a baseline ecological risk assessment. These assessments were conducted to evaluate potential risks to ecological receptors that may be exposed to Facility-related constituents in the soil, sediment and surface water at or near the Facility.



### Section 7 – Phase II RFI Summary

This section summarizes the results, evaluations, and conclusions of the Phase II RFI and the tasks needed to complete the corrective action process.

### 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<sup>1</sup>, 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). 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. A comprehensive summary of the environmental setting of the Facility and the surrounding area was presented in the *Current Conditions Report* (Payne Firm, 2002) and the Phase I RFI Report (Payne Firm et al., 2004).

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 beginning in 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

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<sup>1</sup> The aerial photographs displayed on figures in this report were obtained from the Greene County Auditors Office, dated 2003.





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 early 2005.

#### **1.4 Summary of Phase I RFI**

Phase I of the RFI was completed between September 2002 and June 2004 (Payne Firm et al., 2004). The Phase I RFI report was approved by the U.S. EPA on October 15, 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) needed 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. The results of the CA725 evaluation concluded that current human exposures to contaminated media were under control, including potential exposure to indoor air at the Facility. The CA725 EI report was completed July 15, 2004 and approved by the U.S. EPA on September 29, 2004. Ground water data collected during the RFI will also be used to complete the RCRA Corrective Action Migration of Contaminated Ground Water Under Control (CA750) EI report, which will be submitted to the U.S. EPA within 180 days following the approval of the Phase II RFI report.

#### Phase I RFI Scope of Work

The U.S. EPA's data quality objectives process was used to prepare detailed scopes of work for Phase I and Phase II of the RFI, and to ensure that the overall goals and objectives of the RFI were 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 (including sand seams and sewer backfill), 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 a conceptual site model and the evaluation of the efficacy of existing interim measures.



Subsequent work tasks conducted during the Phase I RFI 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, totaling 53 monitoring wells in the RFI well network to determine the extent of contamination in the Cedarville Aquifer and storm sewer backfill. Seven quarters of ground water monitoring were conducted during the Phase I RFI to monitor potential migration of the plume within the Cedarville Aquifer, monitor ground water quality recovered from the 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 I RFI Results

Information relating to the hydrogeologic setting of the Facility and vicinity was assembled during the RFI to develop a site hydrogeological model (SHM). The SHM describes two primary aquifer systems, the Cedarville Aquifer and the Brassfield Aquifer. 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. The two bedrock 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. As determined through the Phase I RFI, the Cedarville Aquifer has 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. Ground water flow velocities in the Cedarville Aquifer range from approximately 5 to 75 feet per year. 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. A detailed description of the ground water flow model, including the modeling objectives, computer code selection, model construction, model calibration, and particle tracking analysis was presented in Appendix VII of the RFI Phase I report (Payne Firm et al., 2004). The ground water model assisted in the prediction of the movement of ground water in the subsurface, and was also 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 predictive analysis indicated that the model was well calibrated with actual ground



water data, and supported the determination 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) the U.S. EPA identified at the Facility (TechLaw, 2001). This list included VOCs, SVOCs and metals that have been and/or are currently used in Vernay's manufacturing process. A direct-push boring program was performed to collect soil samples in the immediate vicinity of SWMUs and AOCs, and subsurface water samples from discontinuous sand seams and sewer backfill material. As documented in the Phase I RFI, the most frequently detected contaminants in the sampled environmental media were VOCs. SVOCs and a few metals were detected, but at a much lower frequency than VOCs.

To determine the nature and extent of contamination detected during pre-RFI and Phase I RFI sampling events, and to assess if any additional data were needed to complete the RFI, "Contaminants of Interest" (COIs) were identified from the Phase I RFI. The identified COIs were VOC, SVOC, and metal constituents that exceeded generic risk based screening criteria developed based on the conceptual site model (CSM) for human exposures. This evaluation was conducted as a conservative approach to guide the investigation of 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.

#### Phase I RFI Conclusions

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

- The nature and extent of contamination was 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 was not completely delineated on and off the Facility; additional definition was needed during Phase II of the RFI.
- The horizontal and vertical extent of ground water contamination in the Cedarville Aquifer (upper, middle and lower) was determined.
- Based on the results of the investigation of the nature and extent of contamination of the Cedarville Aquifer during the Phase I RFI, it was determined that an investigation of the Brassfield Aquifer during Phase II of the RFI was not needed to meet the objectives of the CA750 EI and the Corrective Action Order.

Vernay submitted the RFI Phase I report on June 29, 2004. In a letter dated October 15, 2004, the U.S. EPA agreed with Vernay's conclusions and approved the RFI Phase I report. In the approval letter, the U.S. EPA stated that, "Based on the RFI Phase I Report, it appears an investigation of the deeper aquifer (Brassfield Aquifer) will not be required at this time."



The U.S. EPA also agreed with Vernay's recommendations for the Phase II scope of work to address the nature and extent of contamination in soil, complete an assessment of the fate and transport of contamination from the Facility in the Cedarville Aquifer, continuation of quarterly monitoring, continued monitoring of the effectiveness of the ground water interim measure and completion of the baseline human health and ecological risk assessments.



## **2.0 PHASE II RCRA FACILITY INVESTIGATION TASKS**

This section presents the goals, objectives and tasks of the Phase II RFI. The primary objective of the RFI data collection was to provide sufficient characterization of the nature and extent of any releases of constituents to allow a reliable quantification of potential exposures from SWMU and AOC related constituent concentrations. If the spatial distribution of a constituent's concentrations suggested that a conservative estimate of its average concentration (e.g., 95% UCL) in the area investigated would increase materially by sampling additional parts of the area or neighboring areas, then additional sampling was considered.

To assess the potential significance of detected concentrations, Vernay used conservative screening criteria selected based on a conceptual site model of potential human and ecological exposures (Sections 5.0 and 6.0, respectively). The presence of concentrations higher than screening levels did not necessarily mean that additional investigation was warranted, nor were the screening levels intended to be levels above which corrective action was warranted (i.e., the screening levels are not being used to establish cleanup levels). Similarly, the absence of concentrations higher than screening levels did not necessarily mean that additional investigation was unnecessary. Rather, decisions regarding the need for further investigation were made based on professional judgment considering the screening results and results of a qualitative data review, including the magnitude of the concentrations, their spatial distribution, and other factors (e.g., background levels).

The Phase II RFI tasks were completed between July 2004 and December 2004 and followed the procedures and protocols used to document that RFI field and analytical data collected were of sufficient quality and quantity to meet project data quality objectives. A RCRA Corrective Action project schedule is presented on Table 1.

### **2.1 Phase II RFI Tasks**

Based on the findings of the Phase I RFI, and as agreed with U.S. EPA, Phase II of the RFI consisted of the following tasks:

- Completion of the determination of the nature and extent of contamination in soil beneath the Facility.
- Quarterly ground water monitoring.
- Continued evaluation of the efficacy of ground water interim measures.
- Determination of the fate and transport of contaminants in the Cedarville Aquifer from the Facility.
- Assessment of hypothetical site-related risks to human health and the environment.



## **2.2 Phase II RFI Field Activities**

During the Phase II RFI, field activities involved drilling soil borings to collect samples for analytical laboratory analyses, two quarterly sampling events of all ground water monitoring wells (totaling nine monitoring events conducted during Phases I and II of the RFI), and monthly collection of water levels and water samples from the existing ground water interim measures. Analytical data collected during the entire RFI were validated following procedures in the project QAPP (Payne Firm, 2003h). The Phase II RFI field tasks were performed in a step-wise approach following the completion of the Phase I RFI field tasks.

Consistent with the Phase I RFI, analytical data from ground water and surface water were collected during the Phase II 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 U.S. EPA approval of the Phase II RFI. Vernay needs to meet all of the required CA750 EI criteria within 180 days after the U.S. EPA approval of this RFI Phase II report.

All Phase II RFI field sampling activities were managed and conducted by professional and field geologists, and field technicians from the Payne Firm following the SOPs presented in the project QAPP and followed the RFI Procedures and Protocols outlined in Section 2.2 of the RFI Phase I report including:

### Project Management

- There were no significant changes during Phase II of the RFI.

### Statements of Work

- During the Phase II RFI, four SOWs were prepared and implemented (Table 3).

### Project Surveying

- Updated survey data are presented on Table 4. The base map is shown on Sheet 1, which is a comprehensive map of the Facility and vicinity and an areal photo showing buildings and structures as they existed in 2003. Locations of monitoring wells, soil borings, and other sampling locations are depicted using this base map.

### Field Documentation

- There were no significant changes during Phase II of the RFI.



### Sample Identification

- There were no significant changes during Phase II of the RFI.

### Analytical Methods

- There were no significant changes during Phase II of the RFI.

### Drilling Methodologies

- The only drilling method used during the Phase II RFI was direct-push probing (Geoprobe®). The majority of the direct-push borings were advanced for soil and sand seam water sampling at the Facility and vicinity. All sampling locations are shown on Sheet 1. All boring logs from the Phase II RFI are presented in Appendix VIII-C.

### Quality Control Sampling

- There were no significant changes during Phase II of the RFI.

### Data Quality and Validation

- There were no significant changes during Phase II of the RFI.
- Data validation memoranda from the Phase II RFI are included in Appendix IV.

### Data Management

- There were no significant changes during Phase II of the RFI.

### Waste Management

- There were no significant changes during Phase II of the RFI.

### Areas of Interest

- During Phase I of the RFI, 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 and Payne Firm, 2004). These areas were further refined during Phase II of the RFI as shown on Figure 6 and discussed below. AOI-1, AOI-2N and AOI-2S are located on the Facility, and AOI-3, AOI-3A and AOI-4 are located off of the Facility property. AOI-1 consists of the undeveloped/non-operational portion of the Facility, primarily the western fill area. AOI-2N includes the undeveloped/nonoperational portion of the Facility, including parking lots and sewers. AOI-2S bounds the developed/operational portion of the Facility, including Plants 2 and 3 and sewers. AOI-3 includes the off-Facility area that was investigated during the Phase I RFI within the limits of the project survey area. The sewers located on Dayton Street between the Facility and the Unnamed Creek, between Omar Circle and the Facility and between the Facility and the adjacent properties to

the east are identified as a subset of this area (AOI-3A). AOI-4 includes the Unnamed Creek between Dayton Street and Fairfield Pike. AOI-5A includes all Cedarville Aquifer ground water beneath the Facility and AOI-5B includes the Cedarville Aquifer ground water beneath the off-Facility area (AOI-3).

- These AOI have been used to assess current and future risks to human and ecological receptors associated with Facility-related COIs detected in each AOI. The investigation results and evaluation for each AOI are presented in Section 3.0.

The field sampling methods used during the Phase II RFI did not significantly change from those methods presented in Section 2.3 (Phase I RFI Sampling Methods) of the RFI Phase I report including:

#### Soil Sampling

- Field Screening
- Direct-Push Drilling
- VOC Soil Sampling (Method 5035 of Update III to SW-846)
- Borehole Abandonment
- Boring logs completed during the Phase II RFI are presented in Appendix VIII-C.
- Ground water sampling forms completed during the Phase II RFI are presented in Appendix VIII-D.

#### Water Level Measurements

- A complete summary of water elevation measurements from Phase II of the RFI is included in Appendix VIII-B.
- Updated hydrographs from the monitoring wells are included in Appendix I.

#### Subsurface Water Sampling

- Monitoring Well Sampling
- Direct-Push Water Sampling
- Surface Water Sampling
- Ground water sampling forms completed during the Phase II RFI are presented in Appendix VIII-D.

### **2.3 Phase II RFI Soil Investigation**

Vernay prepared the *RCRA Corrective Action, Technical Memorandum No. 4, Soil Confirmation*, (TM-4) (Payne Firm, 2004e) discussing the soil data confirmation process used to demonstrate the relevancy of historical soil data. In a previous review by the U.S. EPA of historical data presented in TM-2 (Payne Firm, 2003f), Vernay was found to have made a good faith effort reviewing the relevancy of their pre-RFI ground water, surface water, and sediment data to the RFI and relying on the guidance supplied





by the Region's 1998 RCRA QA Policy. Based on U.S. EPA comments for TM-2, the U.S. EPA accepted the use of historical data to establish trend analyses in ground water, sediments, and surface water, but did not accept the use of historical Update II (Method 5030) data to establish trend analyses for soil. Instead, U.S. EPA requested additional soil data collection to be completed and confirmation demonstrated. As requested, the submittal from Vernay (TM-4) provided confirmation for historical soil data collected from 1998 to 2001.

The U.S. EPA comments to TM-4 explained that U.S. EPA could not accept past soil Update II VOCs data as quantified, accurate data sufficient for risk analysis calculations. The U.S. EPA stated that the historical soil Update II VOC data may be used for other qualitative purposes and can be incorporated into environmental indicator determinations. As indicated by the U.S. EPA, the historical soil VOC data may also provide rationale for sampling design, or indicate where hot spot zones of contamination exist. However, following Vernay's completion of the requested confirmation demonstration and because of the low results bias, the U.S. EPA could not accept any of the pre-RFI soil Update II VOC data for use in quantitative site risk assessments. As a result, Vernay collected additional soil VOC data using Update III (Method 5035) during Phase II of the RFI.

Additionally, if a saturated sand seam interval(s) was identified in the boring along the perimeter of the Facility, a VOC water sample was also collected consistent with the methodology performed during the Phase I RFI. Additional soil semi-volatile organic compounds (SVOC) data were collected during the Phase II RFI in order to delineate the nature and extent characterization of these constituents in soil on the Facility. Sampling for metals (lead and barium) in a few borings was also conducted during the Phase II RFI to support the ecological risk evaluation (Section 6.0).

Updated survey data are presented on Table 4 from the boring locations installed during the RFI. Analytical results for VOCs, SVOCs and metals data from soil borings are presented in Section 3.0. Electronic copies of the laboratory analytical reports from the Phase II RFI are included in Appendix VIII-E and data validation memoranda are included in Appendix IV. Boring logs from the Phase II RFI are presented in Appendix VIII-C. As presented in Section 3.0, the additional soil samples collected during the Phase II RFI were sufficient to delineate the nature and extent of soil contamination on and off of the Facility.

## **2.4 Quarterly Ground Water Monitoring Events**

In accordance with Section VI, Paragraph 13 of the Corrective Action Order (U.S. EPA, 2002), Vernay implemented a quarterly monitoring program in 2003. The current monitoring well network includes 48 monitoring wells and two extraction wells in the Cedarville Aquifer and three monitoring wells in sewer backfill (Figure 7). In addition, when access was granted, Vernay sampled two additional downgradient monitoring wells located on private property that were identified during the well survey



conducted by Vernay in late 2003/early 2004. A surface water sample was also collected and analyzed for VOCs from the storm sewer outfall that discharges to the Unnamed Creek northeast of the Facility. During the Phase I RFI, a total of six quarterly monitoring events were conducted. During the Phase II RFI, two additional quarterly monitoring events were conducted.

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

1. Confirmation that there are no concentrations 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.
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.
8. Evaluation of the need for surface water sampling at the outfall to the Unnamed Creek.

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 measures are necessary.

Concentrations of all VOCs in on- and off-Facility monitoring wells installed in the sewer backfill and the Cedarville Aquifer presented on Sheet 2 and are summarized in Section 3.0. Graphs of the results from selected VOCs detected in monitoring wells on and off the Facility are presented in Appendix III.

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



Electronic copies of the laboratory analytical reports, data validation memoranda and ground water sampling forms from the Phase II RFI are included in Appendices VIII-E, IV and VIII-D, respectively.

## **2.5 Efficacy of Ground Water Interim Measures and Results**

Consistent with the Phase I RFI (Payne Firm et al., 2004), data associated with the existing ground water interim measures were collected monthly during the Phase II RFI. These data include water level measurements from the Facility monitoring well network, and water samples analyzed for VOCs from the ground water treatment systems of the capture zone and the utility tunnel sump. In addition, monitoring well analytical data collected during the quarterly monitoring events was used to evaluate the efficacy of the ground water interim measure. Monthly water level elevations from the Phase II RFI are summarized in Appendix VIII-B. Potentiometric contour maps generated monthly during the Phase II RFI for the Cedarville Aquifer are included in Appendix II. Electronic copies of the laboratory analytical reports from the Phase II RFI are included on a CD-Rom in Appendix VIII-E.

Water samples collected from the capture zone treatment system included: 1) a sample at each wellhead (CW01-01 and CW01-02); 2) a sample after the first carbon vessel; and 3) a system effluent sample after treatment. Likewise, samples collected from the utility tunnel sump treatment system included: 1) a pre-treatment sample; 2) a sample after the first carbon drum; and 3) a sample after the second carbon drum. The VOC data collected from the two treatment systems are summarized on Tables in the quarterly progress reports.

### Ground Water Capture Treatment System

As described in Section 1.8 of the RFI Phase I report (Payne Firm et al., 2004), 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 preventing VOC-contaminated ground water in the Cedarville Aquifer from migrating beneath the eastern and southeastern portions of the Facility. The captured ground water is then treated with activated carbon (Figure 2) before it is discharged under an indirect discharge permit issued by the Ohio EPA to the Yellow Springs Publicly Owned Treatment Works (POTW). Approximately 700,000 gallons of water is treated monthly by the GWCTS.

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. The ground water flow model assisted in the prediction of the movement of ground water in the subsurface. A detailed description of the ground water flow model, including the modeling objectives, computer code selection, model construction, model calibration, and particle tracking analysis was presented in a separate report (Appendix VII) of the RFI Phase I report (Payne Firm et al., 2004). The results of the



ground water flow modeling indicated that the model is well calibrated when compared with actual ground water data that are collected during the RFI.

Based on the results of the calibrated ground water flow model and particle tracking analysis completed during the Phase I and Phase II RFI, and the monthly water level measurements and ground water analytical results, the capture zone of the interim measure extends at least to the base of the Cedarville Aquifer along the eastern boundary of the Facility. Therefore, the GWCTS is continuing to meet its objective, which is to control and prevent the migration of contaminated ground water off of the Facility in the upper, middle, and lower portions of the Cedarville Aquifer.

#### 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). As described in the RFI Phase I report (Payne Firm et al., 2004), the sump collects water that accumulates inside 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.

Based on the results of the monthly VOC sampling from the UTSWTS during the Phase I and Phase II RFI, the contaminated water in the sump is successfully being treated. Therefore, the UTSWTS interim measure is operating as designed, and is meeting its objectives.

## **2.6 Phase II RFI Modeling Activities**

The objectives and results of the fate and transport ground water modeling are included in Section 4.0.

## **2.7 Baseline Human Health and Ecological Risk Assessments**

As presented in Section 1.1, the primary objective of the Vernay RFI is to characterize the nature and extent of releases of hazardous waste or hazardous constituents at or from the Facility, and to assess the potential significance of hypothetical risks associated with potential current and reasonably likely human and ecological exposures to Facility-released hazardous wastes or hazardous constituents. To characterize the hypothetical risks associated with identified releases, a baseline human health risk assessment, and ecological risk assessment were conducted by ENVIRON during the Phase II RFI. The results of these risk evaluations are then used to determine if corrective measures are necessary.



### Summary of Phase I RFI Risk Evaluation Tasks

During the Phase I RFI, several tasks were conducted to support the baseline human health and ecological risk assessments made during the RFI, as documented in the RFI Phase I 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 pre-RFI data.
- Development of the RFI sampling list.
- Completion of a water well survey and sampling event.
- Completion of the Human Health Environmental Indicator (CA725).

Based on the land use and ecological setting information presented in Section 3.0 of the RFI Phase I report, a CSM for human and ecological exposures was prepared by ENVIRON, and is summarized in the Sections 5.0 and 6.0 of this report. The objective of defining these CSMs was to identify actual or potential exposure pathways on and off of the Facility. The scenario for human exposures presented in this report 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, the CSM for ecological exposures was summarized in the RFI Phase I report, and included 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 in the RFI Phase I report, sensitive, threatened, or endangered species listed by both federal and Ohio Department of Natural Resources (DOT) have been identified in the region; however, habitat conditions both on-site and off-site do not support critical habitats and do not support any ESA species.

Conservative risk-based screening criteria that are appropriate for each environmental medium and receptor identified for the Facility (Payne Firm et al., 2004) were assembled for use in identifying a potential need for additional sampling to support a reliable estimate of exposure concentration. In addition to human exposures, soil contamination migrating to ground water was evaluated. These risk-screening criteria are discussed in detail in Section 3.0 of this report. The results of the risk-based screening evaluation completed during the Phase I RFI indicated that additional data were needed to complete the RFI. The additional data needed for the Phase II RFI as a result of the risk-based screening evaluation is described in Section 3.0. The results of the data that were collected during the Phase II RFI are also presented in Section 3.0.



### Summary of Phase II RFI Risk Evaluation Tasks

During Phase II of the RFI, ENVIRON completed tasks to support the Phase II RFI activities including the following:

- Assistance with Phase II scoping activities such as data analysis and review to evaluate delineation and additional data needs.
- Preliminary evaluation and analysis of data collected during Phase II field activities.
- Formatting and incorporation of Phase II data into the risk assessment database.
- Completion of a baseline human health risk assessment (BHHRA) and an ecological risk assessment (ERA).

Activities to successfully complete these included the following:

#### BHHRA

- Exposure assessment of potential human and ecological receptors, which included identification and refinement of exposure pathways, exposure concentration estimates, and chemical intake estimates.
- Toxicity assessment, which included a compilation and evaluation of toxicity factors.
- Risk characterization.

#### ERA

- Screening level problem formulation/effects evaluation.
- Screening level exposure estimate/risk characterization.
- Baseline ecological risk assessment.

The BHHRA and ERA are further discussed in Sections 5.0 and 6.0, respectively.



### 3.0 RFI RESULTS AND EVALUATION

The results of the RFI are discussed in this section. The discussion is divided into subsections that correspond to the AOIs that were investigated. Each subsection includes a brief description of the AOI, the scope of the field investigations conducted during the Phase I and Phase II RFI, a summary of the results, and discussion of the results with respect to whether a potentially significant release of hazardous constituents has been identified, and if so, the nature and extent of the release for risk evaluation purposes.

The presence of a potentially significant release at an area was identified based on comparison of the on- and off-Facility characterization data for soil, ground water, sediment, and surface water with conservative, generic screening criteria. These criteria were selected based on the CSM for human exposures to identify contamination in each of the environmental media investigated. Where a potentially significant release was identified, the screening criteria were then used to guide characterization of the extent of the release for risk evaluation purposes in the affected media. It should be noted that the identification of an area with constituents at concentrations that are higher than these screening criteria does not mean that the concentrations necessarily poses an unacceptable risk; it only means that the potential for the area to pose an unacceptable risk should be evaluated considering site-specific factors. For example, the concentration is identified for further review relative to:

- Concentrations of the constituent at other locations and depths;
- Distribution of the constituent in other environmental media;
- Background levels (as described below);
- Field observations; and
- Previously identified or additional areas of interest (based on operational history in the vicinity of the sample).

The screening approach described in this section was used to support the demonstration that current human exposures are under control. This demonstration was documented in the *Resource Conservation and Recovery Act CA725 Environmental Indicators Report* ("CA725 Report"; ENVIRON and Payne Firm, 2004, approved by the U.S. EPA on September 29, 2005). Since completion of the CA725 Report, additional data were collected as part of the RFI. Therefore, the screening evaluation discussed in this section provides an update to the screening results presented in support of the CA725 Environmental Indicators determination.

The screening criteria used for evaluating RFI (Phase I and Phase II) data are discussed in Sections 3.1 to 3.7. Results of the data comparison are summarized in Table 9 and are also shown on Figures 8 and 9, which are used to facilitate discussion of the characterization results for each investigated





area in Sections 3.8 to 3.16. A sample by sample comparison of the results to the screening criteria is provided in Appendix VII. A discussion on the use of the screening criteria for evaluating RFI data quantitatively on the screening summary tables and spatially on the figures is provided in Section 3.7. As depicted on Sheet 1, each AOI includes an approximately 30 foot "buffer zone" that extends into adjacent AOIs. Sample locations that fall within the buffer zone are conservatively included in the screening evaluation for each of the designated AOIs.

Appendix VII describes the characterization of background inorganics concentrations, including sampling locations, and upper confidence limits (UCLs) on the mean for 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 Facility-related and not included in the total inorganics concentrations in the screening evaluation. Concentrations higher than these levels are considered Facility-related and are included in the screening evaluation. In addition, the cumulative cancer risks and hazard quotients that are associated with the naturally-occurring background levels, based on the exposure and toxicity assumptions that U.S. EPA Region 9 (2002) used in deriving its PRGs, are also presented in Appendix VII. These background levels of risks are not included in estimates of Facility-related risks.

### **3.1 Soil Screening Criteria**

Based on the CSM, the soil characterization data were compared with the following three types of soil screening criteria: 1) criteria based on direct contact with soil; 2) criteria based on vapor intrusion into indoor air, and 3) criteria based on migration of soil constituents to ground water.

#### **3.1.1 Direct Contact**

The primary set of direct contact soil screening criteria used to guide the RFI field investigation was derived from the U.S. EPA Region 9 risk-based preliminary remediation goals (PRGs) for industrial soil (U.S. EPA, 2002). U.S. EPA Region 9 calculated these PRGs using conservative exposure factors for estimating high-end exposure of workers via incidental ingestion, dermal contact, and inhalation of airborne soil constituents in commercial/industrial settings. The risk-based PRGs published by U.S. EPA Region 9 are based on a target cancer risk of  $10^{-6}$  and a target hazard quotient (HQ) of 1.

These PRGs were chosen as the basis for deriving the primary set of direct contact soil screening criteria because they are based on an exposure scenario that is consistent with the current and reasonably expected future land use at the Facility (see discussion in RFI Phase I). The exposure factors used in these U.S. EPA Region 9 PRGs are conservative assumptions about the magnitude, frequency, and duration of exposures, which in combination are expected to provide estimates of exposures that are higher than actual exposures to a large portion (90% to 99%) of worker populations.



The target cancer risk of  $10^{-6}$  used in the U.S. EPA Region 9 cancer-based PRGs is based on the assumption that workers at a site would be exposed to a large number of carcinogenic chemicals in soil. According to U.S. EPA, a target risk of  $10^{-6}$  can be used to develop soil screening criteria (like the PRGs) to ensure that cumulative cancer risk from exposure to multiple human carcinogens in soil at a particular site would not exceed the acceptable cumulative risk limit of  $10^{-4}$  (61 FR 19432, May 1, 1996; U.S. EPA 1996; U.S. EPA 1991b). Using a target cancer risk of  $10^{-6}$  actually means that an individual can be simultaneously exposed to as many as 100 human carcinogens at concentrations equal to the PRGs, and the cumulative cancer risk estimate for the exposure would not exceed  $10^{-4}$ .

At many sites, including the Vernay Facility, workers are potentially exposed to far fewer human carcinogens in soil (i.e., closer to 10 than 100) so that the PRGs calculated using a target cancer risk of  $10^{-6}$  are far more conservative than necessary to protect for simultaneous exposures to multiple carcinogens in soil. As such, the cancer-based PRGs were adjusted to a target cancer risk of  $10^{-5}$  before they were used as screening criteria for guiding the RFI field investigation at the Facility. The appropriateness of making this adjustment was verified by calculations of cumulative cancer risks based on actual RFI soil characterization data, which are discussed in Section 5.

Additionally, because of the current residential land use surrounding the Facility, off-Facility soil samples collected in residential areas were also evaluated by comparing the detected concentrations with soil screening criteria derived from the U.S. EPA Region 9 risk-based PRGs for residential soil (U.S. EPA, 2002). U.S. EPA Region 9 calculated these PRGs using conservative exposure factors for estimating high-end exposure of residents via incidental ingestion, dermal contact, and inhalation of airborne soil constituents in commercial/industrial settings. The risk-based PRGs published by U.S. EPA Region 9 are based on a target cancer risk of  $10^{-6}$  and a target hazard quotient (HQ) of 1. For the off-Facility sewer lines area (AOI 3A), both industrial and residential PRGs are used to evaluate these data, although residential exposure to subsurface soils is not expected. Potential exposures in this area are expected to be limited to occasional excavation workers.

### **3.1.2 Vapor Intrusion**

The vapor intrusion soil screening criteria were derived to identify on-Facility soil conditions that might result in unacceptable exposure of workers to indoor air concentrations if constituents in the soil were to volatilize and migrate through industrial building foundation cracks into indoor air. These criteria were derived using a vapor intrusion modeling approach recommended by U.S. EPA (2003) for screening-level analysis. The model parameters related to soil properties were based on Facility-specific soil conditions and those related to building characteristics were based on conservative regulatory default assumptions for a hypothetical commercial/industrial building.

To assess current conditions of Vernay's Facility operations for the CA725 Report, the vapor intrusion criteria were calculated using permissible exposure limits (PELs) established by the Occupational Safety



and Health Administration (DHHS, 1997), or threshold limit values (TLVs) recommended by the American Conference of Government Industrial Hygienists (ACGIH, 2003) for chemicals without PELs. Derivation of these screening criteria is discussed in Appendix VI.

To assess soils for the potential future scenario in which Vernay no longer operates the Facility, vapor intrusion criteria were also calculated based on acceptable risk-based air concentrations. Consistent with the approach described for developing the direct contact screening criteria, these values were calculated using U.S. EPA-derived inhalation unit risk factors (URFs) and inhalation reference concentrations (RfCs), with a target cancer risk of  $10^{-5}$  and a target HQ of 1. Derivation of these screening criteria is discussed in Appendix VI.

### **3.1.3 Migration to Ground Water**

Migration to ground water soil screening criteria were utilized to identify on-Facility soil concentrations that may represent a source of ground water contamination. These criteria are based on the protection of ground water as a drinking water source, and were derived using the procedure outlined in U.S. EPA's Soil Screening Guidance, and incorporate a default dilution-attenuation factor of 20 (U.S. EPA 1996).

The data that screen above the migration to ground water criteria were utilized during the field investigation activities to identify if further investigation of ground water quality (i.e., additional ground water monitoring wells) was necessary in the individual AOIs. Although those soil samples immediately above the Cedarville Aquifer are thought to better represent this potential leaching pathway for use in identifying the need for additional monitoring wells, all samples were conservatively screened for this criteria.

## **3.2 Cedarville Aquifer Ground Water Screening Criteria**

The ground water characterization data collected from monitoring wells screened in the Cedarville Aquifer were compared with the following three types of ground water screening criteria: 1) criteria based on drinking water consumption; 2) criteria based on nonpotable use of ground water, and 3) criteria based on vapor intrusion into indoor air. In addition, based on the water well survey conducted during the RFI (Payne Firm et al., 2004), off-Facility ground water data were compared with conservative nonpotable water use criteria.

### **3.2.1 Drinking Water**

The drinking water criteria were based on Ohio or federal maximum contaminant levels (MCLs) established under the Safe Drinking Water Act, and equivalent drinking water concentrations for constituents without MCLs. The equivalent drinking water concentrations are generic risk-based drinking water limits calculated using conservative standard default exposure factors for estimating high-end

exposures via daily drinking water consumption (U.S. EPA, 1991), and target cancer risk and target HQ of  $10^{-5}$  and 1, respectively.

### **3.2.2 Nonpotable Ground Water**

The water well survey conducted during the Phase I RFI (Payne Firm et al., 2004) identified the potential for ground water to be used for nonpotable purposes (e.g., watering lawns, washing cars, filling swimming pools). Therefore, conservative nonpotable water criteria were derived to identify potentially significant exposure to off-Facility ground water used for non-potable purposes. These criteria are based on inhalation exposure to vapor, dermal contact, and incidental ingestion of ground water that may be used to fill a child's play pool (i.e. "kiddie" pool). Derivation of these criteria is described in Appendix VI.

### **3.2.3 Vapor Intrusion**

Ground water screening criteria were derived to identify ground water conditions that might result in potentially significant indoor air exposures if constituents in ground water were to volatilize and migrate through cracks in industrial building foundations into indoor air. These criteria were derived in a manner similar to the derivation of the vapor intrusion criteria for soil. To assess current conditions of Vernay's Facility operations for the CA725 Report, one set of criteria was derived using the same vapor intrusion modeling approach, the same soil properties, the same building characteristics, and the same PELs/TLVs. Similar to the soils evaluation, a second set of criteria were used to identify the potential for significant vapor intrusion at the Facility to assess potential future exposure conditions for the potential scenario in which Vernay no longer operates the Facility. These values were calculated using U.S. EPA-derived URFs and inhalation RfCs, with a target cancer risk of  $10^{-5}$  and a target HQ of 1. Derivation of these screening criteria for ground water is discussed in Appendix VI.

The criteria for evaluating off-Facility areas were derived in a manner similar to the derivation of the on-Facility risk-based criteria, except the building characteristics were based on conservative regulatory default assumptions for a hypothetical residential building. These criteria were calculated using U.S. EPA-derived URFs and inhalation RfCs, with a target cancer risk of  $10^{-5}$  and a target HQ of 1. Derivation of these screening criteria for ground water is discussed in Appendix VI.

## **3.3 Unconsolidated Unit Subsurface Water Screening Criteria**

As described in Section 1.4, subsurface water occurs within discontinuous saturated sand seams or saturated sewer backfill of the Unconsolidated Unit. These water bearing zones are not a source of potable or non-potable water because of the extremely low yield and poor water quality (i.e., high turbidity and suspended solids), and the presence of usable ground water in the Cedarville Aquifer. Potential on- and off-Facility worker exposures to subsurface water in these discontinuous locations may



occur during occasional excavation activities. In addition, exposures may occur via vapor intrusion into on- and off-Facility buildings.

### **3.3.1 Construction Worker Contact**

The ground water screening criteria based on construction worker contact were derived to identify conditions that might result in significant exposure of construction workers during excavations that extend into the discontinuous saturated zones of the Unconsolidated Unit. These criteria were derived using conservative exposure factors for incidental ingestion, dermal contact, and inhalation of vapors from ground water. They were calculated using a target cancer risk of  $10^{-5}$  and a target HQ of 1. Derivation of these screening criteria is discussed in Appendix VI.

### **3.3.2 Vapor Intrusion**

Screening criteria were derived to identify conditions in discontinuous saturated zones in the Unconsolidated Unit that might result in potentially significant indoor air exposures if constituents were to volatilize and migrate through cracks in building foundations into indoor air. These criteria were derived following the approach used for the derivation of the vapor intrusion criteria for soil. To assess current conditions of Vernay Facility operations for the CA725 Report, one set of these criteria was derived using the same vapor intrusion modeling approach, the same soil properties, the same building characteristics, and the same PELs/TLVs. Similar to the soil evaluation, a second set of criteria was used to identify the potential for significant vapor intrusion at the Facility to assess potential future exposure conditions for the potential scenario in which Vernay no longer operates the Facility. These values were calculated using U.S. EPA-derived URFs and inhalation RfCs, with a target cancer risk of  $10^{-5}$  a target HQ of 1. Derivation of both sets of vapor intrusion screening criteria for ground water is discussed in Appendix VI.

The criteria for evaluating off-Facility areas were derived in a manner similar to the derivation of the on-Facility risk-based criteria, except the building characteristics were based on conservative regulatory default assumptions for a hypothetical residential building. These criteria were calculated using U.S. EPA-derived URFs and inhalation RfCs with a target cancer risk of  $10^{-5}$  a target HQ of 1. Derivation of both sets of vapor intrusion screening criteria for ground water is discussed in Appendix VI.

## **3.4 Sediment Screening Criteria**

Generic risk-based screening criteria for evaluating the significance of potential exposure to sediments are not well established. Therefore, as a conservative approach to the identification of a potentially significant release to sediment, the sediment characterization data collected during the RFI were compared with the generic risk-based screening criteria described above for evaluating direct contact exposures to soil.



Specifically, sediment samples collected from the unnamed tributary were compared to the soil screening criteria derived from the U.S. EPA Region 9 industrial and residential soil PRGs. Use of these soil screening criteria for evaluating potential exposures to sediments is highly conservative because potential exposures to sediments are expected to be much lower than potential residential exposures to soil.

### **3.5 Surface Water Screening Criteria**

Water samples were collected during the RFI from the Facility's storm sewers and from the Unnamed Creek, as discussed in Section 2.0. Generic risk-based screening criteria for evaluating the significance of potential exposure to surface water are not well established. Therefore, as a conservative approach to the identification of a potentially significant release to surface water, the storm water and surface water characterization data were compared with the ground water screening criteria described above. Specifically, data from the sewers and the Unnamed Creek were compared with criteria developed for evaluating potential exposures via drinking water, exposures to workers during excavation activities, and/or non-potable water ("kiddie pool").

### **3.6 Indoor Air Screening Criteria**

As described above, risk-based screening criteria were derived to identify conditions in soil and/or ground water that might result in potentially significant indoor air exposures if constituents were to volatilize and migrate through cracks in building foundations into indoor. In addition to modeling soil and ground water concentrations that theoretically could result in significant indoor air concentrations, direct indoor air measurements were conducted inside the on-Facility buildings during the RFI to assess the potential significance of this pathway. These direct measurements were compared to the criteria discussed below.

To assess current conditions of Vernay's Facility operations for the CA725 Report, the data were compared with PELs, or TLVs for chemicals without PELs.

To assess indoor air concentrations for the potential scenario in which Vernay no longer operates the Facility, risk-based indoor air screening criteria were derived to evaluate the potential significance of concentrations identified via direct measurement of indoor air constituents within Facility buildings. These values were calculated using U.S. EPA-derived inhalation URFs and inhalation RfCs, with a target cancer risk of  $10^{-5}$  a target HQ of 1. Derivation of these criteria is discussed in Appendix VI.

### **3.7 Interpretation of Screening Results**

As explained in the introductory text in Section 3.0, the screening criteria described in Sections 3.1 through 3.6 were used during the RFI field investigation to guide data collection and support the CA725 Environmental Indicators determination. Soil, ground water, sediment, subsurface water, indoor air and surface water data collected from each phase of the field investigation were compared with the screening



criteria to facilitate judgment regarding whether sufficient characterization data have been collected to support a risk assessment to determine whether corrective measures are warranted. As such, the comparison results were used during the RFI field investigation to distinguish constituents, media, and areas where further data collection should be considered from those where further data collection was not necessary. The comparison results were not used to eliminate constituents, media, or areas from a baseline risk assessment. All constituents positively identified in soil, ground water, sediment, subsurface water, indoor air and surface water at the Facility and all investigated areas are included in the baseline human health risk assessment discussed in Section 5.0.

The comparison results for each investigated area are presented in screening summary tables discussed below for each AOI. For each AOI, the comparison results for each matrix are presented on a separate screening summary table, which lists all the target constituents, the number of analyses for each constituent, the number of detections, the range of detected concentrations, the screening criteria, and the ratios of the highest detected concentration for each constituent to the screening criteria. An area is identified to have a potentially significant release if it has at least one ratio that exceeds 1.

To facilitate judgment regarding whether the lateral and vertical extent of contamination has been adequately characterized, the data for certain constituents were selected for display on site figures.

### **3.8 AOI 1 – Undeveloped/Non-Operational Portion of the Facility**

AOI 1 is defined as the currently undeveloped/non-operational portion of the Facility, and is comprised of the grass-covered western fill area and parking area (Figure 6). The SWMUs and AOCs in this area were described in the RFI Phase I (Payne Firm et al., 2004). Moderate and high release potential SWMUs and AOCs identified in AOI 1 include the following:

- West fill area (SWMU 39) located on the western portion of the Facility.
- Former agricultural support buildings (AOC E) located on the western portion of the Facility adjacent to Dayton Street.

The largest area of AOI 1 is occupied by SWMU 39 as a result of the placement of fill material from a Village of Yellow Springs road construction project on Dayton Street in the early 1960s (see Section 1.3). Shallow soil contamination (0 to 6 feet) in the SWMU 39 area consists primarily of PAHs believed to be due to asphalt within the road construction fill (see Figure 9). This area is currently grass covered. AOC E is a much smaller area at the northeast corner of AOI 1 where a former farm house and three former agricultural support buildings were located. VOC concentrations are present in subsurface soil, extend to the top of bedrock in some locations, and are concentrated along the former support building locations in AOI 1 (see Figure 8). This area is also currently grass covered. No buildings or structures currently exist

within AOI 1 except for a fire line pump station (Figure 2), and there are no routine Facility activities in this area except for seasonal grass mowing.

### 3.8.1 Scope and Results

The scope of the RFI field investigations at AOI 1 involved the collection of soil and subsurface water (discontinuous saturated sand seams) samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at AOI 1. The sampling locations are shown on Sheet 1.

The following is a summary of the sampling activities conducted for each medium during the investigations at AOI 1:

#### Soil Samples

During the field investigations, 29 soil borings were installed at AOI 1 and soil samples from these locations were collected at depth intervals in accordance with the project DQOs (Table 2) and the Statements of Work (Table 3) for each phase of investigation. Each of the soil samples were analyzed for VOCs, SVOCs, Pesticides/PCBs, Herbicides and metals.

#### Subsurface Water Samples (Saturated Sand Seams)

Subsurface water quality data were collected from four shallow discontinuous sand seams in the upper and middle portions of the Unconsolidated Unit within AOI 1. Direct push water samples were collected in accordance with the procedures described in the RFI Phase I report. Each of the water samples were analyzed for VOCs.

A summary of the analytical data for each medium is shown in Tables 12 and 13.

The analytical data was reviewed and validated, and a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Pesticides/PCBs	Metals
Soil	29	62	54	7	23
Subsurface Water	4	4	0	0	0

The above sample counts do not include QC samples (e.g. field duplicates).



### 3.8.2 Discussion of Results

The concentrations of constituents detected in soil and subsurface water samples collected during the RFI were compared with the screening criteria discussed in Section 3.1 and 3.3, to determine whether a potentially significant release of hazardous constituents has occurred and whether potentially significant concentrations of hazardous constituents are present at AOI 1. The results of the comparison are summarized in Tables 12 and 13 and shown on Figure 8 and 9.

#### Soil

Table 12 indicates that the VOCs carbon tetrachloride, 1,2-DCP, methylene chloride, PCE, and TCE have concentrations in soil at depths ranging from 0 to 18 feet bgs at AOI 1 that are higher than one or more of the screening criteria discussed in Section 3.1 (based on direct contact, risk-based vapor intrusion and migration to ground water). The soil boring locations for each of the VOCs that exceed one or more of the screening criteria are presented on Table VII.1 (see Appendix VII) and summarized as follows:

- Carbon Tetrachloride – Concentrations at one soil boring location, GP01-169 (10.5 to 12.5 feet bgs) exceeds the risk-based vapor intrusion criterion.
- 1,2-DCP – Concentrations at two soil boring locations, GP01-149 (12 to 14 feet bgs) and GP01-171 (17 to 18 feet bgs), exceed the direct contact, risk-based vapor intrusion, and migration to ground water criteria. Of these two locations, however, only one of the exceedances at boring location GP01-171 was identified within the interval directly above the water table, which provides a better representation of the leaching to ground water pathway.
- Methylene Chloride – Concentrations at one soil boring location (GP01-171 at 17 to 18 feet bgs), collected from the interval directly above the water table, exceeds the vapor intrusion and migration to ground water pathway criteria.
- PCE – The concentrations at three soil boring locations, GP01-112 (11 to 14 feet bgs), GP01-113 (6 to 8 feet bgs) and GP01-156 (8 to 10 feet bgs), exceed the vapor intrusion and migration to ground water criteria, however, the maximum depths of the identified exceedances were not located within the interval directly above the ground water table at any of these locations.
- TCE – The concentrations at one soil boring location, GP01-169 (10.5 to 12.5 feet bgs), exceeds the risk-based vapor intrusion criterion.

The horizontal and vertical extent of VOC contamination at AOI 1 has been characterized, with contamination generally limited to subsurface soil at the northeast corner of AOI 1 as depicted on Figure 8.





Table 12 also indicates that one PAH (benzo (a)pyrene) has concentrations that exceed the direct contact criterion, with a total of four soil boring locations, GP01-041 (0 to 2 feet bgs), GP01-042 (0 to 2 and 2 to 4 feet bgs), GP01-047 (2 to 4 feet bgs), and GP01-137 (0 to 2 and 2 to 4 feet bgs) containing one or more samples with concentrations that exceed the criterion. The horizontal and vertical extent of PAH contamination at AOI 1 has been characterized and consists of three sporadic areas of surface soil contamination as depicted on Figure 9.

#### Subsurface Water

Table 13 indicates that no constituent has a concentration in subsurface water (saturated sand seams) within the unconsolidated unit at AOI 1 that is higher than the criteria discussed in Section 3.3 (i.e., criteria based on construction worker contact and vapor intrusion).

### **3.8.3 Conclusions**

The soil data collected during several phases of RFI field investigations at AOI 1 indicate that potentially significant concentrations of three VOCs are present in subsurface soil at AOI 1. Although concentrations of each of the VOCs at each location exceed the risk-based vapor intrusion criteria, there is no building in AOI 1 and, therefore, no current vapor intrusion pathway. Similarly, of the four boring locations that contain concentrations of VOCs that exceed the migration to ground water criteria only two VOCs (1,2-DCP and methylene chloride) from one boring location (GP01-171) are present in a sample collected directly above the Cedarville Aquifer.

The subsurface water (saturated sand seams) data at AOI 1 indicate no potentially significant concentrations of contamination are present in subsurface water at AOI 1. Further investigation of subsurface water at AOI 1 is not warranted.

1,2-DCP and methylene chloride were detected in on-Facility Cedarville Aquifer monitoring wells; these data are discussed as part of AOI 5A (see Section 3.14). Methylene chloride was detected in one off-Facility Cedarville Aquifer monitoring well sample (see AOI 5B, Section 3.15).

Based on data evaluated for the RFI, the nature and extent of soil contamination has been adequately characterized for risk evaluation purposes. Subsurface water sampling has also adequately characterized this AOI for risk assessment purposes. The risk evaluation is presented in Section 5.0.

### **3.9 AOI 2N – Developed/Non-Operational Portion of the Facility**

AOI 2N is defined as the developed non-operational portion of the Facility, and is comprised of the

Plant 3 offices, parking areas, and grass-covered areas (Figure 6). The SWMUs and AOCs in this area were described in the RFI Phase I (Payne Firm et al., 2004). Moderate and high release potential SWMUs and AOCs identified in AOI 2N include the following:

- Process sewer lines and floor drains (SWMU 1) located north of Plant 3.
- Storm sewer system (SWMU 2) located north of Plant 3.

Over one half of AOI 2N is paved with concrete or asphalt, or under concrete building floors where no industrial operations were performed. Soil contamination from past site activities in this AOI consists primarily of VOCs. VOC concentrations are present in subsurface soil, extend to the top of bedrock in some locations, and are concentrated along the southwest-northeast trending (diagonal) storm sewer line in the grass covered area of AOI 2N (see Figure 8). Primarily, waste liquids, including waste solvents and waste oils previously used in Plant 2 and Plant 3, reportedly entered into the sewer system beneath the Facility via floor drains formerly located inside the two buildings. The sewer system beneath the buildings connected to the diagonal storm sewer in AOI 2N and connected to the sewer system along Dayton Street. Soil and subsurface water samples collected near sewer lines, within sewer lines, within sewer backfill, and native soil material around the sewer backfill contain elevated concentrations of VOCs.

### **3.9.1 Scope and Results**

The scope of the pre-RFI/RFI field investigations at AOI 2N involved the collection of soil and subsurface water (saturated sand seams/sewer backfill) samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at the Facility. The sampling locations are shown on Sheet 1.

The following is a summary of the sampling activities conducted for each medium during the investigations at AOI 2N:

#### Soil Samples

During the field investigations, 32 soil borings were installed at AOI 2N and soil samples from these locations were collected at depth intervals in accordance with the project DQOs (Table 2) and the Statements of Work (Table 3) for each phase of investigation. Each of the soil samples were analyzed for a combination of VOCs, SVOCs, Pesticides/PCBs, Herbicides and metals.

#### Subsurface Water Samples

Subsurface water quality data were collected from shallow discontinuous sand seams in the upper and middle portions of the Unconsolidated Unit and saturated backfill surrounding the sewer lines. Eight

direct push water samples were collected in accordance with the procedures described in the RFI Phase I report. Each of the water samples were analyzed for VOCs.

A summary of the analytical data for each medium is shown in Tables 14 and 15.

The analytical data was reviewed and validated, a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Pesticides/PCBs	Herbicides	Metals
Soil	32	67	22	8	8	24
Subsurface Water	8	7	0	0	0	0

The above sample counts do not include QC samples (e.g. field duplicates).

### 3.9.2 Discussion of Results

The concentrations of constituents detected in soil and subsurface water samples collected during the RFI were compared with the screening criteria discussed in Section 3.1 and 3.3 to determine whether a potentially significant release of hazardous constituents has occurred and whether potentially significant concentrations of hazardous constituents are present in AOI 2N. The results of the comparison are summarized in Tables 14 and 15 and shown on Figure 8.

#### Soil

Table 14 indicates that PCE has concentrations in soil at AOI 2N that exceeds the direct contact criterion, and PCE and TCE were detected at concentrations in soil at AOI 2N that are higher than both the risk-based vapor intrusion and migration to ground water criteria discussed in Section 3.1. The soil boring locations for each of the VOCs that exceed one or more of the screening criteria are presented on Table VII.1 (see Appendix VII) and summarized as follows:

- PCE – A total of four soil boring locations, GP01-108 (8 to 10 feet bgs), GP01-126 (8 to 9 feet bgs), GP01-157 (8 to 10 feet bgs), GP01-158 (8 to 10 feet bgs), and GP01-163 exceed the risk-based vapor intrusion criterion and/or the migration to ground water criterion. However, none of the samples containing the exceedances were located within the interval directly above ground water. In addition a PCE exceedance of the direct contact, risk-based vapor intrusion, and migration to ground water criterion was identified in off-Facility soil boring location GP02-054 (14 to 16 feet bgs), and an exceedance of the risk based vapor intrusion criterion was identified in soil boring GP02-104

(0 to 2 and 10.5 to 12.5 feet bgs), which are within the buffer zone of AOI 2N and, therefore, are included in the screening evaluation for AOI 2N.

- TCE – One soil boring location, GP01-108 (12 to 14 feet bgs) exceeds both the risk-based vapor intrusion and migration to ground water criteria, with the exceedance of the migration to ground water criterion located directly above the water table. In addition a TCE exceedance of the risk-based vapor intrusion criterion and migration to ground water criterion was identified in off-Facility soil boring location GP02-054 (14 to 16 feet bgs), which is within the buffer zone of AOI 2N and, therefore, is included in the screening evaluation for AOI 2N.

The horizontal and vertical extent of VOC contamination at AOI 2N has been characterized, with contamination generally limited to subsurface soil beneath the storm sewer line at AOI 2N as depicted on Figure 8.

#### Subsurface Water

Tables 15a, 15b and 15c indicates that no constituent has a concentration in subsurface water (saturated sand seams, stormsewer backfill and sanitary sewer backfill) within the unconsolidated unit at AOI 2N that is higher than the criteria discussed in Sections 3.3 (based on construction worker contact) and 3.3 (based on vapor intrusion).

#### **3.9.3 Conclusions**

The soil data collected during several phases of RFI field investigations at AOI 2N indicate that potentially significant concentrations of PCE or TCE are present in subsurface soil beneath the storm sewer line. Although the concentrations of PCE or TCE exceed the migration to ground water criteria, only two of the boring locations (GP01-108 at 12 to 14 feet bgs and GP02-054 at 14 to 16 feet bgs) exhibited concentrations above these criteria within the interval directly above ground water.

The subsurface water (saturated sand seam water or sewer backfill) data at AOI 2N indicate no potentially significant concentrations of contamination are present in AOI 2N. Further investigation of subsurface water at AOI 2N is not warranted.

TCE and PCE were detected in on-Facility and off-Facility Cedarville Aquifer monitoring wells; these data are discussed as part of AOI 5A (see Section 3.14) and AOI 5B (see Section 3.15), respectively.

Based on data gathered for the RFI, the nature and extent of soil contamination at AOI 2N has been adequately characterized for risk evaluation purposes. Subsurface water sampling has also adequately characterized this AOI for risk assessment purposes. The risk evaluation is presented in Section 5.0.



### **3.10 AOI 2S – Developed/Operational Portion of the Facility**

AOI 2S is defined as the developed current or former operational portion of the Facility, and includes Plant 2, the former industrial operations portion of Plant 3 and the Facility parking areas with adjoining driveways and loading docks (Figure 6). The SWMUs and AOCs in this area were described in the RFI Phase I (Payne Firm et al., 2004). Moderate to high release potential SWMUs and AOCs in AOI 2S were identified as the following:

- Process sewer lines and floor drains (SWMU 1) located beneath and between Plants 2 and 3 and south and east of Plant 3.
- Storm sewer system (SWMU 2) located beneath and between Plants 2 and 3 and south and east of Plant 3.
- Former hazardous waste drum storage area (SWMU 4) located east of Plant 2.
- Dust suppression and weed control areas (SWMU 5) located between Plants 2 and 3 and south of Plant 2.
- Former waste accumulation area (SWMU 6) located inside Plant 3 (former needle inspection room).
- Former storm water catch basin (SWMU 7) located at the Plant 2 southern loading dock.
- Hydraulic oil trench system (SWMU 29) located beneath Plants 2 and 3.
- Former vapor degreasing areas (AOC A) located in Plants 2 and 3.
- Former PCE above ground storage tanks (AOC B) located outside along the western wall of the Plant 3.
- Former empty product drum storage area (AOC C) located outside the south side of Plant 3.

The majority of AOI 2S is paved with concrete or asphalt, or under concrete building floors where industrial operations were performed. Primarily, waste liquids, including waste solvents and waste oils, previously used in Plant 2 and Plant 3 reportedly entered into the sewer system beneath the Facility via floor drains formerly located inside the two buildings. Soil contamination from past site activities in this area consists primarily of VOCs and PAHs. VOC concentrations are present from the surface down to the top of bedrock within this area, and are concentrated in the central portion of AOI 2S (see Figure 8).

Based on the results of the RFI, this area of the Facility is considered the primary source area for ground water contamination detected in the Cedarville Aquifer beneath the Facility. Backfill materials around sewer lines beneath this area are also a source of soil contamination on the Facility. Soil and subsurface water samples collected near floor drains and sewer lines, within sewer backfill, and native soil material around the sewer backfill contain elevated concentrations of VOCs and PAHs.



### 3.10.1 Scope and Results

The scope of the pre-RFI/RFI field investigations at AOI 2S involved the collection of soil, subsurface water (saturated sand seams/sewer backfill) and sewer line water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at AOI 2S. The sampling locations are shown on Sheet 1.

The following is a summary of the sampling activities conducted for each medium during the investigations at AOI 2S:

#### Soil Samples

During the field investigations, 98 soil borings were installed at AOI 2S and soil samples from these locations were collected at depth intervals in accordance with the project DQOs (Table 2) and the Statements of Work (Table 3) for each phase of investigation. Each of the soil samples were analyzed for a combination of VOCs, SVOCs, Pesticides/PCBs, Herbicides and metals.

#### Subsurface Water Samples

Subsurface water quality data were collected from shallow discontinuous sand seams in the upper and middle portions of the Unconsolidated Unit and saturated backfill surrounding the sewer lines. Thirty-two direct push water samples were collected in accordance with the procedures described in the RFI Phase I report. Each of the water samples were analyzed for VOCs.

#### Storm Sewer Water Samples

Seven water sample locations from the storm sewer were collected from inside the sewer line. Each of the water samples were analyzed for VOCs.

A summary of the analytical data for each medium is shown in Tables 16 to 18.

The analytical data was reviewed and validated, a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Pesticides/PCBs	Herbicides	Metals
Soil	98	218	185	13	1	181
Subsurface Water	32	6	0	0	0	0
Storm Sewer Water	7	12	0	0	0	0

The above sample counts do not include QC samples (e.g. field duplicates).

### 3.10.2 Discussion of Results

The concentrations of constituents detected in soil, subsurface water, and sewer water samples collected during the RFI were compared with the screening criteria discussed in Section 3.1, 3.3 and 3.5 to determine whether a potentially significant release of hazardous constituents has occurred and whether potentially significant concentrations of hazardous constituents are present in AOI 2S. The results of the comparison are summarized in Tables 16, 17 and 18 and shown on Figures 8 and 9.

#### Soil

Table 16 indicates that the VOCs (1,2-DCE (total), cis-1,2-DCE, methylene chloride, PCE, TCE, 1,1,2-Trichloro-1,2,2-trifluoroethane, and vinyl chloride) were detected at concentrations in soil at AOI 2S that are higher than one or more of the screening criteria (direct contact, vapor intrusion, and migration to ground water) discussed in Section 3.1. The soil boring locations for each VOC that exceed one or more of the screening criteria are presented on Table VII.1 (see Appendix VII) and summarized as follows:

- 1,2-DCE (total) – A total of five soil boring locations, GP01-055 (0 to 2 and 4 to 6 feet bgs), GP01-068 (8 to 10 feet bgs), GP01-070 (8 to 10 feet bgs), GP01-071 (4 to 6 feet bgs and 8 to 10 feet bgs), and GP01-072 (8 to 10 feet bgs) exceed the risk-based vapor intrusion criterion, but not the occupational-based vapor intrusion criterion.
- cis-1,2-DCE – A total of twelve soil boring locations, GP01-017 (4 to 6, 6 to 8, and 8 to 10 bgs), GP01-050 (4 to 6 feet bgs), GP01-055 (0 to 2 and 4 to 6 feet bgs), GP01-068 (8 to 10 and 12 to 14 feet bgs), GP01-070 (8 to 10 feet bgs), GP01-071 (4 to 6 and 8 to 10 feet bgs), GP01-072 (8 to 10 feet bgs), GP01-080 (6 to 8 and 8 to 10 feet bgs), GP01-117 (10 to 12 feet bgs), GP01-123 (14 to 16 feet bgs), GP01-144 (8 to 10, 10 to 12, and 13 to 14 feet bgs), and GP01-145 (10 to 12 feet bgs), exceed the risk-based vapor intrusion criterion, but not the occupational-based vapor intrusion criterion.
- Methylene Chloride – A total of one soil boring location (GP01-055 at 0 to 2 feet bgs) exceeds the migration to ground water criterion, however, the sample containing the exceedance was not located within the interval directly above ground water.
- PCE – Six soil boring locations GP01-017 (8 to 10 feet bgs), GP01-019 (10 to 12 and 12 to 13.5 feet bgs), GP01-050 (8 to 10 feet bgs), GP01-055 (0 to 2 and 8 to 10 feet bgs), GP01-070 (8 to 10 feet bgs), and GP01-072 (4 to 6 and 8 to 10 feet bgs) exceed all three of the criteria discussed in Section 3.1 (direct contact, vapor intrusion, and migration to ground water). A total of eleven soil boring locations, GP01-017 (6 to 8 feet bgs), GP01-019 (13.5 to 15.5 feet bgs), GP01-052 (4 to 6 feet bgs), GP01-055 (0 to 2 and 4 to 6 feet bgs), GP01-069 (0 to 2 feet bgs), GP01-071 (0 to 2 feet bgs),





GP01-073 (8 to 10 feet bgs), GP01-080 (0 to 2, 6 to 8, and 8 to 10 feet bgs), GP01-123 (14 to 16 feet bgs), GP01-144 (10 to 12 feet and 13 to 14 feet bgs), and GP01-145 (10 to 12 and 12 to 14 feet bgs) exceed both the risk-based vapor intrusion criterion and the migration to ground water criterion, and a total of sixteen soil boring locations, GP01-017 (4 to 6 feet bgs), GP01-019 (4 to 6 feet bgs), GP01-050 (8 to 10 feet bgs), GP01-052 (4 to 6 and 8 to 10 feet bgs), GP01-059 (8 to 10 and 16 to 18 feet bgs), GP01-063 (4 to 6 feet bgs), GP01-068 (12 to 14 feet bgs), GP01-071 (0 to 2 feet bgs), GP01-072 (0 to 2 and 8 to 10 feet bgs), GP01-091 (8 to 10 feet bgs), GP01-115 (11 to 12.5 feet bgs), GP01-131 (0 to 2 and 2 to 4 feet bgs), GP01-143 (1 to 2 feet bgs), GP01-144 (8 to 10 feet bgs), GP01-145 (7 to 8 and 8 to 10 feet bgs) and GP01-166 (10 to 12 feet bgs) exceed only the risk-based vapor intrusion criterion. None of the soil boring locations that exceed for PCE, however, exceed the occupational-based vapor intrusion criterion.

- TCE – Two soil boring locations, GP01-055 (0 to 2 feet bgs) and GP01-123 (14 to 16 feet bgs) exceed the risk-based vapor intrusion criterion, but not the occupational-based vapor intrusion criterion. A total of eleven soil boring locations, GP01-017 (8 to 10 feet bgs), GP01-052 (8 to 10 and 10 to 12 feet bgs), GP01-055 (0 to 2 feet bgs), GP01-068 (10 to 12 feet bgs), GP01-070 (8 to 10 feet bgs), GP01-071 (8 to 10 feet bgs), GP01-080 (6 to 8 and 8 to 10 feet bgs), GP01-115 (11 to 12.5 and 12.5 to 14.5 feet bgs), GP01-116 (8 to 10 feet bgs), GP01-117 (10 to 12 feet bgs), and GP01-144 (10 to 12 and 13 to 14 feet bgs) exceed both the risk-based vapor intrusion and the migration to ground water criteria, but not the occupational vapor intrusion criterion.
- 1,1,2-Trichloro-1,2,2-trifluoroethane – One soil boring location, GP01-019 (12 to 13.5 feet bgs) exceeds the risk-based vapor intrusion criterion, but not the occupational criterion.
- Vinyl Chloride – A total of thirteen soil boring locations, GP01-017 (6 to 8 feet bgs), GP01-020 (6 to 8, 8 to 10 and 10 to 12 feet bgs), GP01-050 (4 to 6 feet bgs), GP01-068 (12 to 14 feet bgs), GP01-072 (4 to 6 feet bgs), GP01-080 (0 to 2, 4 to 6, 6 to 8, and 8 to 10 feet bgs), GP01-128 (8 to 10 feet bgs), GP01-131 (2 to 4 and 10 to 12 feet bgs), GP01-141 (8 to 10 feet bgs), GP01-142 (8 to 10 feet bgs), GP01-143 (10 to 12 feet bgs), GP01-144 (16 to 18 feet bgs), and GP01-145 (8 to 10 feet bgs) exceed the risk-based vapor intrusion criterion, but not the occupational-based vapor intrusion criterion. Two soil boring locations, GP01-068 (8 to 10 feet bgs) and GP01-080 (4 to 6 feet bgs) exceed both the risk-based vapor intrusion criterion and the migration to ground water criterion. However, the migration to ground water exceedances identified in these borings do not represent the interval directly above ground water.

The horizontal and vertical extent of VOC contamination at AOI 2S has been characterized within AOI 2S, with contamination identified in surface and subsurface soil along the storm sewer line between





Plant 2 and Plant 3 as well as locations within and near the footprint of the buildings (see Figure 8). Locations beneath the building are primarily associated with locations of sewer line connections.

Table 16 also indicates that the PAHs (benzo(a)pyrene and dibenz(a,h)anthracene) have soil concentrations that exceed the direct contact criteria. These concentrations are localized to the surface soil (0 to 2 feet bgs) at boring GP01-064. The extent of PAH contamination at AOI 2S has been characterized as shown on Figure 9.

#### Subsurface Water

Tables 17a and 17b indicate that no constituent has a concentration in subsurface water (saturated sand seams and sewer backfill) within the unconsolidated unit at AOI 2S that is higher than the criteria discussed in Sections 3.3 (based on construction worker contact) and 3.3 (based on vapor intrusion).

#### Storm Sewer Water

Table 18 indicates that cis-1,2-DCE, PCE, TCE, and vinyl chloride have concentrations that exceed the conservative drinking water criteria discussed in Section 3.5. The storm sewer sampling locations for each VOC that exceed one or more of the screening criteria are presented on Table VII.2 (see Appendix VII). There were no exceedances, however, of the construction worker contact criterion.

### **3.10.3 Conclusions**

The soil data collected during several phases of RFI field investigations at AOI 2S indicate that potentially significant concentrations of six VOCs (1,2-DCE (total), cis-1,2-DCE, methylene chloride, PCE, TCE, 1,1,2-Trichloro-1,2,2-trifluoroethane, and vinyl chloride) are present in surface and subsurface soil at several locations beneath or adjacent to the Facility buildings and potentially significant concentrations of two PAHs are present in surface soil at one localized location beneath Plant 3.

A large portion of AOI 2S is covered with the Facility buildings and the soil screening results indicate that soil vapor intrusion to indoor air from the VOCs 1,2-DCE (total), cis-1,2-DCE, PCE, TCE, 1,1,2-Trichloro-1,2,2-trifluoroethane, and vinyl chloride exceed the risk-based screening criteria. However, as discussed in Section 3.16, based on indoor air testing conducted in February 2004 none of the soil VOCs that exceed the theoretical soil vapor intrusion to indoor air criteria were detected in indoor air samples at concentrations exceeding the risk-based indoor air criteria. Further investigation of soil at AOI 2S is not warranted.

The subsurface water data at AOI 2S indicate no potentially significant concentrations of contamination are present in AOI 2S. Further investigation of subsurface water at AOI 2S is not warranted.

The storm sewer water data at AOI 2S indicates exceedances of the conservative drinking water criteria for cis-1,2-DCE, PCE, TCE, and vinyl chloride, but no exceedances of the construction worker contact criterion. Further characterization of storm sewer water at AOI 2S is not warranted.

TCE and PCE were detected in on-Facility and off-Facility Cedarville Aquifer monitoring wells; these data are discussed as part of AOI 5A (see Section 3.14) and AOI 5B (see Section 3.15), respectively.

Based on data gathered for the RFI, the nature and extent of soil contamination at AOI 2S has been adequately characterized for risk evaluation purposes. Subsurface water and storm sewer water sampling has also adequately characterized AOI 2S for risk assessment purposes. The risk evaluation is presented in Section 5.

### **3.11 AOI 3 – Off-Facility Area**

AOI 3 includes the off-Facility area that was investigated during the RFI within the limits of the survey area (Figure 6). AOI 3 consists of off-Facility soils and subsurface water (saturated sand seams) in the vicinity of the Facility. As described below, with the exception of off-Facility sewer lines and sewer backfill (AOI 3A) and off-Facility Cedarville Aquifer ground water (AOI 5B), Facility related contamination has not been identified in off-Facility areas. No SWMUs or AOCs were identified in AOI 3 (Payne Firm et al., 2004).

#### **3.11.1 Scope and Results**

The scope of the pre-RFI/RFI field investigations at AOI 3 involved the collection of soil and subsurface water (saturated sand seams) samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at the Facility. The sampling locations are shown on Sheet 1.

The following is a summary of the sampling activities conducted for each medium during the investigation at AOI 3:

##### Soil Samples

During the field investigations, 8 soil borings were installed at AOI 3 and soil samples from these locations were collected at depth intervals in accordance with the project DQOs (Table 2) and the Statements of Work (Table 3) for each phase of investigation. Each of the soil samples were analyzed for a combination of VOCs, SVOCs and metals.

### Subsurface Water Samples

Subsurface water quality data were collected from shallow discontinuous sand seams in the upper and middle portions of the Unconsolidated Unit. Twelve direct push water samples were collected in accordance with the procedures described in the RFI Phase I report. Each of the water samples were analyzed for VOCs.

A summary of the analytical data for each medium is shown in Tables 19 and 20.

The analytical data was reviewed and validated, a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Metals
Soil	8	13	2	22
Subsurface Water	12	9	0	0

The above sample counts do not include QC samples (e.g. field duplicates).

### **3.11.2 Discussion of Results**

The concentrations of constituents detected in soil and subsurface water collected during the RFI were compared with the screening criteria discussed in Section 3.1 and 3.3 to determine whether a potentially significant release of hazardous constituents has occurred and whether potentially significant concentrations of hazardous constituents are present in AOI 3. The results of the comparison are summarized in Tables 19 and 20. Sample locations for AOI 3 are depicted on Sheet 1.

#### Soil

Table 19 indicates that no exceedances of the soil criteria are identified in AOI 3. Therefore, further investigation of soil at AOI 3 is not warranted.

#### Subsurface Water

Table 20 indicates that no constituent has a concentration in subsurface water (saturated sand seams) within the unconsolidated unit at AOI 3 that is higher than the criteria discussed in Sections 3.3 (based on construction worker contact) and 3.3 (based on vapor intrusion). Further investigation of subsurface water at AOI 3 is not warranted.



### **3.11.3 Conclusions**

Based on data gathered for the RFI, soil and subsurface water at AOI 3 has been adequately characterized for risk evaluation purposes. The risk evaluation is presented in Section 5.0.

### **3.12 AOI 3A – Sewers off of the Facility**

As a subset of AOI 3, AOI 3A includes the sewer area located on Dayton Street between the Facility and the unnamed creek, between Omar Circle and the Facility and between the Facility and the adjacent properties to the east (Figure 6). AOI-3A consists of sewer backfill soil and water, water in the sewer lines, and soil in the immediate vicinity of sewer backfill along the off-Facility sewer lines. No SWMUs were identified in AOI 3A (Payne Firm et al., 2004). The off-Facility storm sewers were identified as AOC F. Contamination in the sewer lines area of AOC F consists primarily of VOCs detected beneath the invert of the sewer line and native soil material adjacent to the sewer backfill (see Figure 8).

#### **3.12.1 Scope and Results**

The scope of the RFI field investigations at AOI 3A involved the collection of soil, subsurface water (saturated sewer backfill) and sewer line water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at the Facility. The sampling locations are shown on Sheet 1.

The following is a summary of the sampling activities conducted for each medium during the investigations at AOI 3A:

##### Soil Samples

During the field investigations, 48 soil borings were installed at AOI 3A and soil samples from these locations were collected at depth intervals in accordance with the project DQOs (Table 2) and the Statements of Work (Table 3) for each phase of investigation. Each of the soil samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and metals.

##### Subsurface Water Samples

Subsurface water quality data were collected from shallow discontinuous sand seams in the upper and middle portions of the Unconsolidated Unit and saturated backfill surrounding the sewer lines. Thirty direct push water samples were collected in accordance with the procedures described in the RFI Phase I report. Each of the water samples were analyzed for VOCs.

##### Storm Sewer Water Samples

Nine water sample locations from the storm sewer were collected from inside the sewer line. Each of the water samples were analyzed for VOCs.



A summary of the analytical data for each medium is shown in Tables 21 to 23.

The analytical data was reviewed and validated, a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Pesticides/PCB	Metals
Soil	48	88	26	4	28
Subsurface Water	30	43	4	4	0
Storm Sewer Water	9	31	2	0	1

The above sample counts do not include QC samples (e.g. field duplicates).

### 3.12.2 Discussion of Results

The concentrations of constituents detected in soil, subsurface water, and sewer water collected during the RFI were compared with the screening criteria discussed in Section 3.1, 3.3, and 3.5 to determine whether a potentially significant release of hazardous constituents has occurred and whether potentially significant concentrations of hazardous constituents are present in AOI 3A. The results of the comparison are summarized in Tables 21, 22, and 23. Sample locations for AOI 3A are depicted on Sheet 1.

#### Soil

Table 21 indicates that PCE was detected above the screening criteria in soil boring locations in AOI 3A. As shown on Table VII.3 of Appendix VII, the concentrations of PCE at GP02-053 (6 to 8 feet bgs) exceeds the criteria described in 3.1 (based on migration to ground water), and GP02-054 (14 to 16 feet bgs) exceeds the screening criteria described in Section 3.1 (based on direct contact), and 3.1 (based on migration to ground water). The concentrations of TCE at GP02-054 (14-16 feet bgs) exceeds the screening criteria described in Section 3.1 (based on migration to ground water). In addition, as shown on Table 21, benzo(a)pyrene and dibenz(a,h)anthracene were detected at concentrations in soil at AOI 3A that are higher than the screening criteria described in Section 3.1 (based on direct contact). As shown on Table VII.3 of Appendix VII, the concentrations of benzo(a)pyrene at GP01-076 (0 to 2 feet bgs), GP01-137 (0 to 2 and 2 to 4 feet bgs), and GP02-077 (0 to 2 feet bgs) and the concentrations of dibenz(a,h)anthracene at GP01-076 (0 to 2 feet bgs), and GP01-137 (0 to 2 and 2 to 4 feet bgs) exceed the direct contact criterion.

### Subsurface Water

Tables 22a and 22b indicate that no constituent has a concentration in subsurface water (saturated sewer backfill) at AOI 3A that is higher than the criteria discussed in Sections 3.3 (based on construction worker contact).

### Storm Sewer Water

Table 23 indicates that PCE and TCE have concentrations in storm sewer water at AOI 3A at ST02-03 (see Table VII.4a in Appendix VII) that are higher than the criteria discussed in Section 3.5 (based on drinking water). There were no exceedances, however, of either the construction worker contact and/or the nonpotable water (“kiddie pool”) criterion.

### **3.12.3 Conclusions**

The soil data collected during several phases of RFI field investigations indicate that potentially significant concentrations of soil contamination are present along the off-Facility sewer lines characterized in AOI 3A. The RFI field investigations have adequately characterized AOI 3A and further investigation of soil at AOI 3A is not required.

Subsurface water at AOI 3A has been characterized and found not to contain potentially significant concentrations of constituents in subsurface. Further investigation of subsurface water at AOI 3A does not appear warranted.

Storm sewer water data collected during the RFI field investigations indicate that potentially significant concentrations of storm sewer water contamination are present in AOI 3A. Further characterization of storm sewer water in AOI 3A does not appear warranted.

Based on data gathered for several phases of RFI field investigations, soil, subsurface water and storm sewer water at AOI 3A has been adequately characterized for risk evaluation purposes. The risk evaluation is presented in Section 5.

### **3.13 AOI 4 – Unnamed Creek**

AOI 4 is defined as the Unnamed Creek located off-Facility between Dayton Street and Fairfield Pike (Figure 6). AOI 4 consists of sediment and surface water of the Unnamed Creek. Storm water from the Facility discharges to a storm sewer beneath Dayton Street. The Dayton Street storm sewer discharges to the Unnamed Creek located approximately 0.3 miles northeast of the Vernay Facility. No SWMUs or AOCs were identified in AOI 4 (Payne Firm et al., 2004). VOCs have been detected in the surface water at the sewer outfall discharge and in surface water and sediments collected in the Unnamed Creek. The VOC concentrations in surface water decrease to the reporting limit within a few hundred feet of the



outfall discharge in the Unnamed Creek; VOC concentrations in sediments decrease to the reporting limit within 50 feet of the outfall discharge in the Unnamed Creek.

### 3.13.1 Scope and Results

The scope of the pre-RFI/RFI field investigations at AOI 4 involved the collection of sediment and surface water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at the Facility. The sampling locations are shown on Sheet 1.

The following is a summary of the sampling activities conducted for each medium during the investigations at AOI 4:

#### Sediment Samples

During the field investigations, 6 collection stations were established at AOI 4 and sediment samples from these locations were collected at 0-2 feet depth intervals in accordance with the project DQOs (Table 2) and the Statements of Work (Table 3) for each phase of investigation. Each of the sediment samples were analyzed for VOCs.

#### Surface Water Samples

Surface water quality data were collected from 4 stations established at the Unnamed Creek in AOI 4. Surface water samples were collected in accordance with the procedures described in the RFI Phase I report. Each of the water samples were analyzed for VOCs.

A summary of the analytical data for each medium is shown in Tables 24 and 25.

The analytical data was reviewed and validated, a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs
Sediment	6	34
Surface Water	4	34

The above sample counts do not include QC samples (e.g. field duplicates).

### 3.13.2 Discussion of Results

The concentrations of constituents detected in sediment and surface water collected during the RFI were compared with the screening criteria discussed in Section 3.4 and 3.5 to determine whether a potentially

significant release of hazardous constituents has occurred and whether potentially significant concentrations of hazardous constituents are present in AOI 4. The results of the comparison are summarized in Tables 24 and 25. Sample locations for AOI 4 are depicted on Sheet 1.

#### Sediment

Table 24 indicates that several VOCs were detected in sediment at AOI 4, but all below the screening criteria discussed in Section 3.4 (based on residential and industrial direct contact).

#### Surface Water

Table 25 indicates that PCE is the only constituent that has a concentration in surface water at AOI 4 that is higher than the screening criteria discussed in Section 3.5 (based on drinking water). The surface water sampling locations for PCE that exceed the drinking water criterion are presented on Table VII.4b (see Appendix VII). As shown on Table 25, no exceedances of the non-potable water (“kiddie pool”) criteria are identified in AOI 4.

#### **3.13.3 Conclusions**

The sediment data collected during several phases of RFI field investigations indicate that potentially significant concentrations of contaminants are not present in AOI 4. Based on the RFI data available for sediment at AOI 4, further investigation of sediment at AOI 4 is not required.

AOI 4 contains concentrations of PCE in surface water that exceed the conservative drinking water criteria. The nature and extent of potential contamination in AOI 4 has been adequately characterized and further investigation is not required.

Based on data gathered for the RFI, sediment at AOI 4 has been adequately characterized for risk evaluation purposes. Surface water quality has also been adequately characterized at this AOI for risk assessment purposes. The risk evaluation is presented in Section 5.0.

#### **3.14 AOI 5A – Cedarville Aquifer Ground Water on the Facility**

AOI 5A is defined as the uppermost aquifer beneath the Facility called the Cedarville Aquifer. The Cedarville Aquifer consists of 1) discontinuous sand lenses at the base of the Unconsolidated Unit which are hydraulically connected with the underlying saturated bedrock and 2) saturated Silurian-aged carbonate bedrock units (dolomite and some shale) beneath the Unconsolidated Unit and above the underlying confining units of the Osgood Aquitard. The Cedarville Aquifer is approximately 82 feet in thickness beneath the Facility. At the Facility, the depth to the top of the Cedarville Dolomite (uppermost saturated bedrock unit) ranges from 11 to 26 feet below the surface. No SWMUs or AOCs were identified in AOI 5A (Payne Firm et al., 2004).





Contamination in the Cedarville Aquifer beneath the Facility consists primarily of VOCs that have migrated from the Unconsolidated Unit to the ground water beneath the Facility. VOC contamination exists primarily in the upper and middle portions of the Cedarville Aquifer beneath the Facility (see Figures 10, 11, 12 and 13). The Cedarville Aquifer is not used as a source of potable or non-potable ground water beneath the Facility. In fact, the contaminated ground water is captured by two extraction wells and treated at the Facility prior to being discharged to the POTW.

### 3.14.1 Scope and Results

The scope of the pre-RFI/RFI field investigations at AOI 5A involved the collection of Cedarville Aquifer ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at the Facility. The sampling locations are shown on Sheet 1. Quarterly sampling results are provided on Sheet 2.

The following is a summary of the sampling activities conducted for each medium during the investigations at AOI 5A:

#### Cedarville Aquifer Ground Water Samples

Vernay has installed a total of 33 monitoring wells, extraction wells and remediation wells with the upper, middle and lower portions and 49 direct push borings within the upper portion of the Cedarville Aquifer on the Facility. Ground water samples were collected on a quarterly basis during the RFI. Each of the water samples were analyzed for a combination of VOCs, SVOCs, Pesticides/PCBs, Herbicides or Metals.

A summary of the analytical data for AOI 5A is shown in Tables 26a and 26b.

The analytical data was reviewed and validated, a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Pesticides/PCBs	Herbicides	Metals
Cedarville Aquifer	82	379	78	18	9	132

The above sample counts do not include QC samples (e.g. field duplicates).

### 3.14.2 Discussion of Results

The concentrations of constituents detected in monitoring wells and/or direct push water samples within the Cedarville Aquifer in the on-Facility area collected during the RFI were compared with the screening

criteria discussed in Section 3.5 to determine whether a potentially significant release of hazardous constituents has occurred and whether potentially significant concentrations of hazardous constituents are present in AOI 5A. Ground water testing results for each location from samples collected at any time are conservatively compared to the screening criteria. The results of the comparison are summarized in Tables 26a and 26b. The on-Facility Cedarville Aquifer sampling locations that exceed one or more of the screening criteria are presented on Table VII.5 (see Appendix VII). Sample locations for AOI 5A are depicted on Sheet 1

#### Cedarville Aquifer Ground Water

Tables 26a and 26b indicate that based on ground water samples collected at AOI 5A several VOCs (benzene, 1,2-DCE (total), cis-1,2-DCE, 1,2-DCP, methylene chloride, PCE, TCE, 1,1,1-TCA, and vinyl chloride), one SVOC (bis(2-ethylhexyl)phthalate), three metals (total chromium, iron, and manganese) and nitrate were identified above the screening criteria described in Section 3.2 (based on drinking water). For PCE, TCE, and vinyl chloride detections above the screening criteria described in Section 3.2 (based on vapor intrusion or nonpotable water) and for bis(2-ethylhexyl)phthalate and manganese detections above the screening criteria described in Section 3.2 (based on nonpotable water) were also identified. For PCE and manganese, exceedances of the screening criteria described in Section 3.2 (based on risk-based vapor intrusion and nonpotable water, respectively) are identified in one remediation observation monitoring well (RW01-05) based on samples collected in 1999. There are no other exceedances of the risk-based ground water vapor intrusion to indoor air criteria.

Exceedances of the drinking water, the nonpotable water and/or risk -based vapor intrusion to indoor air criteria were identified for the following direct push water sample locations and constituents: GP01-017 (PCE and TCE), GP01-018 (methylene chloride and PCE), GP01-019 (methylene chloride, PCE, and/or TCE), GP01-020 (methylene chloride, PCE, and/or TCE), GP01-021 (PCE and TCE), GP01-022 (PCE and TCE), GP01-023 (PCE), GP01-024 (cis-1,2-DCE, methylene chloride, and/or PCE), GP01-026 (1,2-DCP, methylene chloride, and/or TCE), GP01-029 (1,2-DCP and TCE), GP01-030 (cis-1,2-DCE, 1,2-DCP, and TCE), GP01-032 (PCE and TCE), GP01-033 (1,2-DCP, PCE, and TCE), GP01-034 (PCE and TCE), GP01-035 (1,2-DCP, PCE, and TCE), GP01-038 (1,2-DCP), GP01-039 (cis-1,2-DCE, PCE, and TCE), GP01-040 (TCE), GP01-049 (1,2-DCP), GP01-050 (PCE), GP01-051 (1,2-DCP), GP01-059 (PCE), GP01-065 (PCE), GP01-067 (cis-1,2-DCE and TCE), GP01-068 (1,2-DCE (total), cis-1,2-DCE, and vinyl chloride), GP01-071 (1,2-DCE (total), cis-1,2-DCE, PCE, 1,1,1-TCA, and TCE), and GP01-073 (cis-1,2-DCE, PCE).

Exceedances of the drinking water criteria were identified for the following monitoring well sampling locations and constituents:

- MW01-01 – 1,2-DCP (last reported exceedance 11/99);



- MW01-02 – methylene chloride (last reported exceedance 02/04), 1,2-DCP (last reported exceedance 07/04), and TCE (last reported exceedance 11/03);
- MW01-03 – bis(2-Ethylhexyl)phthalate (last reported exceedance 02/03) and chromium (last reported exceedance 05/99);
- MW01-04 – methylene chloride (last reported exceedance 02/04), PCE (last reported exceedance 07/04) and TCE (last reported exceedance 07/04);
- MW01-04CD – methylene chloride (last reported exceedance 02/04), PCE (last reported exceedance 07/04), and TCE (last reported exceedance 07/04);
- MW01-05 – nitrate (last reported exceedance 06/00), 1,2-DCP (last reported exceedance 11/00), PCE (last reported exceedance 06/00), and TCE (last reported exceedance 05/99);
- MW01-05CD – bis(2-Ethylhexyl)phthalate (last reported exceedance 02/03), and 1,2-DCP (last reported exceedance 06/00);
- MW01-06 – benzene (last reported exceedance 11/03), cis-1,2-DCE (last reported exceedance 12/99), methylene chloride (last reported exceedance 02/04), PCE (last reported exceedance 07/04) and TCE (last reported exceedance 07/04);
- MW01-08 – bis(2-Ethylhexyl)phthalate (last reported exceedance 02/03)
- MW01-09 – PCE (last reported exceedance 06/01);
- MW01-10 – cis-1,2-DCE (last reported exceedance 07/04), 1,2-DCP (last reported exceedance 06/00), methylene chloride (last reported exceedance 07/04), PCE (last reported exceedance 07/04), TCE (last reported exceedance 07/04) and vinyl chloride (last reported exceedance 07/04);
- MW01-11 – TCE (last reported exceedance 07/04); and
- MW01-14 – cis-1,2-DCE (last reported exceedance 07/04), methylene chloride (last reported exceedance 07/04), PCE (last reported exceedance 07/04), TCE (last reported exceedance 07/04) and vinyl chloride (last reported exceedance 07/04)

### **3.14.3 Conclusions**

The Cedarville Aquifer ground water data indicate that potentially significant concentrations of a number of VOCs, one SVOC, one metal and nitrate are or were present at AOI 5A. The nature and extent of potential contamination at AOI 5A has been adequately characterized for risk assessment purposes. The risk evaluation is presented in Section 5.

### **3.15 AOI 5B – Cedarville Aquifer Ground Water off the Facility**

AOI 5B is defined as the ground water in the Cedarville Aquifer beneath the off-Facility area within the limits of the survey area identified during the RFI. No SWMUs or AOCs were identified in AOI 5B (Payne Firm et al., 2004). Contamination in the Cedarville Aquifer beneath the off-Facility area consists primarily of VOCs in ground water that migrated off the Facility prior to the operation of an interim measure that captures contaminated ground water at the Facility (see Figures 10, 11, 12, and 13).



The Cedarville Aquifer is used as a potable and non-potable source of ground water at a few locations in AOI 5B. Although, the primary source of water in the area is supplied by the Village of Yellow Springs.

### 3.15.1 Scope and Results

The scope of the pre-RFI/RFI field investigations at AOI 5B involved the collection of Cedarville Aquifer ground water samples to determine whether a potentially significant release of hazardous constituents has occurred as a result of operations at the Facility. The sampling locations are shown on Sheet 1.

The following is a summary of the sampling activities conducted for each medium during the investigations at AOI 5B:

#### Cedarville Aquifer Ground Water Samples

Vernay has also installed a total of 32 monitoring wells within the upper, middle and lower portions and 81 direct push borings within the upper portion of the Cedarville Aquifer off the Facility. Ground water testing results from direct push sampling, monitoring wells and 11 existing residential water wells and existing monitoring wells were collected for the RFI. Ground water samples were collected on a quarterly basis during the RFI as summarized on Sheet 2. Each of the water samples were analyzed for a combination of VOCs, SVOCs or metals.

A summary of the analytical data for AOI 5B is shown in Table 27a, 27b and 27c.

The analytical data was reviewed and validated, a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs	SVOCs	Metals
Cedarville Aquifer	124	348	20	22

The above sample counts do not include QC samples (e.g. field duplicates).

### 3.15.2 Discussion of Results

The concentrations of constituents detected in Cedarville Aquifer in the off-Facility area collected during several RFI field investigations were compared with the screening criteria discussed in Section 3.2 to determine whether a potentially significant release of hazardous constituents has occurred and whether potentially significant concentrations of hazardous constituents are present in AOI 5B. The results of the comparison are summarized in Tables 27a, 27b, and 27c for monitoring well sampling, direct push sampling, and water well sampling, respectively. The off-Facility Cedarville Aquifer sampling locations



that exceed one or more of the screening criteria are presented on Table VII.6 (see Appendix VII). Sample locations for AOI 5B are depicted on Sheet 1 and results are presented on Sheet 2.

#### Cedarville Aquifer Ground Water

Tables 27a, 27b, and 27c indicate that just three VOCs (methylene chloride, PCE, and TCE) were detected in AOI 5B above the screening criteria described in Section 3.02.A (based on drinking water). No exceedances, however, of the vapor intrusion and non-potable water (“kiddie pool”) screening criteria were identified.

Exceedances of the drinking water criteria were identified for the following direct push water sample locations and constituents:

- GP02-016 - PCE and TCE;
- GP02-025 - PCE and TCE;
- GP02-028 - TCE;
- GP02-032 - PCE and TCE;
- GP02-033 - PCE and TCE;
- GP02-034 - TCE;
- GP02-035 - PCE and TCE; and
- GP02-089 - TCE

Exceedances of the drinking water criteria were identified for the following monitoring well locations and constituents:

- MW02-02 - TCE (last reported exceedance 11/99);
- MW02-03 - PCE (last reported exceedance 11/03);
- MW02-03CD - PCE (last reported exceedance 02/04) and TCE (last reported exceedance 02/04);
- MW02-06 - PCE (last reported exceedance 07/04) and TCE (last reported exceedance 07/04);
- MW02-08 - PCE (last reported exceedance 07/04) and TCE (last reported exceedance 09/03);
- MW02-08CD - methylene chloride (last reported exceedance 07/04), PCE (last reported exceedance 07/04) and TCE (last reported exceedance 07/04);
- MW02-09 - PCE (last reported exceedance 07/04) and TCE (last reported exceedance 07/04); and
- MW02-13 - TCE (last reported exceedance 04/04).

Exceedances of the drinking water criteria were identified for the following non-potable residential water well sample location and constituents:

- WW02-690 Wright Street - PCE (last reported exceedance 03/04)



No exceedances of the drinking water criteria were identified for any of the active potable residential wells identified during the RFI.

### 3.15.3 Conclusions

The Cedarville Aquifer ground water data collected during several phases of RFI field investigations indicate that potentially significant concentrations of one or more of the VOCs (methylene chloride, PCE, and/or TCE) are present in AOI 5B. The nature and extent of potential contamination in AOI 5B has been adequately characterized for risk assessment purposes and further investigation is not required. The risk evaluation is presented in Section 5.

### 3.16 Indoor Air

As described above, direct measurement of on-Facility indoor air quality were conducted in the Facility buildings of Plants 2 and 3. The sampling locations are shown on Sheet 1. Areas selected for direct measurement included locations where subgrade structures are present where vapors may tend to accumulate and at the locations within the buildings that are closest to elevated concentrations of VOCs in soil, subsurface water and Cedarville Aquifer ground water.

#### 3.16.1 Scope and Results

Air samples were collected for VOC analysis inside Plant 2 and Plant 3 prior to and during the Phase I RFI. 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.

A summary of the analytical data for indoor air is shown in Table 28.

The analytical data was reviewed and validated, a summary of the validation is provided in Appendix IV. The number of locations from which samples were collected for each medium and the number of samples analyzed for each analyte group are as follows:

Media	Locations	VOCs
On-Facility Indoor Air	14	14

The above sample counts do not include QC samples (e.g. field duplicates).

### **3.16.2 Discussion of Results**

The concentrations of constituents detected via direct measurement of indoor air at the Facility were compared with the screening criteria discussed in Section 3.8 to determine whether potentially significant concentrations of hazardous constituents are present in the existing Facility buildings under current conditions. The results of the comparison are summarized in Table 28, with individual indoor air exceedances presented on Table VII.7 of Appendix VII. On-Facility indoor air sample locations are depicted on Sheet 1.

Table 28 indicates that constituents detected via direct measurement of indoor air within the existing Facility buildings are all below the occupational exposure limits. With the exception of non-cancer risk exceedances for two constituents, acrolein and xylenes, there are no exceedances of the risk-based indoor air criteria.

### **3.16.3 Conclusions**

Of the two constituents with concentrations above the risk-based screening levels (acrolein and xylenes) acrolein was not known to be used at the Facility and was not analyzed for in soil or ground water. As past site activities did not include the use of acrolein, this constituent may not be related to environmental contamination observed at the Facility. Similarly, xylenes are not present at significant levels in soil or ground water; as indicated in the risk estimates based on soil and ground water. Therefore, the detected soil and ground water concentrations would not be expected to contribute significantly to indoor air concentrations. Thus, the identification of these chemicals in indoor air may not be related to Facility contamination.



## **4.0 CONTAMINANT FATE AND TRANSPORT IN GROUND WATER**

As part of the Phase I RFI, a ground water flow model of the Cedarville Aquifer was constructed and calibrated primarily 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 at or from the Facility. Details of the ground water flow modeling as well as general descriptions of ground water modeling were presented as Appendix VII to the RFI Phase I report (Payne Firm et al., 2004). During the Phase II RFI, fate and transport modeling focused on using the results of the ground water flow model to form the basis of a contaminant transport model. The transport model was subsequently used to better understand the temporal behavior of the tetrachloroethylene (PCE) and trichloroethylene (TCE) contaminant plumes, and to determine the adequacy of the existing monitoring well network. A detailed description of the fate and transport modeling conducted during the Phase II RFI, including the modeling objectives, conceptual model, computer code selection, model construction, model calibration, and model conclusions is presented in a separate report (Appendix V) to this report.

### **4.1 Objectives of Fate and Transport Modeling**

The hydrologic conceptual site model was developed to collect and process information on the ground water flow and contaminant transport in order to establish the temporal characteristics of the PCE and TCE contaminant plumes. A properly calibrated numerical model that simulates ground water flow and contaminant transport can be used to meet the following objectives: 1) define the temporal behavior of PCE and TCE contaminant concentrations in the Cedarville Aquifer beneath the Facility and the surrounding area since these are the only two VOCs that have been detected above a level of concern off the Facility; 2) determine the effect that two operating pump and treat extraction wells have had on the migration and distribution of PCE and TCE downgradient of the Facility; 3) determine if PCE and TCE concentrations detected in monitoring wells at the fringe of the contaminant plume downgradient of the Facility are stable below a level of concern; and 4) confirm that the existing monitoring well network is sufficient. To accomplish these objectives, the ground water flow model that was constructed and calibrated during the Phase I RFI (Payne Firm et al., 2004) was used as the basis for a contaminant transport model.

### **4.2 Summary of Results**

MODFLOW, MT3D and MODPATH were the computer codes selected to conduct the flow and transport analysis. The major aspect of the site conceptual model that was taken into consideration in selecting a computer code to use for the transport analysis was that the Cedarville Aquifer can be represented as an equivalent porous medium at the scale of the Facility and vicinity. The output from MODFLOW is a ground water velocity field which is used by MT3D, in conjunction with fate and transport parameters, to simulate the migration of PCE and TCE. A particle tracking analysis was also conducted with



MODPATH to illustrate the ground water flow direction from the contaminant source areas. All of these computer codes are widely used, well documented, and in the public domain.

With respect to the construction of the model, a finite difference grid was utilized that incorporated 693,720 active cells ranging in length from 12.5 feet in the vicinity of the contaminant source(s) to 50 feet at the model boundaries. Although the model was discretized vertically into 15 layers, this fine discretization was primarily to reduce vertical dispersion, rather than to simulate vertical inhomogeneities within the model layers.

PCE and TCE source concentrations were determined based upon ground water data obtained from geoprobes and monitoring wells (Payne Firm et al., 2004; Payne Firm, 2004c). Release times were established from a historical review of PCE and TCE use at the Facility. Fate and transport parameters were estimated based on field data, literature reviews and model calibration. Ground water data collected during April 2004 were used as the calibration targets.

The results of the transport analyses indicate that both the PCE and TCE plumes are stable and well contained within the existing monitoring well network. These results are supported by the existing field monitoring data.



## 5.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

### 5.1 Introduction

The human health risk assessment discussed in this section uses the site characterization data that have been collected during the RFI field investigation to evaluate the potential significance of reasonable maximum exposures under reasonably expected future land use and ground water use at and around the Vernay Facility. As discussed in the *Resource Conservation and Recovery Act CA725 Environmental Indicators Report* (ENVIRON and Payne Firm, 2004), based on data collected as part of the RFI, and considering potential exposure pathways and site-specific conditions, current human exposures were determined to be under control according to the provisions of the CA725. Therefore, results of this risk assessment are to be used to identify where a release of hazardous waste or constituents from the Facility may cause reasonable maximum exposures to be significant enough in the future to warrant corrective measures.

The scope of the human health risk assessment is summarized in the conceptual site model (CSM) shown in Table 29. The CSM identifies the scenarios for potential human exposure under current and reasonably expected future conditions at and around the Facility in terms of the potentially exposed populations, the environmental media to which they could be exposed, and the potential routes of exposure. The CSM was developed based on the site information and data discussed in Sections 2.0 and 3.0, respectively. The scenarios for potential human exposure are further discussed in Section 5.3.

Discussion of the human health risk assessment is organized as follows:

- The preparation of data used in the risk assessment is discussed in Section 5.2 – Data Collection and Evaluation. In addition, this section summarizes the areas and environmental media that have been affected by a potentially significant release, and the primary constituents found in these media.
- The scenarios for potential human exposure are discussed in Section 5.3 – Exposure Assessment, which also discusses the estimation of exposure concentrations and chemical intakes for each exposure scenario.
- Toxicity criteria for the constituents included in the risk assessment are summarized in Section 5.4 – Toxicity Assessment.
- The hypothetical risks associated with the potential exposures discussed in Section 5.3 are quantified and their significance is discussed in Section 5.5 – Risk Characterization. Uncertainties associated with the risk estimates are also discussed in this section.
- The findings and conclusions of the human health risk assessment are summarized in Section 5.6 – Summary of Human Health Risk Evaluation.



The methods used in the risk assessment are based on U.S. EPA risk assessment guidance, and the interpretation of the risk assessment results is based on U.S. EPA risk management policies for RCRA corrective action.

## **5.2 Data Collection and Evaluation**

### **5.2.1 Data Collection**

The objectives of data collection during the RFI and strategies for determining when additional data collection is necessary were described in the RFI Phase I report (Payne Firm et al., 2004). The scope of the RFI field investigation completed to date and a summary of the data collection activities are described in Section 3.0 of this report.

### **5.2.2 Data Evaluation**

Validation of data collected during the RFI was performed in accordance with the QAPP in the RFI Work Plan. All soil, ground water, sediment, surface water, and indoor air data included in the data summary tables for each area discussed in Section 3 were validated. In addition, the following procedures were used to prepare the data in these summary tables to support quantitative risk assessment. These procedures, which are based on U.S. EPA guidance on human health risk assessment (U.S. EPA 1989), are as follows:

- Constituent concentrations qualified as not detected (i.e., U or UJ-qualified data) during data validation are evaluated as non-detects.
- Constituent concentrations qualified as not usable (i.e., R-qualified data) during data validation are not included in the risk assessment.
- Concentrations qualified as estimated (i.e., J-qualified data) are included for quantitative assessment.
- Concentrations in duplicate field samples are averaged to obtain a representative concentration for the sample location. When a constituent was detected in only one sample of a duplicate pair, the average of the detected concentration and one-half the quantitation limit is used in further calculations.
- The concentrations of 1,3-dichloropropene (total), methylphenol (total), and xylenes (total) in a sample are the sums of the concentrations of the detected isomers and half the quantitation limits of isomers not detected in the sample but detected in the same matrix at the Facility. If no isomer is detected in a sample, the constituent is considered to be not detected in the sample.
- Similarly, the concentration of PCBs (total) in a sample is the sum of the concentrations of the detected Aroclors and half the quantitation limits of Aroclors not detected in the sample but detected in the same matrix at the Facility. If no Aroclor is detected in a sample, PCBs are considered to be not detected in the sample.



- As a conservative assumption, all concentrations of organic constituents are assumed to be facility-related, since the RFI field investigation did not attempt to establish a site-specific background level for any organic constituent (as discussed in the RFI Phase I).

In addition, as specified by U.S. EPA for this project (see Section 2.3), historical soil VOC data may only be used for qualitative purposes during the RFI (i.e., VOC method update II data); therefore, only soil VOC data collected using Update III (Method 5035) are included in this quantitative risk analysis.

No constituent that was affirmatively identified in any of these media is excluded from the risk assessment, except as noted above. The complete Phase II RFI data (including R-qualified data, and separate results for each sample of a duplicate pair) are provided in Appendix VIII-E. The Phase I RFI and Pre-RCRA data were reported in the RFI Phase I report (Payne Firm et al., 2004). Summaries of the data validation results are provided in Appendix IV.

### **5.2.3 Potentially Significant Releases**

#### Soil

The Section 3.0 tables summarize the soil characterization data for each area, and show the ratios of the highest measured concentrations for each constituent at each area to the screening criteria. As discussed in Section 3.0, the screening criteria used to guide the RFI soil characterization efforts included criteria that are based on direct contact, vapor intrusion, and migration to ground water. A potentially significant release to soil in an area is identified in the Section 3.0 tables by comparing the highest concentration of each constituent in surface and subsurface soil at the area to these screening criteria. Ratios of the highest concentrations in surface or subsurface soil to the screening criteria that exceed 1 are considered indications of a potentially significant release to soil. As shown in the Section 3.0 tables, the ratios for certain constituents exceed 1 at the following AOIs:

- AOI 1 – Undeveloped/Non-Operational Portion of the Facility
- AOI 2N – Developed/Non-Operational Portion of the Facility
- AOI 2S – Developed/Operational Portion of the Facility
- AOI 3A – Sewers Off of the Facility

At each of the on-Facility AOIs, concentrations of one or more VOC are higher than the screening criteria based on direct contact, vapor intrusion and/or migration to ground water. At AOIs 1 and 2S, concentrations of PAHs are also higher than the screening criteria based on direct contact. In off-Facility AOI 3, soil concentrations do not exceed the screening criteria; however, soil concentrations of PCE, benzo(a)pyrene, and dibenz(a,h)anthracene at AOI 3A are higher than the screening criteria.

The potential for human exposure to constituents in soil at all the areas where field investigations were conducted during the RFI, including the areas where a potentially significant release was identified, is discussed in Section 5.3. The significance of the potential exposures is discussed in Section 5.5.

#### Cedarville Aquifer Ground Water

Ground water quality data were collected during the RFI from the upper, middle and lower Cedarville Aquifer monitoring wells on- and off-Facility, as discussed in Sections 3.14 and 3.15. The Section 3 summary tables for ground water data show the ratios of the highest concentrations in each of these water-bearing units to the screening criteria. As discussed in Sections 3.7 and 3.8, the screening criteria used to guide the RFI ground water characterization efforts included criteria that are based on potable water use, nonpotable water use, and vapor intrusion into indoor air (this pathway is most pertinent for shallow Cedarville Aquifer ground water).

A potentially significant release to ground water is identified in the Section 3 summary tables for ground water by ratios of the highest concentrations to the screening criteria that exceed 1. As discussed in Section 3.14 for on-Facility wells (AOI 5A) and 3.15 for off-Facility wells (AOI 5B), constituents with concentrations in Cedarville Aquifer ground water that are higher than the screening criteria consist primarily of a few VOCs (such as TCE and PCE).

The potential for human exposure to constituents in ground water is discussed in Section 5.3, and the significance of any potential exposures is discussed in Section 5.5.

#### Unconsolidated Unit Subsurface Water

Subsurface water quality data were collected during the RFI from shallow discontinuous sand seams in the upper and middle portions of the Unconsolidated Unit and from water in the sewer line backfill, as discussed in Sections 3.8 (AOI 1), 3.9 (AOI 2N), 3.10 (AOI 2S), 3.11 (AOI 3) and 3.12 (AOI 3A). The Section 3 summary tables for unconsolidated unit and sewer backfill water data show the ratios of the highest concentrations in each of these water-bearing units to the screening criteria. As discussed in Section 3.3, the screening criteria used to guide the RFI characterization efforts included criteria that are based on construction worker contact and vapor intrusion into indoor air.

A potentially significant release to subsurface water is identified in the Section 3 summary tables for subsurface water by ratios of the highest concentrations to the screening criteria that exceed 1. As discussed in Section 3.8 through 3.12, no constituents were detected with concentrations in shallow subsurface water that were higher than the screening criteria based on construction worker contact or vapor intrusion.



### Sediment in Unnamed Creek

Sediment data were collected during the RFI from the Unnamed Creek (AOI 4) downstream of the storm water outfall, as discussed in Section 3.6. The Section 3 summary tables for sediment data show the ratios of the highest concentrations detected in sediments to the screening criteria. As discussed in Section 3.13, the screening criteria used to guide the RFI sediment characterization efforts were the soil screening criteria based on direct contact for industrial and residential soil.

As shown in Table 24, the detected concentrations were below screening criteria indicating that there has not been a significant release to unnamed creek sediments. The potential for human exposure to detected constituents in these sediments is discussed in Section 5.3, and the significance of any potential exposure is discussed in Section 5.5.

### Storm Water and Surface Water in Unnamed Creek

Water samples were collected during the RFI from on- and off-Facility storm sewers and off-Facility in the Unnamed Creek, as discussed in Section 3. The Section 3 summary tables for storm water and surface water data show the ratios of the highest concentrations detected in these media to the screening criteria. As discussed in Section 3, the screening criteria used to guide the RFI characterization efforts for storm water and surface water included the ground water screening criteria that are based on construction worker exposures, potable and nonpotable water use.

As shown on Tables 18 and 23 storm water concentrations of one or more VOCs exceed the drinking water screening criterion, with no exceedances of the construction worker direct contact and/or non-potable water criteria. Similarly, as shown on Table 25, the highest detected surface water concentration for PCE is above the drinking water criterion. The potential for human exposure to constituents in storm water and surface water is discussed in Section 5.3, and the significance of any potential exposure is discussed in Section 5.6.

## **5.3 Exposure Assessment**

This section discusses the potential exposures that are relevant under current and reasonably expected future land use and ground water use at and around the Facility. The exposure setting, potentially exposed populations, and exposure pathways are discussed in the subsections below.

For the potential exposures discussed in this section, exposure is quantified as a dose, which is defined as follows:

$$\text{Dose} = \text{Concentration} \cdot \text{Intake}$$

The dose for evaluating cancer risk is averaged over a lifetime and is called a lifetime average daily dose (LADD). For evaluating long-term (or chronic) noncancer effects, the dose is averaged over the period of exposure and is called an average daily dose (ADD).

The concentration term in the dose equation refers to the concentration in an environmental medium to which a population is exposed over a specified period. The intake term refers to the intake rate of the contaminated environmental medium, which is a function of the magnitude, frequency, and duration of exposure. The methods for estimating the concentration term are discussed in Section 5.3.4. The exposure factors that are used to quantify the magnitude, frequency, and duration of potential exposures are discussed in Section 5.3.5.

### 5.3.1 Exposure Setting

The environmental setting at and around the Facility, including climate, geology, hydrogeology, land cover, surface water bodies, water supply, and ground water use, are discussed in Section 1.0, and are not repeated in this section.

### 5.3.2 Potentially Exposed Populations

Based on the information regarding land use at and around the Facility assembled during the RFI (see Section 1), the potentially exposed populations at and around the Facility under current and reasonably expected future land use were identified. As summarized in the CSM on Table 29, the potential receptor populations include:

<u>Current</u>	On-Facility:	Routine workers Construction workers Trespassers
	Off-Facility:	Residents Construction workers
<u>Future</u>	On-Facility:	Routine workers Construction workers Trespassers
	Off-Facility:	Residents Construction workers

The main on-Facility receptor population consists of “routine workers,” who typically spend most of the work day indoors conducting commercial or industrial activities. When outdoors, these routine workers are not currently exposed to surface soil because the operational area of the Facility is completely paved,



and the workers are not anticipated to have significant contact with unpaved, non-operational areas. As discussed in Section 1, exposure to ground water via potable or non-potable use is not reasonably expected to occur at the Facility since it is connected to the municipal water supply. Routine workers, however, could be exposed to volatile constituents in subsurface soil or shallow ground water via vapor migration into indoor air. A small fraction of the workers (“construction workers”) at the Facility conduct occasional subsurface construction or maintenance activities (e.g., installation or repair of underground utilities, or removal or repair of pavement). However, construction activities at the Facility are currently covered by the Facility’s Health and Safety Policy for on-site excavations (ENVIRON and Payne Firm, 2004), which would protect construction workers against the potential for significant exposures during subsurface excavations. In unpaved non-operational areas, trespassers also could be potentially exposed. Therefore, under current conditions, the only potentially exposed populations on-Facility are routine workers and trespassers.

Based on the City of Yellow Springs Master Plan (Payne Firm et al., 2004), the Facility is expected to remain zoned for commercial/industrial use in the future. Therefore, under reasonably expected future land use, the potentially exposed populations at the Facility are expected to include routine workers and construction workers. In areas where surface soil is exposed, trespassers could also be potentially exposed. Although the extent of exposed surface soil is limited, for this evaluation, potential current and future exposures of routine workers and trespassers to surface soil anywhere on the Facility are considered regardless of whether the soil is currently covered. In addition, it is possible for new construction to be performed at the Facility, in which case, construction workers involved with new building construction could be exposed to on-Facility soils. If such work were to occur it is anticipated that workers would be covered by a site-specific Health and Safety Plan. There are, however, no current plans for construction at the Facility.

Under current and likely future land use and ground water use conditions, the potentially exposed populations in off-Facility areas include residents and construction workers. Residential exposures may include exposure via potable and nonpotable use of ground water, exposure to volatile constituents in shallow ground water via vapor migration into indoor air, and occasional exposure in the Unnamed Creek that is downstream of the Dayton Street storm sewer that receives storm water from the Facility. Activities associated with installation or repair of underground utilities could expose construction workers to constituents in the shallow subsurface water and occasional exposure in the Unnamed Creek that is downstream of the Dayton Street storm sewer. Under future conditions, nearby residents also could be potentially exposed to constituents in soil at the Facility due to windblown dust and vapors if parts of the Facility were to become unpaved.



### **5.3.3 Exposure Pathways**

The exposure pathways evaluated in the risk assessment are summarized in the conceptual site model shown on Table 29. Exposure pathways are discussed further below.

#### **5.3.3.1 Potential On-Facility Exposures**

On-Facility receptors include routine workers, construction and maintenance workers, and trespassers. The types of potential exposures for each receptor are discussed below.

##### Routine Workers

Routine workers are expected to be engaged in commercial and/or industrial activities that generally take place indoors. During limited time outdoors, workers could contact surface soil (0 to 2 feet bgs) in unpaved areas if existing pavement were to be removed; the active portion of the Facility is essentially entirely paved currently. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

These workers also could be exposed to constituents in subsurface soil if the constituents were to volatilize and migrate through cracks in a building foundation into indoor air. Similarly, these workers could be exposed to constituents in subsurface water and ground water if the constituents volatilize and migrate through cracks in a building foundation.

Exposure of on-Facility workers via potable ground water use is not expected because ground water is not used as a drinking water supply at the Facility, and future potable or nonpotable use of ground water is not reasonably expected because the Facility is expected to continue to be connected to the municipal water supply.

##### Construction and Redevelopment Workers

As described above, a small fraction of workers at the Facility may conduct occasional excavation activities associated with utility maintenance, etc. ("construction workers"). Such subsurface activities are expected to be of limited size, depth and duration. Typical excavations would not be expected to be larger than a 15 foot by 15 foot area or exceed a depth of 10 to 15 feet. Currently, the Facility's Health and Safety Policy for on-site excavations addresses potential exposures to workers who are involved with construction or maintenance activities at the Facility. Under future site conditions under which Vernay is no longer operating the Facility, there may continue to be a small fraction of the workers at the Facility involved in occasional subsurface construction or maintenance. However, such construction workers are expected to be covered by a site-specific Health and Safety Plan.

These construction activities may put the workers in contact with both surface and subsurface soil (to a maximum estimated depth of 15 feet) in paved and unpaved areas of the facility. If repairs or



maintenance is performed on the storm sewer system, construction workers also could contact water in the storm sewer. In excavations that encounter subsurface water outside the sewer pipe, construction workers could be exposed to shallow ground water. Potential routes of exposure to soil would include incidental ingestion, dermal contact, and inhalation of vapor and airborne particulates. Potential routes of exposure to storm water and subsurface water would include incidental ingestion, dermal contact, and inhalation of vapor.

In addition to the short duration occasional utility excavation/maintenance activities, it is possible for new construction during redevelopment to be performed at the Facility in the future, in which case, “redevelopment workers” involved with new building construction could be exposed to on-Facility soils. Potential routes of exposure to soil for redevelopment workers include incidental ingestion, dermal contact, and inhalation of vapor and airborne particulates. Potential routes of exposure to storm water and subsurface water would include incidental ingestion, dermal contact, and inhalation of vapor.

In this risk assessment, construction worker and redevelopment worker exposures to soil are evaluated indirectly using risk estimates for routine workers. As discussed in Appendix VI, this approach streamlines the risk assessment and is conservative because construction worker exposures to soil during occasional excavations or redevelopment worker exposures during one-time building construction would be lower than routine worker exposures to soil. Although soil ingestion rates for construction and redevelopment workers potentially are higher, this is offset by reduced exposure frequency and duration. However, exposure conditions for large scale construction should be reviewed at the time actual construction plans are developed. This review should consider the data collected in the specific areas where potential exposures of redevelopment workers to soil may occur and the expected duration of these exposures.

#### Trespassers

Potential exposure of trespassers is possible under current and reasonably likely future site conditions although plant security would control access to the Facility. These controls would limit the duration of any unauthorized access as well as the types of activities while on-Facility. While on-Facility, trespassers could come into contact with soil in unpaved areas or in currently paved areas if existing pavement were to be removed in the future. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

In this risk assessment, trespasser exposures to soil are indirectly evaluated using risk estimates for routine workers. As discussed in Appendix VI, this approach streamlines the risk assessment and is conservative because trespasser exposures to soil would be lower than routine worker exposures to soil.



### **5.3.3.2 Potential Off-Facility Exposures**

Off-Facility receptors include residents, routine workers and construction workers. The types of potential exposures for each receptor population are discussed below.

#### Residents

As discussed in Section 3, the soil characterization data collected during the RFI show that the extent of potentially significant releases to soil does not extend to locations near any off-Facility residential areas. Therefore, the only potential exposure of off-Facility residents to soil constituents is via airborne transport from on-Facility soil that would become exposed if existing pavement or vegetative cover were to be removed. In this risk assessment, such potential exposures are indirectly evaluated using risk estimates for on-Facility routine workers. As discussed in Appendix VI, this approach streamlines the risk assessment and is conservative because airborne exposures off-Facility are expected to be lower than exposures on-Facility due to much greater air dispersion between an on-Facility emission source and off-Facility receptors as compared to air dispersion directly over an emission source.

Residents may also be exposed via potable and non-potable ground water use. Potential exposure is also possible if constituents in subsurface water and ground water volatilize and migrate through cracks in building foundations.

Recreational waders could be exposed to surface water and sediments in the Unnamed Creek downstream of the Dayton Street municipal storm sewer outfall, which discharges storm water contributions from the Facility. Potential exposure to sediment would include incidental ingestion and dermal contact. Potential exposure to surface water would include incidental ingestion, dermal contact, and inhalation of vapors.

#### Construction Workers

Off-Facility workers involved in maintenance, repair or installation of municipal storm sewers could be exposed to contaminated sewer backfill soil and storm water from the Facility's storm sewers. Potential exposures to contaminated sewer backfill would include incidental ingestion and dermal contact. Potential routes of exposure to storm water would include ingestion, dermal contact, and inhalation of vapors. The off-Facility workers who perform utility maintenance/installation could be also exposed to constituents in shallow subsurface water, in areas where the water is within typical excavation depths. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of vapor.

Off-Facility workers could be exposed to surface water and sediments in the Unnamed Creek downstream of the Dayton Street municipal storm sewer outfall, which discharges storm water from the Facility. Potential exposure to sediment would include incidental ingestion and dermal contact. Potential exposure to surface water would include incidental ingestion, dermal contact, and inhalation of vapors.



#### 5.3.4 Estimation of Exposure Concentrations

This section discusses the estimation of exposure concentrations for the media to which receptors could be exposed in the exposure scenarios summarized in the CSM (Table 29). The following subsections discuss the calculation of exposure concentrations in soil, ground water, sediment, and surface water.

##### Soil

Reasonable maximum exposures (RME) are conservatively estimated in this risk assessment by using the maximum detected concentrations at each area for most constituents and the 95% upper confidence limits (UCLs) on the mean for certain constituents, if sufficient data are available. In this approach, maximum concentrations are first used to calculate bounding estimates of cumulative cancer and noncancer risks. If these bounding estimates of RME risks do not exceed EPA's cumulative cancer and noncancer risk triggers for corrective measures (i.e., cumulative site-related cancer risk of  $10^{-4}$  and noncancer hazard index (HI) of 1; 61 FR 19432, May 1, 1996; U.S. EPA 1996; U.S. EPA 1991b), then further calculations are not necessary.

If a bounding estimate exceeds a trigger for corrective measures, then the bounding estimate is refined by replacing the maximum concentrations for constituents that contributed the most to the bounding risk estimate with 95% UCLs on the mean concentrations for these constituents. Experience with this approach at many facilities shows that cumulative cancer and noncancer risk estimates are often influenced by only a few constituents. This means the computation of 95% UCLs is usually necessary for only a few constituents.

The 95% UCL for a constituent is calculated using the nonparametric bootstrap method known as the bias-corrected and accelerated (BCa) method with 4,000 bootstrap replications (Efron and Tibshirani 1998). A nonparametric bootstrap confidence interval does not rely on assumptions about the data's underlying probability distribution which are often difficult to confirm, but instead are based on statistical re-sampling of the empirical distribution of the observed concentrations. For an empirical distribution that is approximately normal, the bootstrap confidence interval will be essentially the same as the normal confidence interval. For an empirical distribution that is not normal, however, the bootstrap confidence interval will be more accurate than a confidence interval calculated assuming a normal (or even lognormal) distribution (U.S. EPA 1997c).

The constituents selected for 95% UCL calculations are those with maximum concentrations that contribute the most to the initial bounding estimates of the RME cumulative risks, if these data sets have at least eight data points. Using 95% UCLs for these constituents and maximum concentrations for other constituents still overestimates the RME cumulative risks, but is an efficient approach that avoids 95% UCL calculations that would not materially affect cumulative risk estimates, and is consistent with



U.S. EPA guidance (1989; p 6-25). UCLs were not calculated for data sets with less than eight data points, because nonparametric BCa bootstrap UCLs might be less reliable for these smaller data sets. The use of maximum concentrations for many constituents introduces more conservatism than necessary for RME estimates because it assumes simultaneous exposure to maximum concentrations of many constituents constantly, when the RME generally would not have so many constituents at such maximum concentrations at all times. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.5.4.

#### Other Media

Exposure concentrations for ground water, sediment, indoor air, subsurface water and surface water are conservatively estimated using the highest detected concentrations in these media.

#### **5.3.5 Fate and Transport Models**

The following models are used to estimate exposure concentrations for the exposure scenarios discussed in Section 5.4. These models are used by U.S. EPA and state regulatory agencies for screening-level analysis. The following are brief descriptions of the models. Further details of these models are provided in Appendix VI.

##### Vapor Intrusion into Buildings

Indoor air concentrations that might result from migration of vapors from soil or ground water into a building are estimated using the model described by Johnson and Ettinger (1991), which U.S. EPA recommends for screening-level evaluations (U.S. EPA 2003a). The calculations in this risk assessment are based on hypothetical commercial/industrial buildings and hypothetical residential buildings, rather than actual on-Facility and off-Facility buildings. The characteristics of the hypothetical buildings are modeled using conservative assumptions from regulatory guidance for these building types. Site-specific data for soil properties collected during the RFI are also used in the calculations. A discussion of the model and the input parameters used in the assessment is provided in Appendix VI.

##### Vapor Emissions from Exposed Water

The model for estimating vapor emissions from exposed subsurface water in excavations, storm sewer water and surface water are based on mass-transfer coefficients recommended in U.S. EPA guidance (U.S. EPA 1995c). A discussion of the model and the input parameters used in the assessment is provided in Appendix VI.

##### Ambient Air Dispersion

Ambient (outdoor) air concentrations are estimated using U.S. EPA's SCREEN3 air dispersion model (U.S. EPA 1995a). The area-source algorithm in SCREEN3 is used with default and region-specific meteorological parameters to estimate maximum 1-hour concentrations at ground level. Source areas are

estimated as square sources. A discussion of the model and the input parameters used in the assessment is provided in Appendix VI.

For the construction worker scenario, the maximum 1-hour air concentrations are converted to maximum 24-hour average air concentrations using a conservative factor of 0.4. The air concentrations estimated in this approach are conservative (i.e., expected to predict higher than actual air concentrations to which receptors would be exposed).

Uncertainties inherent in the models and assumptions used in estimating exposure concentrations are discussed in Section 5.5.4.

#### Migration to Ground Water

Migration of constituents from soil to ground water is estimated using U.S. EPA's Soil Screening Guidance (U.S. EPA 1996a) values with a dilution-attenuation factor of 20. Conservative default parameters provided in the Soil Screening Guidance are used, with protection of ground water as a drinking water source as the end point.

### **5.3.6 Estimation of Intakes**

The exposure factors for evaluating the exposure scenarios summarized in the CSM are discussed in this section. In this risk assessment, standard default exposure factors recommended by U.S. EPA for estimating reasonable maximum exposures are used where available and appropriate. Where standard default exposure factors are not available or not appropriate for an exposure scenario, the evaluation is conducted using similarly conservative exposure factors that are based on site-specific considerations and professional judgment. Uncertainties associated with the exposure factors used in estimating chemical intakes are discussed in Section 5.5.4.

#### **5.3.6.1 Routine Workers**

In this risk assessment, potential exposure of routine workers to soil is conservatively evaluated using the exposure factors that U.S. EPA Region 9 used in deriving its PRGs (U.S. EPA 2002). These exposure factors are standard default exposure factors recommended by U.S. EPA (1991a) for estimating RME, except Region 9 used a soil ingestion rate of 100 mg/day which is twice the standard default rate of 50 mg/day. According to U.S. EPA (2002), the standard default exposure factors are conservative assumptions about the magnitude, frequency, and duration of exposures, which in combination are intended to provide estimates of exposures that are higher than actual exposures to a large portion (90% to 99%) of a potentially exposed population.

Although it is recognized that the use of these exposure factors, rather than site-specific factors, results in overestimation of RME risks at the Facility, this approach streamlines the risk assessment by allowing risk estimates to be calculated very efficiently from the PRGs. The evaluation is also streamlined because



the added conservatism in the PRG-based risk estimates allows them to be used as conservative estimates for other receptors. In this risk assessment, the risk estimates for routine workers are used to evaluate potential exposures of construction workers and trespassers to soil, because the exposure to these receptors are expected to be lower than those assumed in the PRGs (see Appendix VI).

### **5.3.6.2 Construction Workers**

Potential exposure of construction workers to soil is initially evaluated using the risk estimates for routine workers for all AOIs. For those AOIs where more site-site specific evaluation is warranted, the exposure factors used for evaluating potential exposure of construction workers to soil are as follows:

#### Soil Ingestion Rate

A soil ingestion rate of 200 mg/day is used for workers performing maintenance work that involves excavation into the soil. This rate is lower than the 480 mg/day that is often cited as U.S. EPA's recommended soil ingestion rate for excavation or construction scenarios (U.S. EPA 1991a). However, the 480 mg/day rate is based on an assumption regarding soil adherence to hands that has been shown in U.S. EPA-funded field studies to overestimate (by 3 to 4-fold) soil adherence to hands during various excavation and construction activities. Replacing the earlier soil adherence assumption with soil adherence data from the U.S. EPA-funded studies (U.S. EPA 1997b) would give a soil ingestion rate of approximately 120 mg/kg to 160 mg/kg. Therefore, using a rate of 200 mg/kg is conservative.

#### Soil Dermal Contact Rate and Absorption

The dermal contact rate is the product of the exposed skin surface area and the soil-to-skin adherence factor. The exposed skin area of 3,300 cm<sup>2</sup> and the soil-to-skin adherence factor of 0.2 mg/cm<sup>2</sup> are the U.S. EPA-recommended skin area and adherence factor for evaluating high-end contact with soil by workers in industrial settings (U.S. EPA 2001). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by U.S. EPA-recommended absorption factors for absorption from soil (U.S. EPA 2001).

#### Ground Water Ingestion Rate

A rate of 0.005 L/hour is used for incidental ingestion of ground water during construction work in excavations that extend into ground water. This rate is 10% of the rate that U.S. EPA (1989) recommends for ingestion while swimming, and represents a very conservative estimate of incidental ground water ingestion that could occur while workers are in an excavation pit.

#### Ground Water Dermal Contact Rates

The exposed skin surface area is the same as that discussed above for exposure to soil. Workers are conservatively assumed to be covered with ground water over this exposed skin surface area for 2 hours per event. The absorbed dose for organic chemicals is estimated using a nonsteady-state approach



(U.S. EPA 2001), which is more conservative than the steady-state approach (U.S. EPA 1989), particularly for hydrophobic chemicals. The permeability coefficients ( $K_p$ ) for dermal absorption from ground water are estimated following U.S. EPA guidance (1992, 2001).

#### Exposure Frequency and Duration

The number of days of construction/maintenance activities is assumed to be 50 days, which is assumed to occur at a frequency of 5 days/year for a period of 10 years. This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time that workers are actually in contact with soil and ground water (as opposed to the total time for maintenance or construction, which typically includes time not associated with excavation). This combination of exposure frequency and exposure duration is also expected to be conservative for the amount of time that workers may spend maintaining or repairing storm sewers or working in the Unnamed Creek, since such utilities do not generally require periodic cleaning or maintenance. The assumption of 5 days/year can represent the time for a few small repairs per year or one larger repair. The duration of 10 years is more than twice the length of time that workers typically work at one location (U.S. EPA 1997b).

#### Body Weight

The body weight of 70 kg is the standard U.S. EPA-recommended body weight for assessing exposure to adults (U.S. EPA 1989).

#### Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (U.S. EPA 1989).

### **5.3.6.3 Residents**

The exposure factors for evaluating potential inhalation exposure of residents via vapor intrusion are as follows.

#### Exposure Frequency

An exposure frequency of 350 days per year is used for evaluating high-end residential exposure of children and adults (U.S. EPA 1991a). This exposure frequency assumes daily exposure at the residence, except for two weeks per year away from home (e.g., while on vacation).

#### Exposure Duration

The exposure duration is 30 years and is based on the U.S. EPA-recommended exposure duration for evaluating high-end residential exposures (U.S. EPA 1991a). It is the 95th percentile number of years residents live at one location.





#### Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (U.S. EPA 1989).

#### **5.3.6.4 Recreational Waders in the Unnamed Creek**

The exposure factors for evaluating potential exposure of residential waders to sediments in the Unnamed Creek are as follows.

#### Sediment Ingestion Rate

The sediment ingestion rate of 50 mg/day is used for evaluating high-end exposure youth residents that may be exposed to creek sediments, respectively. These sediment ingestion rates are 50% of the U.S. EPA-recommended soil ingestion rate of 100 mg/day for adults (U.S. EPA 1991a), based on professional judgment that simultaneous contact with surface water in this scenario would tend to wash sediment off hands and thereby reduce incidental sediment ingestion during hand-to-mouth contact.

#### Sediment Dermal Contact Rate and Absorption

The exposed skin surface area for youth residents is 3,950 cm<sup>2</sup>. These areas are based on exposed skin on the arms, legs and hands while wading in the creek. The sediment adherence factor is the same as that recommended in U.S. EPA guidance for soil, i.e., 0.2 for children (U.S. EPA 2001). The absorbed dose from dermal contact with soil is estimated by multiplying the dermal contact rate by U.S. EPA-recommended absorption factors for absorption from soil (U.S. EPA 2001).

#### Exposure Frequency and Duration

For evaluating potential exposures to sediment in readily accessible segments of the Unnamed Creek, an exposure frequency of 26 days/year is assumed. This frequency assumes that visits to the creek occur 2 days/week for three months when the average daily temperature is above 70 degrees F based on air temperature data for Columbus, Ohio (NOAA 2000). The exposure duration for the youth resident is 10 years (U.S. EPA 1999).

#### Body Weight

The body weight of 51 kg is the standard U.S. EPA-recommended body weight for assessing exposure to youths (age 9 to 18) (U.S. EPA 1989).

#### Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (U.S. EPA 1989).



## 5.4 Toxicity Assessment

A toxicity assessment identifies potential adverse health effects that are associated with exposure to chemicals, and determines the dose-response relationship between exposure and the occurrence of adverse effects. Toxicity information used in the risk assessment is derived from two categories of sources. The toxicity values that U.S. EPA Region 9 used in developing its PRGs are implicitly used in cancer and noncancer risk estimates that are derived using the PRGs. The toxicity values used in deriving site-specific soil and ground water screening criteria, and the associated estimates of cumulative cancer and noncancer risks, were compiled from the following U.S. EPA hierarchy of sources (U.S. EPA 2003c):

1. Integrated Risk Information System (IRIS)
2. Provisional Peer Reviewed Toxicity Values (PPRTV)
3. Other (i.e., additional EPA (e.g., HEAST) and non-EPA sources of toxicity information)

When a toxicity value was not available from the first two tiers of sources, other U.S. EPA sources of toxicity values were consulted. The toxicity values used in the risk assessment and their sources are summarized in Appendix VI, and are discussed below.

### 5.4.1 Toxicity Values for Carcinogens

U.S. EPA considers chemicals belonging to the following U.S. EPA cancer weight-of-evidence groups as human carcinogens:

- |          |  |
|----------|--|
| Group A  | Known Human Carcinogen: Sufficient evidence of carcinogenicity in humans   |
| Group B1 | Probable Human Carcinogen: Limited evidence of carcinogenicity in humans   |
| Group B2 | Probable Human Carcinogen: Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans |
| Group C  | Possible Human Carcinogen: Limited evidence of carcinogenicity in animals and inadequate or lack of evidence in humans     |

As shown in Appendix VI, U.S. EPA has designated some of the constituents as Group B2 or Group C, which means that U.S. EPA acknowledges that there is either inadequate or a lack of evidence that these constituents actually cause cancer in humans. Therefore, evaluating these constituents as human carcinogens in the risk assessment is highly conservative.

U.S. EPA-derived cancer slope factors (SFs) and inhalation unit risk factors (URFs) for these constituents and their sources are shown in Appendix VI. The oral SFs and URFs represent 95% upper confidence bounds on the probability of getting cancer over a lifetime per unit dose. As recognized by U.S. EPA, there is significant scientific evidence that some of the SFs and URFs may be overly conservative and

may ignore the potential existence of threshold doses. Nonetheless, they are used here as conservative assessment tools.

#### **5.4.2 Toxicity Values for Noncarcinogens**

Constituents designated by U.S. EPA as belonging to the cancer weight-of-evidence Group D (Not Classifiable as to Human Carcinogenicity) are considered noncarcinogens. Constituents not designated as belonging to any cancer group are treated as noncarcinogens. U.S. EPA-derived chronic reference doses (RfDs) and chronic inhalation reference concentrations (RfCs) for these constituents and their sources are shown in Appendix VI. U.S. EPA-derived chronic RfDs and chronic inhalation RfCs for carcinogenic compounds were also used to assess the potential for noncarcinogenic effects from such constituents as well, and are shown in Appendix VI. U.S. EPA has not developed a cancer slope factor or a reference dose for lead. Therefore, risks from exposures to lead are not expressed in terms of cancer risks or noncancer HQs. The approach used for lead is discussed in Section 5.5.3.

The oral RfDs and inhalation RfCs represent conservative estimates of the daily exposure to the human population, including sensitive subpopulations (e.g., children), which are likely to be without an appreciable risk of deleterious effects during a lifetime. These RfDs and RfCs typically incorporate several safety factors to account for uncertainties in their derivation, which in combination often result in overall uncertainty factors of 1,000 or more. Furthermore, for many constituents, there is significant scientific debate about the validity of these RfDs and RfCs, and the association of these doses and concentrations to potential adverse health consequences. Nonetheless, the RfDs and RfCs are used here as conservative assessment tools.

#### **5.4.3 Extrapolation of Toxicity Values**

The U.S. EPA sources of toxicity values do not provide dermal toxicity values for any of the constituents. Therefore, oral toxicity values (i.e., oral SFs and RfDs) are used as dermal toxicity values in this risk assessment. Adjustments to the oral toxicity values are made in this route-to-route extrapolation based on U.S. EPA guidance (U.S. EPA 2001).

The U.S. EPA sources of toxicity values do not provide inhalation toxicity values (URFs and RfCs) for all of the constituents. For a constituent that has no inhalation toxicity value, the oral SF and/or RfD, if available, is converted to an URF and/or RfC using default U.S. EPA assumptions (U.S. EPA 1997a).

Uncertainties introduced by using extrapolated toxicity values are discussed in Section 5.5.4.3.

## 5.5 Risk Characterization

The health significance of the potential exposures identified in Section 5.3 is discussed in the following subsections. Section 5.5.1 describes the methods for quantifying cancer risks and noncancer hazard indices. Section 5.5.2 discusses the risk estimates and the significance of the potential exposures associated with chemicals other than lead. Section 5.5.3 discusses the significance of potential exposures to lead. Uncertainties in the risk evaluation are discussed in Section 5.5.4.4.

### 5.5.1 Cancer Risk and Noncancer Hazard Index

The cancer risk associated with potential exposure to a carcinogenic chemical is calculated by multiplying an estimate of the lifetime average daily dose (LADD) for a particular exposure scenario by the cancer slope factor (SF) for the chemical, as follows:

$$Risk = LADD \cdot SF$$

For the inhalation route, the inhalation cancer risk is calculated using the chemical concentration in air ( $C_{air}$ ) and the URF, as follows:

$$Risk = C_{air} \cdot URF \cdot \frac{EF \cdot ED}{AT}$$

where EF is exposure frequency, ED is exposure duration, and AT is averaging time.

The noncancer hazard quotient (HQ) associated with potential noncarcinogenic effects is calculated by dividing an estimate of the average daily dose (ADD) for a particular exposure scenario by the reference dose (RfD) for the chemical, as follows:

$$HQ = \frac{ADD}{RfD}$$

For the inhalation route, the inhalation HQ is calculated using  $C_{air}$  and the RfC, as follows:

$$HQ = \frac{C_{air}}{RfC} \cdot \frac{EF \cdot ED}{AT}$$

The potential cancer risk and noncancer effects that may result from exposure to the combination of constituents at an area are estimated following U.S. EPA guidance (1989), as follows:

$$Cumulative\ Risk = \sum_i Risk_i$$

$$Hazard\ Index = \sum_i HQ_i$$

where:

$$\begin{aligned}\text{Risk}_i &= \text{estimated cancer risk for the } i\text{th constituent} \\ \text{HQ}_i &= \text{hazard quotient for the } i\text{th constituent}\end{aligned}$$

This approach may result in estimates of cumulative cancer and noncancer risks that are more conservative than necessary. For example, different chemicals may cause different and unrelated health effects, so summing the HQs for their individual effects would overestimate the significance of their combined effect. As such, estimates based on this approach are further evaluated where necessary (e.g., by segregating HIs by target organs and/or mode of action). Uncertainties associated with this approach are discussed in Section 5.5.4.

The cumulative cancer risk and HI estimates for each receptor population are compared with U.S. EPA's cancer risk limit of  $10^{-4}$  and HI limit of 1, respectively, for determining whether corrective measures are warranted for a particular area of the Facility (61 FR 19432, May 1, 1996; U.S. EPA 1991b). The risk estimates and results of the comparison to the U.S. EPA-established limits are discussed in the following sections.

## **5.5.2 Risk Estimates for Potentially Exposed Populations**

### **5.5.2.1 Routine Workers**

The significance of hypothetical risks associated with potential exposure of on-Facility routine workers to soil via direct contact (incidental ingestion, dermal contact, and inhalation), and to soil and ground water via vapor intrusion is discussed below.

#### Outdoor Soil Exposures

Potential exposure of routine workers to exposed outdoor soil was first evaluated using bounding estimates of RME cumulative cancer and noncancer risks to streamline the risk evaluation, as explained in Section 5.3. The initial estimates were calculated using maximum site-related concentrations for all constituents detected in soil at an area and the risk-based industrial PRGs. These estimates are considered bounding estimates because the RME risks for an area would be lower if concentrations representative of the area were used instead of maximum concentrations, and if site-specific exposure factors were used to account for the magnitude, frequency, and duration of exposures appropriate for the area.

The bounding estimates of site-related cumulative cancer and noncancer risks were compared to U.S. EPA's cancer risk limit of  $10^{-4}$  and HI limit of 1, respectively. For an area where the bounding estimate of cancer risk or HI was higher than the U.S. EPA limits, these risk estimates were refined using 95% UCLs for certain constituents, as explained in Section 5.3.4.

The bounding estimates of site-related cumulative cancer risk and HI for potential exposure of routine workers to exposed outdoor soil based on the maximum concentrations for all constituents detected in soil are summarized on Table 30 (see Table VII.1 of Appendix VII which presents the risk estimates by individual constituent). The table shows that the risk estimates for all of the areas investigated during the RFI do not exceed the cancer risk limit of  $10^{-4}$  and the HI limit of 1, with the exception of AOIs 1 and 2S. As shown on Table 30, the cumulative cancer risk estimate for AOI 1 is  $7 \times 10^{-4}$ , and the HI estimate for AOI 1 is 20. A review of Table VII.1 of Appendix VII indicated that the constituent with the maximum concentration contributing most significantly to these bounding risk estimate for AOI 1 is 1,2-dichloropropane, which was detected at a depth of 17 to 18 feet below ground surface. Therefore, the significance of potential exposures at AOI 1 was further evaluated using 95% UCLs on the mean concentration for 1,2-DCP. As discussed above, this approach is efficient in that it avoids calculation of 95% UCLs that would not materially affect cumulative risk estimates, and is consistent with U.S. EPA guidance (1989). UCLs on the mean were calculated using data from surface soil (0 to 2 feet bgs; the depth interval that routine workers are expected to encounter in unpaved areas), and soil data from sampling depths down to 15 feet (to allow for assessment of the excavation worker exposures). The UCL used to further evaluate the significance of potential exposure in this AOI was the greater of these two values; in this case, the UCL for data collected from surface and subsurface samples was higher than the UCL based on surface soil data only. Refined risk estimates for routine workers in AOI 1 using the 95% UCL value for 1,2-DCP are provided in Attachment VI-2-2 of Appendix VI and summarized on Table 30. As shown on Table 30, the estimated cumulative cancer risk estimate for AOI 1 is  $5 \times 10^{-5}$ , and the HI is 0.5. These values do not exceed the U.S. EPA's acceptable risk limits of 1 and  $10^{-4}$  (U.S. EPA, 1991b).

As shown on Table 30, the cumulative cancer risk estimate for AOI 2S is  $4 \times 10^{-4}$ , and the HI estimate for AOI 2S is 2. A review of Table VII-1-1 of Appendix VII indicated that the constituent with the maximum concentration contributing most significantly to these bounding risk estimates is PCE, which was detected at a number of locations at depths ranging 0 to 2 bgs to 12 to 13.5 bgs feet below ground surface. Therefore, the significance of potential exposures at AOI 2S was further evaluated using 95% UCLs on the mean concentration for PCE. As discussed above, this approach is efficient in that it avoids calculation of 95% UCLs that would not materially affect cumulative risk estimates, and is consistent with U.S. EPA guidance (1989). UCLs on the mean were calculated using data from surface soil (0 to 2 feet bgs; the depth interval that routine workers are expected to encounter in unpaved areas), and soil data from sampling depths down to 15 feet (to allow for assessment of the excavation worker exposures). The UCL used to further evaluate the significance of potential exposure in this AOI was the greater of these two values; in this case, the UCL for data collected from surface and subsurface samples was higher than the UCL based on surface soil data only. Refined risk estimates for routine workers in AOI 2S using the 95% UCL value for PCE are provided in Attachment VI-2-2 in Appendix VI and summarized on Table 30.



As shown on Table 30, the estimated cumulative cancer risk estimate for AOI 2S is  $6 \times 10^{-5}$ , and the HI is 1. These values do not exceed the U.S. EPA's acceptable risk limits of  $10^{-4}$  and 1 (U.S. EPA, 1991b).

Based on the results of this risk evaluation, these potential exposures of on-Facility routine workers are not significant.

#### Indoor Air Exposures

To assess the significance of potential exposure of on-Facility routine workers to constituents in soil and ground water via vapor intrusion to indoor air, the hypothetical risks to on-Facility routine workers via indoor air exposures are estimated based on URFs and RfCs. Details of the vapor intrusion modeling calculations and the derivation of these criteria are provided in Appendix VI. The bounding risk estimates based on the maximum detected soil and ground water concentrations in each AOI are summarized on Tables 33 and 34, respectively (the calculations are presented in Attachment VI-3-4 in Appendix VI). As shown on Table 33, the bounding cancer risk estimates for AOIs 1, 2N and 2S exceed the cancer risk limit of  $10^{-4}$ ; the highest cancer risk estimate is  $2 \times 10^{-2}$  at AOI 2S. The bounding noncancer risk estimates for AOI 1 and 2S exceed the noncancer HI limit of 1; the highest HI estimate is 1,000 at AOI 1. As shown on Table 34, vapor migration to indoor air from constituents detected in on-Facility ground water do not exceed U.S. EPA's acceptable cancer risk limit of  $10^{-4}$  and the HI limit of 1 (U.S. EPA, 1991b).

As a result of the bounding estimates summarized above, this exposure pathway was further evaluated using the results of direct measurement of indoor air concentrations. The indoor air measurements were used to calculate cumulative risk estimates based on URFs and RfCs. The calculations are presented in Attachment VI-3-6 in Appendix VI and summarized on Table 35b. As shown on Table 35b, the cumulative risk based on direct measurement results is below the cancer risk limit of  $10^{-4}$ . The noncancer HI is 90, which is above the HI limit of 1. However, as discussed in Section 3.16, the two constituents that contribute most significantly to the noncancer HI are acrolein and xylenes. Acrolein was not known to be used at the Facility and was not analyzed for in soil or ground water. As past Facility activities did not include the use of acrolein, this constituent may not be related to environmental contamination observed at the Facility (it was detected in only 2 of the 8 indoor air samples collected). Similarly, xylenes are not present at significant levels in soil or ground water. Thus, as indicated in the risk estimates based on soil and ground water, the detected soil and ground water concentrations would not be expected to contribute significantly to indoor air risks. Therefore, the identification of these chemicals in indoor air is not considered to be related to Facility contamination subject to corrective action.





### 5.5.2.2 On-Facility Construction Workers

The significance of hypothetical risks associated with potential exposure of occasional excavation workers and one-time construction workers to on-Facility soil, subsurface water (found in sand seams and sewer backfill) and storm sewer water is discussed below.

#### Soil Exposures

Potential exposure of construction workers to soil is evaluated indirectly using exposure estimates for routine workers for all AOIs, as explained in Section 5.3. This streamlines the risk assessment and is conservative because soil exposures associated with occasional excavations would be lower than routine worker exposures. Therefore, the risk and HI estimates for construction workers are expected to be no higher than the estimates for routine workers discussed in Section 5.5.2.1 and summarized in Table 30, which shows that the high end risk estimates do not exceed U.S. EPA's acceptable cancer risk limit of  $10^{-4}$  and the HI limit 1 (U.S. EPA, 1991b). Based on the results of this risk evaluation, these potential exposures of on-Facility construction workers are not significant.

#### Subsurface Water and Storm Water Exposures

Estimates of risks for potential exposure of construction workers to shallow subsurface water and water in the on-Facility storm sewers are calculated in Appendix VI (see Attachment VI-5). The highest detected constituent concentrations in subsurface water and storm sewer water are used as the exposure concentrations for all AOIs. The estimates of cumulative cancer risk and HI for potential exposure of construction workers to shallow ground water are summarized in Table 36, which shows that all areas have estimates that do not exceed U.S. EPA's acceptable cancer risk limit of  $10^{-4}$  and the HI limit of 1 (U.S. EPA, 1991b). The highest cumulative cancer risk estimate is  $7 \times 10^{-6}$  in AOI 2N and the highest HI estimate is 0.2 for subsurface water exposures in AOI 2S. Based on the results of this risk evaluation, these potential exposures to on-Facility construction workers are not significant.

### 5.5.2.3 Trespassers

Currently, the Facility is completely paved, except in western undeveloped area (AOI 1), which is landscaped. Therefore, there are no current reasonably anticipated exposures of trespassers to surface soil. However, potential exposure of trespassers to soil in the future is evaluated indirectly using exposure estimates for routine workers, as explained in Section 5.3. This streamlines the risk assessment and is conservative because soil exposures associated with trespasser activities would be lower than routine worker exposures. Therefore, the risk and HI estimates for trespassers are expected to be no higher than the estimates for routine workers discussed in Section 5.5.2.1 and summarized in Table 30, which shows that the high end risk estimates do not exceed U.S. EPA's acceptable cancer risk limit of  $10^{-4}$  and the HI limit of 1 (U.S. EPA, 1991b). Based on the results of this risk evaluation, these potential exposures of on-Facility trespassers are not significant.





#### **5.5.2.4 Off-Facility Residents**

The significance of potential exposure of off-Facility residents to constituents in ground water via potable use, nonpotable use, and vapor intrusion into indoor air are discussed below.

##### Potable Ground Water Exposures

Potential off-Facility resident exposure from potable use of Cedarville Aquifer ground water is evaluated by comparing maximum concentrations in the Cedarville Aquifer wells with drinking water criteria based on maximum contaminant levels (MCLs) established under the Safe Drinking Water Act and equivalent drinking water levels (EDWLs) for constituents without MCLs. The EDWLs are generic risk-based drinking water limits calculated using conservative standard default exposure factors for estimating high-end exposures via daily drinking water consumption, and target cancer risk of  $10^{-5}$  for carcinogenic constituents and HI of 1 for non-carcinogenic constituents. The results of this comparison for on-Facility Cedarville Aquifer ground water concentrations (AOI 5A) are presented on Tables 26a-b. The results of this comparison for off-Facility Cedarville Aquifer ground water concentrations (AOI 5B) are presented on Tables 27a-c.

As discussed in Section 3.15, no existing potable wells have concentrations greater than the drinking water criteria, thus indicating that there are currently no unacceptable exposures via this pathway. However, ground water concentrations exceeding drinking water criteria were detected in off-Facility monitoring wells, and therefore, there exists a potential for unacceptable exposures in the future if a new potable well were to be installed within the existing limits of the off-Facility plume where concentrations exceed drinking water criteria. In addition, in the absence of interim measures at the Vernay Facility, the potential exists for on-Facility ground water that currently exceeds drinking water criteria (see Section 3.14) to migrate off-Facility where unacceptable exposure via potable water use may occur.

##### Non-Potable Ground Water Exposures

Potential off-Facility resident exposure via non-potable uses of Cedarville Aquifer ground water is evaluated by comparing maximum concentrations in the Cedarville Aquifer wells with risk-based criteria derived for exposures associated with use of ground water in a residential “kiddie pool” (including incidental ingestion, dermal contact and inhalation). As shown in Table 27a-c, none of the constituent concentrations in the off-Facility wells, including nonpotable water use wells, exceed these criteria, thus indicating that exposures to off-Facility residents via this pathway are not significant under current conditions. However, on-Facility concentrations were detected above these nonpotable criteria (see Table 26a). Therefore, if the on-Facility plume migrates to locations of existing off-Facility nonpotable wells or new nonpotable wells are installed in areas where the plume may migrate, there is a potential for unacceptable exposure via nonpotable water use.

#### Indoor Air Inhalation of Vapors from Subsurface Water and Cedarville Aquifer Ground Water

Potential off-Facility residential exposure to inhalation of vapors migrating into indoor air from Unconsolidated unit water and Cedarville Aquifer ground water is evaluated by calculating bounding risk estimates based on URFs and RfCs and using maximum detected subsurface water and ground water concentrations. Details of the vapor intrusion modeling calculations and risk estimates are provided in Appendix VI. The bounding risk estimates based on the maximum detected subsurface water and ground water concentrations in each AOI are summarized on Table 37 (the calculations are presented in Attachment VI-7-2 in Appendix VI). As shown on Table 37, the bounding cancer risk estimates for subsurface water in AOIs 3 and 3A do not exceed U.S. EPA's acceptable cancer risk limit of  $10^{-4}$  and the HI limit of 1 (U.S. EPA, 1991b). Similarly, the risk estimates based on off-Facility Cedarville Aquifer ground water concentrations (AOI 5B) are also below the cancer risk limit of  $10^{-4}$  and the HI limit of 1.

To assess potential future conditions in the absence of interim measures pumping, bounding risk estimates for this pathway were calculated using the maximum on-Facility Cedarville Aquifer ground water concentrations (AOI 5A). As shown on Table 38, these hypothetical future bounding risks for residential exposure via vapor intrusion are above the cancer risk limit of  $10^{-4}$  and the HI limit of 1.

Based on the results of this risk evaluation, potential exposures via migration to indoor air are not significant under current conditions. However, there is a potential for future exposures of off-Facility residents to be significant if on-Facility ground water migrates to off-Facility areas where this pathway may be complete.

#### Recreator Exposure to Creek Sediment and Surface Water

As discussed in Section 5.3, exposures to surface water and sediment in the Unnamed Creek were identified as potentially complete pathways to be evaluated. The receptors identified as having the potential for incidental exposures to site-related constituents detected in surface water and sediments in the creek include off-Facility "recreators." Using the methodology and exposure factors summarized in Appendix VI, and the data collected in the Unnamed Creek, the hypothetical human health risks were calculated for these potential exposures to both surface water and sediments. The risk estimates are summarized below:

Area	Receptor	Cumulative Risk	HI
Unnamed Creek	Off-Facility Recreator	3E-07	0.001

These upper-bound estimates of cumulative cancer risk and noncancer HIs are less than U.S. EPA's established goals of  $10^{-4}$  and 1 (U.S. EPA, 1991b). Based on the results of this risk evaluation, these potential exposures of off-Facility receptors are not significant.



#### **5.5.2.5 Off-Facility Construction Workers**

The significance of hypothetical risks associated with potential exposure of occasional excavation/maintenance workers to off-Facility soil, subsurface water (found in sand seams and sewer backfill), storm sewer water, surface water and sediment is discussed below.

##### Soil Exposures

Potential exposure of construction workers to soil (AOIs 3 and 3A) and creek sediment (AOI 4) is evaluated indirectly using exposure estimates for routine workers, as explained in Section 5.3. This streamlines the risk assessment and is conservative because soil and sediment exposures associated with occasional excavation/maintenance activities would be lower than routine worker exposures. The bounding estimates of cumulative risk based on routine worker exposure assumptions and maximum detected concentrations in each AOI are presented in Appendix VI, Attachment VI-4-2 and summarized on Table 39. As shown on Table 39, the bounding risk estimates do not exceed U.S. EPA's acceptable cancer risk limit of  $10^{-4}$  and the HI limit of 1 (U.S. EPA, 1991b). Based on the results of this risk evaluation, these potential exposures of off-Facility construction workers are not significant.

##### Subsurface Water and Storm Water Exposures

Estimates of risks for potential exposure of construction workers to shallow subsurface water in AOIs 3 and 3A (i.e., sand seams and sewer backfill water), storm water in the municipal storm sewer (AOI 3A) and surface water in the Unnamed Creek (AOI 4) are calculated in Appendix VI (see Attachment VI-5). The highest detected constituent concentrations in subsurface water, storm water and surface water are used as the exposure concentrations for these AOIs. The estimates of cumulative cancer risk and HI for potential exposure of construction workers to shallow subsurface water are summarized in Table 40, which shows that all areas have estimates that do not exceed U.S. EPA's acceptable cancer risk limit of  $10^{-4}$  and the HI limit of 1 (U.S. EPA, 1991b). The bounding risk estimates for off-Facility construction worker exposures to storm sewer water (AOI 3A) and surface water (AOI 4) are summarized on Table 41, which shows that all areas have estimates that do not exceed the cancer risk limit of  $10^{-4}$  and the HI limit of 1. Based on the results of this risk evaluation, these potential exposures of off-Facility construction workers are not significant.

#### **5.5.3 Migration from Soil to Ground Water Pathway**

In addition to the assessment of potential exposures to constituents detected in ground water discussed in Sections 5.5.2.1 through 5.5.2.3, the significance of potential exposures to constituents that could potentially migrate from soil in each on-Facility AOI to Cedarville Aquifer ground water was evaluated. Soil migration to ground water criteria were derived using the procedure outlined in U.S. EPA's Soil Screening Guidance (U.S. EPA 1996a) and taking into account the reasonably likely exposure scenarios for Cedarville Aquifer ground water. Specifically, soil migration to ground water criteria were developed based on the drinking water criteria in ground water. The results of this evaluation are presented in



Section 3.8 through 3.10, and indicate that migration of constituents present in soils in AOIs 1, 2N and 2S to Cedarville Aquifer ground water may result in ground water concentrations exceeding drinking water criteria.

#### **5.5.4 Exposures to Lead in Soil**

U.S. EPA has not developed a cancer slope factor or a reference dose for lead. Therefore, risks from exposures to lead are not expressed in terms of cancer risks or noncancer HQs. The significance of potential exposures to lead in soil are discussed below.

U.S. EPA evaluates the risk from exposure to lead in soil using blood lead level as an index of exposure. Using a blood lead model, U.S. EPA has established a conservative soil screening level of 400 mg/kg that is protective of residential exposure to lead in soil. U.S. EPA has also recommended a blood lead modeling methodology for deriving criteria that are protective of routine worker exposure to lead in soil (U.S. EPA 2003). Criteria derived using this methodology can range from approximately 750 mg/kg to 1,750 mg/kg, with an average of approximately 1,000 mg/kg.

The maximum on- and off-Facility soil lead concentration is approximately 102 mg/kg (based on soil boring location GP01-078, which is on the border of on-Facility AOI 2S and off-Facility AOI 3A). This concentration does not exceed the protective levels for routine worker exposures or residential exposures.

### **5.6 Uncertainty Analysis**

#### **5.6.1 Exposure Concentrations**

As discussed in Section 5.3.4.1, most exposure concentrations for soil in this risk assessment are based on the highest concentrations detected in soil at each area, and 95% UCLs are calculated only when a bounding estimate of the RME cumulative cancer risk or HI exceeds the cancer risk limit of  $10^{-4}$  or the HI limit of 1, respectively. This approach streamlines the risk assessment by avoiding calculation of 95% UCLs that would not materially affect risk assessment conclusions regarding the need for corrective measures.

However, this approach inflates the cumulative cancer risk and HI estimates that do not exceed  $10^{-4}$  and 1, respectively, since these estimates are entirely based on maximum concentrations. As explained in Section 5.3.4.1, the use of maximum concentrations for all constituents introduces more conservatism than necessary for RME estimates because it assumes simultaneous worst-case exposure to all constituents constantly, when the RME generally would not have all constituents at worst-case concentrations at all times. The inflation of these risk and HI estimates makes them closer to the cumulative cancer risk limit of  $10^{-4}$  and the HI limit of 1 than they would be if 95% UCLs were used.

The above discussion regarding soil exposure concentrations also applies to water exposure concentrations for the excavation scenario, since construction workers would not be expected to contact water with the maximum concentrations of every constituent during every on- and off-Facility excavation.

For the ground water vapor intrusion scenarios, the use of maximum concentrations also overstates the RME risk. This is because the ground water under an individual on-Facility or off-Facility building is unlikely to have the maximum concentrations of all constituents. However, these bounding estimates can be useful for identifying constituents for which significant risk is possible, so that risk-based concentration limits for such constituents can be used to identify specific locations where significant exposures might occur.

Most exposure concentrations that are based on mathematical modeling of constituent transfer from soil or ground water to air are conservative for the same reasons discussed above, since the model estimates are based on the use of maximum concentrations in soil or ground water. In addition, the model estimates are conservative because they generally do not account for the reduction of constituent concentrations in the soil or ground water as constituent transfer from these media. As a result, risk estimates are more conservative than necessary for RME estimates.

Another factor that inflated some exposure concentrations and their associated estimates of site-related cancer and noncancer risks is the assumption that all concentrations are site-related. As noted in Section 5.2, the concentrations of all organic chemicals were assumed to be site-related in this risk assessment because the RFI field investigation did not attempt to quantify site-specific background levels (i.e., levels not associated with a release from the Facility). However, as discussed in Section 2, the concentrations of several organic chemicals in soil appear to be unrelated to any release from the Facility's operations. Specifically, the presence of potentially significant concentrations of PAHs in soil in AOI 1 appear related to fill material that was placed during construction activities along Dayton Street, rather than to a release associated with Facility operations. However, the risk assessment conservatively evaluated these concentrations as though they are site-related.

### **5.6.2 Exposure Factors**

As discussed in Section 5.3, most of the exposure factors used in the risk assessment are high-end (i.e., 90<sup>th</sup> to 95<sup>th</sup> percentile) estimates of the magnitude, frequency, and duration of potential exposures. When several such high-end factors are multiplied, the resulting estimates of dose will be higher than the 90<sup>th</sup> percentile of the distribution of exposures in the potentially exposed population and could be higher than the exposure to the maximally exposed individual, particularly when such exposure factors are combined with exposure concentrations that are based on maximum concentrations.

Also, the use of generic default exposure factors for evaluation of potential exposure of workers to soil is more conservative than necessary for RME estimates, which allow the use of site-specific considerations (U.S. EPA 1989). For example, the “fraction contacted” terms used in this evaluation assume that routine workers are exposed to soil for an entire work day at each area, but workers at commercial/industrial sites generally spend only a part of the work day at a particular part of the Facility.

As noted in Section 5.3.5.1, the ingestion rate used for estimating exposure of routine workers to soil is twice the U.S. EPA-recommended standard default value of 50 mg/day. Therefore, the risk estimates for this scenario are more conservative than necessary, particularly for constituents with risk estimates that are dominated by the ingestion route (e.g., most SVOCs and metals).

The ingestion rate for estimating exposure of construction workers to soil in this risk assessment is 200 mg/day. As noted in Section 5.3.5.2, this ingestion rate is based on U.S. EPA-compiled soil-to-hand adherence data for construction-related activities (U.S. EPA 1997), and is believed to be plausible, conservative, and consistent with the expectation that incidental soil ingestion is associated primarily with hand-to-mouth contact. More recently, U.S. EPA guidance (2003) recommends an ingestion rate of 330 mg/day that is based on the variability in the data from a single soil ingestion study that involved a small number of individuals. This ingestion rate was not used in the risk analysis presented in Appendix VI because it is based on very limited data that might not be appropriate.

### 5.6.3 Toxicity Values

As discussed in Section 5.5, the dermal toxicity values used in the risk assessment are oral toxicity values that were extrapolated to the dermal route without chemical-specific judgment regarding whether such extrapolation might be appropriate for a particular chemical. This is a conservative approach to ensure that potential risk via the dermal route is not overlooked. However, some constituents might exhibit different degrees of toxicity for the dermal route relative to the oral route. For such constituents, the extrapolation approach used in the risk evaluation could introduce uncertainty.

The conversion of an oral toxicity value to an inhalation toxicity value generally should be justified by consideration of a number of factors, including point of entry effects, pharmacokinetic data on the chemical's behavior in the different routes of exposure, and differences in the target organs affected. However, as a conservative measure for constituents without any inhalation toxicity values, oral SFs and RfDs were converted to inhalation URFs and RfCs in this risk assessment. Use of these extrapolated inhalation toxicity values reduces the potential for underestimating inhalation risks, but could introduce uncertainty.

The toxicity values for chromium were conservatively based on those for the hexavalent form, even though most chromium in soil and ground water at the Facility is expected to be in the much less toxic

trivalent form. For example, the oral RfD for hexavalent chromium is 500 times more stringent than that for trivalent chromium.

#### **5.6.4 Risk Characterization**

The summation of cancer risks and HQs for multiple constituents, as described in Section 5.5, is based on U.S. EPA guidance (1989) to assume dose additivity, which means that constituents in a mixture are assumed to have no synergistic or antagonistic interactions and each constituent has the same mode of action and elicits the same health effects. In general, this approach can introduce significant uncertainty. However, the majority of the cumulative cancer risk and HI estimates in this risk assessment are dominated by contributions from no more than a few constituents, so that the cumulative risk estimates are nearly the same as those for the few key constituents.

As discussed in Section 5.5 and Appendix VI, the significance of potential exposure via vapor intrusion are highly conservative because they assume that vapor intrusion will actually occur and that the highest concentrations of contaminated soil are located immediately beneath the building foundation. Using more representative concentrations (e.g., vertically-averaged) instead of the maximum concentrations would reduce the risk estimates presented in Section 5.5. Further refinement of the calculations (e.g., accounting for depletion of constituent concentrations near the building foundation, as suggested in Johnson & Ettinger 1991) would likely further reduce the risk estimates. Refinements to the calculations were not performed since direct measurement of indoor air concentrations was performed in areas where the highest soil and ground water concentrations were observed.

#### **5.7 Summary and Conclusions**

As discussed in the CA725 EI Report (ENVIRON and Payne Firm, 2004), based on data collected as part of the RFI, and considering potential exposure pathways and site-specific conditions, no unacceptable human exposures were identified under current conditions. The risk assessment presented in this Phase II RFI Report evaluates the significance of potential exposures to concentrations of constituents in soil, ground water, indoor air, subsurface water, sediment and surface water based on conservative estimates of reasonable maximum exposures under reasonably expected future land use and ground water use at and around the Facility. The evaluation uses the data that were discussed in Section 3 and methods that are consistent with U.S. EPA risk assessment guidance. The significance of potential exposures is determined by comparing estimates of site-related cumulative cancer and noncancer risks with an acceptable cancer risk limit of  $10^{-4}$  and a HI limit of 1, respectively, which U.S. EPA has established as triggers for corrective measures under RCRA corrective action (U.S. EPA 1991b).

The Facility is currently active and is almost entirely paved. Ground water that is affected by releases from the Facility does not extend off-site where land use is a mix of both commercial/industrial and residential. Receptors at the Facility and the downgradient areas include the following:





<u>Current</u>	On-Facility:	Routine workers Construction workers Trespassers
	Off-Facility:	Residents Construction workers
<u>Future</u>	On-Facility:	Routine workers Construction workers Trespassers
	Off-Facility:	Residents Construction workers

The potential exposures evaluated for these receptors are summarized in the conceptual site model shown on Table 29. Results of the evaluation are summarized below for each receptor population.

#### Routine Workers

The risk assessment evaluated potential exposures to outdoor soil at the Facility via incidental ingestion, dermal contact, and inhalation of vapors and particulates. Exposure via inhalation of soil and ground water constituents assuming that they volatilize and migrate through cracks in building foundations was also evaluated.

The conservative estimates of site-related cumulative cancer risk and HI for incidental ingestion, dermal contact, and inhalation of vapors and particulates do not exceed the cancer risk limit of  $10^{-4}$  and the HI limit of 1, respectively, at any of the areas. The lead concentrations in soil do not exceed the range of soil lead criteria for routine workers. However, risk estimates for hypothetical future indoor air exposures (based on predicted and measured air concentrations) do indicate the potential for unacceptable risks to routine workers. It is noted that the measured indoor air concentrations that contribute most significantly to these risk estimates do not appear to be related to releases subject to corrective action.

#### Construction Workers

The risk assessment evaluated the significance of potential exposures to on-Facility soil during occasional excavation/maintenance activities and one-time new building construction by using the risk estimates for routine workers, which is a conservative and streamlined approach. Similar risk estimates were prepared for off-Facility exposures during excavation/maintenance activities. These calculations show that





constituent concentrations in on-Facility and off-Facility soil do not pose a significant risk to construction workers.

The risk assessment also evaluated the significance of potential exposures to constituents in on- and off-Facility subsurface water and sewer line backfill water via incidental ingestion, dermal contact, and vapor inhalation. The conservative estimates of cumulative cancer risk and HI do not exceed the cancer risk limit of  $10^{-4}$  or the HI limit of 1, respectively. Therefore, constituent concentrations in subsurface water do not pose a significant risk to construction workers.

Potential exposures of construction workers to on- and off-Facility storm water in the storm sewers were evaluated and determined to be insignificant. The cancer and noncancer risk estimates for this scenario do not exceed the limits of  $10^{-4}$  or 1, respectively.

Potential exposures of construction workers to surface water and sediments in the Unnamed Creek were evaluated and determined to be insignificant. The cancer and noncancer risk estimates for this scenario do not exceed the limits of  $10^{-4}$  or 1, respectively.

#### Trespassers

The risk assessment evaluated the significance of potential exposures of trespassers to on-Facility soil by using the risk estimates for routine workers, which is a conservative and streamlined approach. Since the constituents in on-facility soil do not pose a significant risk to routine workers, they do not pose a significant risk to trespassers.

#### Off-Facility Residents

The risk assessment evaluated potential exposures to off-Facility via potable and nonpotable use of Cedarville Aquifer ground water. No existing water wells have concentrations exceeding relevant use criteria, indicating that there are no current unacceptable exposures via these pathways. However, ground water concentrations exceeding potable criteria were detected in on-Facility and off-Facility monitoring wells. Therefore, the potential exists for unacceptable exposures in the future if ground water exceeding these criteria migrate to an existing well, or a new potable well is installed at a location where ground water concentrations exceed these criteria.

In addition, potential exposures via vapor intrusion from ground water and subsurface water to indoor air were evaluated. As documented in the CA725 EI Report, the estimates of cumulative cancer risk and HI based on the highest concentrations in the off-Facility wells do not exceed the cancer risk limit of  $10^{-4}$  or the HI limit of 1, thus indicating that current off-Facility concentrations do not present an unacceptable risk via this pathway. Conversely, conservative estimates of future off-Facility concentrations (based on current on-Facility concentrations) exceed the cancer risk limit of  $10^{-4}$  or the HI limit of 1, thus indicating



that in the absence of ground water controls the potential exists for future off-Facility concentrations to present an unacceptable risk via this pathway.

#### Recreational Waders in Unnamed Creek

The risk assessment evaluated potential exposure to sediment and surface water in the Unnamed Creek via incidental ingestion and dermal contact. The estimates of cumulative cancer risk and HI based on the highest concentrations in sediment and surface water do not exceed the cancer risk limit of  $10^{-4}$  or the HI limit of 1.

In conclusion, the risk assessment determined that current potential exposures to constituents in on-Facility and off-Facility soil, subsurface water, ground water, sediment storm water, indoor air and surface water do not pose a significant risk. However, it determined that there is the potential for future hypothetical exposures to constituents in some of these media to present an unacceptable risk. Specifically, potential future exposures via off-Facility potable and nonpotable ground water use downgradient of the Facility as well as hypothetical vapor intrusion from ground water to off-Facility indoor air could pose an unacceptable risk. Similarly, hypothetical vapor migration from soils to indoor air in on-Facility buildings could pose an unacceptable risk in the future. In addition, migration of constituents from on-Facility soils to ground water may continue to contribute to ground water concentrations exceeding potable use criteria.



## **6.0 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT**

The ecological risk assessment (ERA) described in this section is comprised of a screening level ecological risk assessment (SLERA), and as needed a baseline ecological risk assessment (BERA). The ERA discussed in this section uses the site characterization data that have been collected during the RFI to assess potential risks to ecological receptors that may be exposed to Facility-related constituents in the soil, sediment and surface water at and near the Facility.

The ERA presented herein was conducted in a manner consistent with appropriate U.S. EPA ecological risk assessment (ERA) guidance (e.g., U.S. EPA 1997; 1998; 2000a; 2001a). The ecological risk screening evaluation conducted for Vernay is considered representative of current site conditions and reasonably anticipated future conditions, and includes the following steps:

Step 1: Screening-level Problem Formulation and Ecological Effects Evaluation

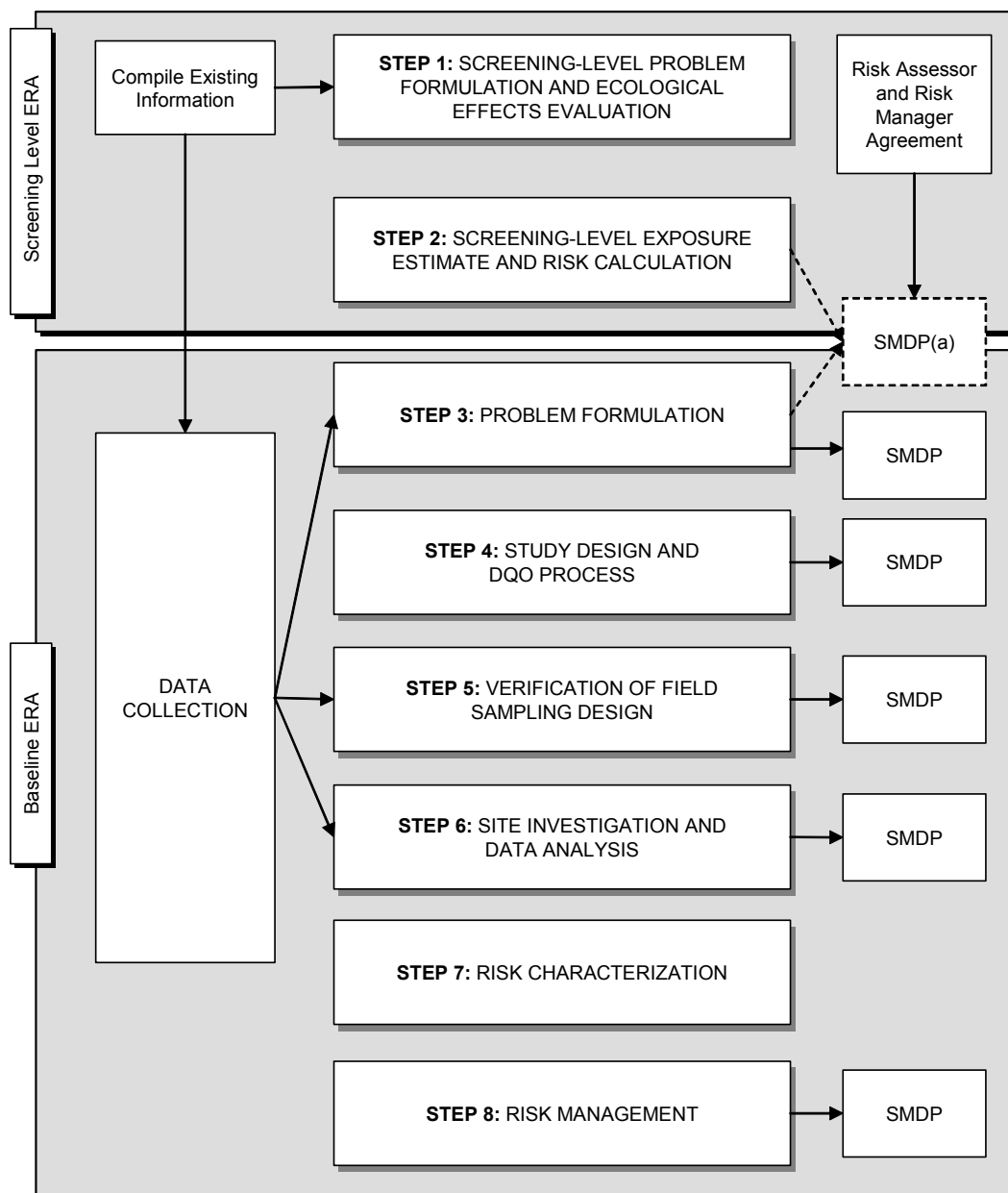
Step 2: Screening-level Preliminary Exposure Estimate and Risk Calculation

Step 3: Baseline ERA Problem Formulation

These three steps are components of the U.S. EPA 8-Step ERA process, as illustrated on page 2 of this section. Steps 1 and 2 comprise the SLERA. A SLERA evaluates the potential risk to wildlife exposed to chemical constituents by providing a conservative estimate of the risks that may exist for wildlife, and incorporating uncertainty in a precautionary (i.e., conservative) manner. The purpose of a SLERA is to either indicate that there is a high probability that there are no ecologically significant risks for wildlife, or to indicate the need for additional consideration (U.S. EPA, 1997; 2000a). Additional consideration may include additional chemical investigation, reevaluation of the SLERA, remedial action for reasons other than ecological risks, or a BERA, in which case the information developed in the SLERA is used to help focus the BERA. A BERA (Step 3 through 8) is more complex than a SLERA and typically incorporates more realistic wildlife exposure information. Only those wildlife receptors (and particular constituents) identified with potential risks in the SLERA are carried forward in a BERA.

The ERA process produces a series of clearly defined scientific management decision points (SMDPs), as illustrated on page 2 of this section (U.S. EPA 1997; 2000a). The SMDPs represent critical steps in the process where ecological risk management decision-making occurs. Generally, the following types of decisions are considered at the SMDPs:

### Eight-Step Ecological Risk Assessment Process



**Notes:**

- (a) SDMP occurs EITHER after Step 2 or after Step 3a.
- ERA Ecological Risk Assessment.
- SMDP Scientific Management Decision Point.
- Source: Adapted from USEPA, 2000a.



- Whether the available information is adequate to conclude that ecological risks are negligible and, therefore, there is no need for any further action on the basis of ecological risk.
- Whether the available information is not adequate to make a decision at this point, and the ecological risk assessment process will continue.
- Whether the available information indicates a potential for adverse ecological effects, and a more thorough assessment or remediation is warranted.

## **6.1 Screening-Level Problem Formulation and Ecological Effects Evaluation**

Step 1 of the SLERA involves the screening-level problem formulation and ecological effects evaluation. Step 1 is presented in Section 6.1.1 (screening-level problem formulation) and Section 6.1.2 (screening level effects evaluation).

### **6.1.1 Screening-Level Problem Formulation**

The overall purpose of the screening-level problem formulation is to describe the environmental setting on the Facility and adjacent to the Facility, and to provide a preliminary evaluation of ecological exposure pathways and assessment endpoints. The screening-level problem formulation serves to define the reasons for the SLERA and the methods for analyzing/characterizing risks (U.S. EPA 1998). Information pertaining to Facility characterization, potential receptors, and ecosystem characteristics is vital to the problem formulation, as is information on the sources and effects of the stressors (U.S. EPA 1998). The screening-level problem formulation provides information used to establish the overall goals, breadth, and focus of an ERA (U.S. EPA 1997; 1998). Once these are established, the problem formulation is used to develop a conceptual model for the ERA.

The screening-level problem formulation produces two outputs: 1) assessment endpoints that reflect the management and ecosystem attributes the endpoints are meant to protect; and 2) a conceptual site model that describes the relationships between stressors and the assessment endpoints. The remainder of this section presents the following components of the screening-level problem formulation for the Facility:

- Ecological Setting
- Identification of Constituents Detected
- Description of Constituent Fate and Transport Pathways
- Description of Constituent Mechanisms of Ecotoxicity
- Description of Potentially Exposed Receptors
- Identification of Potentially Complete Exposure Pathways
- Identification of Generic Assessment and Measurement Endpoints

### Ecological Setting

The characterization of the ecological setting is based on a field survey conducted by a qualified environmental biologist from ENVIRON in 2002. In addition, the characterization of ecological setting includes correspondence with ODNR Division of Natural Areas and Preserves for a Natural Heritage Data Search regarding endangered species information for an area within one-mile radius from the Facility.

As discussed previously (Section 1.3), the Facility currently consists of paved parking lots and walkways, office and manufacturing buildings, and landscaped grounds (Figure 2). Landscaping includes grass lawns and perennial shrubbery. With the exception of AOI 1 (Western Fill Area), which is primarily grass lawn, the Facility is largely covered with buildings or paved parking lots (AOI 2N and 2S). There is no surface water on the Facility property.<sup>3</sup> In addition, there is little evidence of small mammal or avian forage or habitat, though the occasional individual rodent or bird may briefly visit the grass lawns. The lack of cover will inhibit significant use of the area by individual small mammals and birds. Exposure to small mammal and bird populations is not expected. Further, there is no evidence of large mammal forage or habitat on-Facility; thus, exposure to large mammal populations is not expected.

Storm water from the Facility enters a subsurface roadside storm water pipe beneath Dayton Street (AOI 3A) and ultimately discharges to an Unnamed Creek (AOI 4) east of the Facility. There are no Facility-related discharges to off-Facility soils (AOI 3). 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 6). There are no other known surface water bodies in the area. At creek monitoring locations, the depth of the creek has been reported less than approximately four inches and water flow has been reportedly perceptible, 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 grow along both creek banks and generally reach the water line.

Given the intermittent nature and shallow depths of the Unnamed Creek, wildlife use of the creek is limited. For example, small fish (approximately 1 to 2 inches in length) are found only at the furthest creek monitoring location (see Sheet 1) where the depth of water in pools adjacent to a roadway is less than approximately 6 to 10 inches. A common species of frog inhabits the creek, but only species with comparatively short juvenile stages may use the creek during breeding season because the dry conditions would not support development of longer juvenile stages. There is some evidence of small and large mammal and avian forage and habitat along the Unnamed Creek, but no evidence of significant small and large mammal activity along the banks of the creek.

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<sup>3</sup> Storm sewer water is identified herein as surface water, but no exposed surface water bodies are present on-Facility.

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 federal and state listed threatened or endangered species information for an area within one-mile radius from the Facility. The response from ODNR (2003) indicated that several potentially threatened or threatened state-listed species are located within one-mile of the Facility listed on the table below.

Scientific Name	Common Name	Status
<i>Verbesina helianthoides</i>	Hairy Wingstem	Potentially Threatened
<i>Asplenium ruta-muraria</i>	Wall-Rue	Threatened
<i>Arabis hirsuta</i> var. <i>adpressipilis</i>	Southern Hairy Rock Cress	Threatened
<i>Oryzopsis racemosa</i>	Mountain Rice	Threatened
<i>Carex retroflexa</i> var. <i>retroflexa</i>	Reflexed Sedge	Threatened
<i>Spiranthes ovalis</i>	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 (ODNR 2003).

### 6.1.2 Identification of Constituents Detected

The analytical data obtained during the RFI were used to identify constituents on- and off-Facility that are of potentially ecological significance. Consistent with the AOI designations developed for the Facility and used throughout this Phase II RFI Report, the data were compiled into on- and off-Facility groupings by AOI, with sample locations presented on Sheet 1 and summaries provided by medium in Tables 43-1 and 43-2 as follows:

- Table 43-1a: Occurrence of Detected Constituents in On-Facility Soil
- Table 43-1b: Occurrence of Detected Constituents in On-Facility Surface Water (storm sewer water)
- Table 43-2a: Occurrence of Detected Constituents in Off-Facility Soil
- Table 43-2b: Occurrence of Detected Constituents in Off-Facility Sediment
- Table 43-2c: Occurrence of Detected Constituents in Off-Facility Surface Water (storm sewer water and Unnamed Creek)

In keeping with the conservative nature of a SLERA, maximum detected chemical concentrations identified on Tables 43-1 and 43-2 are used in this SLERA (U.S. EPA, 2000a, 2001a). In addition, for surface water, which may also include storm sewer water, samples collected during any sampling event are conservatively included in the data evaluation. Such tables also identify the frequency of detection, the range of sample quantitation limits, and the range of detected concentrations.



Volatile organic compounds, SVOCs, and/or inorganics were detected in one or more medium as follows:

- On-Facility Soil (Table 43-1a): 20 VOCs, 17 SVOCs, 9 inorganics
- On-Facility Surface (storm sewer) Water (Table 43-1b): 5 VOCs
- Off-Facility Soil (Table 43-2a): 8 VOCs, 16 SVOCs, 8 inorganic
- Off-Facility Sediment (Table 43-2b): 5 VOCs
- Off-Facility Surface Water (Table 43-2c): 8 VOCs, 7 SVOCs

For soils, the results presented are for samples collected from 0-2 feet bgs and for sediment samples collected from 0-0.5 feet bgs.

#### Description of Constituent Fate and Transport Pathways

After the environmental setting and the constituents are described, the next step in the screening-level problem formulation is consideration of the fate and transport pathways that might allow constituent exposure with individual organisms or populations of organisms. Knowledge about the potential fate and transport pathways of the constituents detected is vital to understanding which chemicals and receptors are associated with complete exposure pathways. This is because the pathway and route of exposure may have a strong influence on the ecological effect of a constituent. This information is ultimately used to develop the ecological conceptual site model (CSM) presented on Table 42.

Potential migration pathways at the Facility were evaluated for the limited constituents detected (i.e., those discussed in the preceding section). The concentration and distribution of these constituents in environmental media on and in the vicinity of the Facility hypothetically could be (and/or could historically have been) affected by one or more of the following general mechanisms:

- Suspension and transport of constituents in surface water runoff;
- Leaching of constituents from contaminated soil to ground water;
- Ground water-to-surface water transport of constituent;
- Storm sewer water-to-surface water transport of constituents.

Surface water drainage at the Facility flows to several on-Facility storm sewer drains and lines, which are connected to a 54-inch Village of Yellow Springs storm sewer located beneath Dayton Street (Figure 2). As contamination at the Facility is generally limited to subsurface soil, soil under buildings or pavement, or under well-established lawn, suspension and transport of constituents in surface water runoff is not reasonably expected.



Although leaching of constituents from contaminated soil to ground water is possible, ground water is not believed to be in hydraulic communication with any surface water body within the Study Area. Therefore, ground water discharge to surface water (Unnamed Creek) is not reasonably expected. In contrast, the on-Facility storm sewer discharges to the Unnamed Creek, therefore, storm sewer water may transport (or may have previously transported) constituents to surface water and/or sediment in the Unnamed Creek.

#### Description of Constituent Mechanisms of Ecotoxicity

The mechanisms of ecotoxicity for constituents vary depending on a wide range of factors, such as constituent concentration, the wildlife receptor species exposed, the exposure route (e.g., ingestion or direct contact), and physical factors (e.g., pH, temperature, organic carbon, oxygen levels). Some of the effects that could be observed in wildlife are mortality and reduced reproductive ability, decreased fertility, decreased offspring survival, alteration of immune and behavioral function, decreased hatching success of eggs/larvae, and retarded growth (Sample et al., 1996; U.S. EPA, 2002). Mechanisms of ecotoxicity for the classes of compounds detected at the Facility are discussed below. These descriptions of constituent mechanisms of toxicity are presented without consideration of constituent concentrations, as the descriptions seek to convey an understanding of possible effects rather than describe the concentrations at which these effects might occur.

– Volatile Organic Compounds

VOCs tend to attenuate rapidly in surface soil due to their inherent volatility. Although the effects of VOCs on wildlife are not well understood, there have been extensive studies of the effects of VOCs under laboratory conditions. In laboratory test organisms, inhaled VOCs are typically metabolized in the liver, which may cause liver damage or the release of more toxic secondary metabolites. VOCs are not known to bioaccumulate because they are so rapidly metabolized. The VOC or its metabolites may also cause neurological damage, and many are mutagenic or carcinogenic. Additionally, some VOCs are fetotoxic and/or teratogenic (U.S. EPA, 2003a).

– Semivolatile Organic Compounds

SVOCs include a wide variety of compound classes, such as phenols, organochlorine alkenes, phthalates, polynuclear aromatic hydrocarbons, and pesticides. Semivolatile constituents vary greatly in regard to their toxicity (particularly the mechanisms), bioaccumulative potential, and an organism's ability to metabolize. SVOCs or their metabolites may cause neurological damage and many are mutagenic, carcinogenic, fetotoxic, and/or teratogenic (U.S. EPA, 2003a; Newman, 1998; Sample et al., 1996). PAHs (such as benzo(a)pyrene, chrysene, fluoranthene, and pyrene) are often released as a result of human activities, such as the incomplete combustion of fossil fuels or other organic

materials. Some of these compounds are persistent and are known to be mammalian carcinogens, though the ecological effects of PAHs that are not carcinogenic are not well understood. Primary non-point sources of PAHs to the environment are aerial fallout (or rainout), road runoff (from the wear and leaching of asphalt, tire wear, vehicle exhaust, and dripping vehicle fluids), and combined storm sewer runoff (domestic sewage contains some PAHs). Most PAHs are sorbed to solid particles in the environment, which radically reduces the bioavailability and toxicity of the sorbed PAHs. PAHs may be transformed by biotic and abiotic processes in the environment, and may bioaccumulate. PAHs have been shown to cause changes in liver enzymes and to perturb cell membranes but, in general, are not viewed as acutely toxic. Sublethal effects attributed to PAHs in aquatic animals include reduced reproductive ability and fertility, developmental abnormalities, delayed or retarded maturation, histological changes, and carcinogenesis (Neff, 1985).

– Inorganic Constituents/Metals

The potential adverse impacts on aquatic wildlife from trace metals (such as arsenic, barium, beryllium, chromium, copper, lead, and zinc) are well understood (Newman, 1998). Chromium, copper, and zinc are essential for healthy enzyme function, and some organisms cannot survive without these metals. However, these naturally occurring constituents may cause adverse effects when exposure occurs at concentrations that significantly exceed background concentrations. The toxicity and effects of trace metals may be greatly influenced by pH, hardness, and organic carbon content of the water in which they occur (Leland and Kuwabara, 1985).

Imbalances in the trace metals may cause a decrease in photosynthetic ability, poor spawning/hatching success, teratogenesis, susceptibility to predation and disease, reduced growth, mortality, histopathological changes, organ dysfunction of the liver or kidneys, neurological defects, changes in respiration and osmoregulation, and anemia. Some metals may bioaccumulate, but this mechanism is thought to be of minor ecological concern. Because these constituents are naturally occurring, many organisms have a capacity (albeit limited) to biotransform and/or eliminate naturally occurring inorganics (Newman 1998; Leland and Kuwabara, 1985).

Description of Potentially Exposed Receptor Populations

The identification of the categories of receptors most likely affected helps focus the SLERA. The ecological setting provides descriptions of the terrestrial and aquatic habitat and wildlife on-Facility and off-Facility. This information was used to develop the CSM illustrated in Table 42. As illustrated on the CSM, terrestrial and aquatic wildlife and plants could be exposed to constituents from the Facility, including: song birds, small and large mammals, amphibians, reptiles, and fish. As discussed previously, only limited exposures are expected to occur for individual organisms, and exposure to wildlife populations are not expected on- or off-Facility. Although exposure to populations are not expected due

to limited habitat conditions, this SLERA includes the conservative evaluation of risks to individual receptors within wildlife populations. No sensitive, threatened, or endangered species are identified on or within a one mile radius of the Facility.

#### Identification of Potentially Complete Exposure Pathways

A complete exposure pathway is one in which constituents can be traced or expected to travel from the source to a receptor that can be affected by the constituents (U.S. EPA 1997). A receptor within the context of this SLERA is a population, ecosystem, or critical habitat as defined by U.S. EPA (1999). Therefore, a chemical, its release and migration from the source, a receptor (as discussed above), and the mechanisms of toxicity of that chemical must be demonstrated before a complete exposure pathway can be identified. The components of an exposure pathway (the constituents, their migration, their effects, and the receptors) have already been discussed.

As indicated in the CSM (Table 42), a complete exposure pathway is not identified for the Facility. Although as discussed above, individual organisms could be exposed to constituents from the Facility, there are no complete exposure pathways to critical habitats and/or populations. If individual exposure were to occur, exposure routes would include direct contact and indirect contact via forage and prey consumption.

#### Identification of Generic Assessment and Measurement Endpoints

Assessment endpoints are the explicit expression of ecological entities (e.g., mammal populations) and attributes (e.g., reproductive ability) to be protected (U.S. EPA 1997; 2004). The selection of assessment endpoints depends on knowledge of the receiving environment, knowledge about the constituents released (including ecotoxicological properties and concentrations that cause adverse impacts), and understanding of the values that will drive risk management decision-making (Suter, et al. 1995). "For the SLERA, assessment endpoints are any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments. Many of the ecotoxicity screening values are based on generic assessment endpoints (e.g., protection of aquatic populations or communities from changes in structure or function) and are assumed to be widely applicable to Sites around the United States" (U.S. EPA 1997).

Since direct measurement of assessment endpoints is often difficult (or impossible), surrogate endpoints (called measurement endpoints) are used to provide the information necessary to evaluate whether the values associated with the assessment endpoint are being protected. A measurement endpoint is a measurable ecological characteristic and/or response to a stressor (U.S. EPA 1998). Measurement endpoints are also referred to as measures of potential effect (U.S. EPA 1998). Measurement endpoints, such as mortality, reproductive effects, and reduced growth are considered for the SLERA but are not directly measured. These measurement endpoints are indirectly evaluated in the SLERA through the use



of hazard quotients (HQs). An HQ is the ratio of a constituent concentration to an associated ecotoxicity screening value. The measurement endpoints/HQs for the Facility are discussed further in Section 6.2.2.

### **6.1.3 Screening Level Ecological Effects Evaluation**

The screening-level ecological effects evaluation involves the identification of appropriate ecotoxicity screening values (ESVs) for each chemical in each medium. ESVs are chemical concentrations in environmental media below which there is negligible risk to receptors exposed to those media (U.S. EPA 2000a). ESVs are available from a broad range of federal and state sources, one or more of which may be applicable for any given site. Further, ESVs for all media and all receptors may not be available from each source; thus, consideration of a range of sources provides greater opportunity for identification of ESVs. The ESVs used in this SLERA are the U.S. EPA Region V (2003) Ecological Screening Levels (ESLs).

## **6.2 Screening-Level Exposure Estimate and Risk Calculation**

The screening-level exposure assessment is comprised of the identification of exposure estimates, risk calculations, and the evaluation of uncertainties (U.S. EPA, 1997; 2000a). These form lines of evidence to support the scientific management decision point (SMDP) at the conclusion of the SLERA.

### **6.2.1 Identification of Screening-Level Exposure Estimates**

The maximum concentrations detected in on- and off-Facility soil, off-Facility sediment, and on- and off-Facility surface water were used for this SLERA as part of the evaluation of potential direct toxicity. These concentrations along with the appropriate corresponding U.S. EPA Region V ESLs are summarized on the following tables, for the following media groupings:

- Table 43-1a: On-Facility Soil
- Table 43-1b: On-Facility Surface Water (storm sewer)
- Table 43-2a: Off-Facility Soil
- Table 43-2b: Off-Facility Sediment
- Table 43-2c: Off-Facility Surface Water (Unnamed Creek)

### **6.2.2 Screening-Level Risk Calculations**

Risks are calculated in this SLERA by dividing conservative chemical-specific exposure estimates (described in Section 6.2.1) by conservative chemical-specific ESVs (described in Section 6.1.3). These unitless chemical-specific ratios are referred to as hazard quotients (HQs). HQs are considered a surrogate for the assessment endpoint, which is the protection of individual organisms and wildlife populations (as described in Section 6.1.2). An HQ equal to or less than a value of 1 (to one significant figure) indicates that adverse impacts to individual organisms are considered unlikely (U.S. EPA 1997;



2000a). An HQ greater than 1 is an indication that further evaluation may be necessary to evaluate the potential for adverse impacts to individual organisms, and ultimately wildlife populations. The SLERA risk calculations are provided below.

#### On-Facility SLERA Risk Calculations

The risk calculations for on-Facility surface soil (0-2 feet bgs) and surface water (storm water) are presented on Tables 43-1a and 43-1b, respectively. Constituents with HQ values greater than 1 are summarized below.

SLERA Maximum HQs Greater Than 1 On-Facility				
Constituent	Soil (Table 43-1a)			Surface Water (Table 43-1b)
	AOI 1	AOI 2N	AOI 2S	AOI 2S
1,2-Dichloroethene			4	
Cis-1,2-Dichloroethene			4	
Tetrachloroethene			8	2
Benzo(a)pyrene	3		4	
bis(2-Ethylhexyl)phthalate			2	
2-Methylnaphthalene			7	
Naphthalene			30	
Arsenic	2	2	4	
Barium	200	90	100	
Cadmium			700	
Chromium	40	50	50	
Copper	3	3	4	
Lead	900	300	2000	
Selenium	30	30	30	
Zinc	9	10	9	
Blank cells indicate that HQ was less than or equal to 1, or the constituent was not detected. HQs rounded to nearest whole number.				

As indicated in the table above, the majority of the constituents identified in soil with HQ values greater than 1 are metals. With the exception of one PAH [benzo(a)pyrene], all other VOCs and SVOCs with soil HQs greater than 1 are limited to location AOI 2S. HQs could not be calculated for constituents lacking ESLs: cumene, cyclohexane, and carbazole (Table 43-1a).

For surface water, tetrachloroethene was the only constituent with detected concentrations exceeding the screening criteria. However, on-Facility surface water samples were collected from within the storm sewer and are not accessible to ecological receptors. Therefore, this pathway is no longer discussed further in this SLERA or BERA.

### Off-Facility SLERA Risk Calculations

The risk calculations for off-Facility soil, sediment, and surface water are presented on Tables 43-2a, 43-2b, and 43-2c, respectively. Constituents with HQ values greater than 1 are summarized as follows:

SLERA Maximum HQs Greater Than 1 Off- Facility					
Constituent	Soil (Table 43-2a)		Sediment (Table 43-2b)	Surface Water (Table 43-2c)	
	AOI 3	AOI 3A	AOI 4	AOI 3A	AOI 4
Acetone			3		
Tetrachloroethene				10	2
Benzo(a)pyrene		2			
Naphthalene		2			
Arsenic		2			
Barium		100			
Chromium		50			
Copper		4			
Lead	300	2000			
Selenium		20			
Zinc		9			
Blank cells indicate that HQ was less than or equal to 1, or the constituent was not detected. HQs rounded to nearest whole number.					

As indicated in the table above, lead is the only soil constituent identified in AOI 3 with an HQ value greater than 1, with caprolactum and carbazole lacking ESLs (Table 43-2a). There were two PAHs and 7 metals with HQs greater than 1 at location 3A. Acetone was the only constituent in sediment exceeding the ESL (HQ of 3); and, tetrachloroethene was the only constituent in surface water with HQs greater than 1.

#### **6.2.3 Evaluation of Uncertainties**

A SLERA is designed to provide conservative estimates of the potential risks that may exist for wildlife and, therefore, incorporates uncertainty in a precautionary manner. Uncertainty in an ERA is “the imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or its spatial and temporal distribution” (U.S. EPA, 1997). Uncertainties that may lead to either an overestimation or an underestimation of risk are associated with each stage of risk assessment. A summary of uncertainties that are associated with an ERA is provided in Table 44.

#### **6.2.4 Scientific Management Decision Point**

SMDPs represent critical steps in the ecological risk assessment process where risk management decision-making occurs. The first SMDP in the ERA process may occur either at the end of Step 2 or



Step 3a (U.S. EPA, 2000a). The purpose of the flexibility of the first SMDP is so that additional evaluation of risks can occur and reporting can be streamlined into a single report. Generally, the following types of decisions are considered at this SMDP:

1. Whether the available information is adequate to conclude that ecological risks are negligible and, therefore, there is no need for further action on the basis of ecological risk.
2. Whether the available information is not adequate to make a decision at this point, and the ecological risk assessment process will continue.
3. Whether the available information indicates a potential for adverse ecological effects, and a more thorough assessment or remediation is warranted.

The SLERA results indicate that focused initial BERA analysis is warranted (i.e., Step 3a) because the results of the screening-level risk calculation result in HQs greater than 1, and because this information is not adequate for decision-making. Each of the constituents with HQs greater than 1 are retained for further analysis in the BERA where information such as background constituent concentrations, more reasonable exposure estimates, and the spatial distribution of chemicals in relation to habitat can be considered. Constituents lacking ESLs are also retained for further analysis in the BERA. Therefore, as described in the following sections, the risk assessment will proceed to Step 3a for the receptors, media, and constituents described below:

On-Facility:

Soil: 3 VOCs, 4 SVOCs, 8 metals with HQs greater than 1, and 3 constituents lacking ESLs (2 VOCs, 1 SVOC).

Off-Facility:

Soil: 2 PAHs, 7 metals

Sediment: Acetone only

Surface water: Tetrachloroethene only

### **6.3 Step 3a: Baseline ERA Problem Formulation (Refinement of Step 2 Screening-Level ERA Exposure Estimates and Risk Calculations)**

Step 3a of the BERA problem formulation is designed to more realistically identify the nature and extent of ecological risks in order to support informed environmental management decision-making (U.S. EPA, 1997; 2000a). This is in contrast to the SLERA, which is designed to conservatively rule out further evaluation of chemicals and media that clearly do not pose significant ecological risk. The BERA problem formulation presented in this section is consistent with the following guidance:

- Ecological Risk Assessment Guidance for Superfund (U.S. EPA, 1997)



- Guidelines for Ecological Risk Assessment (U.S. EPA, 1998)
- Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders (U.S. EPA, 2000a)
- ECO-Update: Role of Screening-level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments (U.S. EPA, 2001a)

The BERA problem formulation (Step 3) is the initial step in the BERA process, as illustrated on Figure 6-1 on the page 15 of this section. According to the U.S. EPA (2000a):

*“The Problem Formulation [i.e., Step 3] is commonly thought of in two parts: Step 3a and Step 3b. Step 3a serves to introduce information to refine the risk estimates from steps one and two. For the majority of Sites, ecological risk assessment activities will cease after completion of Step 3a. At many Sites, a single deliverable document consisting of the reporting of results from Steps 1, 2 and 3a may be submitted. At those Sites with greater ecological concerns, the additional problem formulation is called Step 3b. It is very important at this stage to perform a ‘reality check.’ Sites that do not warrant further study should not be carried forward.”*

Step 3a of the ERA process (i.e., Problem Formulation) is an opportunity for iterative refinement of potential risks using methods similar to those used in Steps 1 and 2 (U.S. EPA 2000a; 2001b), as illustrated on Figure 6-1 on page 15 of this section. Specifically, constituents identified in the SLERA may be eliminated from further consideration based on the refinement of certain assumptions, such as reasonable chemical exposure estimates and consideration of background/reference location comparisons. Additional ecological screening values may be included in Step 3a, if needed to understand the range of potential risks. Also, this step also allows consideration of the spatial distribution of elevated chemical concentrations in relation to relevant ecological habitat. As such, Step 3a is a refinement of the Step 2 exposure estimates and risk characterization, focused only on the following constituents and media that were identified in the SLERA.

The remainder of this section identifies the refined exposure estimates and the refined risk calculations. Step 3a is followed by a SMDP.

### **6.3.1 Refined Exposure Estimates**

While the SLERA was conducted using maximum detected chemical concentrations, refined exposure estimates include both consideration of mean concentrations and background concentrations, as shown as follows:

- Table 43-3: On-Facility Soil



- Table 43-4a: Off-Facility Soil
- Table 43-4b: Off-Facility Sediment
- Table 43-4c: Off-Facility Surface Water (storm sewer water and Unnamed Creek)

Maximum and mean constituent concentrations are compared to background concentrations. Only those constituents with both maximum and mean concentrations exceeding background are considered for the refined risk characterization.

### 6.3.2 Refined Risk Calculations

The risk calculations (i.e., HQs) are refined and presented on Tables 43-3 and 43-4 for on- and off-Facility, respectively. Only those constituents with maximum and mean concentrations are included in the refined risk calculations. HQs are calculated using mean detected concentrations from each location to represent average exposure that may occur over time. In addition, as shown on Tables 43-3 and 43-4, HQs are calculated using background constituent concentrations. This background information provides insight and context for interpreting elevated HQs associated with the Facility.

#### On-Facility BERA Risk Calculations

The refined risk calculations for on-Facility surface soil (0-2 feet bgs) are presented on Tables 43-3, with mean HQs greater than 1 summarized below.

BERA Mean HQs Greater Than 1 On-Facility			
Constituent	Soil (Table 43-3)		
	AOI 1	AOI 2N	AOI 2S
1,2-Dichloroethene			4
2-Methylnaphthalene			7
Naphthalene			10
Barium	80		
Lead	400		
Cadmium			200
Selenium	30	30	20
Blank cells indicate that HQ was less than or equal to 1, the constituent was not detected with maximum and mean concentrations greater than background, or the constituent was not detected.			

Mean HQs show that only 4 metals were present with detected concentrations that exceed both background and ESLs. The constituents with greatest HQs, such as lead and cadmium, are not Facility-related. Barium, however, may be Facility-related. Elevated HQs seen at location AOI 2S and 2N are not ecologically significant because these locations lack suitable habitat. For example, AOI 2S is in an area covered with asphalt and pavement and AOI 2N is largely covered with asphalt or building with only an extremely limited exposed maintained grassy area. Due to the limited exposures that occur in these areas, adverse impacts are not expected to occur despite the elevated HQs. Location AOI 1 is in a



grassy area, but this area too is maintained and offers limited disturbed habitat. Further, the vegetation is dense, suggesting that ecological exposure to soils at depth is limited. As was described previously in the CSM, population level exposure pathways are not complete given the limited available habitat.

Adverse impacts are considered unlikely for location AOI 1 because the habitat is very limited, the spatial distribution of elevated HQs is limited, many of the elevated HQs are based on concentrations that are not significantly greater than background.

#### Off-Facility SLERA Risk Calculations

The refined risk calculations for off-Facility media are presented on Tables 43-4a, 43-4b, and 43-4c for surface soil, sediment, and surface water, respectively. Mean HQs greater than 1 summarized below.

<b>BERA Mean HQs Greater Than 1 Off-Facility</b>					
<b>Constituent</b>	<b>Soil (Table 43-4a)</b>		<b>Sediment (Table 43-4b)</b>	<b>Surface Water (Table 43-4c)</b>	
	<b>AOI 3</b>	<b>AOI 3A</b>	<b>AOI 4</b>	<b>AOI 3A</b>	<b>AOI 4</b>
Acetone			3		
Tetrachloroethene				4	
Naphthalene		2			
Lead		700			
Selenium		20			
Blank cells indicate that HQ was less than or equal to 1, the constituent was not detected with maximum and mean concentrations greater than background, or the constituent was not detected.					

Mean soil HQs show that only two metals are present with detected concentrations that exceed both background and ESLs. Similar to the trends seen on-Facility, the two constituents with greatest HQs, lead and selenium are not known to be Facility-related. Elevated HQs seen at location AOI 3A are not significant because the lead and selenium exceedances are limited to a small area (approximately 20 square feet). Further the values obtained for lead and selenium are only slightly higher than the background (i.e., background HQs are 400 and 10, respectively).

Habitat in the intermittent creek is extremely limited, and slightly elevated HQs in surface water and sediment are considered to overestimate risk. The lack of continuous water flow prevents the colonization of the creek by many of the wildlife species used to generate the ESLs. Further, as was described previously in the CSM, population level exposure pathways are not complete given the limited available habitat. Considering these factors, adverse impacts are not expected for aquatic wildlife.

### **6.3.3 Scientific Management Decision Point**

As previously mentioned, SMDPs represent critical steps along the process where multi stakeholder risk management decision-making occurs. It is at the SMDPs where the salient aspects of the ecological risk assessment are integrated in a manner that allows for informed risk management. Therefore, it is useful at

this point to reiterate the critical context and findings of this BERA, on those bases, provide a conclusion for the Facility. Specifically:

- Federally listed threatened and endangered species are not present at or in the vicinity of the Facility.
- Elevated HQs associated with soil, surface water, and sediment exposures are predicted, typically in areas with poor habitat characteristics, and/or of limited spatial extent.
- Adverse impacts are not considered likely for wildlife associated with soil, surface water, and sediment on-Facility and off-Facility.
- Population-level exposure pathways are not complete, and population-level exposures are not expected to occur.

Based on this information, adverse impacts predicted by HQs greater than 1 are not indicative of ecologically significant impacts to populations, communities, or ecosystems (a primary risk management consideration according to U.S. EPA [1999]). Therefore, it is concluded that the available information is adequate to decide that ecological risks are negligible at the Vernay Facility and, therefore, there is no need for further action on the basis of ecological risk.



## **7.0 PHASE II RFI SUMMARY**

The following conclusions were based on the results of the Phase I RFI, and were demonstrated in the RFI Phase I report (Payne Firm et al., 2004):

- The nature and extent of contamination was 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 was not completely delineated on and off the Facility; additional definition was needed during Phase II of the RFI.
- The horizontal and vertical extent of ground water contamination in the Cedarville Aquifer (upper, middle and lower) was determined.
- Based on the results of the investigation of the nature and extent of contamination of the Cedarville Aquifer during the Phase I RFI, it was determined that an investigation of the Brassfield Aquifer during Phase II of the RFI was not needed to meet the objectives of the CA750 EI and the Corrective Action Order.

Upon approval of the RFI Phase I report, the U.S. EPA agreed with Vernay's recommendations for the Phase II scope of work to address the nature and extent of contamination in soil, complete an assessment of the fate and transport of contamination from the Facility in the Cedarville Aquifer, continuation of quarterly monitoring, continued monitoring of the effectiveness of the ground water interim measure and completion of the human health and ecological baseline risk assessments.

### **7.1 Summary of the Phase II RFI Tasks**

Phase II of the RFI focused on completing the nature and extent of contamination in soil, determining any unacceptable current and future risks to human health and the environment, and assessing the fate and transport of contaminants detected in the Cedarville Aquifer. Information presented in the Phase I and Phase II RFI reports will be used to complete the Migration of Contaminated Ground Water Under Control (CA750) report, and to evaluate corrective measures needed to remediate hazardous waste and hazardous substances detected at and in the vicinity of the Facility.

During the Phase II RFI, three task specific statements of work were prepared and submitted to the U.S. EPA. Table 3 shows the project SOWs that were prepared during each step of the Phase I and Phase II RFIs, 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.

### **7.1.1 Phase II RFI Tasks Completed**

Several tasks were completed during the Phase II RFI (Section 2.0) to meet the objectives described above and to support evaluations made during the Phase II RFI in order to complete the RCRA Facility Investigation portion of the Corrective Action and to support the corrective measures evaluation. These tasks included:

- Field activities to support the determination of the nature and extent of contamination in soil beneath the Facility.
- Field activities to support the completion of quarterly ground water monitoring.
- Field and modeling activities to support the continued evaluation of the efficacy of ground water interim measures and support the Migration of Contaminated Ground Water Under Control (CA750) report.
- Modeling activities to support an assessment of the fate and transport of contaminants in the Cedarville Aquifer from the Facility and the completion of the baseline human health and ecological risk evaluations.
- Evaluation of human health and ecological risk.

### **7.1.2 Phase II RFI Results**

As discussed in Section 2.0, data collected during the Phase II RFI are consistent with the DQOs for the RFI and were collected following the project QAPP. Section 2.0 also presented the results of the quarterly monitoring program and results and conclusions of the on-going efficacy of the ground water interim measures.

The nature and extent of contamination in soil on the Facility was completed during the Phase II RFI; the results and conclusions of this investigation were presented in Section 3.0. Section 4.0 summarized the contaminant fate and transport ground water model that was prepared for the Facility and vicinity. The fate and transport ground water flow model report is present in Appendix V. Section 5.0 presented the human health risk assessment. The risk assessment was conducted to evaluate the potential significance of reasonable maximum exposures under reasonably expected future land use and ground water use at and around the Facility. Section 6.0 described a screening level ecological risk assessment, and as needed a baseline ecological risk assessment. These assessments were conducted to evaluate potential risks to ecological receptors that may be exposed to Facility-related constituents in the soil, sediment and surface water at or near the Facility.

#### **7.1.2.1 Nature and Extent of Contamination in Soil**

As requested by the U.S. EPA, additional soil VOC analytical data using Update III (U.S. EPA Method 5035) were obtained during the Phase II RFI to delineate the nature and extent of contamination in soil on and off the Facility. Additional soil SVOC data were collected during the Phase II RFI in order to delineate the nature and extent characterization in soil on the Facility. Based on conservative risk-based screening criteria, the nature and extent of contamination in soil have been delineated.

The presence of a potentially significant release at an AOI was identified during the RFI field investigation based on comparison of the on- and off-Facility characterization data for soil with conservative, generic risk-based screening criteria. These criteria were selected based on the conceptual site model for current human exposures to identify contamination in each of the environmental media investigated. Based on the CSM, the soil characterization data were compared with the following three types of soil screening criteria: 1) criteria based on direct contact with soil; 2) criteria based on vapor intrusion into indoor air, and 3) criteria based on migration of soil constituents to ground water. This was conducted as a conservative method to make judgments about whether or not the determination of the nature and extent of contamination in soil was sufficient to meet the objectives of the RFI; and, to depict the nature and extent of contamination.

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

- The nature and extent of contamination has been delineated in soil within the Unconsolidated Unit for risk evaluation purposes based on data gathered for the RFI.

#### **7.1.2.2 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 and Phase II RFI, the monthly water level measurements and ground water analytical results, the capture zone of the interim measure extends at least to the base of the Cedarville Aquifer along the eastern boundary of the Facility.



### **7.1.2.3 Contaminant Fate and Transport**

As part of the Phase I RFI, a ground water flow model was constructed and calibrated primarily 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. During the Phase II RFI, fate and transport modeling focused on using the results of the ground water flow model to form the basis of a contaminant transport model. The transport model was subsequently used to better understand the temporal behavior of the PCE and TCE contaminant plumes, and to determine the adequacy of the existing monitoring well network. A detailed description of the fate and transport modeling conducted during the Phase II RFI, including the modeling objectives, conceptual model, computer code selection, model construction, model calibration, and model conclusions was presented in Section 4.0 and in a separate report (Appendix V) to this RFI Phase II report.

- Based on the results of the fate and transport modeling for the Cedarville Aquifer, the results of these analyses indicate that both the PCE and TCE plumes are stable and well contained within the existing monitoring well network. This conclusion is supported by the existing field monitoring data.

### **7.1.2.4 Baseline Risk Evaluations**

On completion of the Phase II RFI field activities, an assessment of potential current and future risks to human and ecological receptors was conducted to determine if corrective measures are necessary and to provide the justification for performing corrective measures. The assessment of hypothetical human health risks under current conditions was presented in the CA725 EI Report. The baseline risk assessment conducted for this Phase II RFI Report evaluated hypothetical risks associated with potential human exposures under reasonably likely future land use and ground water use conditions.

#### **7.1.2.4.1 Human Health**

As discussed in the *Resource Conservation and Recovery Act CA725 Environmental Indicators Report* (ENVIRON and Payne Firm, 2004), based on data collected as part of the RFI, and considering potential exposure pathways and site-specific conditions, current human exposures were determined to be under control according to the provisions of the CA725. The human health risk assessment discussed in Section 5.0 used the site characterization data to evaluate the potential significance of reasonable maximum exposures under reasonably expected future land use and ground water use at and around the Vernay Facility. The methods used in the risk assessment were based on U.S. EPA risk assessment guidance, and the interpretation of the risk assessment results was based on U.S. EPA risk management policies for RCRA corrective action.

- Based on the results of the human health risk assessment during the Phase II RFI, the risk assessment determined that there is the potential for future exposures to constituents in these media to present an



unacceptable risk. Specifically, future exposures via off-Facility potable and nonpotable ground water use downgradient of the Facility as well as hypothetical vapor intrusion from ground water to indoor air could pose an unacceptable risk. Similarly, hypothetical vapor migration from soils to indoor air in on-Facility buildings could pose an unacceptable risk in the future. In addition, migration of constituents from on-Facility soils to ground water may continue to contribute to ground water concentrations exceeding potable use criteria.

- The results of this risk assessment are to be used in the next steps of the Corrective Action (Section 7.2) to identify where a release of hazardous waste or constituents from the Facility may cause reasonable maximum exposures to be significant enough in the future to warrant corrective measures.

#### **7.1.2.4.2 Ecological**

The ecological risk assessment (ERA) described in Section 6.0 was comprised of a screening level ecological risk assessment (SLERA), and as needed a baseline ecological risk assessment (BERA). The ERA used the site characterization data that were collected during the RFI to assess potential risks to ecological receptors that may be exposed to Facility-related constituents in the soil, sediment and surface water at and near the Facility.

The ERA was conducted in a manner consistent with appropriate U.S.EPA ERA guidance. The ecological risk screening evaluation conducted for Vernay was considered representative of current Facility conditions and reasonably anticipated future conditions, and included the following steps:

Step 1: Screening-level Problem Formulation and Ecological Effects Evaluation

Step 2: Screening-level Preliminary Exposure Estimate and Risk Calculation

Step 3: Baseline ERA Problem Formulation

- Based on the results of the ERA and SLERA, adverse impacts predicted by HQs greater than 1 are not indicative of ecologically significant impacts to populations, communities, or ecosystems (a primary risk management consideration according to U.S. EPA [1999]). Therefore, it was concluded that the available information was adequate to conclude that ecological risks were negligible at the Vernay Facility and, therefore, there is no need for further action on the basis of ecological risk.

## **7.2 Next Steps in Corrective Action Process**

Based on the results of the investigations conducted at the Facility and vicinity, Vernay has identified the nature and extent of releases of hazardous waste and hazardous constituents at or from the Facility which potentially pose an unacceptable risk to human health and the environment. The results of these investigations are documented in the Phase I RFI report (Payne Firm et al., 2004), and in this Phase II RFI





report. As a result of these investigations, Vernay has completed the RCRA Facility Investigation portion of the Corrective Action process.

As shown on the flow chart in Section 1.1, the next step in the Corrective Action process is to complete an Environmental Indicator Report for ground water (CA750). The CA750 report must demonstrate that the migration of contaminated ground water at or from the Facility is stabilized, and will remain within any existing areas of contamination as defined by monitoring locations designated at the time of the demonstration. Based on the Corrective Action Order (Section VI., paragraph 16), the CA750 report is required to be submitted to the U.S. EPA within 180 days of U.S. EPA's approval of this Phase II RFI report.

In addition to the CA750 report, Vernay must also propose to the U.S. EPA final corrective 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. Based on the Corrective Action Order (Section VI., paragraph 19), the Final Corrective Measures Proposal is required to be submitted to the U.S. EPA within 180 days of the positive determination of the CA750 report. The U.S. EPA will prepare a Statement of Basis document that proposes its final corrective measures based on the range of information provided in Vernay's Final Corrective Measures Proposal. The U.S. EPA will then provide the public with an opportunity to review and comment on its proposed final corrective measure presented in its Statement of Basis. Based on the comments, the U.S. EPA will then select its final corrective measure, and will notify Vernay and the public of its decision and rationale in a Final Decision and Response to Comments (Final Decision) document.

Based on the two tasks described above, additional ground water monitoring and performance of a corrective measures evaluation is needed to be completed. These two tasks are described below.

### **7.2.1 Post RFI Ground Water Monitoring**

During the RFI, eight quarters of ground water monitoring were conducted in 2003 and 2004. At least one year of quarterly analytical data (four quarters) was collected from the last monitoring wells that were installed at or in the vicinity of the Facility. Post RFI ground water monitoring data will continue to be needed to further support the additional corrective action tasks. There are four ground water data needs during this post-RFI period, including:

1. Monitor plume stability for the CA750 demonstration;
2. Monitor the effectiveness of the existing ground water interim measures;
3. Monitor to support the calibration of the contaminant fate and transport ground water model; and
4. Monitor to support the conclusion of the risk assessment and the CA725.



In order to meet these post-RFI ground water monitoring data needs, future ground water monitoring events will occur on a semi-annual basis until the final corrective action is determined by the U.S. EPA. This frequency is appropriate since the potentiometric surface beneath the Facility and vicinity has semi-annual seasonal cyclic pattern (seasonal high in the spring and low in the fall), and since the quarterly ground water analytical data does not exhibit seasonal effects on the concentrations detected the monitoring wells.

In order to demonstrate plume stability for the CA750, a sufficient number monitoring wells located near the fringe of the contaminated ground water plume be sampled on a semi-annual frequency. These monitoring wells include MW01-01, MW01-07, MW01-03, MW01-03CD, MW01-04SE, MW02-14, MW02-14CD, MW02-10, MW02-10CD, MW02-15, MW02-15CD, MW02-17, and MW02-17CD (Figure 14). In order to monitor the effectiveness of the existing ground water interim measure, the following monitoring wells will be sampled on a semi-annual basis: CW01-01, CW01-02, MW01-04, MW01-04CD, MW02-11, MW02-08, MW02-08CD, MW02-03, MW02-03CD (Figure 14). The monitoring wells to be sampled on a semi-annual bases located on Figure 14 and Table 11 are also sufficient to support the calibration of the contaminant fate and transport ground water model and the risk assessment.

In order to support the conclusions of the CA725 and the risk assessment, Vernay will follow up in 2005 with the property owners having water wells identified in the water well survey area (Payne Firm et al., 2004). The purpose of the follow-up is to verify any change in water well use, and will be in the form of written correspondence to the property owner. If a reply is not obtained from the written correspondence, other means will be attempted (i.e. telephone call, personal visit) to contact the property owner. In addition, during the corrective measures study, Vernay will resample those water wells that are identified as currently being used for potable or non-potable purposes within the water well survey area that are downgradient from the Facility.

### **7.2.2 Corrective Measures Evaluation**

A number of tasks will be conducted during the Corrective Measures Evaluation. These tasks will include:

- Determination of proposed media cleanup standards (Preliminary Remediation Goals)
- Identification, screening, and development of Corrective Measures Alternatives; and
- Evaluation and recommendation of Final Corrective Measure Alternative.

In addition to the above tasks, a pilot study/treatability study may be conducted at the Facility to support the Corrective Measures Evaluation.



## 8.0 REFERENCES

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