

THIRD FIVE-YEAR REVIEW REPORT

Delaware City PVC Plant Site

New Castle County, Delaware

Prepared by:

U.S. Environmental Protection Agency

Region III

Philadelphia, Pennsylvania



Kathryn A. Hodgkiss, Acting Director
Hazardous Site Cleanup Division

9/10/09

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List of Acronyms

AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CoCs	Contaminants of Concern
DE ODW	Office of Drinking Water (State of Delaware)
DNREC	Department of Natural Resources and Environmental Control (State of Delaware)
EDC	Ethylene Dichloride (1,2-Dichloroethane; 1,2DCA)
EPA	U.S. Environmental Protection Agency
FYR	Five-Year Review
GCS	Groundwater Collection System
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
ppm	Parts per million
PVC	Polyvinyl Chloride
RA	Remedial Action
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study

ROD	Record of Decision
RPM	Remedial Project Manager
RV	Reservoir
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
TCE	Trichloroethylene
ug/L	Micrograms per Liter (equivalent to parts per billion)
VCM	Vinyl Chloride Monomer (Vinyl Chloride; VC)
VI	Vapor Intrusion
VOC	Volatile Organic Compound
WWTP	Waste Water Treatment Plant

Executive Summary

The Delaware City PVC Plant Site (PVC Site or Site) is located approximately two miles northwest of Delaware City, New Castle County, Delaware. The Site originated from a polyvinyl chloride (PVC) manufacturing facility that contaminated area soils and groundwater with PVC sludges and volatile organic compounds (VOCs). In May 1984, EPA and the Delaware Department of Natural Resources and Environmental Control (DNREC) entered into a Consent Order with Stauffer and Formosa to perform a Feasibility Study (FS) and to implement an approved Remedial Action (RA). EPA issued a Record of Decision (ROD) in 1986. The remedy described in the ROD included:

- excavation of PVC sludge and contaminated soils from the three off-grade material batch pits, two aeration basins, and stormwater retention pond;
- lining of the three off-grade batch pits, two aeration basins, stormwater retention pond, and two unlined ditches;
- capping of the closed buried sludge pits and the former PVC storage area;
- capture of the groundwater and treatment in Formosa's plant; and
- operation and maintenance of the caps and groundwater recovery system.

In 1991, EPA issued an Explanation of Significant Differences (ESD). The changes in the ESD included:

- addition of an air stripper to remediate recovered groundwater instead of having water remediated and reused in the existing Formosa plant; and
- replacing several earthen lagoons with an above-ground storage tank.

The site achieved construction completion with the signing of the Preliminary Closeout Report on September 26, 2001. The trigger for this five-year review was the date of the second five-year review, September 10, 2004.

The assessment of this Five Year Review Report found the remedy was constructed in accordance with the ROD and ESD.

EPA finds that overall the Site is protective of human health and the environment in the short-term and appears to be protective in the long-term because of the issues discussed below.

Remedial actions at the plant have continued to reduce the source of ground water contamination and the ground water extraction and treatment system continues to operate as designed and is expected to achieve the cleanup standards specified in the ROD in approximately 15 years. Recently, EPA and the State of Delaware completed the investigation of a potentially site-related contaminant, ethylene dichloride (EDC), found in the drinking water well of a gasoline filling station and other properties near the Site in February 2004. The State of

Delaware Office of Drinking Water (DE ODW) has been sampling these properties routinely since this problem was uncovered in 2004.

Decreasing levels of this contaminant in area groundwater has led EPA and DNREC to conclude that while this contaminant may have originated at the Site, there may no longer be a significant “source” in this area. Since 2008, none of the wells serving these properties showed EDC above applicable drinking water standards. In 2009 the PRP, with EPA approval and under DNREC oversight, began connecting these properties to a public drinking water supply to insure that no current or future exposure to EDC could occur. Even if no one is currently obtaining their drinking water from this aquifer, if the EDC is determined to still be present and from the Site, the remedy would not be protective in the long-term. EPA will continue to monitor this issue in the near term.

Vapor intrusion into structures above the VOC-contaminated groundwater plume had called into question the protectiveness of the remedy. In May and June 2009, EPA evaluated the potential for vapor intrusion with the other owners/occupants of buildings that appear to be located above the contaminated ground water plume, primarily on the eastern portion of the Site, where vapor intrusion may pose a potential risk. EPA’s evaluated these properties and found little or no potential risk associated with vapor intrusion. These findings are detailed in Appendix A of this Five-Year Review.

GPRA Measure Review

As part of this Five Year Review the GPRA Measures have also been reviewed. The GPRA Measures and their status are provided as follows:

Environmental Indicators

Human Health: Current Human Exposure Controlled (HEUC)

Groundwater Migration: Groundwater Migration Under Control (GMUC)

Site-Wide RAU

The Site is not yet considered Site-Wide Ready for Anticipated Use (SWRAU) but is expected to achieve SWRAU status on September 30, 2010.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name: Delaware City PVC Plant		
EPA ID: DED980551667		
Region: 3	State: DE	City/County: New Castle County
SITE STATUS		
NPL status: <input checked="" type="checkbox"/> Final <input type="checkbox"/> Deleted <input type="checkbox"/> Other (specify) _____		
Remediation Status (choose all that apply): <input type="checkbox"/> Under Construction <input checked="" type="checkbox"/> Operating <input type="checkbox"/> Complete		
Multiple OUs?* <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	Construction completion date: September 26, 2001	
Has site been put into reuse? <input type="checkbox"/> YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> NA (On-going active facility)		
REVIEW STATUS		
Lead agency: <input checked="" type="checkbox"/> EPA <input type="checkbox"/> State <input type="checkbox"/> Tribe <input type="checkbox"/> Other Federal Agency _____		
Author name: Frederick N. Mac Millan		
Author title: Remedial Project Manager	Author Affiliation: U.S. EPA - Region 3	
Review period: January 14, 2009 – August 10, 2009		
Date(s) of site inspection: June 10, 2009		
Type of review: <input type="checkbox"/> Post-SARA <input checked="" type="checkbox"/> Pre-SARA <input type="checkbox"/> NPL-Removal only <input type="checkbox"/> Non-NPL Remedial Action Site <input type="checkbox"/> NPL State/Tribe-lead <input type="checkbox"/> Regional Discretion		
Review number: <input type="checkbox"/> 1 (first) <input type="checkbox"/> 2 (second) <input checked="" type="checkbox"/> 3 (third) <input type="checkbox"/> Other(specify) _____		
Triggering action: <input type="checkbox"/> Actual RA Onsite Construction at Site OU <input type="checkbox"/> Actual RA Start at OU# _____ <input type="checkbox"/> Construction Completion <input checked="" type="checkbox"/> Previous Five-Year Review Report <input type="checkbox"/> Other (specify) <u>Informed public review would be conducted</u>		
Triggering action date: September 10, 2004		
Due date (five years after triggering action date): September 10, 2009		

* ("OU" refers to operable unit.)

Five-Year Review Summary Form, cont'd.

Issues:

- 1) The presence of solvents is now known to be associated with the contaminant 1,4-dioxane, a potential human carcinogen which is not removed from water by air stripping. This chemical is usually associated with TCA rather than TCE, and there is relatively little TCA at this site. However, samples for 1,4-dioxane have not been taken at the Site.

Recommendations and Follow-up Actions:

- 1) EPA will sample for 1,4-dioxane at the Site.
- 2) EPA and the State of Delaware will insure that health and safety programs are in place for process areas where Site-related VOC contaminants are in use and monitor changes in chemical use or land use, so that the impact of any changes related to potential vapor intrusion can be considered.

Protectiveness Statements:

The remedy for OU 1 is fully protective. The remedy has effectively reduced and/or eliminated the sources of site-related contaminants to groundwater. These actions included the excavation and removal of sludges from various surface impoundments, capping of closed areas, the installation of liners and leachate detection in basins used in process operations.

The remedy for OU 2 is currently protective in the short-term and should be protective in the long-term. The remedy currently protects human health and the environment by effectively reducing the migration of Site-related contaminants in groundwater, by capturing and removing them from groundwater, and by eliminating them through treatment. These measures have reduced the risk of exposure to Site contaminants and will continue until groundwater cleanup standards are achieved. Current estimates call for completion of the groundwater remedy in 15 years. EPA will continue to monitor these trends following this five-year review.

Properties whose drinking water wells were previously affected by EDC in 2004 were placed on public water in August 2009. Detections of potentially site-related EDC appear to have ceased in wells in this area, but vigilance should be maintained. If EDC or other potentially site-related contaminants were to be found in other drinking water wells, additional remedial measures may have to be considered.

Vapor intrusion into structures above the VOC-contaminated groundwater plume had called into question the protectiveness of the OU 2 remedy. In May and June 2009, EPA evaluated the potential for vapor intrusion with the owners/occupants of buildings that appear to be located above the contaminated ground water plume, primarily on the eastern portion of the Site, and found little or no potential risk associated with vapor intrusion. These findings are detailed in Appendix A of this Five-Year Review.

Overall the Site is protective of human health and the environment in the short-term and in the long-term as discussed above.

**Delaware City PVC Plant Superfund Site
New Castle County, Delaware
Second Five-Year Review Report**

I. Introduction

The purpose of five-year reviews is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review (FYR) reports. In addition, FYR reports identify issues found during the review, if any, and recommendations to address them.

The Agency is preparing this Five-Year Review report pursuant to CERCLA §121 and the National Contingency Plan (NCP). CERCLA §121 states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

The statutory requirement to conduct a five-year review applies to CERCLA §121 remedial actions selected after the effective date of SARA (October 17, 1986). For sites where a statutory review is not specifically required, reviews may be conducted as a matter of policy for any of the following type actions:

1. A pre-SARA remedial action that leaves hazardous substances, pollutants, or contaminants above levels that allow for unlimited use or unrestricted exposure.
2. A pre- or post-SARA remedial action that, upon completion, will not leave hazardous substances, pollutants, or contaminants above levels that allow for unlimited use or unrestricted exposure, but will take longer than five years to complete, i.e., achieve the cleanup levels that allow for unlimited use and unrestricted exposure.

3. A removal action for a site on the NPL that leaves hazardous substances, pollutants, or contaminants above levels that allow for unlimited use or unrestricted exposure, and where no remedial action has or will take place.

The pre-SARA remedial action described above (item 1) corresponds to the remedy specified for the Delaware City PVC Plant Site; therefore, EPA Region 3 has conducted this five-year review of the remedy implemented at the Site in New Castle County, Delaware as a matter of policy due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure.

This is the third five-year review for the Delaware City PVC Site. The triggering action for this policy review is the second five year review completed on September 10, 2004. This review was conducted for the entire site by the Remedial Project Manager (RPM) from January 14, 2009 through August 10, 2009. This report documents the results of the review.

II. Site Chronology

Table 1 lists the chronology of events for the PVC Site.

Table 1: Chronology of Site Events

Date	Event
1966	Stauffer Chemical Company (Stauffer, now AstraZeneca Pharmaceuticals LP (Zeneca)) begins manufacture of polyvinyl chloride (PVC) resin from vinyl chloride monomer (VCM) at the Site.
Late 1960s and 1970s	Off-grade PVC resins, sludges from wastewater treatment system and residues from plant processes are disposed in buried sludge pits, which are closed and covered.
May 1981	Stauffer sells the PVC plant to Formosa Plastics Corporation of Delaware (Formosa) but keeps the area outside of the PVC plant. Formosa continues operations of the PVC plant to present.
October 23, 1981	PVC Plant placed on Interim National Priorities List (NPL).
October 18, 1982	PRP-led investigation confirms groundwater contaminated with vinyl chloride monomer (VCM), ethylene dichloride (EDC) and trichloroethene (TCE).
December 20, 1983	Delaware City PVC Plant Site is placed on the final NPL.

Date	Event
May 23, 1984	Stauffer and Formosa agree under an Administrative Order on Consent (AOC) to complete remedial investigation and perform all necessary remediation under EPA oversight.
September 30, 1986	EPA issues Record of Decision (ROD). Formosa and Stauffer divide the work. Formosa was responsible for the remedial actions on the PVC plant property (OU 1), Stauffer was responsible for remedial actions off of the PVC Plant property (OU 2. RA onsite construction (PVC sludge removal) at OU 1 begins.
April 28, 1987	AOC amended, Remedial Design Starts for OU 1 and OU 2.
March 31, 1988	Remedial Design completed, Remedial Action begins - OU 1.
September 29, 1989	Remedial Design completed, Remedial Action starts - OU 2.
September 18, 1991	EPA issues Explanation of Significant Differences (ESD) for OU 1 and OU 2 for installation of above ground storage tank to replace 3 ponds (OU 1) and air stripper to treat groundwater instead of using the existing Waste Water Treatment Plant (OU 2).
April 6, 1992	Interim Remedial Action Report, OU 2.
April 30, 1992	Work plan completed for revised RI/FS to address additional groundwater contamination migrating offsite from eastern portion of the Site and additional soil contamination from buried PVC resins.
June 30, 1992	Remedial Action Report, OU 1.
June 30, 1995	Begin investigation of additional groundwater contamination migrating from eastern portion of the Site.
December 12, 1995	Begin investigation to address additional soil contamination from buried PVC resins.
March 23, 1999	First five-year review completed at the Site.
October 25, 2000	Additional capture wells under OU 2 installed.
February 29, 2000	Investigation completed for additional groundwater contamination migrating from eastern portion of the Site.
March 8, 2001	Remedial Design for additional groundwater contamination begins, activities combined into OU 2.

Date	Event
July 26, 2001	OU 2 Interim Remedial Action construction starts.
September 25, 2001	OU 2 Interim Remedial Action construction completed.
June 14, 2002	Investigation for additional soil contamination from buried PVC resins completed; any future related activities to be part of OU 1.
June 14, 2002	OU 2 Interim Remedial Action report completed.
August 30, 2002	2002 PRP Groundwater Interceptor System Performance Monitoring Report submitted to EPA.
August 22, 2003	2003 PRP Groundwater Interceptor System Performance Monitoring Report submitted to EPA.
February 19, 2004	Delaware Department of Health and Social Services, Office of Drinking Water (DE ODW) finds EDC in drinking water well of Getty Gas station @ 24ug/L (MCL=5ug/L), confirmed later that month @31 ug/L.
March 11, 2004	DE ODW and DNREC involve EPA in EDC issue; EPA involves PRP. Later that month, Getty Gas Station directed by DE ODW to cease use of EDC-contaminated well for drinking water; PRP provides bottled water.
May 12, 2004	DE ODW, DNREC, EPA and PRP begin year of quarterly sampling regimen at Getty Station and three other affected properties to discern any trends in contamination after 50% EDC drop in Getty well observed.
September 2, 2004	2004 PRP Groundwater Interceptor System Performance Monitoring Report submitted to EPA.
September 10, 2004	Second Five-Year Review completed at the Site.
June 14, 2005	Reports of last quarterly sampling made to affected property owners; no trends identified. Except for Getty well, EDC exceeds MCL minimally and only sporadically.
September 21, 2005	2005 PRP Groundwater Interceptor System Performance Monitoring Report submitted to EPA.
August 23, 2006	2006 PRP Groundwater Interceptor System Performance Monitoring Report submitted to EPA.
September 19, 2006	Following exploratory discussions with EPA and DNREC, PRP (Stauffer Management Co. LLC, (SMC)) offers to connect properties affected by 2004 EDC exceedance to public water supply by letter to EPA.

Date	Event
December 12, 2006	EPA accepts SMC offer to connect property owners to public water under DNREC and DE ODW oversight.
November 1, 2007	2007 PRP Groundwater Interceptor System Performance Monitoring Report submitted to EPA.
April 03, 2008	DE ODW reports to DNREC and EPA that Getty Gas Station originally affected by 2004 EDC exceedance is now below MCL of 5ug/L to EPA.
September 24, 2008	2008 PRP Groundwater Interceptor System Performance Monitoring Report submitted to EPA.
November 26, 2008	2008 PRP Groundwater Interceptor System Performance Monitoring Report approved by EPA and DNREC.
May 27, 2009	EPA inspects and evaluates IENOS Films for vapor intrusion issues.
June 3, 2009	EPA inspects and evaluates Formosa Plastics for vapor intrusion issues.
June 10, 2009	EPA and DNREC conduct FYR Site Inspection w/representatives of SMC and Formosa.
June 11, 2009	EPA conducts community interviews in conjunction with 2009 FYR.
August 19, 2009	DNREC confirms Getty Gas Station and remaining properties originally affected by 2004 EDC exceedance connected to public water supply.

III. Background

Physical Characteristics

The Delaware City PVC Plant Site (Site) is located approximately two miles northwest of Delaware City, Delaware (DE) at latitude 39°35'16" North and longitude 75°39'50" West in New Castle County, DE. It is situated east of State Route 13 and just west of the IENOS Films Co. (formerly VPI Mirrex Corporation; American Mirrex Co. prior to 2004) and the Valero (formerly Motiva Enterprises, prior to that Star Enterprise Oil) Refinery, between Red Lion Creek to the north, and Dragon Creek to the south (See Attachment 1). The Site, according to the ROD, is approximately 260 acres in size. However, during remedial action the contaminated groundwater plume beneath the western portion of the Site (western plume) was discovered to extend further north and south than expected. This increased the Site to approximately 400 acres in size. Since the last five-year review in 2004, the area of the plume of contaminated groundwater beneath the western portion of the Site has diminished significantly. The discovery of the Eastern Plume in 1996 added to the area of the Site even as the western plume diminished. By 2004 the combined area of the Site, i.e. the area underlain by contaminated groundwater, still covered approximately 250 acres.

The Site consists of a polyvinyl chloride (PVC) production facility owned and operated by Formosa Plastics Corporation (Formosa) and adjacent land owned by others under which contaminated groundwater flows. The land to the east of the Site is primarily industrial; the land to the west of the site is farmland with some housing developments as is land south of the Site. Land to the north of the Site has some industry and rail lines, but is largely undeveloped. Originally the plant contained a number of unlined earthen lagoons, ditches and sludge pits where off-grade PVC production resins and process wastes were collected. Wastewater and PVC solids were treated in concrete-lined, aerated lagoons that were found to be cracked and potential sources of contamination. The storm water reservoir pond was an unlined, earthen basin that also received process wastewater and PVC solids from the production area.

Land and Resource Use

The Site is bordered by several industrial facilities, Akzo Nobel and VPI MirreX Corporation to the north and east respectively. Further east and southeast of the Site is the Valero Refinery (formerly Motiva and prior to that Star Enterprise Oil Refinery). The Site is generally bordered on the south by Wrangle Hill Road and on the west by U.S. Route 13 (South Dupont Highway) and further south and west by Delaware State Route 1. The Site terrain is generally flat. The Plant area itself sits atop a groundwater divide that causes groundwater (and subsequently groundwater contaminants) to flow in all directions from beneath the PVC Plant. The western portion of the contaminant plume moves primarily north and south likely under the influence of a buried stream channel.

There is some business but little residential development in the immediate Site area. Additional residential development is present on the outskirts of the Site, primarily along Route 13 and west. Several of these residences are downgradient (south) from the direction of flow of the western portion of the contaminated groundwater plume and they do use groundwater as their primary source of drinking water.

History of Contamination

Stauffer Chemical Company built a carbon disulfide (CS₂) production plant around 1960, followed by a PVC production plant in 1966. Several impoundments were constructed as part of the PVC plant. Two of the impoundments were concrete-lined aeration basins, three were earthen lagoons (off-grade batch pits) used to dump off-grade PVC. One was used to collect stormwater and any chemical or oil spills from the PVC plant. This same pond also occasionally collected process wastewater.

The Site had two earthen ditches which carried water and a water/PVC suspension to the off-grade batch pits and the stormwater reservoir. When necessary, PVC sludge was removed from all of the impoundments and buried on the north side of the aeration basins. In 1978 this burial area was capped with a PVC membrane and earthen cap. In an area west of the CS₂ plant and north of the PVC plant, PVC resin was stored in a mound. By 1972, storage was discontinued in this area, but PVC resin remained in the soil. Resin from this pile spread to a wetlands area to the north of resin storage area. The resin also extended to an area of stressed vegetation northeast of the wetlands that also contained waste sulfur from the CS₂ plant. North

of the wetlands and the stressed vegetation area is a burial area for the CS₂ plant that had previously been capped with a plastic liner and soil. From 1966 until May 1981, Stauffer Chemical Company (Stauffer) operated the PVC resin production plant and the CS₂ production plant at the Site.

Stauffer manufactured polyvinyl chloride (“PVC”) resin from vinyl chloride monomer (VCM) at the Site. In May 1981, Stauffer Chemical Company conveyed to Formosa the PVC production plant but retained ownership of the CS₂ plant and kept the area outside of the PVC plant. Formosa has continued to operate the PVC plant to the present day. In April 1982, one of the domestic supply wells on Stauffer’s property was found to be contaminated with 1,2-dichloroethane (a.k.a. ethylene dichloride, EDC), VCM, and trichloroethylene (TCE). This prompted Formosa and Stauffer to perform a hydrogeologic investigation which identified a plume of EDC, VCM, and TCE in the lower portion of the Columbia aquifer, underneath and west of the PVC plant. Further investigation determined that the sources of the groundwater contamination from the PVC plant were two unlined ditches, three off-grade batch pits, two aeration basins, and a stormwater reservoir (RV) pond. The sources outside of the PVC plant were closed buried sludge pits and a former PVC storage area. Groundwater sampling conducted in March 1982 and April 1983 confirmed that high concentrations of site-related contaminants had impacted nearby residential wells. Concentrations of VCM ranging from 19 parts per billion (ppb) to 220 ppb and EDC ranging from 490 ppb to 2,900 ppb were found in private well water supplies. See Attachment 2 for various depictions of the groundwater plume.

Initial Response Activities

The Site was included on the Interim Priorities List in October 1981, proposed for inclusion on the National Priorities List in December 1982, and finalized on September 8, 1983, as published in the Federal Register, 48 Fed. Reg. 40658.

In March 1982, samples from monitoring wells located in the vicinity of the off-grade batch pits and the PVC burial area documented the presence of VCM, EDC, and TCE in the groundwater (Sampling Inspection Report, Ecology & Environment, Inc.). Monitoring Well 8 had EDC at 13,000 ppb and TCE at 15 ppb and Monitoring Well 9 had VCM at 370 ppb. Sampling in April 1982 showed that the contaminants had polluted a residential groundwater well adjacent to the Site with VCM at 605 ppb, EDC at 4,500 ppb and TCE at 12 ppb. Subsequent samples obtained in March 1983 showed that the contaminants had migrated in the groundwater and impacted two additional private well water supplies. Concentrations of VCM ranging from 19 ppb to 220 ppb and EDC ranging from 490 ppb to 2,900 ppb were found in those private well water supplies.

In 1984 EPA, DNREC, Stauffer Chemical and Formosa Plastics Corporation signed an Administrative Order on Consent (Docket No. III-84-6-DC) in which it was agreed that Stauffer and Formosa would perform a feasibility study (FS) and carry out any remedial action as determined by EPA. Stauffer Chemical Company submitted a FS to EPA which was approved on July 15, 1986. This study outlined alternatives for remediating this Site.

Basis for Taking Action

Contaminants

Hazardous substances that have been released at the Site in each media include:

Groundwater

1,2-Dichloroethane (EDC)
Trichloroethylene (TCE)
Vinyl Chloride Monomer (VCM)

Soils

1,2-Dichloroethane (EDC)
Trichloroethylene (TCE)
Vinyl Chloride Monomer (VCM)

Potential human exposure pathways for Site contaminants evaluated in the risk assessment included inhalation of volatilized contaminants from unlined ditches, pits, ponds and lagoons. This was determined to be an insignificant pathway at the time of the ROD. Direct and indirect contact with soils, especially PVC sludges contaminated with EDC, VCM and TCE were considered the most significant direct dermal pathway, but also the least likely due to worker protective controls and robust plant controls. Direct contact with onsite PVC sludges, resulting in dermal contact, inhalation and ingestion of groundwater contaminated with EDC, VCM and TCE constituted the greatest potential human health threat.

A hydraulic connection between groundwater and Red Lion Creek and Dragon Run, both used for recreation and drinking water, represented a potential surface water exposure pathway.

Future potential environmental receptors of Site contaminants included aquatic and terrestrial bioreceptors, but there was little information on the actual communities present in this primarily industrial/rural area. The primary pathway would be the contamination of surface water via groundwater. The persistence of Site contaminants in surface waters would be limited by volatilization and none of these compounds has a high potential for bioaccumulation or biomagnification in aquatic or terrestrial biota. The risk associated cleanup standards for groundwater in the 1986 ROD were as follows:

EDC - 0.94 Micrograms per liter (ug/L)*
VCM - 1 ug/L
TCE - 2.7 ug/L

*(NB: ug/L is equivalent to parts per billion (ppb))

IV. Remedial Actions

The Remedial Action Objectives for the Site, though not precisely stated in the ROD, included the abatement of sources of contamination and the mitigation of the existing plume of contaminated groundwater. This would involve a) preventing or reducing infiltration of contaminants through their sources, b) preventing or reducing migration of Site-related contaminants in groundwater (contaminant plumes), c) preventing direct contact of the soil with PVC resins, d) preventing future degradation of groundwater and/or surface waters by site contaminants, and e) preventing exposure to contaminated groundwater via residential wells.

Remedy Selection

EPA approved an initiative by Formosa and Stauffer to divide the work at the Site and perform the remedial action activities as operable units (“OUs”) under EPA oversight. The Delaware City PVC Plant Site was originally divided into operable units as follows:

September 30, 1986 ROD

- OU 1 (Actions on PVC Plant Property)
- OU 2 (Actions off PVC Plant Property)

Formosa was responsible for the remedial actions on the PVC plant property (i.e. “OU1”) which included:

Off-grade Batch Pits, Storm Water Reservoir and Unlined Ditches-

Excavate and remove existing PVC sludges and contaminated soils; install a double synthetic liner, monitoring wells and perform quarterly sample analysis for TCE, EDC and VCM.

Aerated Lagoons-

Excavate and remove PVC sludges, clean and repair lagoons as necessary, install a double synthetic liner and monitoring wells, and perform quarterly sampling analysis for TCE, EDC and VCM

Stauffer was responsible for remedial actions off of the PVC Plant property (“OU 2”) which included:

Closed Buried Sludge Pits-

Place a drainage layer on top of the existing synthetic cap and cover with a 2nd synthetic cap; cover with topsoil and revegetate

Former PVC Resin Storage Area-

Cover the entire area with a double synthetic cap, then cover with topsoil and revegetate

Groundwater-

Install a line of groundwater recovery wells at the northern and southern edges of the contaminant plume, collect and reuse the groundwater in Formosa’s plant operations. Install two monitoring wells at the southern edge of the plume and provide alternate water supply for existing contaminated wells. Initially several residences were supplied alternative potable water via tanker truck by Stauffer Chemical. Several properties including three businesses (Stapleford Chevrolet, Diamond State Telephone and Foraker Getty) had their drinking water wells replaced by Stauffer in 1987 as part of the remedial action.

Both Stauffer and Formosa were responsible to conduct Operations and Maintenance (“O&M”) activities to insure the effectiveness of their respective remedial actions. These activities include conducting regular inspections, making repairs to liners and caps as necessary,

and routinely monitoring the groundwater recovery system to assure that it is capturing the contaminant plume.

On December 18, 1991, EPA issued an Explanation of Significant Differences (“ESD”) for the Delaware City PVC Plant Site. This ESD described two significant changes to the remedy selected in the ROD. The first one involved the addition of an air stripper to remediate the recovered groundwater instead of having the water remediated and reused in Formosa’s plant. Although at the time of the FS reuse of the groundwater was the preferred alternative, it was determined in the ROD that not all of the recovered groundwater could be consumed in Formosa’s operations. Since this may have required the installation of an air stripper at some future date, it was decided that a dedicated air stripper was the most reliable alternative. The second change to the remedy involved replacing several existing earthen lagoons (viz. the three off-grade batch lagoons and the storm water reservoir pond) with one above-ground storage tank. The tank was designed with a capacity of about 2.3 million gallons to replace these facilities.

Remedy Implementation

On April 28, 1987, EPA, Formosa and Stauffer agreed to amend the May 14, 1984 Administrative Order on Consent for the purposes of carrying out the remedial actions specified in the ROD dated September 30, 1986. Both Formosa and Stauffer then began work on remedial designs to address their respective portions of the remedy.

Formosa began the remedial design and initiated its remedial action (“RA”) under OU 1 (sludge removal) shortly after the ROD was issued. The OU 1 RA included excavation of the PVC sludge and contaminated soils from the three earthen off-grade batch pits, two aeration basins, and RV #1 (a former stormwater reservoir); lining of the concrete aeration basins and two earthen ditches; and backfilling of the three off-grade batch pits. Additionally, Formosa constructed an above-ground tank to contain stormwater runoff instead of rebuilding RV #1 and the off-grade batch pits and constructing an additional stormwater reservoir. Formosa also constructed RV #2, a new impoundment used to store stormwater from the northern section of the plant. The water from the tank and RV #2 are pumped to the aeration lagoons for treatment prior to discharge to the Delaware River.

Stauffer completed its remedial design and initiated remedial action under OU 2 on September 29, 1989. The ROD called for a recovery system, initially a line of six groundwater recovery wells at the northern edge of the plume and another six wells at the southern edge, plus two monitoring wells at the southern edge of the plume, to collect the contaminants and to prevent the plume from migrating further. The groundwater recovery system is operational and the effluent from the air stripper is discharged to the Delaware River.¹

¹ A dedicated air stripper was installed to remediate contaminated groundwater instead of having Formosa recover and reuse the groundwater in their plant cooling system (where it would have been remediated via air-stripping in the plant’s cooling towers). Stauffer volunteered to install the air stripper because Formosa was reluctant to use contaminated groundwater in its cooling system. Additionally, Formosa may not have been able to utilize all of the contaminated groundwater for cooling, which would have necessitated directing some of it to Formosa’s waste water treatment plant (“WWTP”). Formosa was concerned that its WWTP may not have been able to handle the types and levels of contamination present in the groundwater. The decision to install the dedicated air stripper

Formosa completed its RA activities under OU 1 on June 30, 1992 and Stauffer likewise completed its RA activities under OU 2 on April 6, 1992. Remedial Action Reports were signed to document both completions.

Additional Contaminants Investigations - 1992-2002

At the time that Stauffer was nearing completion of the construction activities originally envisioned under OU 2 another contaminated groundwater plume was discovered east of the PVC plant. In 1992 the Star Enterprises Refinery, east of and adjacent to the plant, discovered a groundwater plume on their property contaminated with chlorinated organic compounds. At approximately the same time, PVC resins were also found in vicinity of the Akzo Nobel Chemical and the VPI Mirrex facilities north and east of the Formosa plant where they were not expected. In 1993 Stauffer, now AstraZeneca Pharmaceuticals, LP (“Zeneca”) began a Pre-Design Investigation, designated as “Phase II,” to determine to what extent the PVC Site was the source of the contaminant plume beneath Star. Formosa also began an investigation of soil contamination associated with the newly discovered buried PVC resins in 1993.

During the Phase II Groundwater study, EPA suspected that EDC contamination had penetrated the Columbia aquifer and reached the Potomac aquifer beneath. Further investigations were initiated in 1996. Stauffer’s investigation found no EDC in the Potomac aquifer but did find a very localized area of groundwater contamination flowing east of the Site in the Columbia aquifer.²

was documented by EPA in an Explanation of Significant Differences dated September 18, 1991.

² At one point, EPA separately designated the newly-discovered contaminant plume in the eastern portion of the Site as Operable Unit 3 (“OU 3”) and the additional soil contamination associated with the buried PVC resins as Operable Unit 4 (“OU 4”). As both investigations progressed, it was decided that these separate actions could be handled more efficiently under the two pre-existing operable units. By the time both studies were completed in 2002, the additional groundwater contamination in the eastern portion of the Site had been made part of OU 2 and the soil contamination associated with the buried PVC resins had been made part of OU 1.

After Stauffer discovered the eastern plume in 1996, further investigation was done in 1999 to verify the finding. In 2000, a Pre-Design investigation was conducted, which consisted of: monitoring well installation, water level measurements, groundwater sampling, installation of test borings, pumping well installations, pumping well specific capacity tests, and groundwater capture zone modeling. These tasks provided the data needed to design a pump and treat system to address the eastern plume. Stauffer submitted the pump and treat system design to EPA on May 1, 2001, and construction of the pump and treat system started on July 9, 2001.

The pump and treat system consists of five pumping wells with their associated valves, pumps, piping, related electrical equipment (i.e., digital flow meter, power and telemetry wiring), and a pipeline for conveying the extracted groundwater to the existing air stripper for treatment. On September 26, 2001, a Preliminary Close Out Report was signed which signified construction completion of the pump and treat system and construction completion for the Delaware City PVC Plant Site. These recovery wells are continuing to withdraw contamination from area groundwater and mitigate the continued migration of contaminants eastward. The capture zone of the pump and treat system is managed so as to not extend beyond the eastern property line. Significant withdrawals of contaminants from the source area will also reduce contaminants in the downgradient direction.

Formosa's soil investigation associated with buried PVC resins was completed in 2002 and found no additional contaminated soil.

Systems Operations/Operation & Maintenance

Operation and Maintenance, as stated in the ROD, includes conducting regular inspections and, as necessary, repairs to the liners and caps, and annual monitoring of the groundwater recovery system to insure that it is capturing the plume. Annual groundwater monitoring at the Site started in 1993 and is ongoing. The pump and treat system constructed in 2001 to address contamination associated with the eastern plume is now part of the groundwater recovery system constructed in 1992. The eastern plume has also been examined in subsequent annual groundwater monitoring events, which will continue until the cleanup goals stated in the ROD are achieved. Zeneca and its contractor, Roux Associates, conduct O&M for the off-plant property portion of the remedy, including the landfills and groundwater remediation and Formosa conducts the O&M activities on plant property (aeration basins, ditches, and tank).

Formosa reports on its O&M activities to EPA monthly. Zeneca performs weekly maintenance inspections of the pump and treat system and makes repairs as needed. Zeneca reports on its activities quarterly to EPA and DNREC. Information on the condition Formosa's and Zeneca's respective systems are described under Site Inspections in Section VI below.

V. Progress Since the Last Five-Year Review

Actions Taken Since Last Five-Year Review					
Issues from Previous Review	Recommendations/ Follow-Up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Date(s) of Action
Potentially Site-related Contaminant of Concern in drinking water well in vicinity of Site	Revised sampling plan ongoing for ongoing ground water investigation to determine if Site-related	Zeneca	10/30/04	See discussion below	
Possible vapor intrusion into structures above contaminated ground water plume	1) discuss issues w/Formosa, Zeneca & other owners/occupants 2) Develop action plan if necessary	Zeneca Formosa EPA	11/30/04	See discussion below	

Since the last five-year review dated September 10, 2004 the EDC exceedance investigation at drinking water wells in the vicinity of the western plume that began with the Getty Gas Station well at the intersection of Rt. 13 and Wrangle Hill Road has largely been completed. In 2008 DE ODW reported that area wells no longer exceeded the MCL for EDC (5 ug/L) and four affected properties are in the process of being placed on the area municipal drinking water supply to prevent any possible future exposure to contaminated groundwater. In addition, two new, additional monitoring wells (OW 60 and OW61) were installed in 2005 to monitor possible EDC and other site related contaminants in this area. In late 2005, PRP Stauffer also proposed to EPA and DNREC that the property owners whose drinking water wells were affected by EDC believed to be from the Site's western plume in 2004 being placed on public drinking water at the PRPs expense. EPA and DNREC agreed in 2006 and DNREC has been the lead agency on this effort with EPA oversight. This work was done by Stauffer under DNREC oversight and was completed in August 2009. There have been no detections of EDC in these wells as of 2008.

Groundwater monitoring results between 2003 and 2008 led to EPA and Zeneca agreeing on the shutdown of pumping Well A in the vicinity of the western plume, but no well abandonments. The several annual Groundwater Interceptor System Monitoring Performance Results reports between 2003 and 2008 showed the groundwater plume in the western area of the Site (western plume) was continuing to shrink along the north/south axis of groundwater flow west of the groundwater divide and contamination levels in the eastern portion of the Site (eastern plume), though still some two orders of magnitude higher, have likewise been reduced.

EPA will continue to monitor these trends following this five-year review. In addition, EPA has evaluated the Site for potential vapor intrusion. See Appendix A for further details.

VI. Five-Year Review Process

Administrative Components

The five-year review included the following administrative components:

- Community Involvement
- Interviews
- Document Review
- Data Compilation and Review
- Site Inspections
- Five-Year Review Report Development and Review

Community Involvement

EPA conducted community interviews on June 11, 2009. EPA's Community Involvement Coordinator for the Site (Mr. William Hudson) and the EPA Remedial Project Manager (RPM) for the Site (Mr. Frederick Mac Millan) met with the current and former Directors of Public Safety for Delaware City, with the Co-Principals of the Kathleen Wilbur Elementary School, about a mile west of the Site, and with several local residents who live near to the Site.

During the interviews, EPA representatives summarized the requirements of the five-year review inspection for the Delaware City PVC Plant Site and asked for any input or concerns on the protectiveness of the remedy.

Following issuance of this Five-Year Review document, a notice will be sent to a local newspaper announcing that the Five-Year Review report for the Delaware City PVC Plant Superfund Site is complete, and that the results of the review and the report are available to the public in the information repository located at the Delaware City Public Library at 250 5th Street, Delaware City, DE 19706.

Interviews

On June 11, 2009 EPA conducted a joint meeting with the former and current Directors of Public Safety for Delaware City. Both of these two officials had similar views about the Site. Each knew of the Site but had experienced no issues that required their involvement or response during their respective tenures. Neither felt very well informed about the Site or knew of any particular community concerns. Both directors told EPA that the main community concerns were the economy and the Valero Refinery next to the Site. They described the Valero Refinery as the most pressing environmental concern in the area, especially with respect to odors. Both the current and former directors suggested speaking with the local fire chief and tried to contact

that person during the meeting, but without success. EPA stopped by the Delaware City Fire Station later in the day, but again, the fire chief was unavailable.

EPA also spoke with the two co-principals of the Kathleen Wilbur Elementary School, located on Wrangle Hill Road in Bear, DE west of the Site. After explaining the reason for our visit, EPA found that neither co-principal had any knowledge of the Site, but they were aware of odor problems coming from the Valero Refinery. EPA offered to return to brief staff and/or parents about the Site if there was interest.

EPA also spoke to several local residents and shared information about the Site, one of the oldest in Region 3 dating back to 1982. EPA informed these residents that health risks from Site contaminants were low and that the remedies intended to control these contaminants, primarily in groundwater, were functioning properly. EPA also assured them that this five year review report and other information about the Site would be made available to the public once completed.

In general, the public interviewed is very satisfied with the project and thinks EPA has done and continues to do a “good job” with issues regarding the Site itself. The respondents do not feel threatened by the site work or the management or operation of the site. As to the issues that received the most attention during these interviews, respondents primarily cited the economy and the shutdown of the Valero plant. Sensitivity of the local area to environmental issues ran high and community interest or concern about the site was also elevated, more so among local citizens. Overall, people felt less than well informed about the Delaware City PVC Plant Site. As to effects on the surrounding community from the Site, respondents most often cited odors from the neighboring Valero refinery, although they were made aware that the Site did not include that facility.

Document Review

This five-year review consisted of a review of relevant documents including the ROD, ESD, administrative orders on consent, O&M records, monitoring data and applicable or relevant and appropriate requirements (ARARs). See Attachment 3 for a list of these documents.

Data Compilation and Review

Air Stripper

Air emissions from the stripper do not appear to pose an unacceptable risk, based on estimates from current information.

Groundwater Monitoring

Information detailed in the 2008 Groundwater Interceptor System Monitoring Performance Results (most recent) report showed that the groundwater plume in the western area of the Site (western plume) continues to shrink demonstrably along the north/south axis of groundwater flow west of the groundwater divide (see Attachment 2). Contamination levels in the eastern portion of the Site (eastern plume) are still some two orders of magnitude higher than

levels in the western plume, but annual evaluations do show signs that the plume is being reduced in areal extent and concentration. Sampling for the 2009 Groundwater Interceptor System Monitoring Performance Results report was completed in May 2009 and EPA expects to receive this report by September 2009. EPA will continue to monitor these trends following this five-year review.

Site Inspection

On June 10, 2009, a site visit was conducted by EPA accompanied by representatives from DNREC, Formosa and Zeneca. A number of areas on Formosa were inspected including the two former earthen ditches, the 2.3 MG above-ground storage tank, the western and eastern aeration basins and the additional storm water reservoir (RV#2) and the pumping wells for the eastern contaminated groundwater plume. Several areas off of Formosa property were also inspected the groundwater telemetry station, the air stripper and the remaining pumping wells used to remediate the western contaminated groundwater plume. The Delaware City PVC Site review team consisted of Mr. Frederick Mac Millan, RPM, EPA, Ms. Morgan Price, Project Manager, DNREC, Ms. Kim Bennett, Environmental Affairs Manager, Formosa Plastics Corporation of Delaware, Mr. Robert Shay, Environmental Program Manager, AstraZeneca Pharmaceuticals LP, Nathan Epler, Ph. D. Principal Hydrogeologist, Roux Associates, Inc. (Roux), consultant to AstraZeneca Pharmaceuticals LP, and Mr. Jade Borowski, Project Engineer, also employed by Roux. The weather was sunny and clear with temperatures in the low 80s.

There is active security at the Formosa property and all area perimeters are fenced with locked gates at access points. In general, the Site property appears to be in good condition, with signs of recent and ongoing maintenance evident. The two former earthen ditches were previously lined with synthetic material and cement during the remedial action. They are now used to route stormwater and wastewater to the above-ground storage tank and were in use and functioning. The cement in the southern ditch had recently been repaired with epoxy materials and was sound. The northern ditch appeared to be in good condition. The above-ground storage tank was likewise in good condition and well maintained. Three vertical sections of concrete on the south side of the containment basin surrounding the storage tank had separated and need to be replaced. That work has been scheduled. The additional stormwater reservoir (RV#2), installed at the same time the storage tank was built was in good condition. One of the aeration lagoons had been shut down for repairs, but the other lagoon was functioning and has sufficient capacity to support the operation of the treatment system.

The five pumping wells for the eastern plume, designated Wells Q, R, P, O, and S are located on a north/south line on Formosa property adjacent to the IENOS Films property line. All of the wells are installed in concrete chambers that extend about two feet above ground and about six feet below ground. Two of the five wells, Q and O, were inspected. Each had a locked steel access door, a ladder and a confined space warning on the inside surface of the access door. The bunker for Well Q was in good condition, except for an apparently clogged floor drain that allowed rainwater to accumulate on the bottom. The well head, pipes and access ports are all located above the floor of the chamber. The pressure gauge was functioning. Well O was similarly operational and in good condition, and had no drainage issues. All pumping wells feed data to the remote telemetry building at the western portion of the Site. Real time operational data is available and reports are automatically faxed daily to Zeneca and Roux.

Wells B and D are the two remaining pumping wells used to remediate the western plume. Well D is about two hundred feet off of State Road 13 in a field. The concrete well chambers are similar to the well chambers for the eastern plume pumping wells, except they are older and Well B is much deeper, about 12 feet below ground. They operate at higher flow rates than the eastern pumping wells and the pressure gauges can be read clearly from the top of the chambers. Well B has an extended sampling pipe to allow sampling from above ground and a ventilation fan to increase air exchange in the deep chamber. Both have metal doors secured by chains and a lock.

The remote telemetry building on Zeneca's property is locked and is visited regularly. The building contains power controls for the western plume pumping wells, plus a computer and modem that provides data telemetry for all the pumping wells. The building and all the electronic equipment appears to be well maintained and in good operating order. Groundwater wells are inspected annually although all wells are not sampled during each Annual Performance Monitoring event. Roux Associates has reported no damaged wells to EPA.

VII. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Yes. The groundwater extraction and treatment system continues to operate effectively and is expected to achieve the cleanup standards specified in the ROD in approximately 15 years. Cleanup in the western portion of the Site appears to be moving more quickly.

The ROD addressed contamination in the Columbia or uppermost aquifer. As mentioned previously, a 1997 groundwater study found no contamination in the next lower aquifer, the Potomac. In 2004, EDC contamination was found in a well in the Potomac aquifer belonging to a Getty Gas Station. While it could not be confirmed that the contamination was site-related, action was taken at that time to prevent exposure to persons using this well by use of bottled water. Stauffer provided bottled water and EPA, DNREC and DE ODW sampled and monitored several Potomac drinking water wells in the area for the presence of EDC. Detections of EDC above the maximum contaminant level for EDC (5 ug/L) waned in these wells with no detections of EDC by 2008. In 2006, EPA and DNREC approved of a proposal by Stauffer to place four properties whose wells had been impacted by EDC on public water to prevent any further potential exposure. This work is being done by Stauffer under DNREC oversight and is expected to be completed by September 2009.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Individual questions responsive to this topic are answered below.

Have standards identified in the ROD been revised, and does this call into question the protectiveness of the remedy?

The performance standards identified in the ROD were: vinyl chloride (monomer or VCM), 1 ug/L; 1,2-dichloroethane (12DCA or EDC), 0.94 ug/L; TCE, 2.7 ug/L. MCLs were not mentioned in the ROD, but the current MCLs are 2 ug/L, 5 ug/L, and 5 ug/L, respectively.

Therefore, achievement of the ROD standards would still meet MCLs.

Do newly promulgated standards call into question the protectiveness of the remedy?

No.

Have TBCs changed, and could this affect the protectiveness of the remedy?

The current drinking water screening concentrations (EPA Regional Screening Levels) for vinyl chloride, EDC, and TCE are 0.016 ug/L, 0.15 ug/L, and 1.7 ug/L, respectively. While these are lower than the ROD standards, the RSLs are screening, not cleanup, levels. The ROD standards were confirmed to be protective (see Attachment 4).

Has land use or expected land use on or near the site changed?

On-site land use is still industrial. There is a residential development about one mile or more west of the site. It appears that there may be some agricultural land use in the area also. Significant changes from previous years have not been reported.

Have human health or ecological routes of exposure or receptors been newly identified or changed in a way that could affect the protectiveness of the remedy?

Air emissions from the stripper do not appear to pose an unacceptable risk, based on estimates from current information. The analysis was summarized in a memorandum from the EPA site toxicologist.

Over the past several years, EPA has gained a greater understanding that groundwater contamination by volatile organic compounds (VOCs) may give rise to the possibility of vapor intrusion into structures above a VOC-contaminated groundwater plume. This is influenced by the variety of factors, including the concentration and characteristics of VOCs in groundwater, the depth of the contaminated plume, the characteristics of the structures above the plume (basements, etc.), seasonal and other circumstances. Exposures may also vary based upon setting (i.e., residential v. industrial) and by the type(s) of activities going on under these scenarios.

The typical approach at vapor intrusion sites involves the collection of samples, ideally subslab, indoor air, and ambient air. Of particular interest is the subslab, which determines if a potential source is accumulating beneath the buildings, whether or not it is currently entering the building. Such samples have not been collected at this site to date.

The EPA RPM performed a preliminary evaluation of the site with respect to vapor intrusion. In this particular setting there are two industrial facilities (IENOS Films, Inc. and Formosa Plastics, Inc.) above the eastern plume that could be at risk for potential vapor intrusion (NB: there are no residential properties in the vicinity of either the western or eastern plumes). One facility (Formosa) uses volatile organic solvents or compounds including or similar to the contaminants of concern at the Site (viz. TCE, EDC, and vinyl chloride monomer or VCM) and the other (IENOS) does not. In May and June 2009, EPA inspected both of these facilities to

evaluate the potential for vapor intrusion and found that both facilities are at little or no risk for potential vapor intrusion. Those inspections are detailed in Appendix A.

Based on the characteristics of the buildings reported to and observed by the RPM during these site inspections, the Air/Superfund coordinator, concluded that the vapor intrusion potential at the Formosa and IENOS facilities was very low to non-existent due to the following:

-Both buildings have been built on intact thick concrete slabs which present very little potential for sub-slab vapors to migrate into the buildings.

-Both buildings have high-volume ventilation systems needed to control vinyl chloride and other VOCs from their production areas to ensure a safe working environment for the workers. The control of vinyl chloride vapors and other VOCs will also mitigate any accumulation of sub-surface vapors.

-The buildings are very large with many natural ventilation points (such as windows and large bay doors) in addition to the high-volume ventilation systems.

The Air/Superfund Coordinator also pointed out that the workers occupy both buildings during a work shift (typically 8 hours per day), not the 24-hrs that a resident may spend inside his/her home.

For current process areas where Delaware City PVC chemicals of concern are used, the following items are recommended:

Insure that health and safety programs are in place for such process areas, especially with respect to data collection and monitoring, engineering controls, PPE, and medical surveillance;

Notification or other mechanisms, with periodic monitoring, to ensure that changes in current chemical use or land use are communicated to EPA, so that the impact of any changes can be considered.

Finally, given the amount of VOCs in the subsurface environment, vapor intrusion may also be a concern for any future buildings. If new buildings are constructed in the plume area, they would need to consider this exposure pathway and plan accordingly. Conversely, as the remedial action continues to reduce the concentration of site-related contaminants in groundwater beneath current and any future structures, the concern for exposure via vapor intrusion should be reduced as well.

Are there newly identified contaminants or contaminant sources?

No.

As part of the last five-year review, the May 2003 data were examined to determine whether any VOCs, besides the three identified in the ROD, would pose an unacceptable risk. Not only were the risks at that time within EPA's typical risk targets, but they were expected to

decrease further over time because of the remedial action. Even if the concentrations (and thus the risks) could be higher in the eastern plume, the concentrations of the VOCs are still expected to decrease along with those of the ROD chemicals. The concentrations of the fourteen non-ROD VOCs were also compared to their current MCLs and non-zero MCLGs; no exceedances were noted in the May 2003 data set. In the last two years of monitoring, 2007 and 2008, analyses focused on the three ROD VOCs.

The presence of solvents is now known to be associated, at some sites, with the contaminant 1,4-dioxane. 1,4-Dioxane is not removed from water by air stripping. This chemical is usually associated with TCA rather than TCE, and there is relatively little TCA at this site. However, collecting a few confirmatory samples for 1,4-dioxane is recommended.

Are there unanticipated toxic byproducts of the remedy not previously addressed by the decision documents?

No.

Have physical site conditions or the understanding of these conditions changed in a way that could affect the protectiveness of the remedy?

When soil VOCs were assessed earlier, the detection limit was 4 parts per million (ppm), which is substantially above the concentrations of concern for migration to groundwater. Since the major known contaminant sources have been contained, and groundwater remediation is continuing, this probably does not affect the remedy significantly. However, if any future assessment is done for the soil, every effort should be made to achieve lower detection limits.

As pointed out by the EPA toxicologist during the 1998 five-year review, “An analysis for metals and pesticides was never done at this site. Although the site history would not indicate that metals and pesticide contamination would be a problem, this is a data gap that adds to the uncertainty in the nature of contamination.”

The possibility of vapor intrusion into local buildings was discussed above. See also the preliminary evaluation reports in Appendix A.

Have toxicity factors for contaminants of concern at the site changed in a way that could affect the protectiveness of the remedy?

Toxicity factors have changed since the 1986 ROD and the 1991 ESD. To determine whether the ROD performance standards for vinyl chloride (1 ug/L), EDC (0.94 ug/L), and TCE (2.7 ug/L) are still protective, concentrations of these chemicals underwent an updated risk assessment using current exposure and toxicity characteristics (Ref. Attachment 3, Risk Assessment Issues for 2009 Five-Year Review, Delaware City PVC, Appendix A for specific input assumptions). The HIs for adults and children would be 0.01 and 0.03, respectively, meeting the goal not to exceed 1. The cancer risk would total approximately 6E-5, driven primarily by vinyl chloride. While other VOCs present in the groundwater could contribute some additional risk, their contribution is expected to be minimal, as discussed above. Therefore, the ROD goals for these three chemicals still appear to be protective.

Air emissions from the stripper do not appear to pose an unacceptable risk, based on estimates from current information.

Have other contaminant characteristics changed in a way that could affect the protectiveness of the remedy?

No.

Have standardized risk assessment methodologies changed in a way that could affect the protectiveness of the remedy?

Risk assessment guidance has changed considerably since 1986, with the introduction of the Risk Assessment Guidance for Superfund and many new national and regional guidance documents. However, if one incorporates these new practices into an updated risk assessment, as discussed above, the ROD standards still appear to be protective. Similarly, air emissions from the stripper do not appear to pose an unacceptable risk, based on estimates from current information.

Changes in Standards and To Be Considereds

Applicable or Relevant and Appropriate Requirements (ARARs) were not identified in the ROD for this Site since the ROD was issued prior to SARA. However, as part of the first Five-Year Review, a list of potential ARARs was developed to help evaluate the protectiveness of the remedy. There have been no changes in these potential ARARs and to-be-considereds at the Site. All potential ARARs associated with the discharge of treated effluent from the air stripper and the aeration basins are being met by the remedy. The groundwater cleanup standards for the Site have yet to be met. A list of ARARs is included in Attachment 4.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No.

Technical Assessment Summary

According to the data reviewed and the site inspection, the remedy is functioning as intended by the 1986 ROD and the 1991 ESD. The air stripper continues to function acceptably within Superfund risk parameters and the pump and treat system continues to address the plume of contaminated groundwater on the east and especially the west side of the groundwater divide running north/south beneath the Site. EPA has completed investigating the source and nature of EDC groundwater contamination recently found in the Getty gas station well. Detections of EDC appear to have ceased and properties with affected wells are in the process of being placed on public water.

EPA also evaluated the potential for vapor intrusion to affect structures above the plume of VOC-contaminated groundwater in the eastern portion of the Site (eastern plume) and has determined that there is little or no risk at this time. A more complete discussion of that process can be found in Section VII. Technical Assessment, Question B, and in Appendix A.

There is no other information that calls into question the protectiveness of the remedy.

VIII. Issues

Table 2 - Issues

Issue	Currently Affects Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Potential Site-related Contaminant of Concern in drinking water well in vicinity of the Site	N	N
Possible vapor intrusion into structures above contaminated groundwater plume	N	N

IX. Recommendations and Follow Up Actions

Table 3 – Recommendations/Follow-Up Actions

Issue	Recommendations / Follow-Up Actions	Party Responsible	Oversight Agency	Target Date	Affects Protectiveness? (Y/N)	
					Current	Future
Potentially Site-related Contaminant of Concern in drinking water well in vicinity of the Site	Complete connection of affected properties to public water supply	Stauffer	DNREC /DE ODW	complete 08/19/09	N	N
	Sample for 1,4-dioxane	Stauffer	EPA	05/30/10	N	N
Possible vapor intrusion into structures above contaminated groundwater plume	1) Monitor chemical use	EPA	EPA	09/01/10	N	N
	2) Insure that health and safety programs are in place for such process areas, including data collection and monitoring,				N	N

Issue	Recommendations / Follow-Up Actions	Party Responsible	Oversight Agency	Target Date	Affects Protectiveness? (Y/N)	
					Current	Future
	<p>engineering controls, PPE, and medical surveillance and OSHA-related documentation</p> <p>3) Monitor land use and facility operations</p>				N	N

X. Statement on Protectiveness

The remedy for OU 1 is fully protective. The remedy has effectively reduced and/or eliminated the sources of site-related contaminants to groundwater. These actions included the excavation and removal of sludges from various surface impoundments, capping of closed areas, the installation of liners and leachate detection in basins used in process operations.

The remedy for OU 2 is currently protective in the short-term and should be protective in the long-term. The remedy currently protects human health and the environment by effectively reducing the migration of Site-related contaminants in groundwater, by capturing and removing them from groundwater, and by eliminating them through treatment. These measures have reduced the risk of exposure to Site contaminants and will continue until groundwater cleanup standards are achieved. Current estimates call for completion of the groundwater remedy at the Site to take another 15 years. EPA will continue to monitor these trends following this five-year review.

Properties whose drinking water wells were previously affected by EDC in 2004 were placed on public water in August 2009. Detections of potentially site-related EDC appear to have ceased in wells in this area, but vigilance should be maintained. If EDC or other potentially site-related contaminants were to be found in other drinking water wells, additional remedial measures may have to be considered.

Potential vapor intrusion into structures above the VOC-contaminated groundwater plume was evaluated by EPA in 2009 and little or no risk was found. Additional details can be found in Section VII. Technical Assessment, Question B, and in Appendix A.

Overall the Site is protective of human health and the environment in the short-term but may not be in the long-term because of the issues discussed above for OU 2.

XI. Next Five-Year Review

The next five-year review for the Delaware City PVC Plant Site is required by September 2014, five years from the signature date of this review.

Appendix A and Attachments

Appendix A and Attachments 1, 2, 3 and 4 follow this page.

Appendix A

EPA Evaluations of Buildings above Contaminated Groundwater Plume at Potential Risk for Vapor Intrusion

On May 27, 2009, the RPM visited the IENOS Film Company (IENOS, formerly VPI Mirrex Co.), just west of the Delaware City PVC Plant Site at 1389 School House Road, New Castle, DE to conduct an evaluation of the potential impact of possible vapor intrusion due to the presence of the contaminated groundwater plume beneath facility structures. IENOS took over the former VPI Mirrex Corporation facility in 2007 and produces plastic pharmaceutical blister packs, plastic credit card stock, shrink wrap and various other plastic films used in the packaging industry. IENOS uses PVC extensively in their products. IENOS describes their production approach in general as using some plasticizing compounds to render bulk PVC powder to a taffy-like texture, then extruding their products under the influence of heat. They report that none of their processes utilize volatile organic solvents or compounds including or similar to the contaminants of concern (viz. TCE, EDC and VCM) at the Site.

The RPM explained the potential for vapor intrusion associated with the Site to IENOS senior staff members Ms. Tabitha Kuech, Safety, Health and Environmental Manager and Mr. Marco Pifferi, Operations Manager US. The RPM then toured the IENOS facility with Ms. Kuech and Mr. Pifferi, led by Mr. Dan Neel, Maintenance Manager for IENOS.

The ground-level facilities (office space and production areas) are generally built on concrete slabs and are serviced by a year-round climate control system, including in the production areas. The large production areas also include powered ventilation fans near the interior roof line that are used primarily during hot weather and to control vapors. The offices and production areas appeared well-ventilated. The heat produced by the production equipment was discernable but the temperature, humidity and ventilation control seemed quite adequate and the spaces were comfortable.

The basement areas, though large and two-levels down in some places are present beneath only part of the ground-level facilities. They consisted primarily of power, heating and chilling equipment and extensive pipe-runs. No production takes place in these areas. The entire space appears to be constructed of substantial concrete in good condition without obvious cracks or other openings. There are numerous current and former liquid collection sumps in floors for condensate and waste collection, but all of them are reportedly concrete-lined with no drainage below. Waste is drawn up from each floor sump by siphon pipes into collection tanks, and then pumped to treatment/collection out of the basement area. No sumps or basement areas are open to the subsoil. Based on this inspection, the potential for entry of VOCs from the subsurface groundwater contaminant plume and the potential for any significant human exposure appear minimal.

On June 3, 2009, the RPM and the DNREC Project Manager for the Delaware City PVC Site visited Formosa Plastics Corporation Delaware City facility at 780 School House Road, New Castle, Delaware to conduct an evaluation of the potential impact of possible for vapor intrusion due to the presence of the contaminated groundwater plume in the subsurface near and beneath some facility structures. The Delaware City facility is a subsidiary of Formosa Plastics

Corporation, U.S.A. which is affiliated with Formosa Plastics Group in Taiwan. The Formosa Plastics facility in Delaware City is a leading producer of Specialty (Dispersion) PVC resins used by other plastics products manufacturers in a variety of products including extruded films, sealants, inks, foams, liners, tiles, protective coatings to name just a few.

The RPM reviewed a diagram of groundwater contamination at the Site and explained the potential for vapor intrusion associated with the Site to Formosa senior staff members Ms. Kimberly Bennett, Environmental Affairs Manager and Mr. Kevin Tsai, Plant Manager. The RPM and DNREC Project Manager toured the plant in the vicinity of the known contaminated groundwater plume with Ms. Bennett, including offices, laboratory, production, storage and maintenance facilities and power equipment (e.g. chillers) buildings. Since the facility is quite extensive and construction and building functions were of uniform design and construction according to Ms. Bennett, EPA and DNREC toured representative buildings in this area.

There are no basements or below-ground crawl spaces anywhere in the plant according to Ms. Bennett. Furthermore, all buildings have poured concrete floors and any floor drains are piped to a wastewater collection and treatment area. During the inspection, all floors appeared to be structurally competent and well maintained and drains appeared to be in good condition. Typical production areas were on the second floor. All office/laboratory spaces are served by a year-round climate control system and all other structures feature copious natural and/or powered ventilation of high-volume interiors. Formosa maintains solvents and other volatile organic compounds in quantity onsite. Some of these compounds are the same or similar to those associated with potential vapor intrusion at the Site.

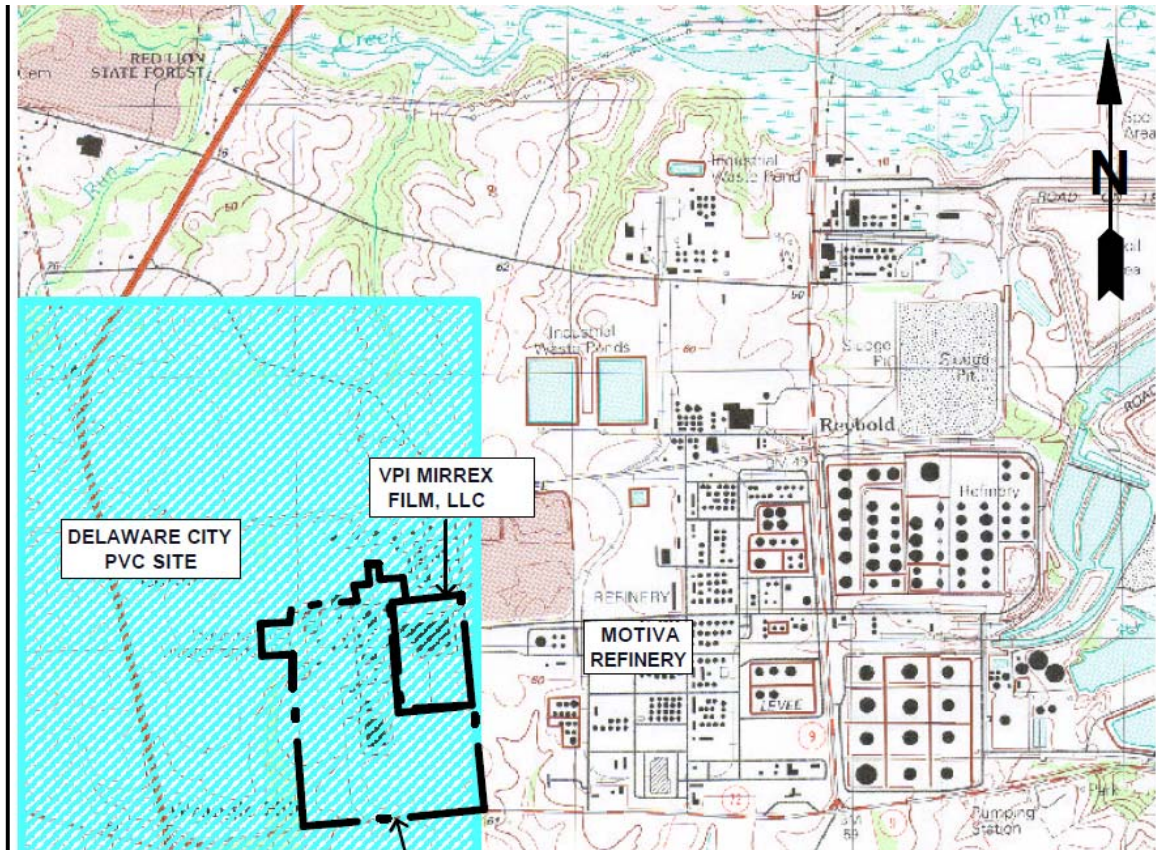
Based on this inspection, the potential for entry of VOCs from the subsurface groundwater contaminant plume and the potential for any significant human exposure likewise appear minimal.

In summary, the vapor intrusion potential at both the Formosa Plastics and IENOS Films facilities is very low to nonexistent due to the following:

1. Both buildings have been built on intact, thick concrete slabs which present very little potential for sub-slab vapors to migrate into the buildings.
2. Both buildings have high-volume ventilation systems needed to control vinyl chloride and other VOCs from their production areas to ensure a safe working environment for the workers. The control of vinyl chloride vapors and other VOCs will also mitigate any accumulation of sub-surface vapors.
3. The buildings are very large with many natural ventilation points (windows, large bay doors, etc.) in addition to the high-volume ventilation systems.
4. The industrial/office workers in both buildings are exposed for 8-hour work shifts per day, not the 24 hours that a resident may spend inside his/her home.

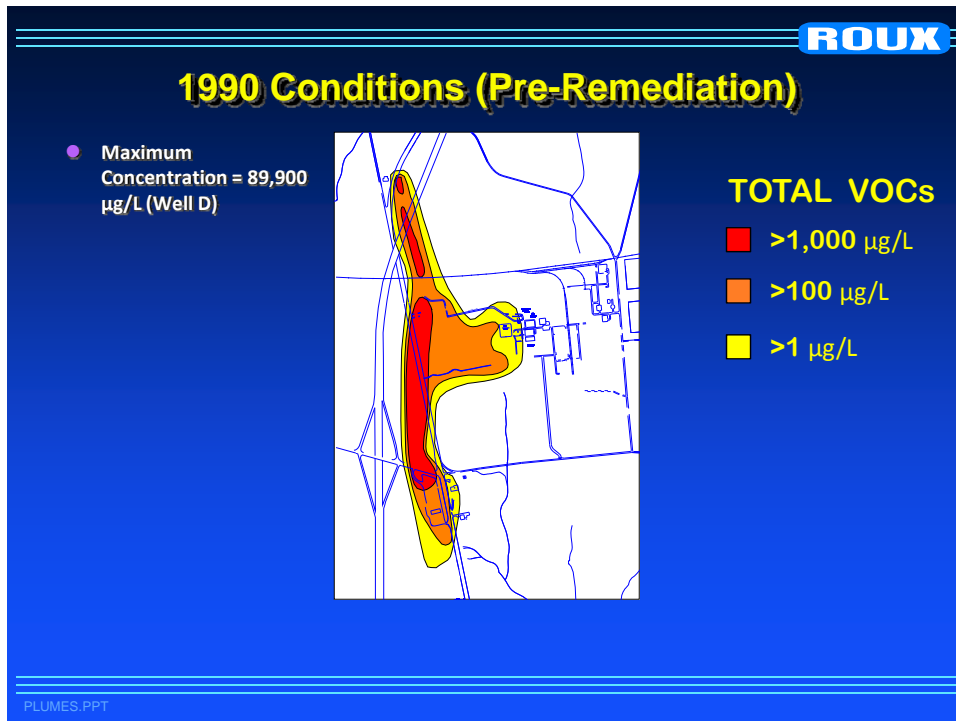
ATTACHMENT 1

Site Location



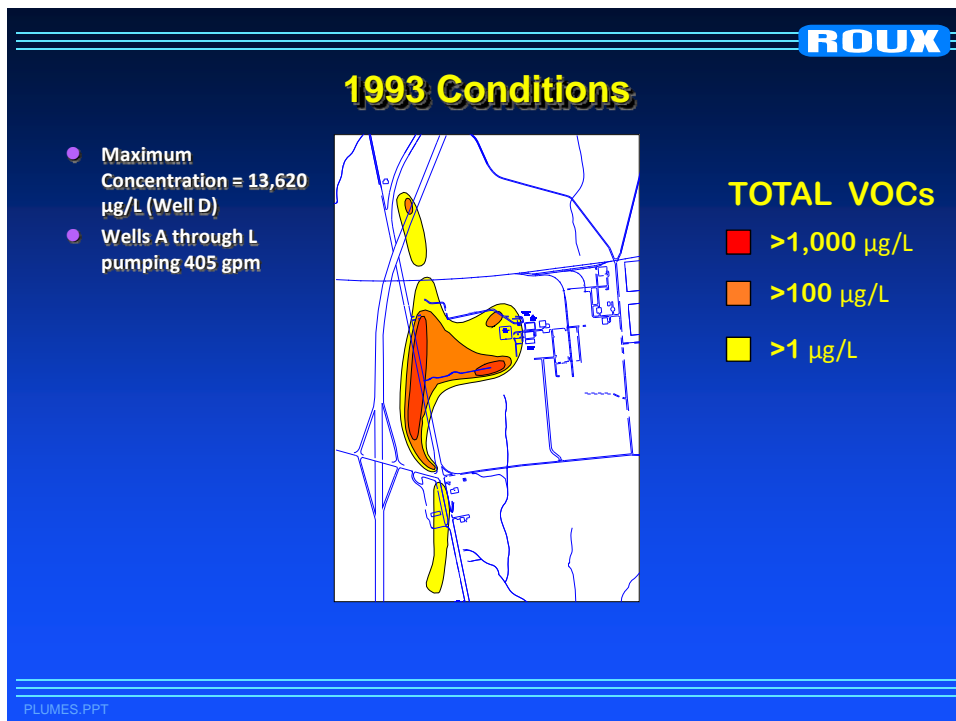
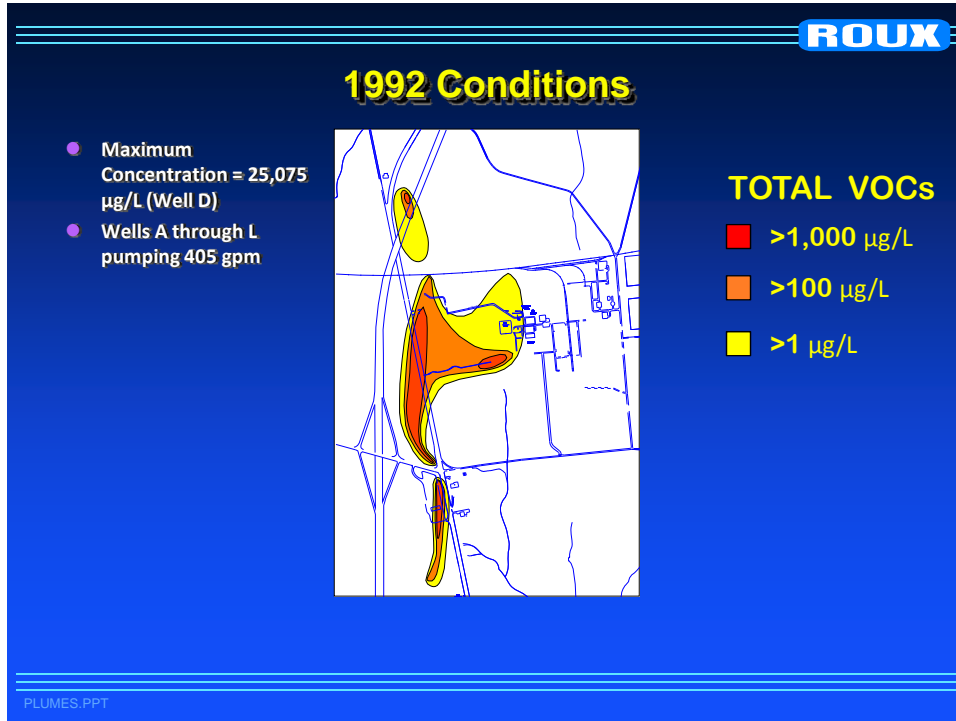
ATTACHMENT 2

Maps Depicting Locations of Contaminant Plume
1990-2008 (Page 1 of 8)



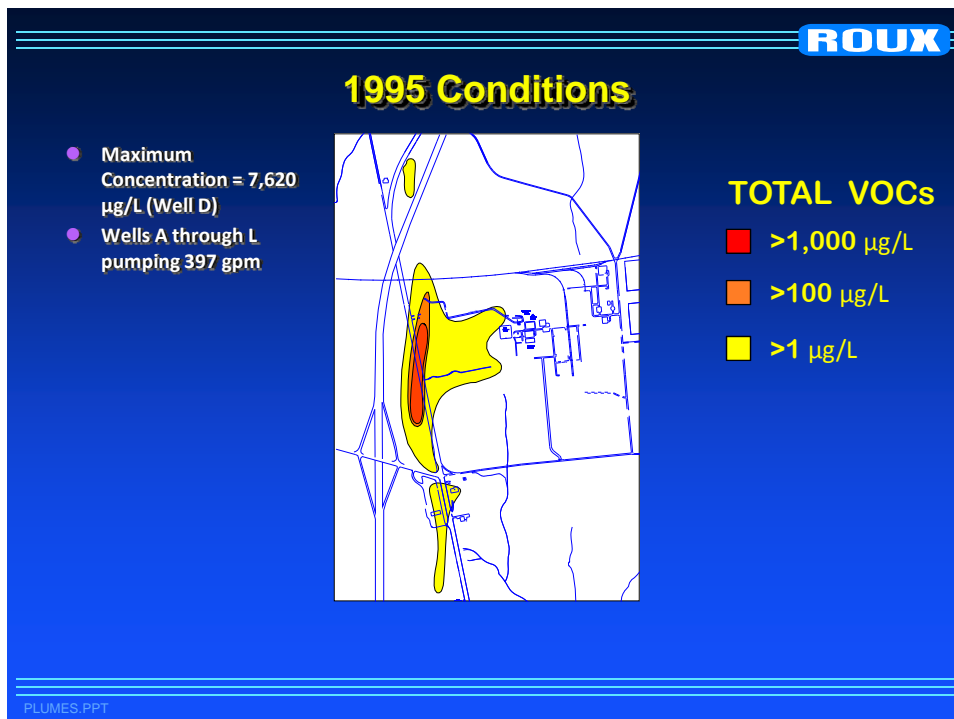
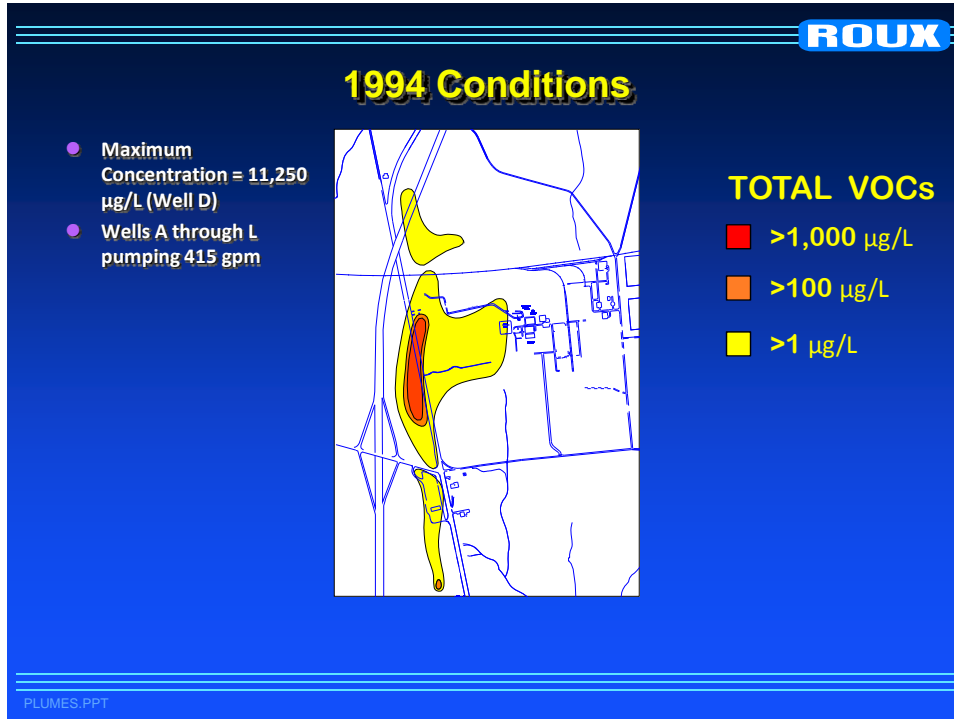
ATTACHMENT 2 (Con't)

Maps Depicting Locations of Contaminant Plume 1990-2008 (Page 2 of 8)



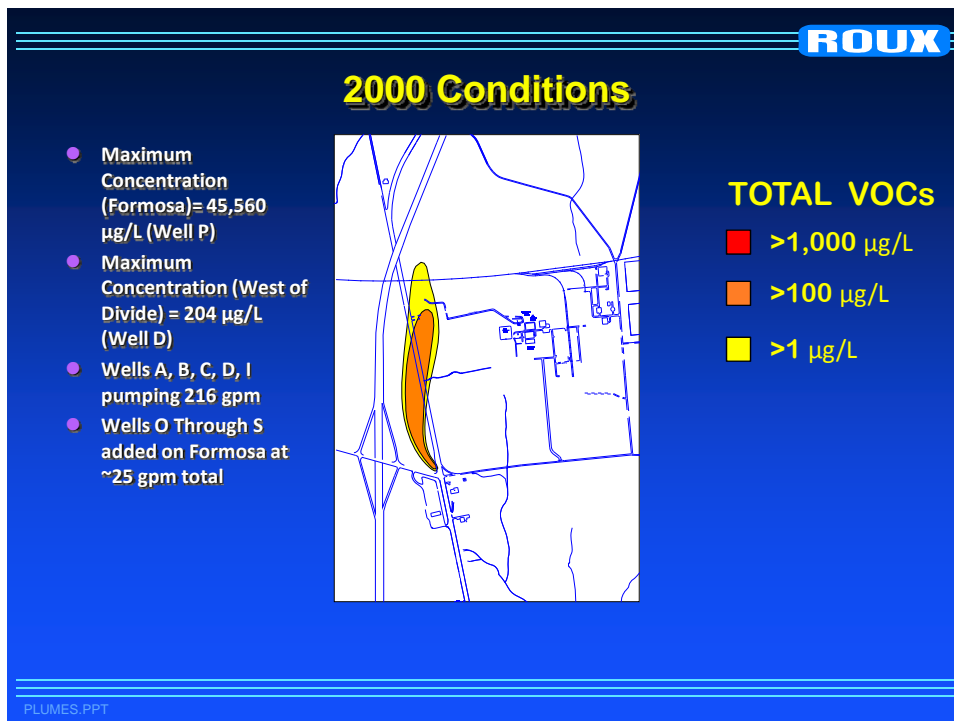
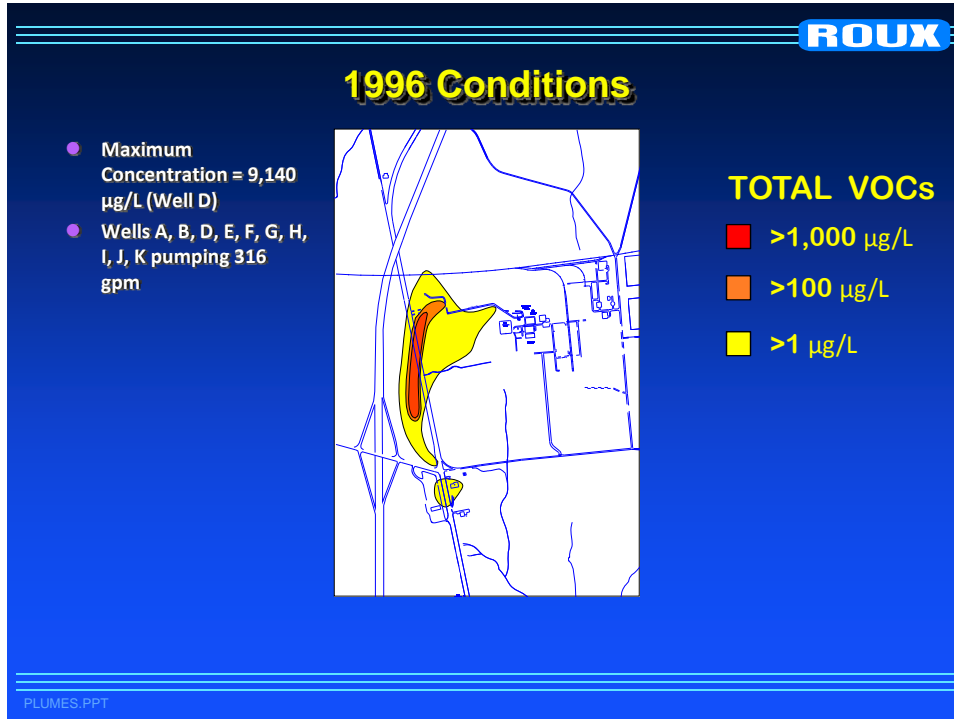
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Maps Depicting Locations of Contaminant Plume 1990-2008 (Page 3 of 8)



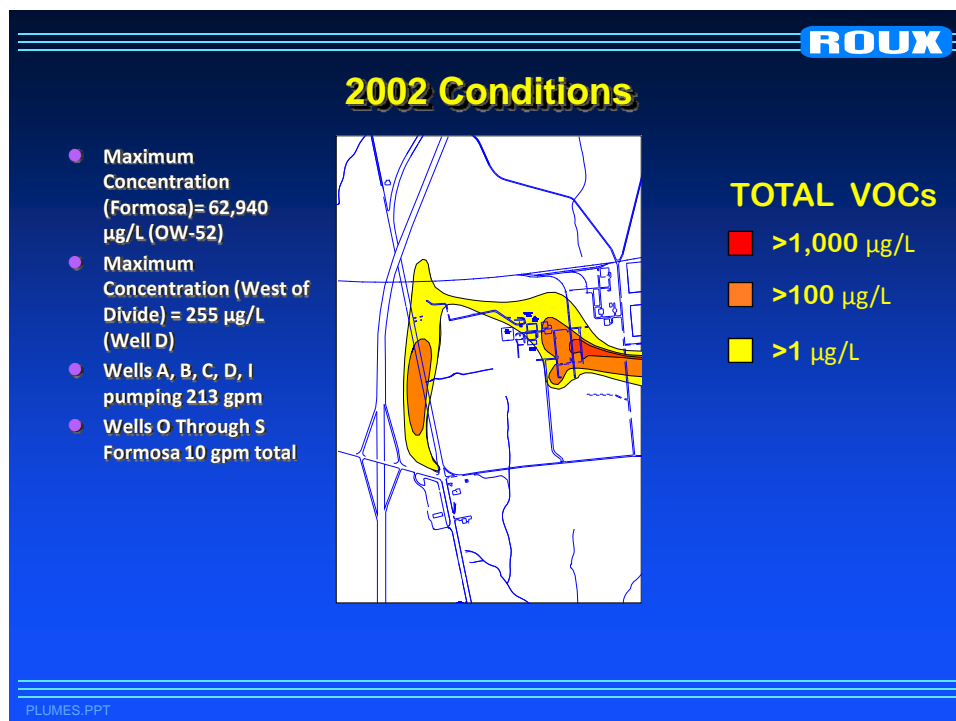
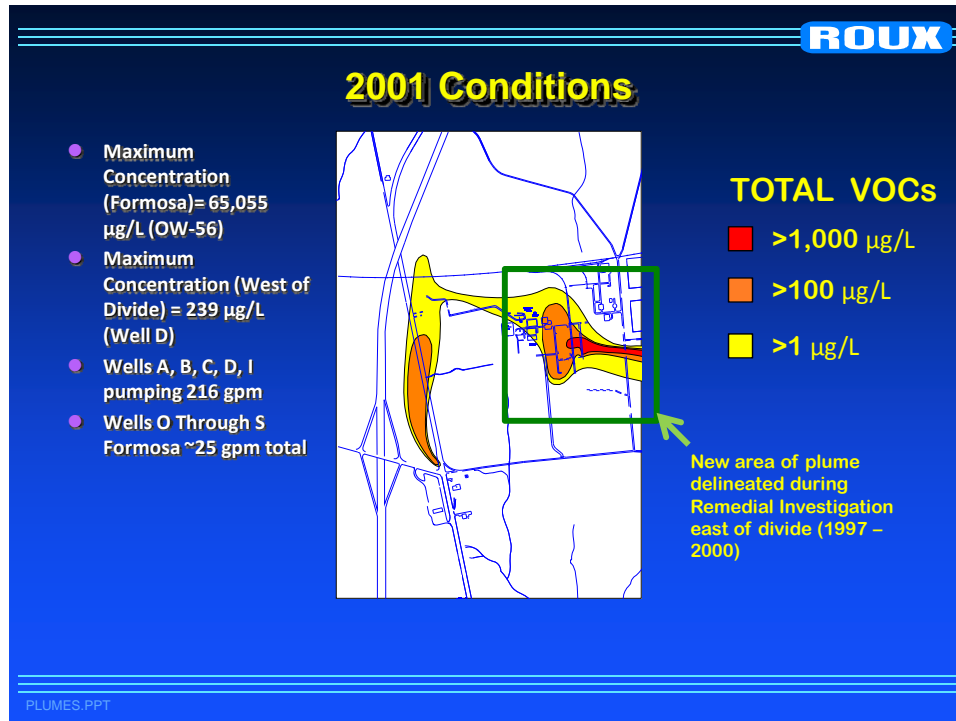
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Maps Depicting Locations of Contaminant Plume 1990-2008 (Page 4 of 8)



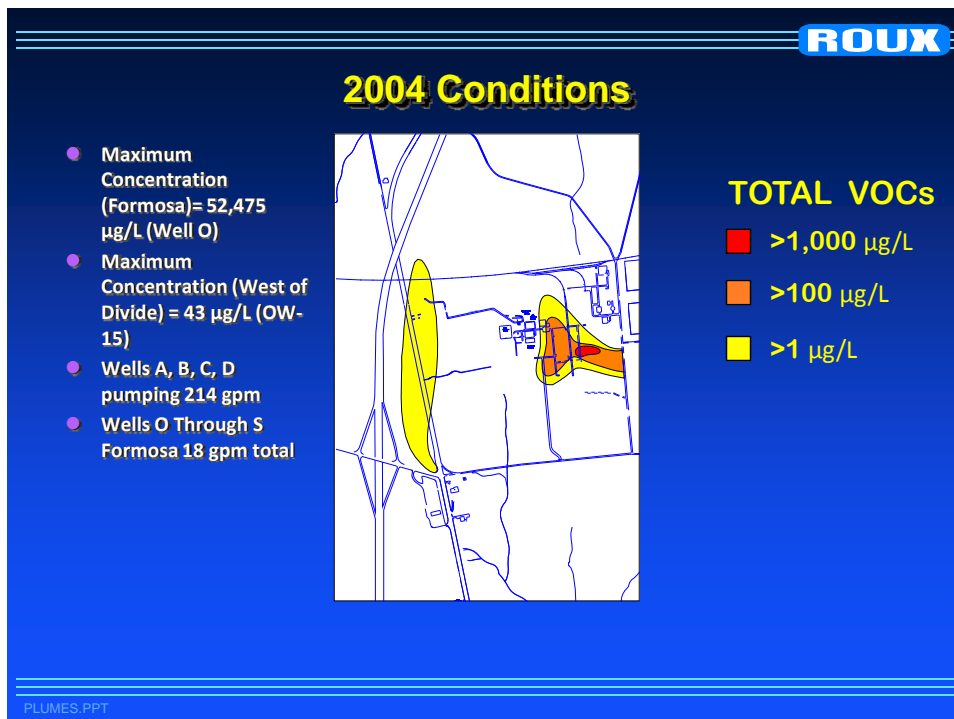
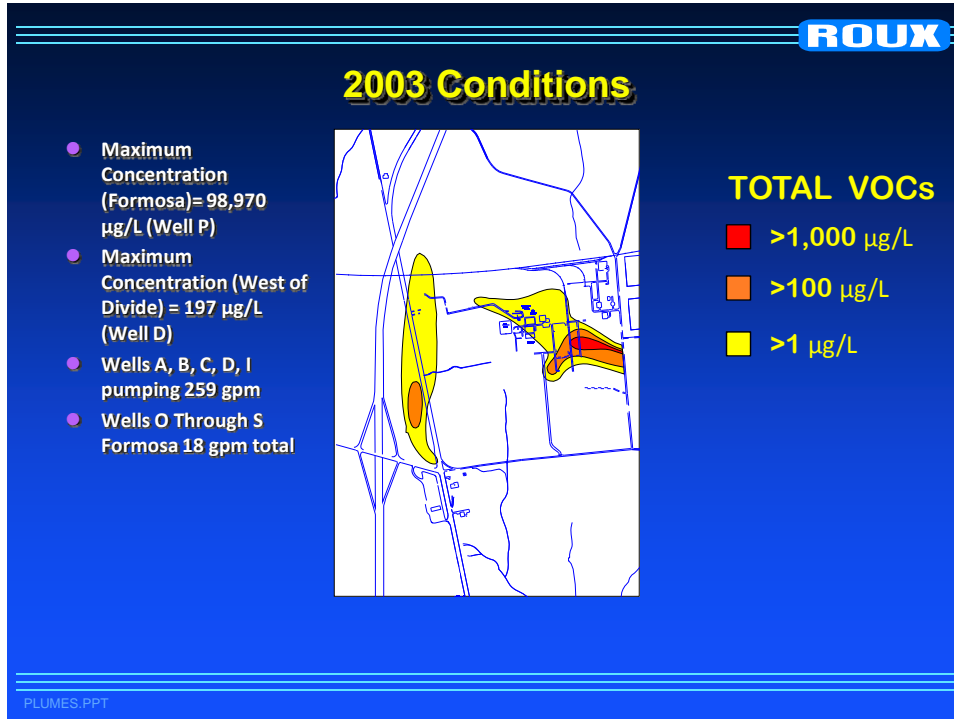
ATTACHMENT 2 (Con't)

Maps Depicting Locations of Contaminant Plume 1990-2008 (Page 5 of 8)



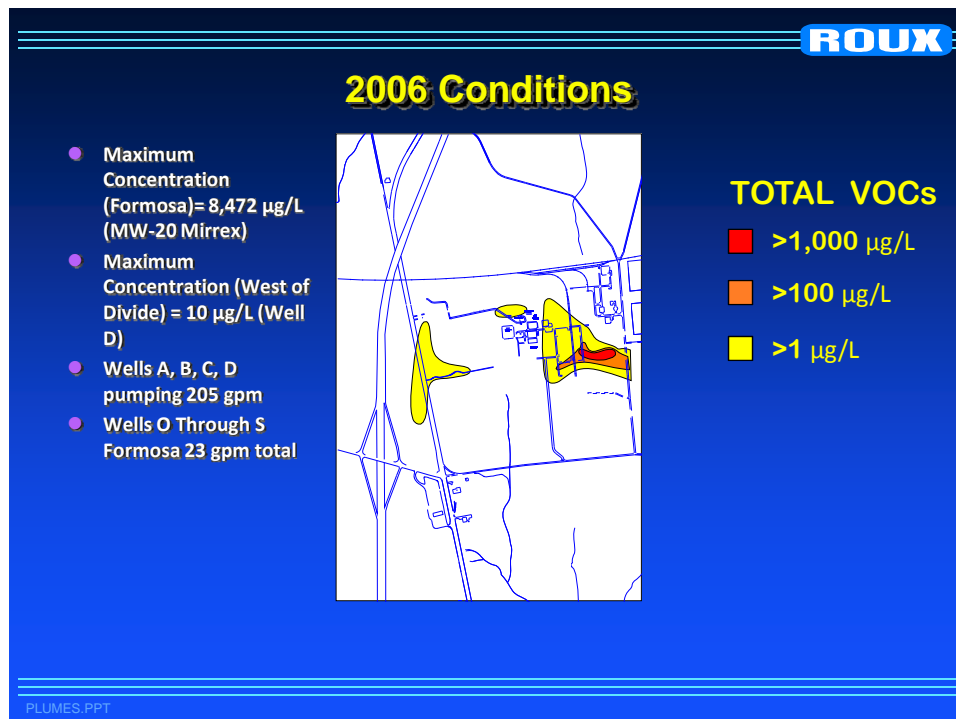
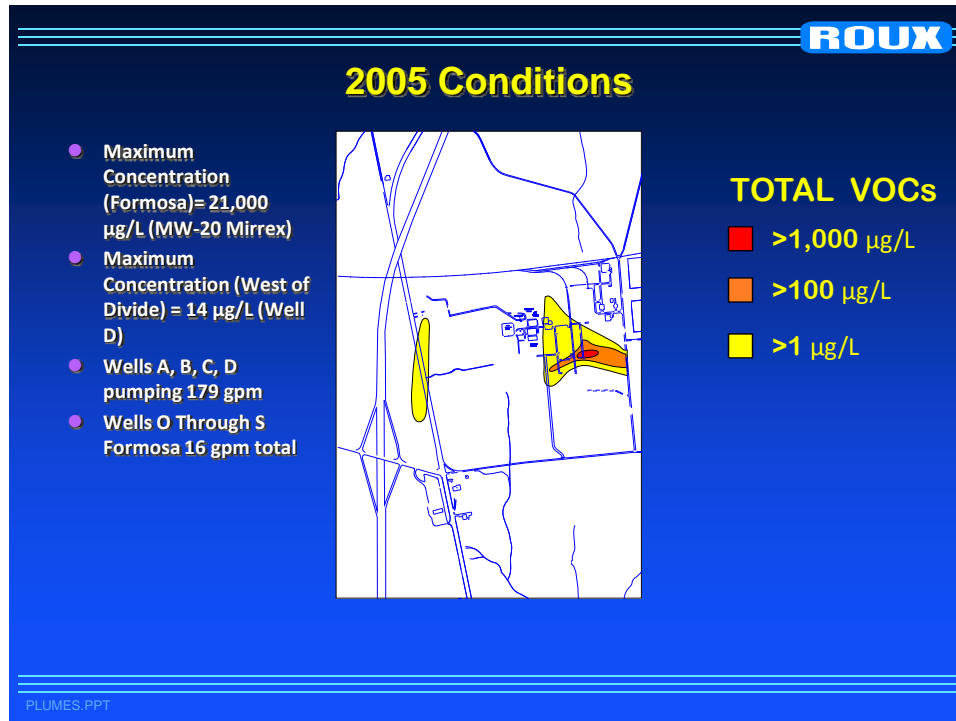
ATTACHMENT 2 (Con't)

Maps Depicting Locations of Contaminant Plume 1990-2008 (Page 6 of 8)



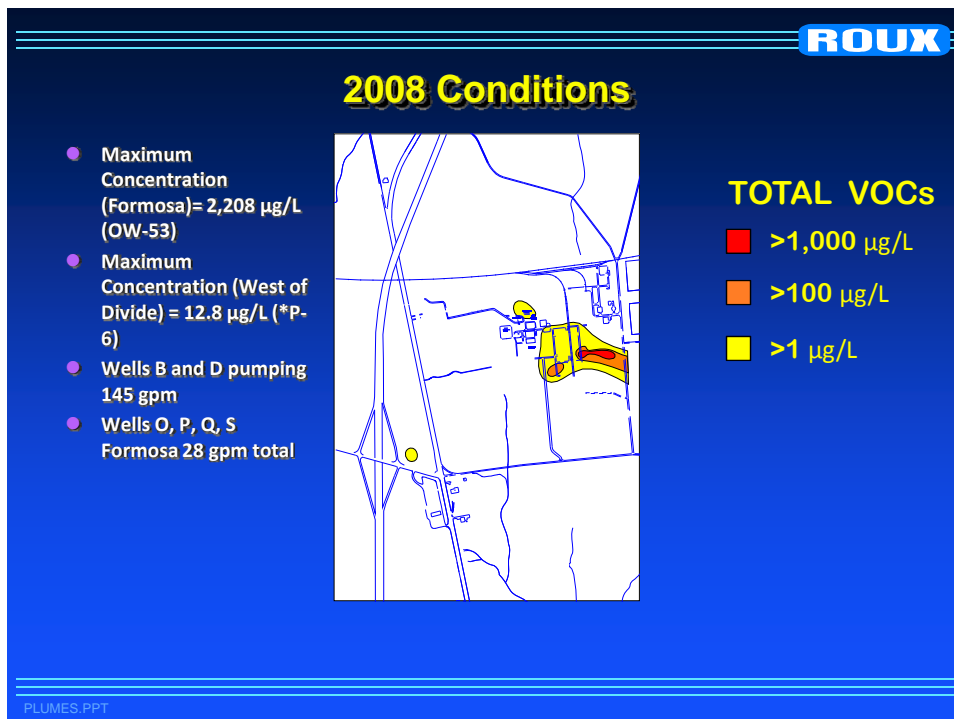
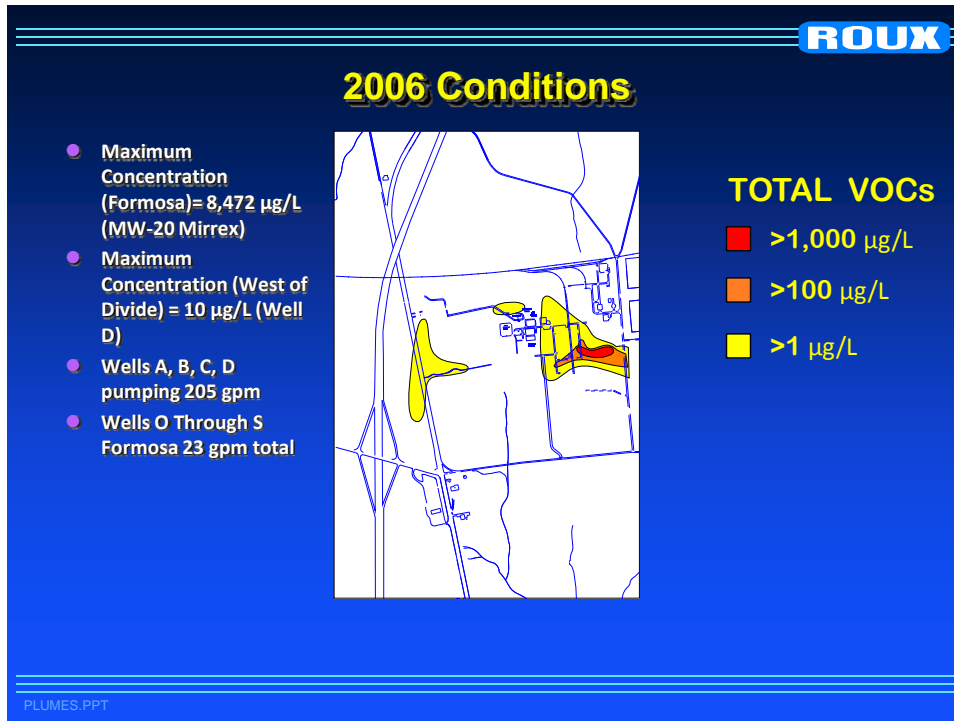
ATTACHMENT 2 (Con't)

Maps Depicting Locations of Contaminant Plume 1990-2008 (Page 7 of 8)



ATTACHMENT 2 (Con't)

Maps Depicting Locations of Contaminant Plume 1990-2008 (Page 8 of 8)



ATTACHMENT 3

List of Documents Reviewed

- Superfund Record of Decision: Delaware City PVC, DE, dated September 30, 1986
- Explanation of Significant Differences, Delaware City PVC Superfund Site, New Castle County, DE, dated September 18, 1991
- Superfund Remedial Action Report, Operable Unit 1, Delaware City PVC Site, Delaware City, DE, dated June 30, 1992.
- Five-Year Review Report, Delaware City PVC Superfund Site, Delaware City, DE, dated March 23, 1999
- Potential Applicable or Relevant and Appropriate Requirements (ARARs) table, from Five-Year Review Report, Delaware City PVC Superfund Site, Delaware City, DE, dated March 23, 1999
- Interim Remedial Action Report, Operable Unit 2, Delaware City PVC Superfund Site, Delaware City, New Castle County, Delaware dated June 14, 2002
- Annual Groundwater Interceptor System Performance Monitoring Results for 2003, 2002, 2001 by Roux Associates, AstraZeneca remediation contractor
- Delaware City PVC: Estimated Risks from Air Stripper Emissions: Memorandum from Jennifer Hubbard, Toxicologist, Technical Support Section, EPA Region 3 to Frederick Mac Millan, Remedial Project Manager, EPA Region 3, dated December 18, 2003
- Risk Assessment Issues for 2003 Five-Year Review, Delaware City PVC: Jennifer Hubbard, Toxicologist, Technical Support Section, EPA Region 3 to Frederick Mac Millan, Remedial Project Manager, EPA Region 3, dated June 15, 2004
- Formosa Plastics Corporation monthly reports
- Quarterly reports submitted by A.C. Shultes, Inc., AstraZeneca's O&M contractor
- Risk Assessment Issues for 2009 Five-Year Review, Delaware City PVC: Jennifer Hubbard, Toxicologist, Technical Support Section, EPA Region 3 to Frederick Mac Millan, Remedial Project Manager, EPA Region 3, dated July 9, 2009

ATTACHMENT 4

List of Potential ARARs and To Be Considereds (TBCs)

As part of the Five-Year Review Report for the Delaware City PVC Superfund Site, Delaware City, DE, dated March 23, 1999, EPA evaluated the following potential ARARs and TBCs:

- Safe Drinking Water Standard, Maximum Contamination Level Goals (MCLGs)
- Safe Drinking Water Standard, Maximum Contaminant Levels (MCLs)
- Delaware Surface Water Quality Criteria Standards as amended, February 26, 1993
- Delaware Regulations Governing the Control of Air Pollution
- Delaware River Basin Commission (DRBC) Standards

Environmental standards identified or promulgated after the ROD is signed become ARARs only if they bring into question the protectiveness of the remedy. Based on this evaluation, EPA believes that the clean-up standards identified in the ROD remain protective.

Potential ARARs and To Be Considereds from First Five-Year Review (March 23, 1999)

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy
I. CHEMICAL SPECIFIC				
Safe Drinking Water Standard, Maximum Contaminant Level Goals (MCLGs)	40 CFR § 141.50-51	Relevant and Appropriate	Non-enforceable health goals for public water supplies. The NCP requires that non-zero MCLGs shall be attained by remedial actions for groundwater that is a current or potential source of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release.	The Site-specific clean-up criteria are at or below non-zero MCLGs.
Safe Drinking Water Standard, Maximum Contaminant Levels (MCLs)	40 CFR § 141.61-62	Relevant and Appropriate	Enforceable standards for public drinking water supply systems (with at least fifteen service connections or used by at least 25 persons). The NCP requires that MCLs, for those contaminants whose MCLG is zero, shall be attained by remedial actions for groundwater that is a current or potential source of drinking water, where the MCLs are relevant and	The Site-specific clean-up criteria are at or below MCLs. ROD cleanup level for VCM, EDC, and TCE are 1.0, 0.94, and 2.7 ppb, respectively

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy
			appropriate under the circumstances of the release. MCLs for VCM, EDC and TCE are 2.0 ppb, 5 ppb, and 5 ppb, respectively	
Delaware Surface Water Quality Criteria Standards as amended, February 26, 1993	Delaware Surface Water Quality Standards as amended, February 26, 1993 Sections 3, 4, 5, 6, 8, 9, 10, 11.1, 11.2, 11.3, 11.4, 11.6, and 12	Applicable	Criteria are provided to maintain surface water for streams, lakes, rivers, and standing water in wetlands of satisfactory quality consistent with public health and recreational purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of water. water effluent	Any surface water discharge must not cause exceedances of these criteria, if more stringent than federal water quality criteria, in the Delaware River.
II. LOCATION SPECIFIC				
Groundwater Protection Strategy of 1984 EPA 440/6-84-002	No Legal Citation	To Be Considered	Identifies groundwater quality to be achieved during remedial actions based on aquifer characteristics and use.	The classification of the aquifers at this Site as Class II
III. ACTION SPECIFIC				
A. Air				
Control of Air Emissions from Air	No Legal Citation	To be Considered	Policy to guide the selection of controls for air strippers at	To be considered in determining if air emissions

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy
Strippers at Superfund Groundwater Sites, June 15, 1989 EPA OSWER Directive 9355.0-28			groundwater sites according to the air quality status of the site's location (i.e., ozone attainment or nonattainment area)	controls are necessary for an air stripper because New Castle County is an ozone non-attainment area. Sources most in need of controls are those with emissions rates in excess of 3 lbs./hr or 15 lbs/day or a potential rate of 10 tons/yr of total VOCs.
Delaware Regulations Governing the Control of Air Pollution	DNREC Air Pollution Control Regulations Number 2, 19, and 24	Applicable	Sets forth the requirement that a permit is necessary to operate an air stripper if emissions will exceed 2.5 lbs/day. Section 2 describes general conditions. Section 19 deals with odor. Section 24 deals with volatile organic compounds.	If emissions exceed 2.5 lbs/day then the substantive requirements of the regulations must be met. Permits are not ARARs.
Clean Air Act	Listed as hazardous air pollutants		Emission less than 10 tpy for individual HAP and less than 25 tpy for combination HAPs.	
B. Water				
Clean Water Act (CWA); National Pollutant Discharge Elimination System Requirements	40 CFR § 122.41(e), 122.44, 122.45, 125.61-63, 125.73	Applicable	Enforceable standards for all discharges to waters of the United States.	Discharge limits shall be met for all on-site discharges from the groundwater treatment facility. Only substantive requirements shall be met since the treatment facility is on Site.

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy
Delaware River Basin Commission (DRBC) Standards	DRBC Groundwater Protected Area Regulation 4; Water Code of the Basin, Section 2.20.4		The operation of a water withdrawal project shall not cause long-term progressive lowering of groundwater levels, permanent loss of storage capacity or substantial impact on low flows of perennial streams.	
Delaware Regulations Governing Control of Water Pollution, amended 6/23/83	Delaware Regulations Governing Control of Water Pollution, amended 6/23/83 Sections 7,8,9,10,11,12, and 13	Applicable	Contain water quality regulations for discharges into surface and groundwater.	Applicable for discharge of treated groundwater into surface water.
Delaware RCRA	Delaware Regulations Governing Hazardous Wastes 264.117, 264.228		Landfilling of waste. [30 year post closure care (including prevent migration of liquids through landfill, promoting drainage and minimize erosion of cover, accommodate settling, restrict post closure use of property as necessary, landfill closure and post-closure.	
Delaware RCRA	264.221, 264.227, 264.228		Operation of plant wastewater treatment system [prevent overtopping, monitoring for leaks, etc.]	