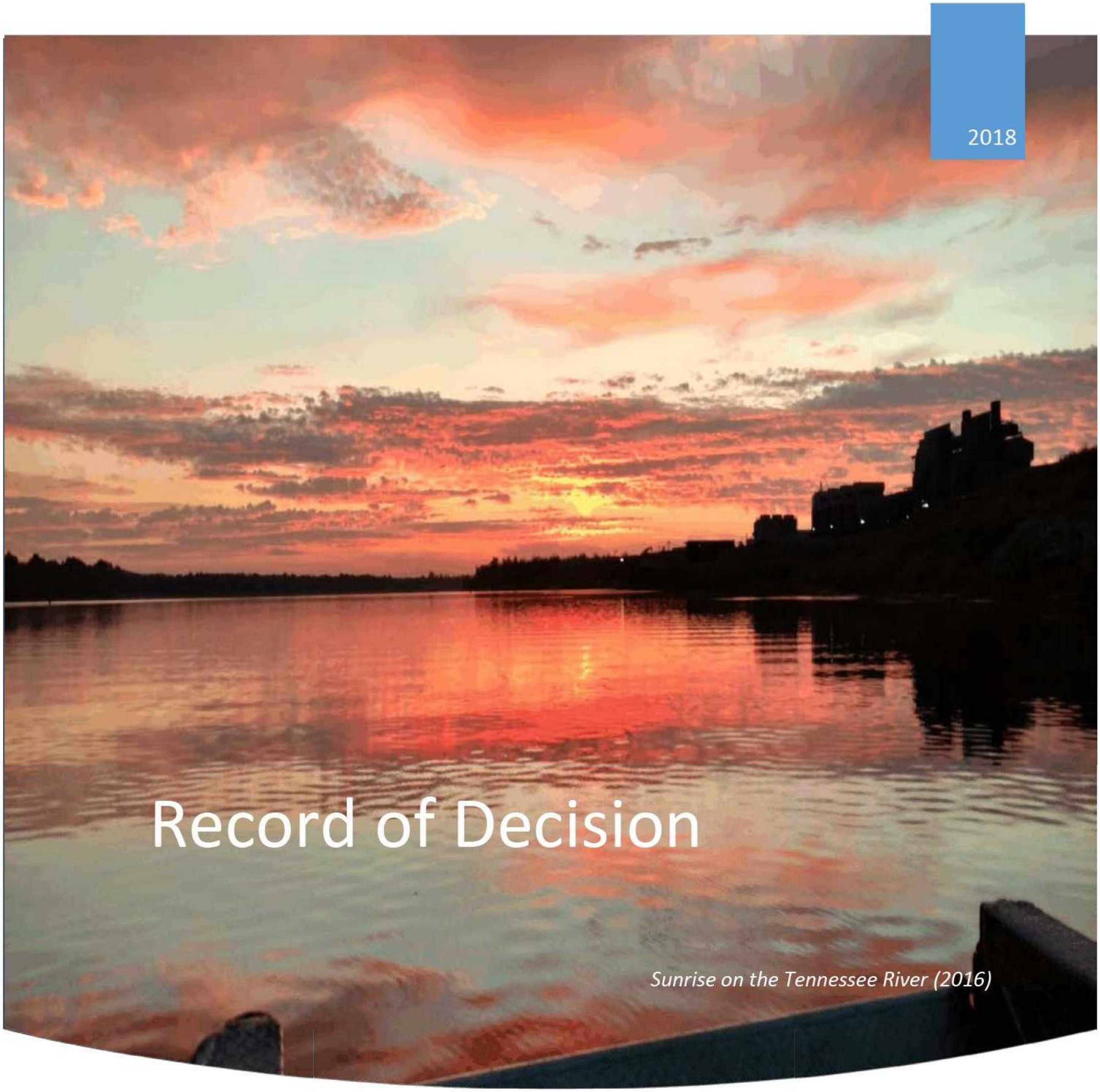
2018



Record of Decision

Sunrise on the Tennessee River (2016)

BF GOODRICH SUPERFUND SITE
CALVERT CITY, MARSHALL COUNTY, KENTUCKY
EPA ID KYD006370167

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 4
ATLANTA, GEORGIA

SEPTEMBER 2018

DECLARATION FOR THE RECORD OF DECISION
BF GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

FACILITY NAME AND LOCATION

BF Goodrich Superfund Site
Kentucky Highway 1523
Calvert City, Kentucky
EPA Superfund Site Identification Number KYD006370167

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) documents the U.S. Environmental Protection Agency's (EPA's) selection of a remedy for the contamination at the B.F. Goodrich Superfund site (Site), chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, 42 U.S.C. §§ 9601-9675, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. This decision document explains the factual and legal basis for selecting the remedy. The Administrative Record (AR) Index (Appendix A) identifies the documents that are part of the AR upon which the Selected Remedy is based.

The Commonwealth of Kentucky was consulted on the proposed remedy in accordance with CERCLA Section 121(f) (42 §§ U.S.C. 9621(f)). The Commonwealth concurs with EPA's Selected Remedy for remediation of the Site.

ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect public health, welfare and the environment from actual or threatened releases of hazardous substances, pollutants or contaminants into the environment from the Site.

DESCRIPTION OF THE SELECTED REMEDY

This is the second ROD for the Site. EPA issued the first ROD in 1988 and it addressed a 2-acre landfill and burn pit. At the time of the 1988 ROD, the landfill and burn pit area were the only areas to be addressed pursuant to CERCLA. At the time of the second Five-Year Review (FYR), EPA concluded that areas of the cleanup process were not progressing as expected in the ROD. This led to additional studies and the expansion of the Site to include some areas being addressed under the Resource Conservation and Recovery Act (RCRA). The rest of the Site was addressed by the Kentucky Department of Environmental Protection (KDEP) pursuant to RCRA. All requirements of the 1988 ROD have been implemented and long-term monitoring is underway. These items have been implemented and operation and maintenance (O&M) activities are ongoing. The 1988 ROD will be evaluated in addition to this current action.

Several active chemical plants are still located at the Site and much of the contamination underlies the chemical plants and part of the Tennessee River. The primary contaminants include volatile organic compounds (VOCs) such as ethylene dichloride (EDC) (also known as 1,2-dichloroethane) and benzene, semi-volatile organic compounds (SVOCs) such as naphthalene (a chemical associated with coal tar), and mercury. Many of these chemicals are toxic to both human and ecological receptors.

This ROD selects a final remedy for most of the Site. It also includes an interim remedy for an area of non-aqueous phase liquid (NAPL) located under the Tennessee River next to the Site. The interim component of the remedy removes NAPL and highly contaminated media from beneath the river. EPA will issue a ROD that selects the final remedy for this area in the future.

EPA, the lead agency, in consultation with KDEP, the support agency, believes that the remedy selected in this ROD will provide a comprehensive strategy to protect human health and the environment at the Site. The total present worth cost for the Selected Remedy is estimated at $107 million ($107M). A summary of the Selected Remedy is provided below.

Onshore Components

The Selected Remedy for the onshore portion of the Site includes restoration of groundwater to beneficial use outside of the technical impracticability (TI) waiver zone and isolation of site contamination through containment, which will prevent further migration and potential exposure to human receptors and the environment. Where practicable, NAPL (organic or mercury) will be removed. Recovered NAPL is likely to be categorized as RCRA hazardous waste and require treatment to meet RCRA Land Disposal Restriction treatment standards that are identified as applicable or relevant and appropriate requirements (ARARs) prior to disposal. It may be treated, recycled (with EPA approval), and/or disposed on site or treated and/or disposed of at an off-site, EPA-approved, permitted RCRA facility.

Outfall 004 Ditch: Outfall 004 channels runoff from the eastern part of the Site to the Tennessee River. Over time, the unlined ditch has eroded in depth and width, creating the potential exposure to contaminated soil and groundwater, as well as potential contaminant migration to the river. At the time of the feasibility study (FS), it was estimated that a 2,000-foot-long section of the ditch needs to be excavated and lined to prevent further erosion and contaminant migration. Soil excavated during the lining of the ditch will be characterized and disposed of at an off-site, EPA-approved RCRA facility.

Ponds 1A and 2: Two ponds remain (designated as “Pond 1A” and “Pond 2”) after the RCRA-era closure of the former waste treatment and management pond system. The ponds are not currently used, but because the ponds are unlined, they serve as a significant point of groundwater recharge from rainfall infiltration and have NAPL located beneath them. Pond 2 will be closed by draining the water, backfilling and grading, along with installation of a low-permeability layer that meets identified RCRA ARARs to reduce the amount of contaminated groundwater to be managed as part of the site-wide groundwater containment system. A low-permeability layer will also be installed in Pond 1A that meets identified RCRA ARARs, although it may not be backfilled.

Barge Slip: The Barge Slip extends approximately 750 feet south from the main Tennessee River channel and is used for the daily transport of raw material and finished products by the main chemical plant operator at the Site. Contaminants, including mercury, have been identified in the Barge Slip sediments and surface water. A minimum of 2 feet of contaminated sediments (approximately 5,000 cubic yards) will be excavated. Should NAPL or mercury be encountered during the dredging, it will be removed. Where practicable, treatment will be conducted on site, but the material may be shipped off site for treatment and disposal at an EPA-approved RCRA facility. A clean layer of material will be put in place to prevent future migration of contaminants into the river and to restore the critical habitat for benthic ecological receptors such as mussels.

Barrier Wall: A barrier wall will be installed from ground surface into the low-permeability bedrock and/or clay at the bedrock surface. This wall will extend around the approximately 3-mile-long perimeter of the onshore contamination. This perimeter wall generally coincides with the boundary of the area underlying the operating chemical plants. The objective of the wall is to prevent further migration of NAPL-contaminated groundwater and other media beyond the onshore site boundary.

Hydraulic Control: Groundwater will be pumped from the inside of the perimeter of the barrier wall to control groundwater levels and hydraulic pressures on the barrier wall. The collected water will be treated on site and the treated water discharged to the Tennessee River. It is estimated that approximately 7,000 pounds of dissolved contaminants will be collected annually through the groundwater pumping.

NAPL Recovery: Recoverable NAPL will be collected from inside the barrier wall, to the extent practicable, and treated on site or off site and disposed of at an off-site, EPA-approved RCRA facility, or recycled on site (with EPA approval).

Technical Impracticability Waiver: Groundwater beneath the Site is a potential drinking water aquifer (Class II) in accordance with EPA's 1986 Groundwater Classification Guidance. VOC groundwater contaminants mainly include EDC, perchloroethylene (PCE), trichloroethylene (TCE), vinyl chloride (VC) and benzene. However, during the evaluation of alternatives to address the onshore source, it was determined that: 1) a large volume of NAPL; 2) complex hydrogeologic conditions; and 3) limited access due to plant infrastructure make it technically impracticable to restore groundwater within the containment area to drinking water standards (maximum contaminant levels [MCLs]) within a reasonable period. EPA is invoking a waiver under CERCLA Section 121(d)(4)(C) for compliance with the MCLs for VOC contaminants at 40 CFR 141.61 (a) and (c) (identified as chemical-specific ARARs) for groundwater cleanup based on a demonstration of TI. As a result, MCLs are being waived for the portion of the onshore groundwater as determined by the TI determination shown in Figure 30 and as further detailed in Appendix B.

Vapor Intrusion: Based on the results from the remedial investigation (RI) for indoor air, all new buildings and building expansions on site will be constructed using VOC and mercury vapor intrusion-resistant construction. Existing administrative buildings will be retrofitted, as necessary, to prevent any unacceptable risk from potential vapor intrusion.

Offshore Components

The offshore components relate to areas outside of the onshore containment.

River NAPL: NAPL (organic and mercury) that has migrated from on shore, beneath the Tennessee River, will be recovered to the maximum extent practicable.[1] A range of NAPL recovery options may be used, including fixed or temporary recovery vertical and/or horizontal wells. The recovered NAPL may be treated on site or treated and disposed of off site at an EPA-approved RCRA facility, or recycled on site (with EPA approval). To maximize recovery of the NAPL, chemicals may be used to increase NAPL mobility.[2]

After it has been demonstrated that the practicable limit of NAPL recovery has been achieved, additional characterization of the remaining contamination will be conducted to develop remedial alternatives to restore groundwater in this area and attain drinking water standards. It is anticipated that EPA will issue a final ROD for this area at a future date.

River Groundwater: The Selected Remedy for the groundwater plume extending from the facility beneath the Tennessee River is Alternative RG3, which includes groundwater recovery and treatment for the portion of the groundwater plume with contaminant levels exceeding 1,000 micrograms per liter (µg/L), along with monitored natural attenuation of the plume with contaminant levels below 1,000 mg/L. It is anticipated that once the influx of contaminants from the onshore source and NAPL source beneath the river ceases, natural biological and physical processes will be effective in reducing contaminant levels in the groundwater beneath the river, with groundwater eventually attaining drinking water standards.

Therefore, pumping and treating of the groundwater plume will be delayed until after the first FYR to evaluate the effectiveness of the onshore and offshore NAPL source actions and whether active pumping and treating of the groundwater beneath the river is necessary to restore the groundwater to drinking water standards.

RCRA Actions

Early RCRA actions in 1982, 1988 and 1992 addressed the waste ponds in the floodplain and control of groundwater migration to the river. The pond closures resulted in the construction of a 240,000-cubic-yard RCRA landfill. The landfill will continue to be regulated pursuant to RCRA, under KDEP's oversight.

---

[1] "Maximum extent practicable" is distinguished from "extent practicable" in that efforts will be made to locate and recover NAPL using the best available technologies, which could include the use of enhanced recovery technologies. Extent practicable will focus on the recovery of NAPL from known areas where access is not limited by facility infrastructure and where the use of enhanced recovery technologies is not required. Figure 32 in Section 12 of this ROD shows onshore locations where NAPL may be recoverable.

[2] Chemical additives may be evaluated and selected during the remedial design and/or implementation of the remedy with the goal of enhancing the effectiveness of the NAPL recovery. In contrast, these chemical additives are not primarily intended for the in-situ treatment of the NAPL and/or residual contamination in the soil matrix. In-situ treatment options may be considered after the completion of the NAPL recovery, as part of a final remedy for the restoration of groundwater.

The implementation of the CERCLA remedy will be coordinated with the operation of the RCRA Plant-Wide Corrective Action Program (PCAP). The PCAP will be maintained until the CERCLA remedy has been implemented.

Performance Monitoring

To ensure the long-term performance and protectiveness of the remedy, an integrated performance monitoring program is included as part of the Selected Remedy. Major monitoring requirements include:

- Onshore groundwater gradients, pond and monitoring well water levels, and groundwater contaminant levels to verify plume stability beneath the chemical manufacturing plant complexes and hydraulic control.
- Groundwater contaminant levels beneath the river to evaluate plume reduction and stability.
- NAPL and groundwater contaminant levels in monitoring wells and other monitoring points.
- Sediment porewater and surface water contaminant levels at the groundwater/river interface.
- Potential seep occurrence along the shoreline.
- Indoor air VOC (and mercury, as needed) vapor levels in administrative buildings constructed without vapor intrusion barriers.
- Sediment and sediment porewater contaminant levels in the Barge Slip.

Institutional Controls

Institutional controls (ICs) will be used to support the long-term permanence and protectiveness of the remedy by limiting and/or preventing exposure to contamination and residual waste at the Site. ICs, and the use of existing facility security procedures, will prevent unauthorized intrusive activities or groundwater use. Uniform Environmental Covenants established by Kentucky Revised Statutes (KRS) 224.80 will be drafted and recorded to memorialize the land and activity use restrictions. The environmental covenants will include, at a minimum:

- Prohibit the use of groundwater beneath the Site, including for potable, agricultural, industrial and commercial purposes.
- Prohibit the use of the property within the site area for purposes other than industrial uses.
- Notify EPA, KDEP and other owners/operators within the boundary of the Site of any construction activities that may result in the disturbance of contaminated media.
- Prohibit the dredging of the river bottom within the Barge Slip or Propane Dock areas of

the Site below an elevation of 288 feet above mean sea level (amsl) or installation of structures that may result in the exposure of contaminated media beneath the Tennessee River without EPA notification and approval.

DECLARATION OF STATUTORY DETERMINATIONS

The Selected Remedy is protective of human health and the environment, complies with federal and state environmental requirements that are applicable or relevant and appropriate (except that a TI waiver is invoked as noted below) to the remedial action, is cost effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. For groundwater contained within the onshore barrier wall, restoration of groundwater within certain zones was determined to be technically impracticable from an engineering perspective and attainment of drinking water standards (i.e., MCLs) are being waived as ARARs pursuant to CERCLA Section 121(d)(4)(C) and 40 CFR 300.400(f)(1)(ii)(C)(3). As such, a TI waiver is a necessary part of this Selected Remedy. The TI waiver is provided in Appendix B.

The Selected Remedy does not satisfy the statutory preference for treatment pursuant to 121(b)(1) for principal threat waste (PTW). For the offshore NAPL, efforts will be made to recover the NAPL to the maximum extent practicable. It is anticipated that additional treatment alternatives will be developed for the residual NAPL source beneath the river and documented in a future ROD for offshore contamination. Onshore and offshore recovery of the NAPL will permanently remove NAPL to the extent practicable and reduce the toxicity, mobility and volume through treatment.

Because the remedy will result in hazardous substances, pollutants or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years from the start of construction of remedial action to ensure that the remedy is, or will be, protective of human health and the environment. These reviews are required pursuant to CERCLA Section 120(c) and 40 CFR 300.400(f)(4)(ii).

ROD DATA CERTIFICATION CHECKLIST

The ROD contains the remedy selection information noted below. More details can be found in the attached Decision Summary and the AR file for the Site.

- Chemicals of concern (COCs) and their respective concentrations (see Section 8.0).
- Baseline risks presented by the COCs (see Section 7.0).
- Remedial action objectives for the cleanup (see Section 8.0).
- Basis for invoking a TI waiver (see Appendix B) for groundwater standards for COCs (see Section 7.0).
- Cleanup levels established for COCs and the basis for these levels (see Table 3).
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater considered in the risk assessment (see Section 6.0).

- Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy (see Section 12.8).
- Estimated capital, annual O&M and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (see Sections 9.0 and 10.0).
- Key factors that led to selecting the remedy (i.e., how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (see Section 12.0).
- How source materials constituting principal threats will be addressed (see Sections 7.0 and 11.0).

AUTHORIZING SIGNATURE

Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency

9-5-18
Date

THE DECISION SUMMARY

TABLE OF CONTENTS

Section **Page**

FIGURES

TABLES

APPENDICES

THE DECISION SUMMARY

1.0 SITE NAME, LOCATION AND DESCRIPTION

BF Goodrich Site
Calvert City, Marshall County, Kentucky
EPA ID: KYD006370167
Address: KY Highway 1523, Calvert City, Kentucky

The B.F. Goodrich Superfund site (Site) is located in western Kentucky, along the southern side of the Tennessee River. The closest town is Calvert City, located about a mile to the south (Figure 1). About 3,000 people live in Calvert City. With the damming of the river in 1944 and introduction of a reliable source of electricity, 16 industrial plants have since developed along the river near Calvert City. Beyond the city and industrial developments, land uses are generally rural and agricultural.

Various chemical plants have operated at this location since the mid-1950s. Although many chemicals are produced, the main product is currently vinyl chloride monomer (VCM), which is used to produce polyvinyl chloride (PVC).[3] Because of various sales, mergers and property transfers, the main property owners are Westlake Vinyls, Inc. (Westlake) and PolyOne Corporation. United Technologies Corporation (formerly Goodrich Corporation) is the former owner and operator. These current and former owners and operators are considered potentially responsible parties (PRPs). Several active chemical manufacturing plants currently occupy most of the Site. Figure 2 shows an oblique aerial view of the Site from the southwest. Figure 3 shows an oblique aerial view of the Site from the northeast.

The PRPs conducted the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) remedial investigation (RI) field work. Because of third-party litigation issues, the U.S. Environmental Protection Agency (EPA) prepared the RI Report, conducted additional sampling of the Tennessee River and conducted the feasibility study (FS). EPA anticipates that the PRPs will enter into agreements to conduct the remedial design (RD) and the remedial action (RA).

The Site is about 250 acres in size, including the onshore and offshore areas. The primary source of contamination is approximately 3.5 million cubic yards of non-aqueous phase liquid (NAPL) and NAPL-contaminated soil that underlies the active chemical manufacturing plants. Primary contaminants include volatile organic compounds (VOCs) such as ethylene dichloride (EDC) (also known as 1,2-dichloroethane) and benzene, semi-volatile organic compounds (SVOCs) such as naphthalene (a chemical associated with coal tar), and mercury. The contamination is primarily the result of former plant operations where chemicals are believed to have migrated from plant infrastructure such as tanks, sumps, pipelines and ponds downward into underlying soils. Contaminants then migrated in groundwater, flowing northward, beneath the Site and into the Tennessee River. In some areas, the NAPL has migrated beneath the Barge Slip and the river. A plume of groundwater contamination also extends from the Site beneath the Tennessee River.

---

[3] The formal chemical name for VCM is 1,2-dichloroethane (1,2-DCA). Its common chemical name is ethylene dichloride (EDC).

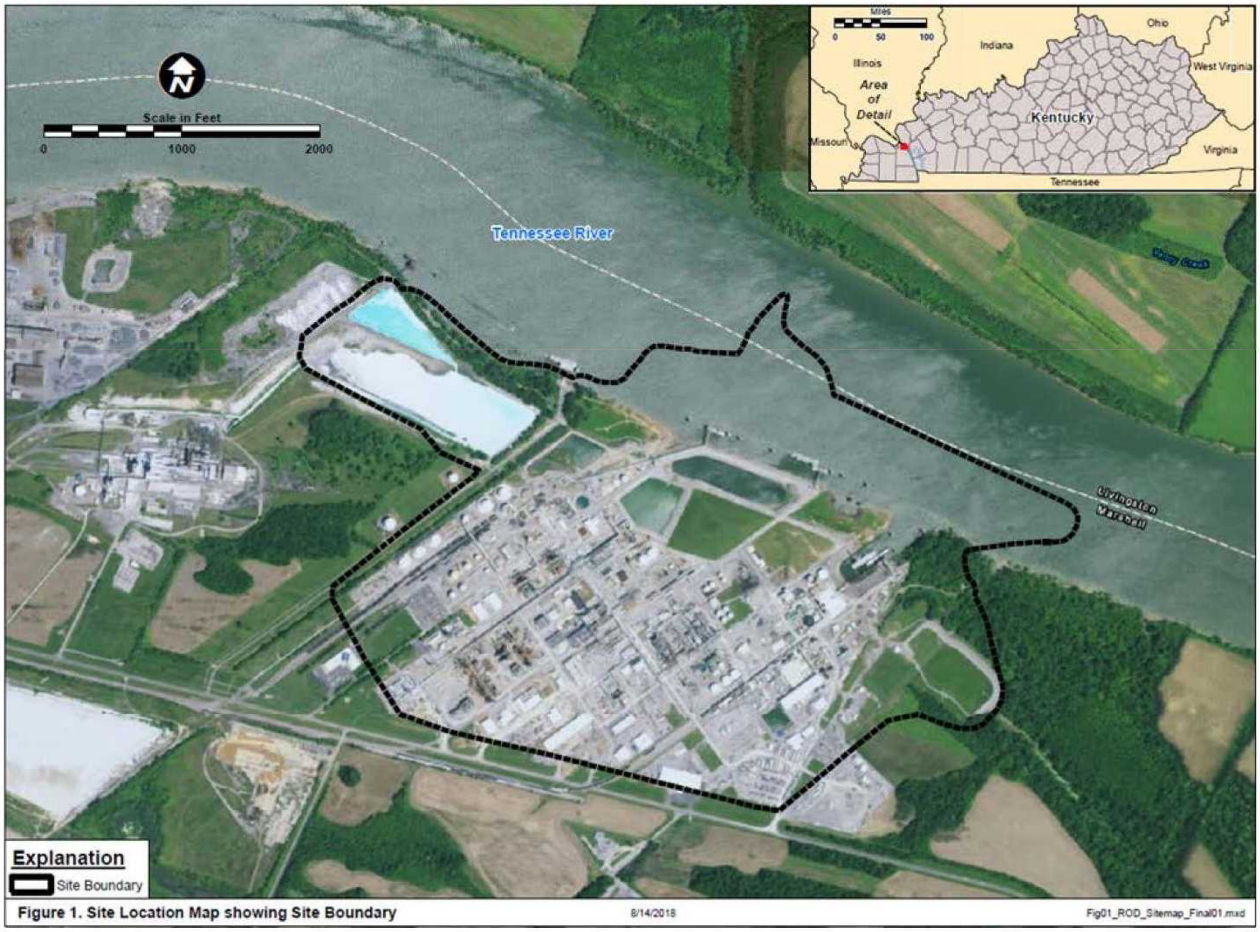


Figure 1. Site Location Map showing Site Boundary 8/14/2018 Fig01_ROD_Sitemap_Final01.mxd

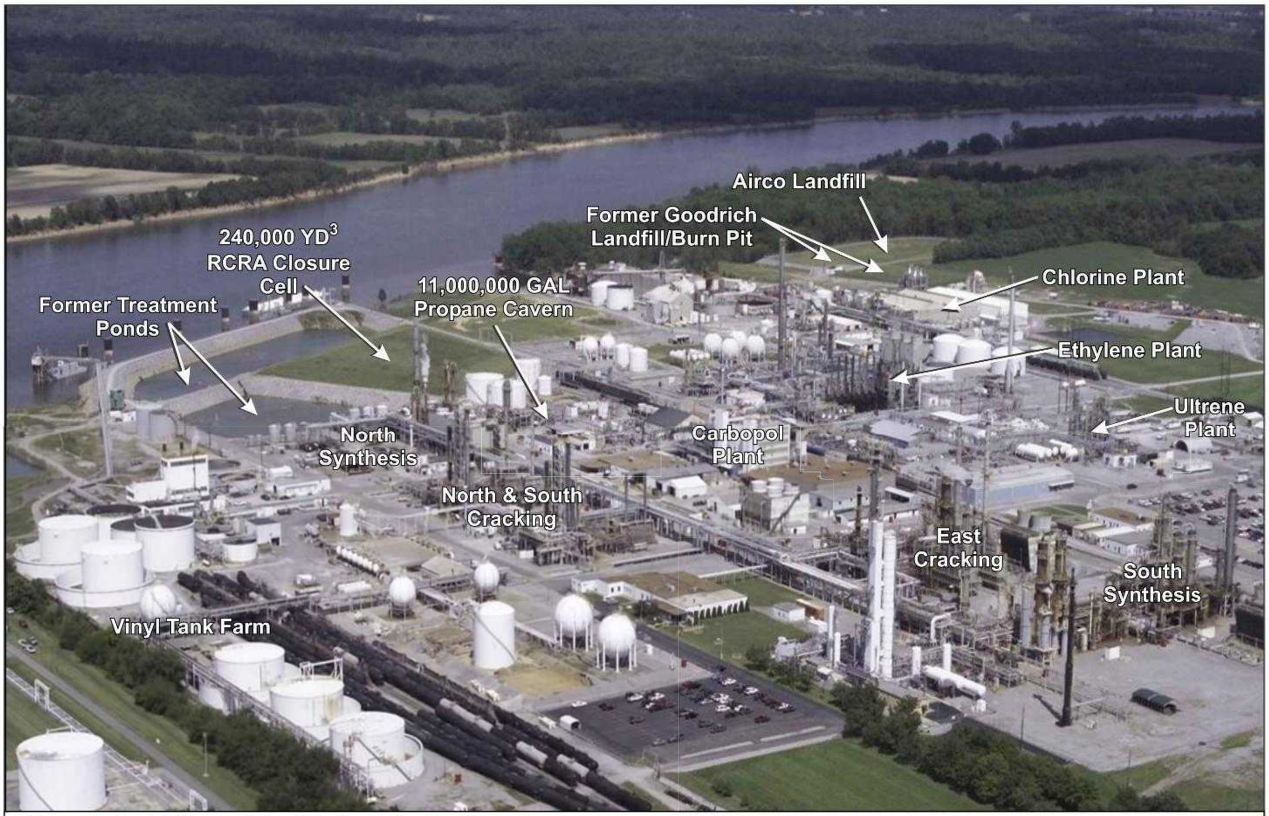


Figure 2. Aerial View of the Site from the Southwest 2_ROD_AERIAL VIEW SOUTHWEST03.CDR

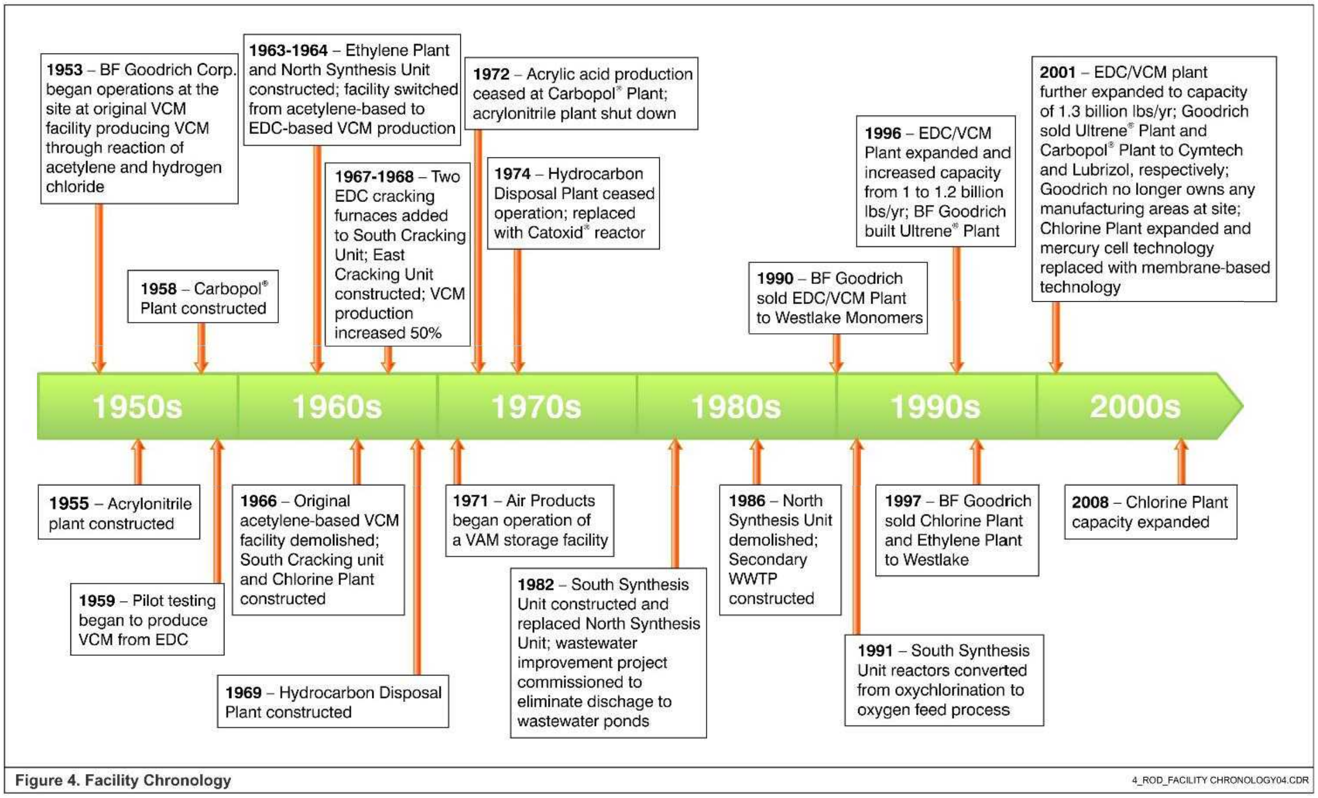
Figure 3. Aerial View of the Site from the Northeast 07/18 3_ROD_AERIAL VIEW NORTHEAST02.CDR

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The B.F. Goodrich Chemical Corporation (now United Technology Corporation) acquired farmland in Calvert City, Kentucky in 1951 to construct and operate a chemical manufacturing facility. Operations at the Site started in 1953, with the production of VCM through a reaction of acetylene and hydrogen chloride. As the plant grew and operations expanded, many other process improvements were made, along with the production of other products. Figure 4 provides a chronology of the facility's development.

In 1990, Goodrich sold the EDC/VCM Plant to Westlake Monomers Corporation. In 1996, the Ultrene® plant was constructed. Goodrich sold the Chlorine Plant and Ethylene Plant in 1997 to Westlake CA & O Corporation. Later, in 2000 and 2001, Goodrich sold the Ultrene® Plant and the Carbopol® Plant, which are now owned by Cymetech and Lubrizol, respectively. In 2007, B.F. Goodrich transferred title of its remaining property at the Site (all non-manufacturing areas) to PolyOne Corporation. Figure 5 shows property ownership boundaries at the time of the FS.

The Site was historically regulated under the Resource Conservation and Recovery Act (RCRA). Today, parts of the Site are regulated under both RCRA and CERCLA. In August 1981, the Kentucky Department of Environmental Protection (KDEP) issued a hazardous waste management permit (KYD006370167) to B.F. Goodrich for the part of the Site that was then the B.F. Goodrich Complex (the "RCRA Facility"). In September 1989, KDEP and EPA's RCRA Division jointly issued a hazardous waste Post-Closure Permit following closure of the former wastewater ponds. KDEP subsequently renewed the permit in October 2003.



1953 – BF Goodrich Corp. began operations at the site at original VCM facility producing VCM through reaction of acetylene and hydrogen chloride

1955 – Acrylonitrile plant constructed

1958 – Carbopol® Plant constructed

1959 – Pilot testing began to produce VCM from EDC

1963-1964 – Ethylene Plant and North Synthesis Unit constructed; facility switched from acetylene-based to EDC-based VCM production

1966 – Original acetylene-based VCM facility demolished; South Cracking unit and Chlorine Plant constructed

1967-1968 – Two EDC cracking furnaces added to South Cracking Unit; East Cracking Unit constructed; VCM production increased 50%

1969 – Hydrocarbon Disposal Plant constructed

1971 – Air Products began operation of a VAM storage facility

1972 – Acrylic acid production ceased at Carbopol® Plant; acrylonitrile plant shut down

1974 – Hydrocarbon Disposal Plant ceased operation; replaced with Catoxid® reactor

1982 – South Synthesis Unit constructed and replaced North Synthesis Unit; wastewater improvement project commissioned to eliminate dischage to wastewater ponds

1986 – North Synthesis Unit demolished; Secondary WWTP constructed

1990 – BF Goodrich sold EDC/VCM Plant to Westlake Monomers

1991 – South Synthesis Unit reactors converted from oxychlorination to oxygen feed process

1996 – EDC/VCM Plant expanded and increased capacity from 1 to 1.2 billion lbs/yr; BF Goodrich built Ultrene® Plant

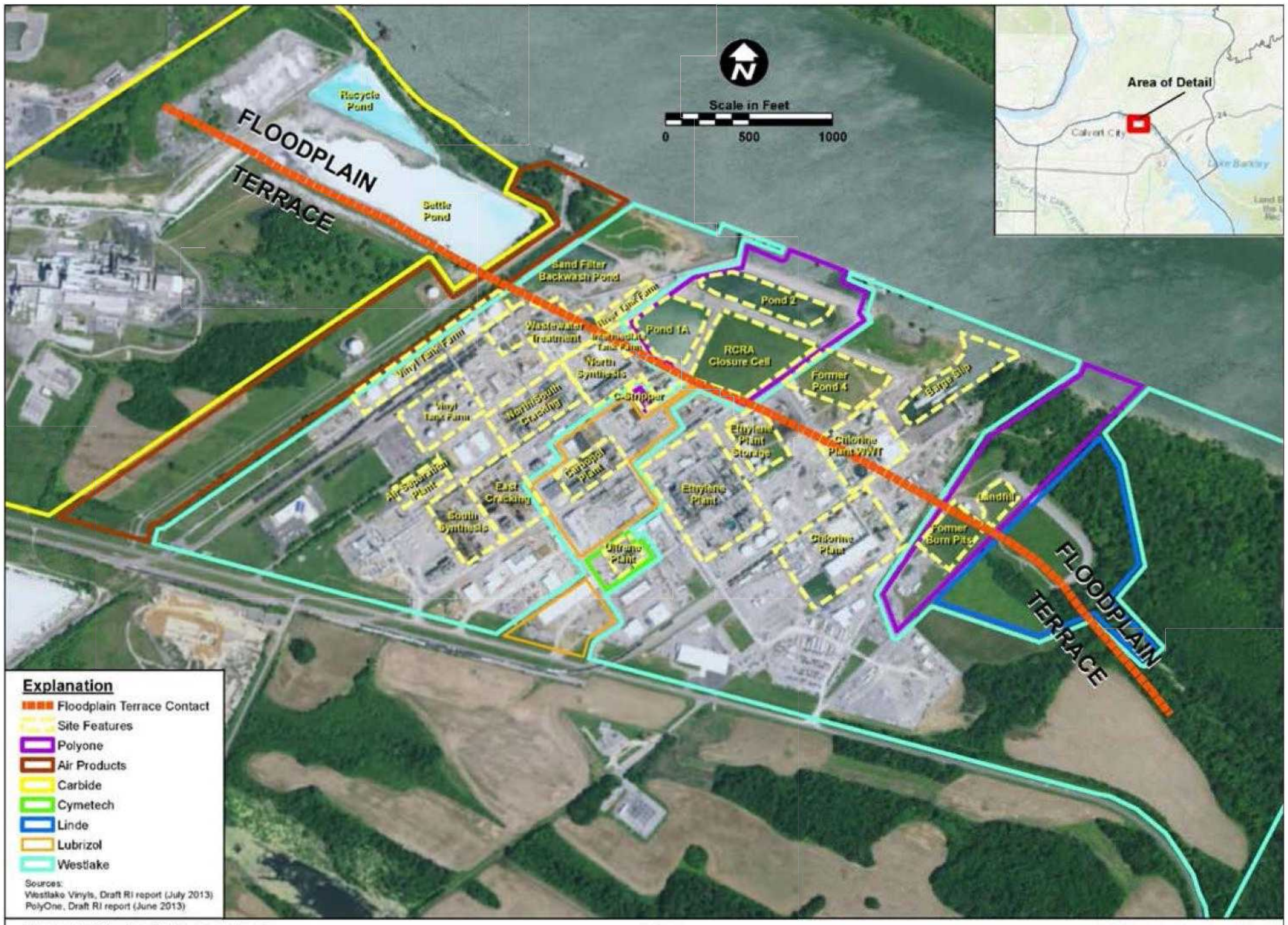
1997 – BF Goodrich sold Chlorine Plant and Ethylene Plant to Westlake

2001 – EDC/VCM plant further expanded to capacity of 1.3 billion lbs/yr; Goodrich sold Ultrene® Plant and Carbopol® Plant to Cymtech and Lubrizol, respectively; Goodrich no longer owns any manufacturing areas at site; Chlorine Plant expanded and mercury cell technology replaced with membrane-based technology

2008 – Chlorine Plant capacity expanded

Figure 4. Facility Chronology

4_ROD_FACILITY CHRONOLOGY04.CDR



Sources:
Westlake Vinyls, Draft RI report (July 2013)
PolyOne, Draft RI report (June 2013)

Figure 5. Site Facilities and Areas

8/7/2018

Fig05_ROD_Facilities_Areas_SP.mxd

A series of Five-Year Reviews (FYRs) of the 1988 remedy took place between 1996 and 2006. They concluded that the remedy had been implemented in accordance with the 1988 Record of Decision (ROD). The 2006 FYR determined that the remedy was protective in the short term. However, additional actions were necessary to ensure that the remedy remained protective over the long term. Deficiencies identified included a lack of deed restrictions to prevent residential use or the installation of private wells, lack of achievement of groundwater cleanup goals within the estimated timeframe, lack of further decrease of EDC levels in the shallow plume, limited effectiveness of the source area groundwater extraction wells, and uncertainty regarding the extent of the principal source of EDC contamination.

The FYRs concluded that chemical manufacturing operations at the Site have resulted in the release of hazardous substances to the air, soil, surface water and groundwater. Groundwater, soil and sediments are contaminated with VOCs, including EDC, benzene, toluene and other related compounds. Dissolved-phase contaminants have been documented at various locations. NAPL has been documented at various locations at the Site, indicating the presence of concentrated source material or principal threat waste (PTW), as defined by EPA.

In May 2009, KDEP requested that EPA exercise its authority under CERCLA to address contamination at portions of the Site formerly addressed under RCRA. EPA and the PRPs entered into an Administrative Settlement Agreement in December 2009. The Agreement expanded the scope of response at the Site to include the areal extent of contamination and the full extent of the releases associated with former operations by B.F. Goodrich.

Over the course of the almost 70-year operational history at the Site, various chemicals were stored, processed and managed on site. Early on, chemicals were not managed using the environmentally protective means used today. As a result, significant quantities of contaminants and waste material were released to the environment from tanks, sumps, pipelines, ponds, spillage to the surface and emissions to the ambient air. These releases have resulted in extensive areas of NAPL contamination of underlying soil and groundwater and the adjacent Tennessee River. Section 5.0 provides a more detailed discussion of the Site's characteristics. Major remedial actions at the Site are summarized below:

- Voluntary closure of the wastewater ponds beginning in 1982 and construction of the RCRA closure cell for the containment of waste.
- Implementation of the Plant-Wide Corrective Action Program (PCAP) system in 1992. The groundwater pump-and-treat system has expanded over the years. It currently consists of 51 extraction wells pumping an average of approximately 600 gallons of water per minute (gpm). To date, the PCAP system has pumped nearly 8 billion gallons of water and recovered approximately 11 million pounds of EDC.
- Closure of the former B.F. Goodrich landfill and burn pit area in accordance with the 1988 ROD and 1992 Consent Decree. This RA included installation of a 100-year flood protection dike, placement of an upgraded clay cap over the landfill, construction of a RCRA cap over the burn pit, operation of a soil vapor extraction system in the burn pit area, and groundwater extraction and treatment.

3.0 COMMUNITY PARTICIPATION

The RI/FS Report and the Proposed Plan for the Site were made available to the public on November 30, 2017. These documents, along with others EPA used to develop this ROD, are available in the Administrative Record (AR) File maintained at EPA Region 4's offices in Atlanta, Georgia, and locally at the Marshall County Public Library in Calvert City, Kentucky. The notice of availability of these documents was published in the local paper, *The Lake News*, on December 7, 2017. A public comment period was held on the Proposed Plan from November 30 through December 30, 2017, and, based on a request from the public, was extended through February 13, 2018. A public meeting was also held on December 7, 2017, where representatives from EPA and KDEP presented the Proposed Plan, accepted comments and answered questions. Responses to all comments received during the public comment are provided in the Responsiveness Summary (Appendix C).

After the review of comments received on the Proposed Plan, EPA, in consultation with KDEP, decided to modify a portion of the proposed remedy and released an amendment to the Proposed Plan on June 20, 2018, for an additional comment period. The Amendment identified a modification to the preferred alternative for the NAPL area beneath the Tennessee River by providing for an interim remedy that uses extraction instead of excavation to remove offshore NAPL. The comment period for the amended plan was open from June 20 through July 20, 2018. The AR file was updated with the public comments and the amended Proposed Plan. A public notice of the availability of the AR file and the announcement of the comment period was published in *The Lake News* on June 21, 2018. A public meeting was held on July 12, 2018.

Except for representatives from local newspapers and the former and current owner/operators of the Site, there was limited attendance at the public meetings. In addition to the public meetings for the Proposed Plan and start of the RI/FS, EPA's remedial project manager conducted periodic presentations for Calvert City's City Council. The City Council and attending members of the public were briefed on the November 2017 Proposed Plan and the June 2018 Proposed Plan Amendment. The Council was generally supportive of the November 2017 Proposed Plan, but did express concern regarding the high cost of the proposed cleanup and the length of cleanup time. The Council supported the amended strategy presented in the June 2018 Proposed Plan Amendment.

EPA's responses to the comments on the June 2018 Proposed Plan Amendment are also included in the Responsiveness Summary (Appendix C).

4.0 SCOPE AND ROLE OF RESPONSE ACTION

The primary goal for this Superfund response is to protect human health and the environment by preventing the further migration of contaminants beyond the boundary of the chemical manufacturing plants and prevent exposures primarily through containment of NAPL and contaminated groundwater and soils; removal of recoverable NAPL (including mercury) onshore and offshore; and restoration of groundwater outside the technical impracticability (TI) zone to its beneficial use as a drinking water source (i.e., attain drinking water standards).

This action is part of a broader environmental cleanup strategy that has been underway since the early 1980s. Since the 1980s, the goal of EPA, the Commonwealth of Kentucky and the PRPs has been to limit the migration of contaminants from the source areas and contaminated soils into the groundwater and Tennessee River. Major environmental response actions that have preceded this ROD include:

- 1982: Voluntary closure of the wastewater ponds located in the floodplain and consolidation of the waste in a RCRA closure cell on site. Eight wastewater ponds were closed under RCRA and approximately 240,000 cubic yards of contaminated soil from the pond closures was consolidated in the RCRA closure cell.
- 1988: ROD that provided for the capping of a 2-acre landfill and burn pit formerly used by B.F. Goodrich for the disposal of waste from plant operations. The ROD also included the construction of a dike to prevent flooding of the landfill, the collection and treatment of contaminated vapors from the subsurface, and the collection and treatment of contaminated groundwater.[4]
- 1992: Implementation of the KDEP-led PCAP system, designed to intercept the migration of contaminated groundwater and NAPL prior to its discharge to the Tennessee River. The PCAP system currently includes 51 extraction wells that pump an average of 600 gpm of groundwater. To date, approximately 8 billion gallons of water have been pumped and treated, and 11 million pounds of EDC have been removed from the subsurface.

4.1 Onshore and Offshore Site Contamination

This ROD addresses remaining site contamination issues, which mainly includes the approximately 3.5-million-cubic-yard source area of NAPL and NAPL-contaminated soil underlying the currently active chemical plants, the associated groundwater contamination, and the NAPL and contaminated groundwater beneath the Tennessee River.

The one area not fully addressed by this ROD is the 3-acre NAPL source area that extends beneath the Tennessee River. This remedy only provides an interim response action for the 3-acre NAPL source zone. The interim response includes the collection of recoverable NAPL to the maximum extent practicable. Based on the results from the NAPL recovery, a ROD will be issued for this area to address residual NAPL and restoration of the groundwater in this area to its beneficial reuse (i.e., attaining drinking water standards).

4.2 1988 ROD/Action

In 1988, a remedy was implemented for a portion of the Site that included a burn pit and landfill. These areas are located along the eastern edge of the Site. The 1988 ROD included the following elements:

- Flood protection dike construction.

---

[4] The 1988 ROD-required groundwater collection system is integrated into the RCRA PCAP system. The contaminant mass recovered from the 1988 remedy is included in the PCAP contaminant mass removal estimate.

- Landfill and burn pit cap installation.
- Leachate collection system installation.
- Relocation of contaminated soil to the burn pit.
- Groundwater pump-and-treat system installation.
- Vapor recovery system installation.

These elements have been implemented and O&M activities are ongoing. The 1988 ROD will be evaluated in light of this current action.

4.3 RCRA Actions

RCRA actions were taken in 1982 and 1992 at the Site to close waste management ponds in the floodplains and install a groundwater recovery and treatment system, respectively. Waste removed from the pond closures was consolidated into a 240,000-cubic-yard RCRA landfill. The groundwater recovery and treatment system is currently part of the PCAP system implemented under RCRA and a CERCLA Consent Decree.

4.3.1 RCRA Landfill

The RCRA landfill will continue to be managed pursuant to RCRA and under KDEP oversight.

4.3.2 PCAP System

The implementation of the CERCLA remedy will be coordinated with the operation of the RCRA PCAP. The PCAP will be maintained until the CERCLA remedy has been implemented.

5.0 SITE CHARACTERISTICS

This section of the ROD provides a general overview of the Site, including hydrogeology, environmental assessments, potential sources of contamination, contaminated media and the corresponding conceptual site model. The investigation reports listed below provide detailed information on the Site's characteristics. As evidenced by the dates and authors of the reports, there have been extensive environmental investigations at the Site over the past 30 years by the former owners and operators, KDEP, and EPA. With the completion of the EPA RI/FS, EPA believes that the Site has been characterized sufficiently to support the selection of a cleanup remedy.

- Ackenheil & Associates Geosystems, Inc. 1980. Hydrogeologic Study, prepared for B.F. Goodrich Company, Calvert City, KY, Geo project G78159, September 24.
- Ackenheil & Associates Geo Systems, Inc. 1981. B.F. Goodrich Chemical Division, Calvert City, Kentucky, Phase II Groundwater Study, November 6.
- A.T. Kearney, Inc. and Pope-Reid Associates, Inc. 1987. "RCRA Facility Assessment Report, B.F. Goodrich Chemical Company, Calvert City, Kentucky," May.

- Dames & Moore. 1985a. Final Geohydrologic Report, B.F. Goodrich Company Chemical Division, Calvert City, Kentucky. Job No. 04235-039-17, June 7.
- Dames & Moore. 1985b. *Phase I – Past Waste Management Facilities, prepared for B.F. Goodrich Company Chemical Group, Calvert City, KY*, Job no. 04235-039-17, May.
- Dames & Moore. 1988. Remedial Investigation, B.F. Goodrich/Airco Site, Calvert City, Kentucky. Job No. 14632-001-17, March 14.
- Woodward Clyde Consultants. 1989. Soil and Groundwater Study, B.F. Goodrich RDC/VCM Plant, Calvert City, Kentucky. Woodward Clyde Consultants. September 14.
- Dames & Moore. 1991a. Remedial Environmental Investigation Groundwater Assessment, B.F. Goodrich Company. Calvert City, Kentucky. Job No. 04235-080-121. October 29.
- Dames & Moore. 1991b. Tennessee River EDC Sampling Study. B.F. Goodrich Company. Calvert City, Kentucky. Job No. 04235-080-121. November 22.
- Dames & Moore. 1991c. Draft Report Groundwater Assessment B.F. Goodrich Company. Calvert City, Kentucky. February 7.
- Dames & Moore. 1991d. Report on the Tennessee River Sampling Survey October 1989. January 14.
- EPA. 1999. Tennessee River (TRM 20 to TRM 13.8) Ecological Site Investigation Report B.F. Goodrich/Westlake Monomer and Elf Atochem Facilities, December.
- TechLaw. 2002. Draft RCRA Facility Assessment of B.F. Goodrich Company. Calvert City, Kentucky. EPA ID No. KYD 006370167. March 19.
- KDWM. 2003. Hazardous Waste Management Permit. Goodrich Corporation. 2468 Industrial Parkway Calvert City, Kentucky. Kentucky Natural Resources and Environmental Protection Cabinet Department for Environmental Protection Division of Waste Management. Post Closure Permit. Permit No. KYD 006370 167. Effective Date October 30.
- URS. 2005. RCRA Corrective Action Program Supplemental Sampling Report. Former B.F. Goodrich Facility. Calvert City, Kentucky. February 28.
- URS. 2006. RCRA Corrective Action Program Confirmatory Sampling/RFI Phase I Report. Former B.F. Goodrich Company, Calvert City, Kentucky. June 29.
- URS. 2007. Report Tentative Area of Concern R (T-AOC R). RCRA Corrective Action Program. Former B.F. Goodrich Company. Calvert City, Kentucky. September 13.
- URS. 2008. Report Status Update Tentative Area of Concern R. RCRA Corrective Action Program. Former B.F. Goodrich Complex. Calvert City, Kentucky. December 8.
- PolyOne Corporation. 2012. B.F. Goodrich Superfund Site, Remedial Investigation Report, Section 2 – Site History. May.
- Westlake Vinyls, Inc. 2012. Historical Releases Summary Report. September.

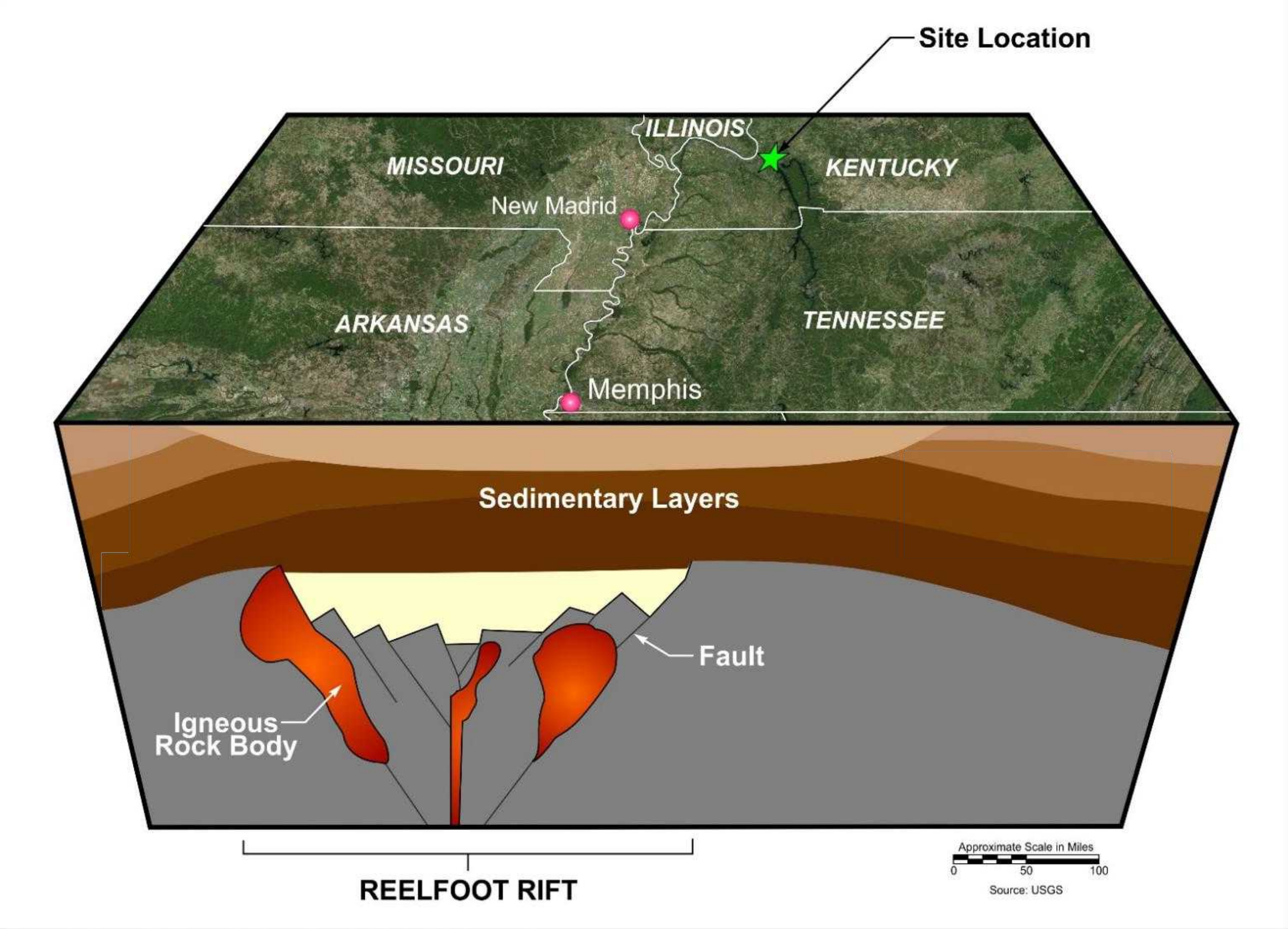
- PolyOne Corporation and Goodrich Corporation. 2013. Draft Remedial Investigation Report – Version 2, B.F. Goodrich Superfund Site, Calvert City, KY. July.
- Westlake Vinyls, Inc. 2013. Remedial Investigation Report, B.F. Goodrich Superfund Site, Calvert City, KY. July.
- McDonald Morrissey Associates, Inc. 2013. Steady State Groundwater Flow Model Report, B.F. Goodrich Superfund Site, Calvert City, Kentucky. September.
- Battelle. 2015. Final, Remedial Investigation Report for the B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky. August.
- Battelle. 2017. Feasibility Study Report for the B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky. November.
- Battelle. 2017. Remedial Investigation Addendum. Summary of 2016/2017 Offshore Investigation at the B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky. November.

5.1 Site Overview

Figures 2 and 3 provide aerial views of the Site and the main chemical plants. Figure 5 shows site features and the location of other properties within the site area. The Site can be accessed from Kentucky Highway 1523. The area undergoing investigation under the Superfund program covers approximately 250 acres, including the onshore and offshore portions. The primary chemical manufacturing facilities and related areas at the Site include:

- The EDC/VCM Plant, which produces VCM as well as EDC for use in the production of vinyl chloride (VC).
- The Ethylene Plant, which produces ethylene for use in the production of VCM.
- The Chlorine Plant, which produces chlorine for use in the production of VCM.
- The Ultrene® Plant, which produces dicyclopentadiene (DCPD).
- The Carbopol® Plant, which produces Carbopol® and other cross-linked polymers.

Near the Site, the land slopes from Highway 1523 northward to the river, ranging in elevation from 325 to 355 feet above mean sea level (amsl). This sloped area abuts a bluff that drops to the floodplain of the Tennessee River, which is approximately 302 feet amsl at normal pool stage. The Site has two general landforms, known as the floodplain and terrace areas (see Figure 5). The floodplain is a low-lying, narrow strip adjacent to the Tennessee River that is characterized by gently sloping topography, sandy beaches and woodlands. The Barge Slip, docks and other marine improvements associated with the Site are in the floodplain. The terrace is a broad, flat plain situated approximately 25 feet above the floodplain. Physiographically, the Site is in the northeastern portion of the Mississippi Embayment (Figure 6).



Source: USGS

Figure 6. Schematic Cross-Section of the Mississippi Embayment

07/18 6_ROD_RIFT ZONE SCHEMATIC02.CDR

5.2 Geology and Hydrogeology

The Site is underlain by varying layers of sand, clay, gravel and interbeds comprising different portions of geologic units. These layers are underlain by a competent, low-permeability limestone. Figure 7 provides a description of the different geologic units and site-specific photos of these units.

These geologic units consist of an underlying zone of generally unconsolidated material ranging from 80 to 120 feet thick, decreasing in thickness from south to north. Underlying these units is a competent limestone rock with a weathered clay surface. The underlying geology is generally divided into five zones: the vadose zone, shallow groundwater, intermediate confining zone, deep groundwater and bedrock. Hydraulic conductivity generally increases with depth because of the coarsening of the overburden, until the bedrock and weathered clay surface is encountered.

Fine-grained to coarse-grained fill. Coarse-grained fill located mainly in the terrace and manufacturing area. Fine- to coarse-grained fill located in the floodplain. Variable permeability. Thickness ranges up to 10 feet.

Interbeds consisting of alternating layers of sand, silt and clay. Continuous over much of the site, ranging in thickness from 1 to 25 feet. Much of the NAPL has been observed in the interbedded units.

Fine- and coarse-grained sand and gravel comprise the most permeable units underlying the site. The majority of groundwater flow occurs in these units. The sand and gravel units underlie the entire site and range in thickness up to 80 feet.

Dense, low permeability clays intermixed with chert nodules form the base of the geologic formations that overlie the bedrock. The clay-rich heteroliths range from 1 to 50 feet thick over the majority of the site.

Competent limestone is encountered at elevations ranging from 230 feet mean sea level (msl) along the southern side of the site (Highway 1523) to 280 feet msl along the northern portion of the site (Tennessee River).

Figure 7. Geologic Units

07/18 7_ROD_GEOLOGIC UNITS02.CDR

Below is a brief overview of the geologic zones underlying the Site.

- Vadose Zone: Fill, shallow portions of clay/silt units and unsaturated portions of the interbeds. Discontinuous portions of perched water zones have been observed. The perched water zones increase in thickness and spatial extent with flooding from the Tennessee River. The thickness of this zone generally ranges from 25 to 40 feet on the terrace to 5 to 15 feet in the floodplain.
- Shallow Groundwater: Unconfined groundwater that occurs in shallow portions of the interbeds, clay/silt unit and fine sand unit. Shallow groundwater flows northward and discharges to the Tennessee River. The thickness of this zone generally ranges from 25 to 30 feet on the terrace to 5 to 10 feet in the floodplain.
- Intermediate Confining Zone: Lower hydraulic conductivity materials in the interbeds unit and clay/silt unit. Interbeds consisting of intervening layers of sand/silty sand and clay, silty clay, silt or clayey silt. The zone may range up to 15 feet thick, but may also be thin or discontinuous in some areas. Groundwater flow does occur in the sand zones of the interbeds and discharges to the Tennessee River. Due to the heterogeneity and discontinuity of the clay/silt zones, the Intermediate Confining Zone does not provide an effective barrier to vertical flow between the shallow and deep groundwater.
- Deep Groundwater: Deeper groundwater under semi-confined conditions that occurs in the fine and coarse sand gravel units, below an elevation of 295 feet amsl. These units have a higher hydraulic conductivity and account for most of the groundwater flow at the Site. Deep groundwater also flows northward and discharges to the Tennessee River.
- Bedrock: Uppermost stratigraphic unit of the Fort Payne Formation limestones. Site-specific investigations into the limestone show that at least the upper 50 feet of the bedrock beneath the Site is competent with a low density of fractures (many of which are filled with calcite). The bedrock surface is weathered and is overlain by a low-permeability clay, intermixed with varying sizes of gravel.

Groundwater flow is generally from the south to the north, discharging into the Tennessee River. The depth to groundwater generally ranges from 25 to 30 feet below land surface in the terrace, to just a few feet along the river in the floodplain. Under normal pool stage, the hydraulic gradient is on the order of 0.002, and increases by an order of magnitude with the rapid elevation decrease from the terrace to the river. In times of flooding or near pumping wells, the hydraulic gradients can vary significantly and even reverse direction. Groundwater elevations of the shallow and deeper groundwater during normal pool are shown in Figures 8 and 9, respectively.

A downward vertical gradient exists southwest of the Site that diminishes to the northeast and reverses near the Tennessee River. The change from a downward vertical gradient to an upward vertical gradient as groundwater approaches the Tennessee River suggests that shallow and deep groundwater flows into the river during times of normal pool stage. During high-river stage, vertical gradients tend to reverse as compared with normal pool stage, with downward gradients near the river and upward gradients further from the river.

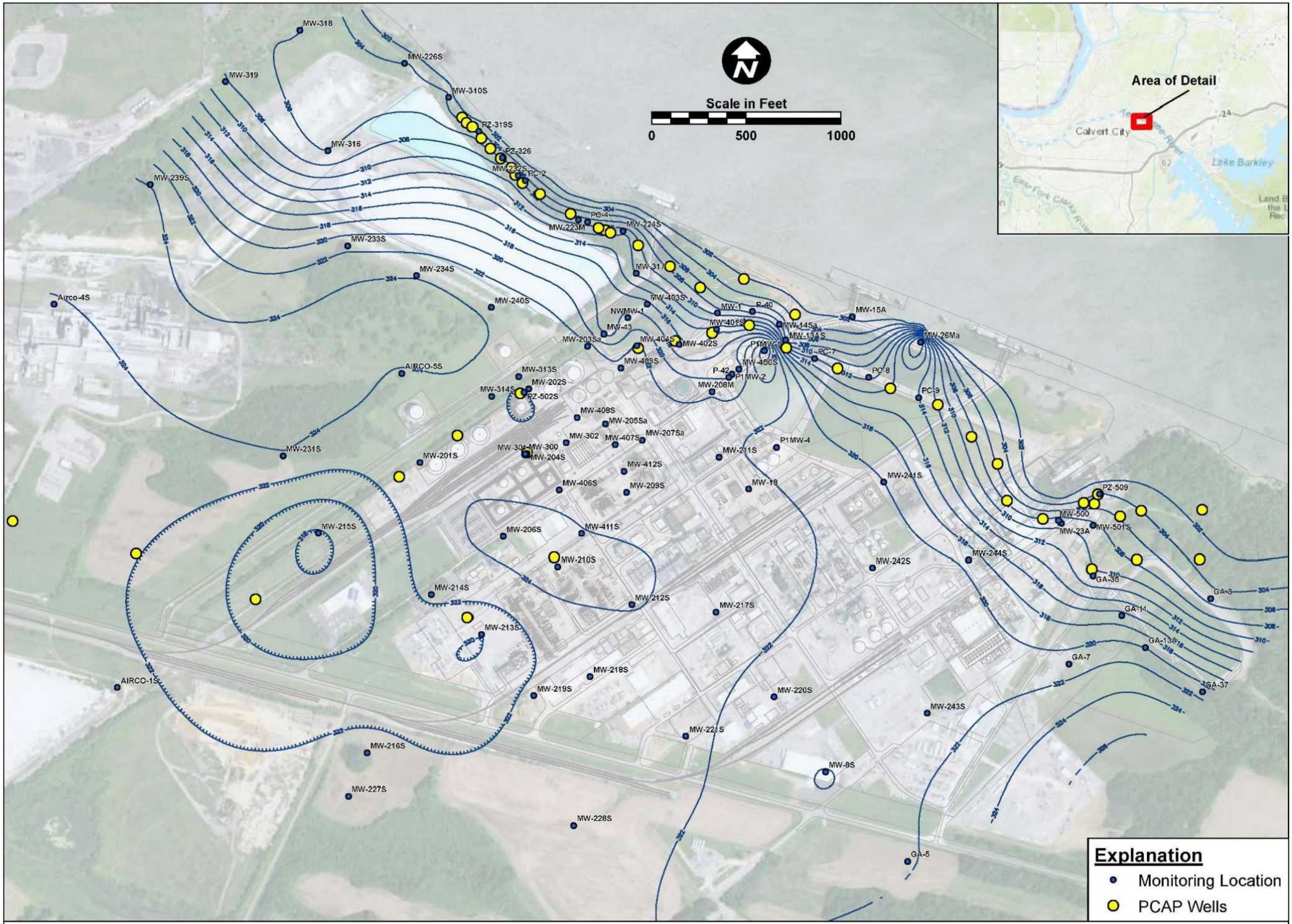


Figure 8. Groundwater Elevation Contours, Upper Aquifer (August 2011)

8/7/2018

Fig08_ROD_GWL_11Aug_Upper.mxd

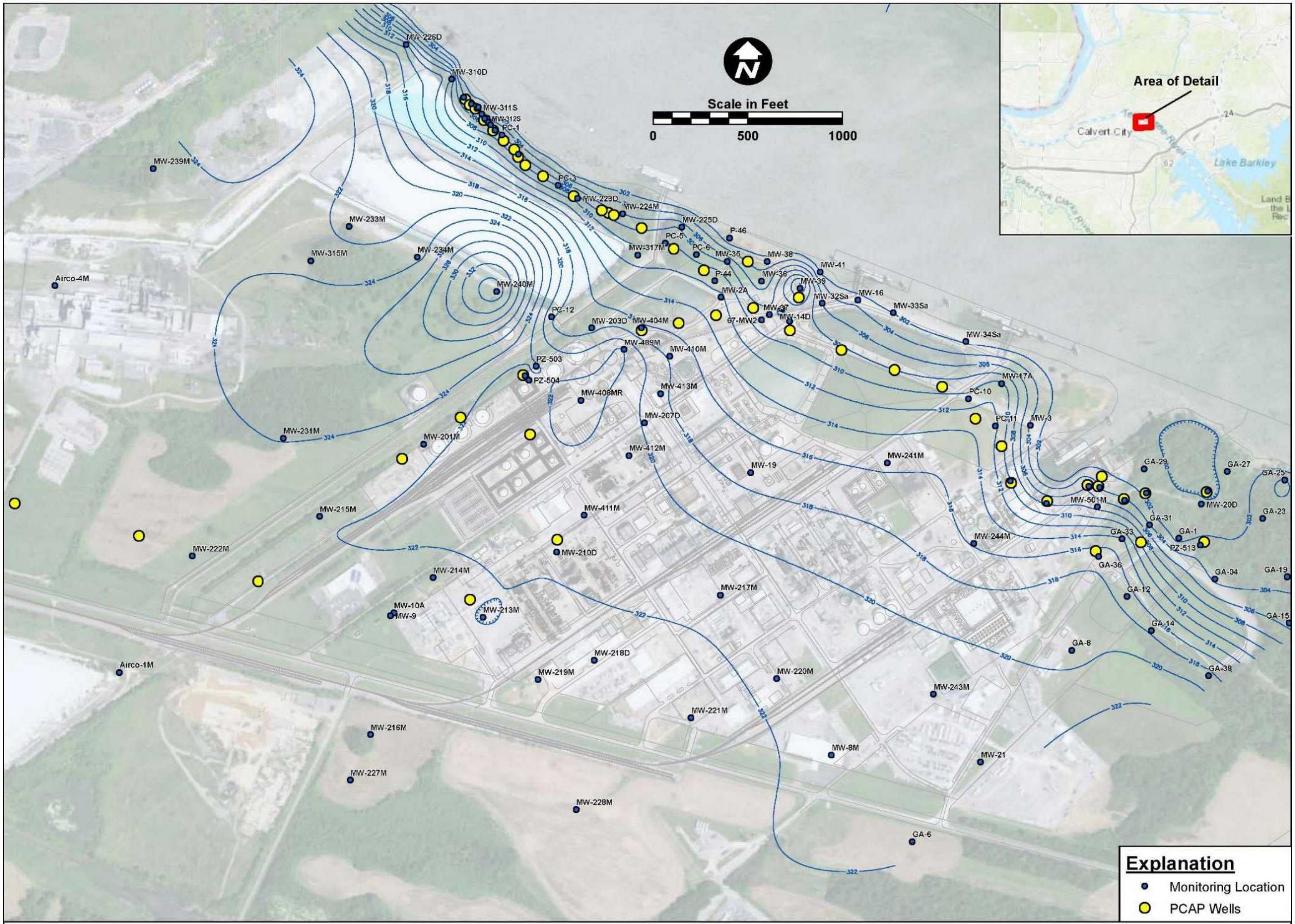


Figure 9. Groundwater Elevation Contours, Lower Aquifer (August 2011)

8/7/2018

Fig09_ROD_GWL_11Aug_Lower.mxd

This vertical gradient reversal suggests that, during times of flooding, the Tennessee River infiltrates into the alluvial aquifer to some distance upgradient, as discussed below.

At some locations and under certain conditions, groundwater bypasses the PCAP system, flowing between or beneath the PCAP wells, and discharges to the Tennessee River or along the banks of the river. The volume and duration of these discharges are dependent on river stage, with the highest discharge condition being when the river stage drops rapidly. The most evident examples of these groundwater discharges occur as groundwater seeps along the bank of the Tennessee River. Chemical analysis of the groundwater seeps indicates the presence of site-related contaminants.

5.3 Hydrology

The average annual rainfall for the site area is about 49 inches per year. Accounting for factors such as evaporation, evapotranspiration and overland runoff, the estimated groundwater recharge rate at the Site from precipitation is 3.9 inches per year. Because of the industrialized nature of the site area, the majority of stormwater runoff is diverted to collection ditches and drains to the Tennessee River through KDEP-permitted outfalls.

The Tennessee River has a major influence on the surface water and groundwater flow conditions. At the Site, during normal pool (elevation 302 amsl), the river is approximately 1,500 feet wide and averages about 15 feet deep in the river channel. The rate of flow of river water near the Site can vary from about 15,000 cubic feet per second (cfs) during normal pool to near 100,000 cfs during flood stage or peak electrical demands at the Kentucky Lake Dam.

As noted above, river elevations can greatly influence groundwater elevations, gradients and groundwater discharge to the river. During periods of river elevation near and below normal pool, groundwater emerges in the form of seeps in the exposed river banks, flowing overland to the river. Conversely, during periods of higher river elevations, the river can cause localized reversal in groundwater gradients near the river and result in bank storage along the shoreline.

5.4 Environmental Assessments

As noted above, over 25 investigations have been conducted by the PRPs, KDEP and EPA over the past 30 years. Investigations of the Site have been exhaustive. In addition to investigating the general nature and extent of contamination, the studies have investigated potential sources of contamination, Site-specific hydrogeology, indoor air vapor intrusion potential, bedrock composition, and potential environmental impacts in and beneath the river. A steady-state groundwater flow model that was calibrated to the Site-specific conditions also was prepared and utilized to evaluate groundwater flow conditions and remedial alternatives.

The most comprehensive study conducted at the Site was the RI. The field work was conducted by the PRPs, with EPA oversight, from January 2010 through December 2012. Figures 10 and 11 show the location of the soil boring and groundwater monitoring well locations, respectively. Locations where samples were collected from seeps, surface water and sediment are shown in Figures 12, 13 and 14, respectively. Based on the data collected

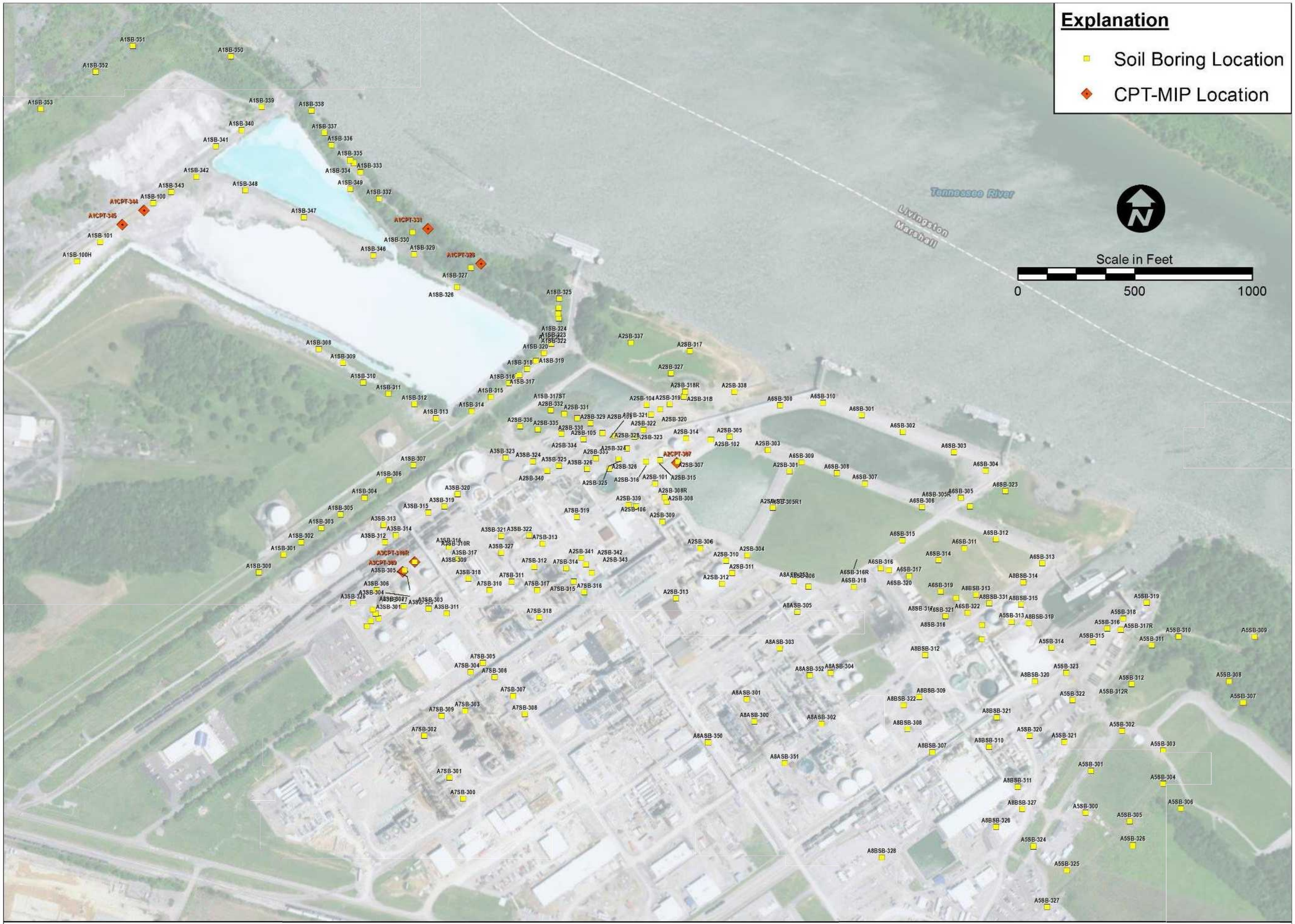


Figure 10. RI Soil Boring Locations

07/18 10_ROD_SOIL_BORING_LOCATIONS02.MXD

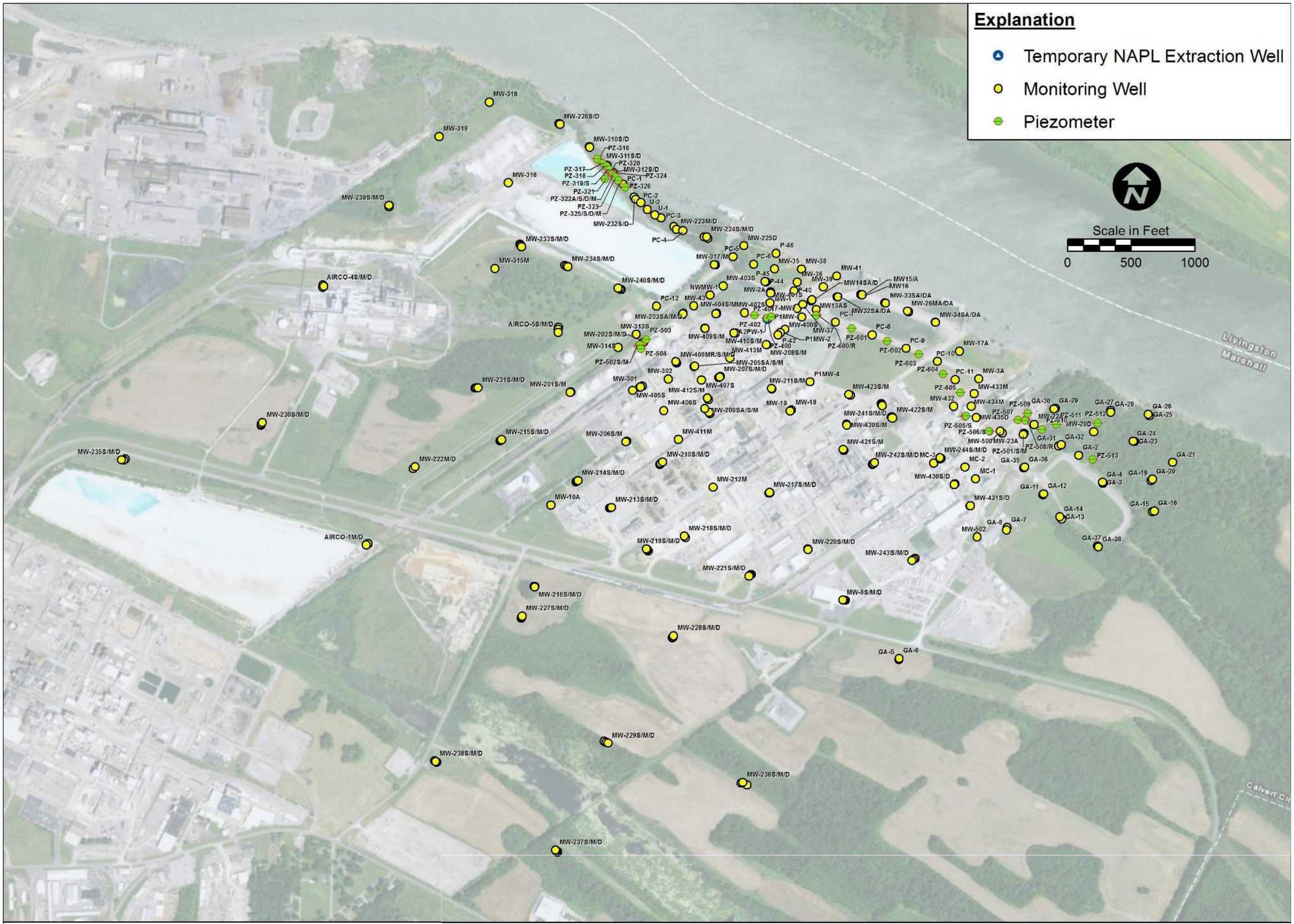


Figure 11. RI Monitoring Wells, Piezometers, and Temporary NAPL Extraction Well Locations

08/18 11_ROD_MW_PZ_TEMPNAPL_LOCATIONS02.MXD

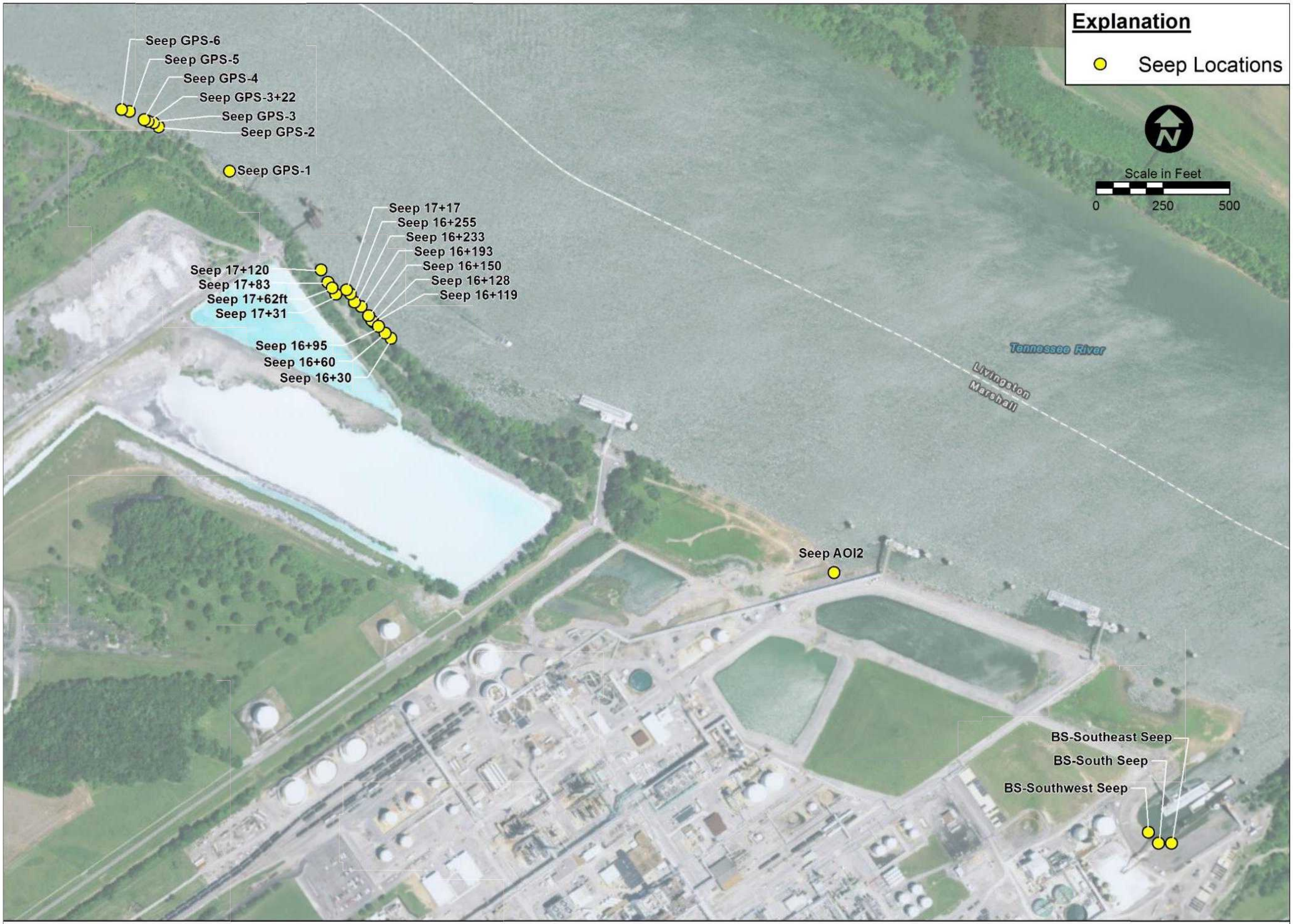


Figure 12. Seep Locations

08/18 12_ROD_SEEP_LOCATIONS02.MXD

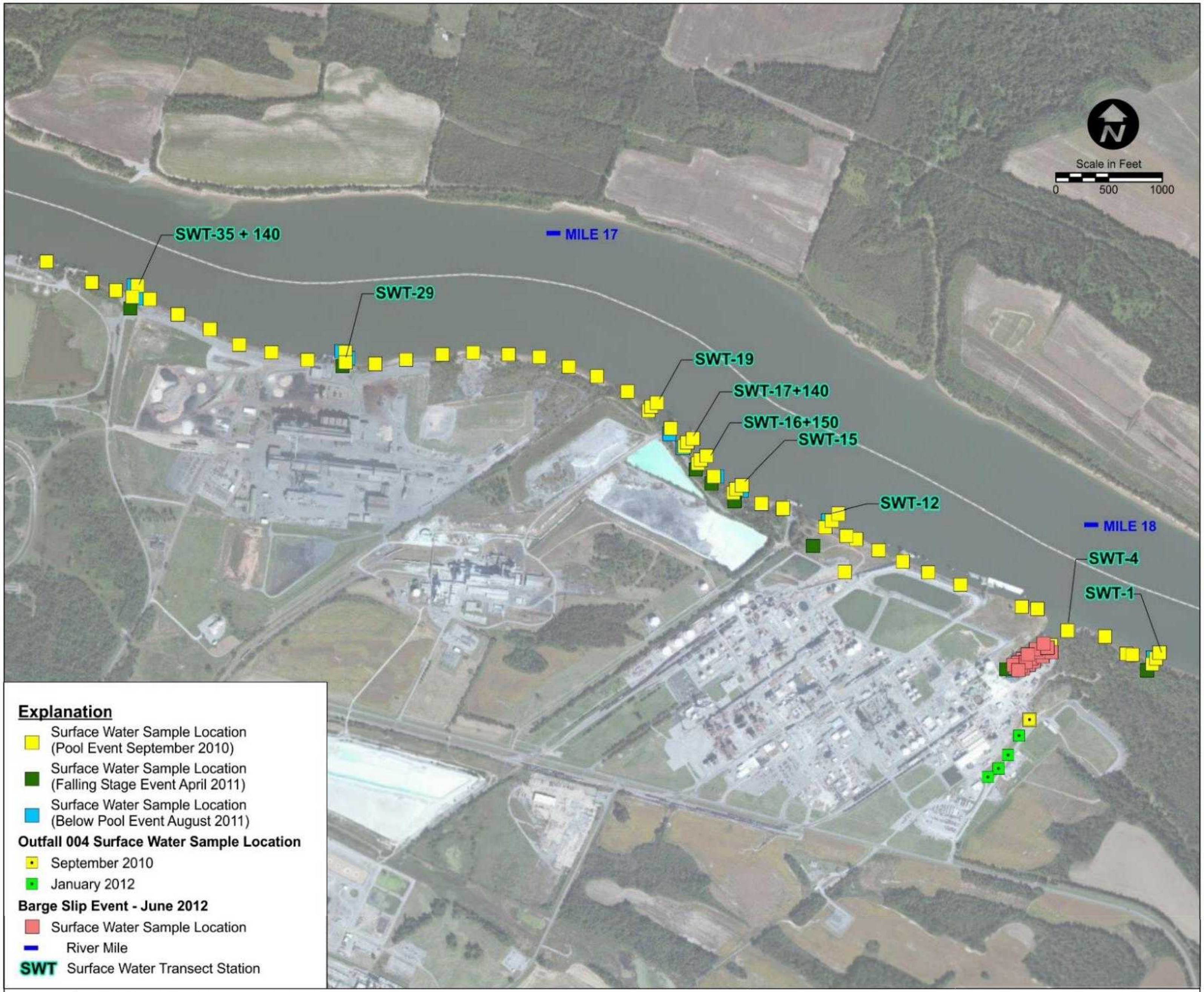


Figure 13. Surface Water Sample Locations

07/18 13_ROD_SURFACE WATER SAMPLING LOCATIONS02.CDR

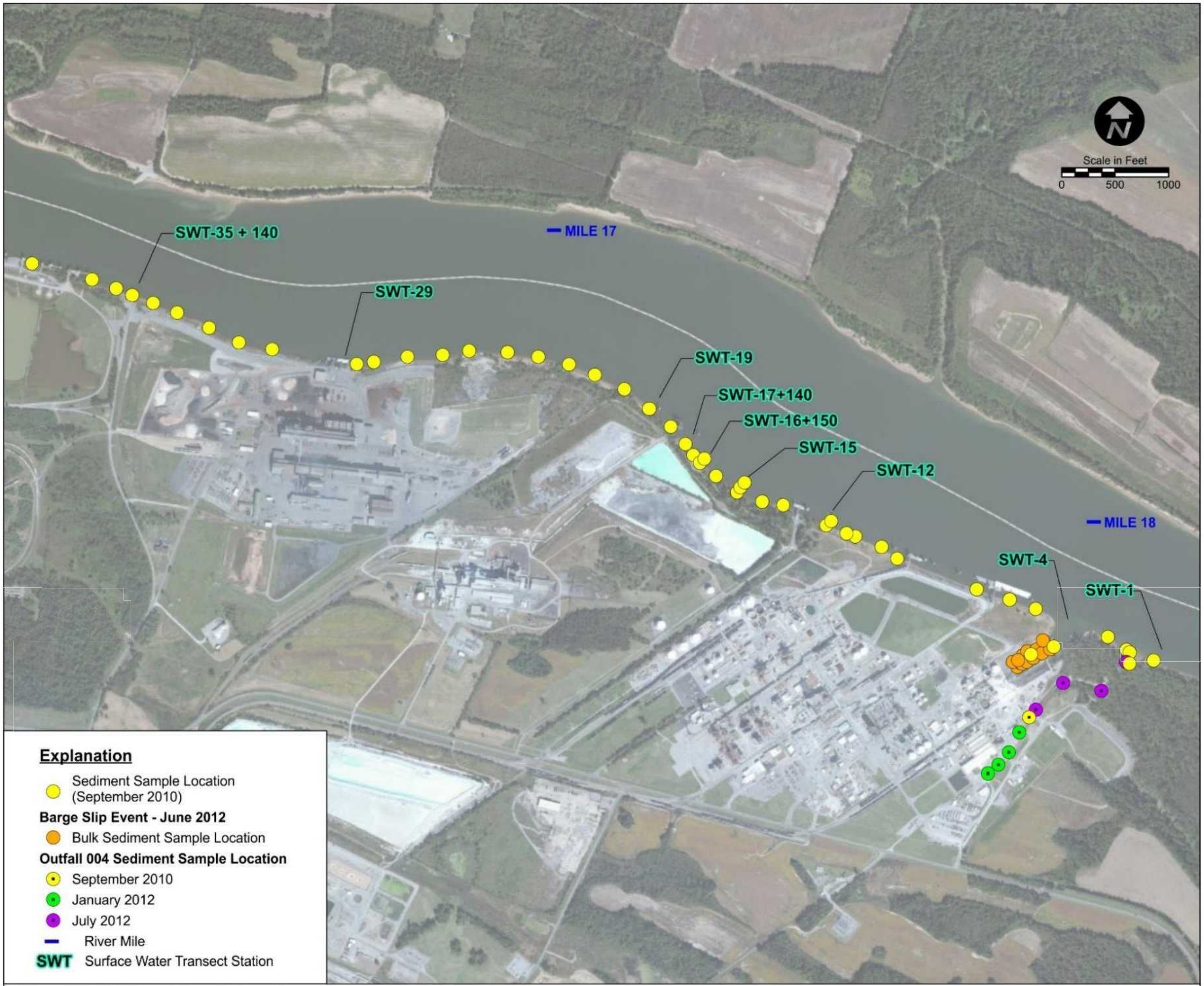


Figure 14. Sediment Sample Locations

07/18 14_ROD_SEDIMENT SAMPLING LOCATIONS02.CDR during prior studies, chemical analyses focused on VOCs, SVOCs and mercury. About 10 percent of the samples collected were submitted for a full scan of potential contaminants.

The primary RI data collection was supplemented by further characterization of the Tennessee River in August and October 2016 and later in August 2017. The objective of the offshore investigations was to determine the extent of contaminated sediment and NAPL migration beneath the river, the extent of groundwater migration beneath the river, and the degree of contaminated groundwater discharge to the river. The studies generally involved the installation of boreholes and temporary well points into the sediment beneath the river bottom using direct push drilling rigs mounted on river barges.

Samples were collected from approximately 80 boring locations. Sediment cores were collected and logged from each location, and soil and groundwater samples were collected from multiple depths for analysis of VOCs, SVOCs and mercury. Surface water samples also were collected from the river water just above the sediment interface, and sediment porewater samples were collected from just below the sediment interface. Sample locations for the three river sampling events are shown in Figures 15, 16 and 17, respectively.

5.5 Potential Sources

Chemical releases have occurred at the Site since manufacturing operations began in the 1950s, and manufacturing operations are presently ongoing at the Site. Chemical releases have been associated directly with the manufacturing facilities at the Site, ancillary features of the manufacturing facilities (e.g., process sewers and chemical storage and transfer areas) and historical waste disposal practices. Significant quantities of chemical contaminants and waste materials have been released to the environment at various areas of the Site. Figure 18 shows the location of potential sources that are believed to have contributed to the contamination at the Site.

Due to the nature of the chemicals present in the organic NAPL and mercury NAPL, and records associated with RCRA permits, it is expected that NAPL constitutes RCRA hazardous waste (listed and/or characteristic). Under EPA's policy, contaminated media (e.g., groundwater, soil or sediments) is considered to contain RCRA hazardous waste: (1) when media is contaminated with characteristic hazardous waste and exhibits a characteristic of hazardous waste; or (2) when the media is contaminated with hazardous constituents from RCRA-listed hazardous waste (63 Fed Reg 28617, May 26, 1998). NAPL is considered waste as opposed to contaminated media. Formal waste determinations will be made in accordance with RCRA applicable or relevant and appropriate requirements (ARARs) at the time the NAPL waste or NAPL-contaminated soil/sediments is removed from the ground.

5.6 Contaminated Media

During the RI, the following media were investigated: soil, groundwater, seeps, surface water, sediment and sediment porewater. A summary of the media-specific chemical distribution at the Site is presented below. Although all media sampled indicated the presence of contamination in varying concentrations, the most significant levels of contamination are

Figure 15. Offshore Investigation Sampling Locations (Phase I) 8/7/2018 Fig15_ROD_Phase1_Locs.mxd

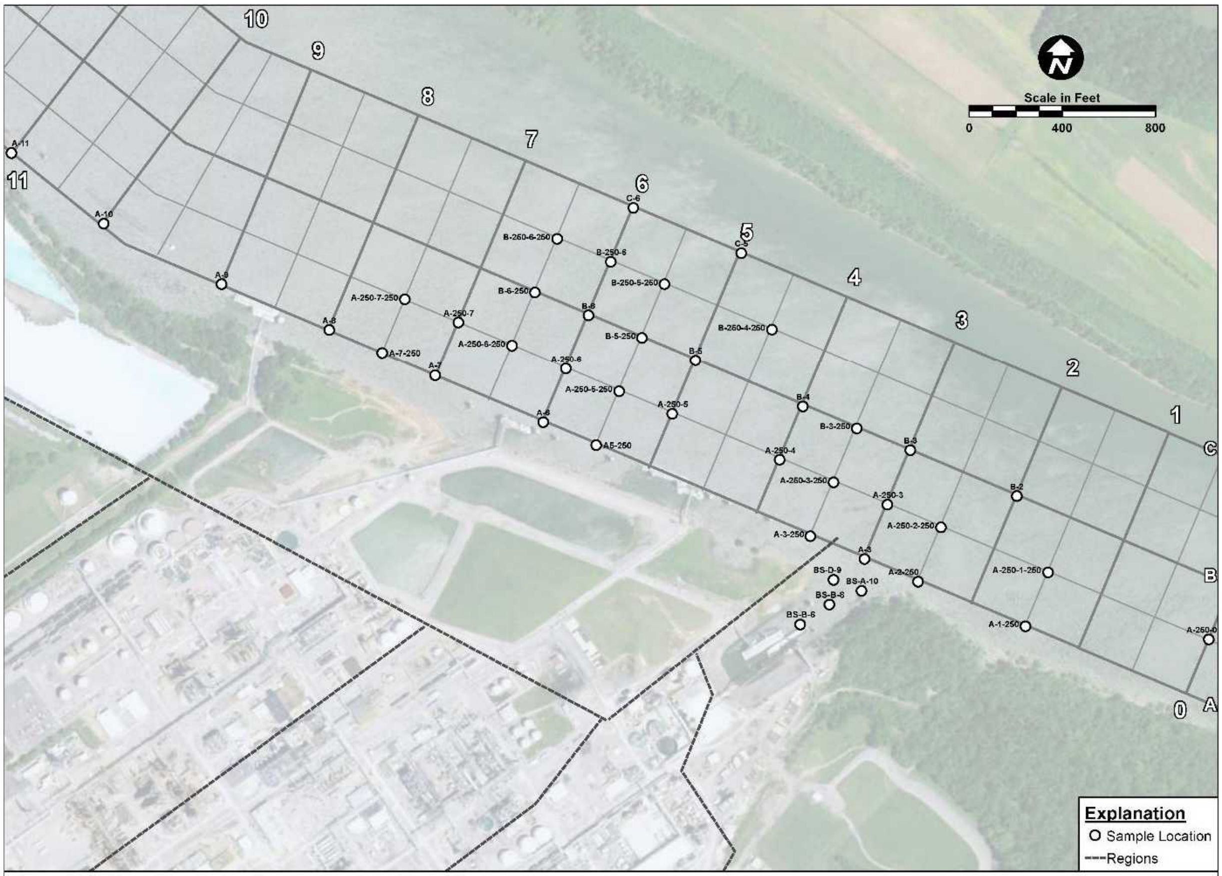


Figure 16. Offshore Investigation Sampling Locations (Phase II) 8/7/2018 Fig16_ROD_Phase2_Locs.mxd

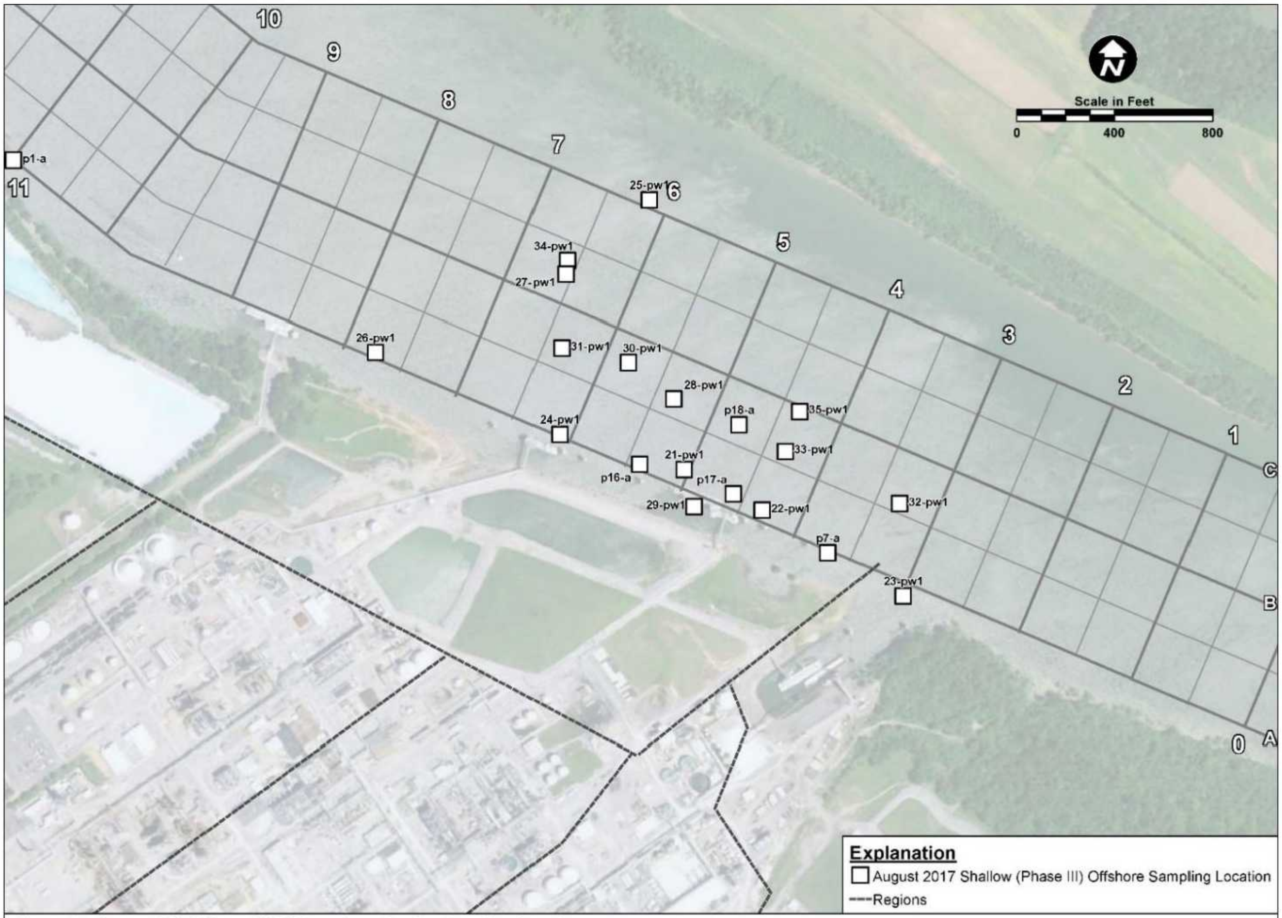
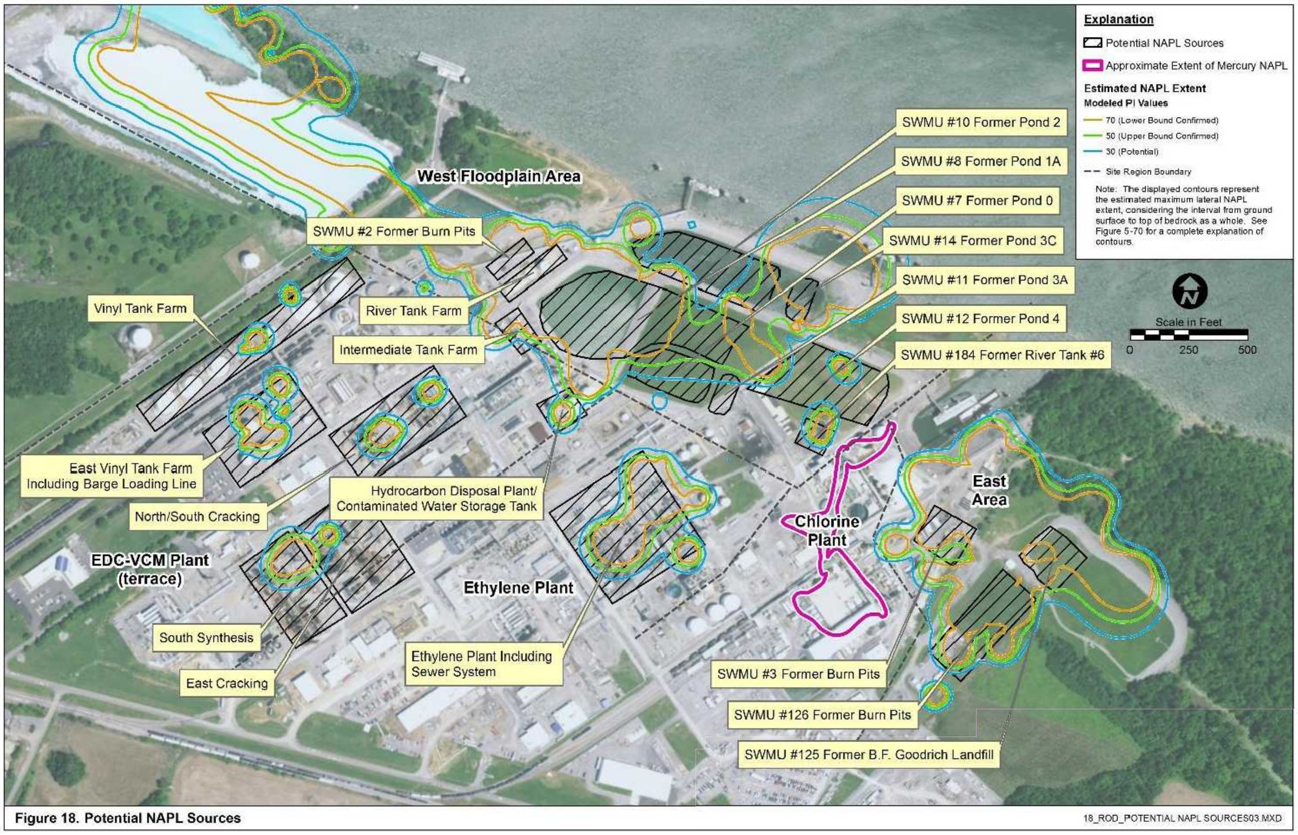


Figure 17. August 2017 (Phase III) Offshore Investigation Sampling Locations 8/7/2018 Fig17_ROD_Phase3_LocsF.mxd



Note: The displayed contours represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. See Figure 5-70 for a complete explanation of contours.

Figure 18. Potential NAPL Sources 18_ROD_POTENTIAL NAPL SOURCES03.MXD

associated with the NAPL-contaminated soil beneath the Site and the associated groundwater. Figures 5-2 through 5-63 of the RI Report provide a detailed presentation of the analytical results.

Soil: The chemicals of potential concern (COPCs) identified from the RI that were found in soil include 1,1-dichloroethane (1,1-DCA), 1,1,2-trichloroethane (1,1,2-TCA), EDC, benzene, chloroform, naphthalene, perchloroethylene (PCE), trichloroethylene (TCE), VC, hexachlorobenzene and mercury. Elevated concentrations of EDC were detected in all areas of the Site, with the highest found in the East and West Floodplain Areas and the EDC-VCM Plant Area. Benzene concentrations are the highest in the Ethylene Plant Area, and occur at elevated concentrations in the East and West Floodplain Areas. Mercury concentrations are highest in the Chlorine Plant Area. In general, all COPCs were identified in soils in the East Area and West Floodplain Area at locations consistent with likely historical release locations and the current distribution of shallow NAPL-impacted soil. Site-wide, COPC concentrations in soil are more elevated in the deeper vadose zone (10 feet below ground surface [bgs] to the water table) when compared to the shallow vadose zone (0 to 10 feet bgs). Below the water table, COPC concentrations are higher than in the vadose zone due to the presence of larger volumes of NAPL-impacted soil below the water table. The highest soil concentrations below the water table are found in the shallowest saturated zone (water table to 295 feet amsl) and generally decrease in concentration with depth.

Groundwater: Twelve COPCs were identified in groundwater – 1,1,2-TCA, 1,1-DCE, EDC, benzene, carbon tetrachloride, chlorobenzene, chloroform, PCE, TCE, VC, arsenic and mercury. The majority of the COPCs were present in the East Area, the West Floodplain Area and the EDC-VCM Plant Area, at locations consistent with the current distribution of NAPL-impacted soil within the saturated zone. In addition, 1,1-DCE, carbon tetrachloride and mercury also were found in the Chlorine Plant Area and benzene was found in the Ethylene Plant Area. Site-wide groundwater COPC concentrations were greatest and most widespread in the shallow groundwater (≥295 feet amsl) compared to the deep groundwater (<295 feet amsl), although several chlorinated VOCs (e.g., 1,1-DCE and TCE) showed higher concentrations in the deep groundwater.

Seeps: Seeps were inspected and sampled along the banks of the Tennessee River in the Northwest Area, Pond 2 and the Barge Slip. In most cases, seeps are the result of groundwater bypassing the PCAP system and discharging along the banks of the Tennessee River or directly to the river. The Pond 2 Seep and the Northwest Area Seeps are along the shoreline of the West Floodplain Area. The Barge Slip Seep is downgradient of the Chlorine Plant Area and the East Area. The analytes that exceeded the ambient water quality criteria (AWQC) (human health organism only) and the general location where the maximum exceedances occurred in each of these areas are listed below:

- Northwest Area Seep: 1,1,2,2-TCA, 1,1,2-TCA, benzene, chlorobenzene, chloroform, EDC, PCE, TCE, VC, bis(2-chloroethyl) ether, bis(2-ethylhexyl) phthalate, arsenic and other metals exceeded their respective AWQC in the Northwest Area Seep. The highest concentrations were found at the River Station #16/#17 series seeps except for mercury, which was detected only in the Global Positioning System (GPS) seeps.[5]

- Pond 2 Seep: 1,1,2-TCA, mercury, arsenic and cadmium were the only chemicals detected at or above their respective AWQC.
- Barge Slip Seeps: 1,1,2-TCA, EDC, benzene, 1,3-dichlorobenzene, chlorobenzene, PCE, TCE, VC, 1,2,4,5-tetrachlorobenzene, bis(2-chloroethyl) ether, mercury, arsenic and other metals exceeded their respective AWQC in the Barge Slip seeps. The seeps with the highest concentration for most of these parameters are found at the Barge Slip South or Barge Slip Southeast seeps.

Surface Water: Surface water was sampled along the south shoreline of the Tennessee River along nine transects, including one transect in the Barge Slip. Surface water also was collected at the Outfall Ditch and at Outfall 001. The parameters that exceeded the AWQC (human health organism only) and the general location where the maximum exceedances occurred in each of these areas are listed below:

- Tennessee River: 1,1,2-TCA, 1,1,2,2-TCA, benzene, EDC, TCE, VC, PCE, bis(2-chloroethyl) ether, bis(2-ethylhexyl) phthalate, pentachlorobenzene and arsenic exceeded their respective AWQC in Tennessee River samples. None of the surface water samples from the river exceeded the AWQC for mercury. Most of the elevated chemical detections were in the Barge Slip area and are likely due to discharges of NAPL-impacted groundwater from the East Area.
- Outfall Ditch and Outfall 001: No VOCs exceeded the AWQC in the Outfall Ditch samples. Benzo(a)pyrene, benzo(b)fluoranthene, bis(2-ethylhexyl) phthalate, mercury and arsenic were detected above the AWQC in the Outfall Ditch samples.

Sediment: Bulk sediment samples were collected from the Tennessee River, from the Barge Slip and from the Outfall 004 Ditch. 1,1,2-TCA, EDC, benzene, 1,1-DCA, chlorobenzene, hexachlorobenzene, mercury and arsenic were detected in a significant number of samples at elevated concentrations. In general, the maximum exceedances occurred in the southwestern-most portion of the Barge Slip, and are likely due to the discharge of NAPL-impacted groundwater from the East Area and from seeps along the Barge Slip.

Sediment Porewater: Sediment porewater samples were collected at 15 locations in the Barge Slip. 1,1,2,2-TCA, 1,1,2-TCA, EDC, benzene, chlorobenzene, TCE, VC, bis(2-chloroethyl) ether, bis(2-ethylhexyl) phthalate and mercury exceeded their respective AWQC. In general, the maximum exceedances occurred in the southwestern-most portion of the Barge Slip, and are likely due to the discharge of NAPL-impacted groundwater from the East Area.

NAPL Zones: The presence of NAPL was evaluated on a spatial, vertical and lithologic scale to thoroughly delineate the distribution of NAPL zones at the Site using NAPL indicator data collected during the RI. The delineation process first evaluated the prevalence of the NAPL

---

[5] GPS seeps are those seeps periodically observed from visual inspections of the river bank area during normal to below normal river pool elevations. The GPS coordinates of these episodic seeps were recorded.

indicators to generate a score to rank the probability of NAPL occurrence at a given monitoring location that was subsequently used to develop a three-dimensional (3D) model of the organic NAPL-impacted soil distribution at the Site. Overall, it was estimated that between 1.1 (upper bound confirmed) and 3.5 (potential) million cubic yards of NAPL and NAPL-impacted soil is present at the Site. Elemental mercury NAPL is present in the subsurface at and downgradient of the former mercury cell building (MCB) in the Chlorine Plant Area. In general, elemental mercury is found near the ground surface around the former MCB and at increasing depths to the north and northwest of the MCB. Figures 19 and 20 show the horizontal and vertical extent of organic and mercury NAPL.

The following text provides a more detailed description of the nature and extent of the NAPL occurrence at the Site. The description is referred to as the “NAPL Architecture”, and further detail is provided in the RI/FS Reports. This detailed discussion is provided because the NAPL remaining at the Site most significantly influences the potential site risks and the scope of cleanup required to protect human health and the environment.

NAPL Architecture Type No. 1: NAPL Architecture (NA)-1 is defined as residual and pooled NAPL within the floodplain interbeds and clay/silt. The floodplain interbeds relevant to NA-1 occur within the saturated zone in the East Area and the West Floodplain Area, typically between elevations of approximately 295 and 325 feet amsl, respectively. The floodplain interbeds consist primarily of a fine-grained matrix (i.e., silty clay, clayey silt and silt) layered with fine sand or sandy silt beds.

The sandy silt beds typically are thin, with observed thicknesses ranging from tenths of a foot up to 1 foot. NAPL zones in NA-1 account for roughly 30 percent of the estimated NAPL volume at the Site. NA-1 occurs within the floodplain and the area contains several features that may limit implementation of certain remedial technologies. Surface water features in this area include the backwash filter pond and Carbide Industries’ rectangular and triangular ponds.

The River Tank Farm and pipe racks cover or traverse parts of Area of Investigation (AOI) 2. (For the purposes of conducting the RI, the Site was divided into multiple AOIs). The floodplain is routinely inundated by the Tennessee River.

NAPL Architecture Type No. 2: NA-2 is exemplified by pooled and residual NAPL present in permeable fine- and coarse-grained sands and/or gravels, which may contain thin layers of clay or silt, but with overall higher permeability and associated groundwater velocity than that attributed to NA-1. NAPL in the sand and gravel zones relevant to NA-2 occurs primarily in the East Area and West Floodplain Area, and is present to a lesser degree in the EDC/VCM Plant Area and the Ethylene Plant Area.

This zone typically occurs at elevations between 280 and 320 feet amsl, and below/outside the floodplain interbeds where they are present. NA-2 accounts for roughly 50 percent of the estimated NAPL volume at the Site. NA-2 is subject to many of the same physical access limitations and propensity to flooding as NA-1, depending on specific location.

NAPL Architecture Type No. 3: NA-3 is exemplified by pooled or residual NAPL present in

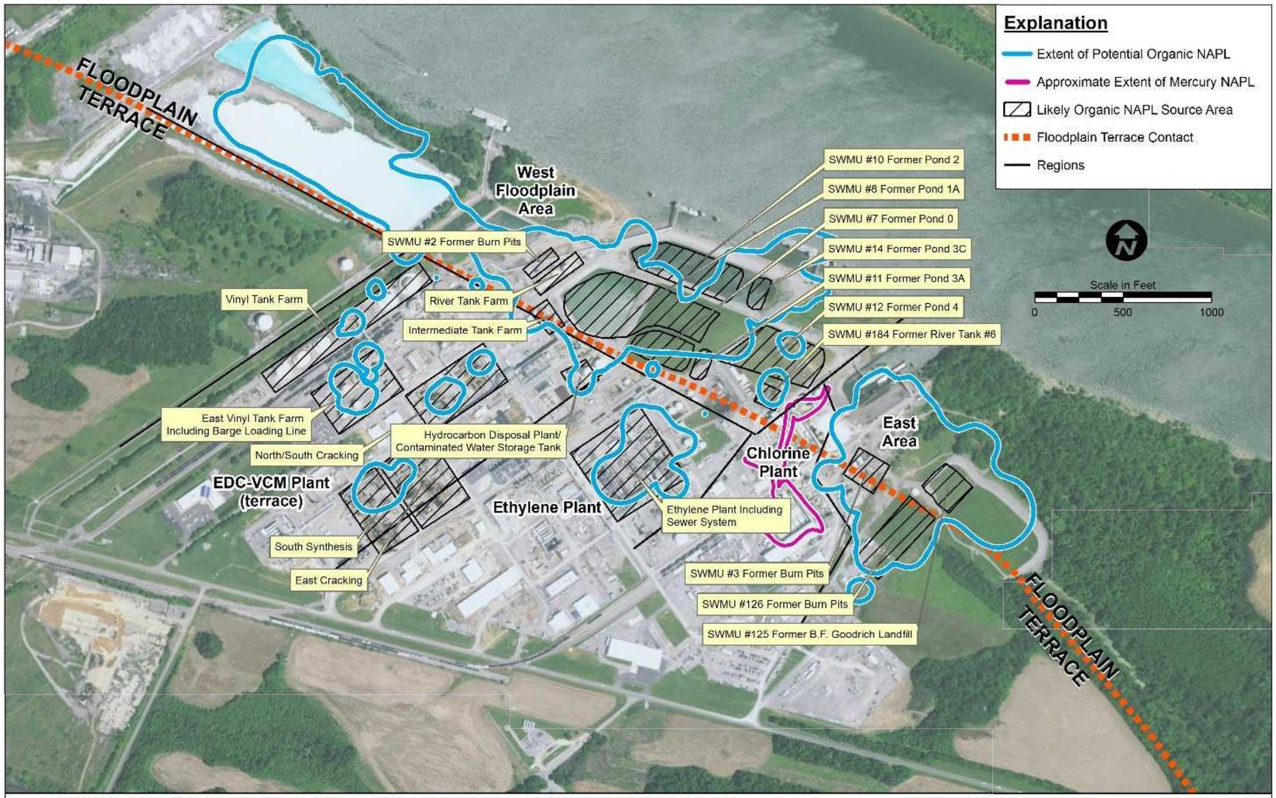


Figure 19. NAPL Delineation showing Extent of Potential NAPL (PI Value ≥ 30) and Likely Organic NAPL Sources

19_ROD_NAPL_DELINEATION_SHOWING_EXTENT_OF_POTENTIAL_NAPL03.MXD

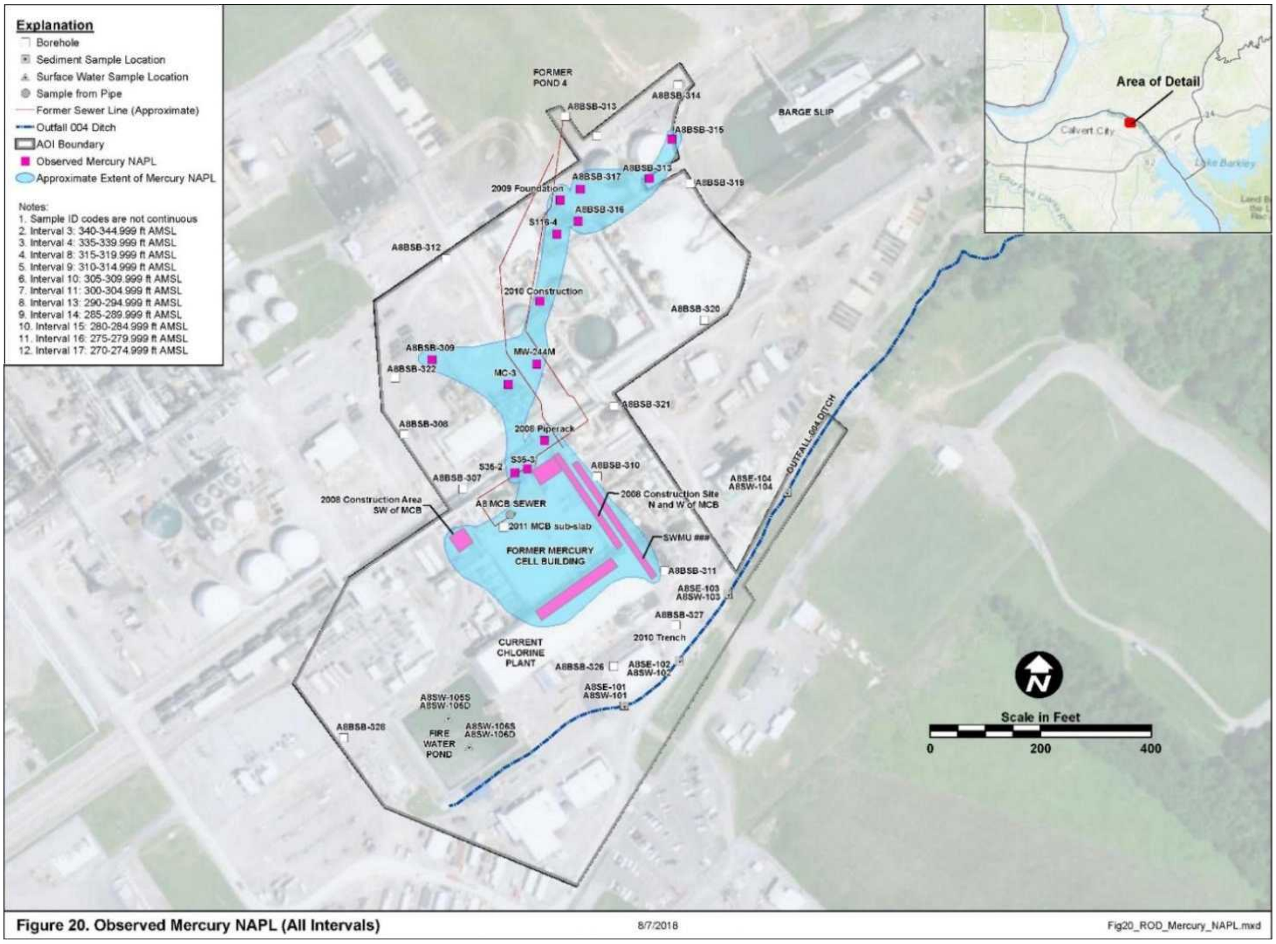


Figure 20. Observed Mercury NAPL (All Intervals)

8/7/2018

Fig20_ROD_Mercury_NAPL.mxd

interbeds that have a higher bulk hydraulic conductivity than those classified as NA-1. These interbeds are distinctly different from the floodplain interbeds because of the greater percentage of sandy material and the presence of thicker sand layers (up to a few feet thick). NA-3 interbeds generally occur between elevations of approximately 280 and 300 feet amsl. NAPL zones in NA-3 occur primarily in the East Area and the West Floodplain Area, and are present to a lesser degree in the EDC/VCM Plant Area and the Ethylene Plant Area. NAPL does not appear to be extensively present in this NAPL architecture, and accounts for roughly 6 percent of the estimated NAPL volume at the Site, depending on the groundwater level. NA-3 is subject to physical access limitations depending upon specific location. Access and construction limitations may be posed by the presence of storage tanks, surrounding structures, underground utilities and railroad tracks.

NAPL Architecture Type No. 4: NA-4 is exemplified by the presence of NAPL in the unsaturated zone. The unsaturated zone at the Site typically includes up to four different soil types: fine-grained fill, coarse-grained fill, clay/silt and shallow interbeds. NAPL within NA-4 typically occurs at depths above 30 feet bgs. NA-4 accounts for roughly 15 percent of the estimated NAPL volume at the Site, depending on the groundwater level. NA-4 is subject to many of the same physical access limitations and propensity to flooding as NA-1, depending on specific location. Given the range of permeability corresponding to these four lithology types identified in the unsaturated zone, the effectiveness of various remedial technologies may be depth-dependent and based on the lithologic zone(s) where NAPL is located. The depth of the unsaturated zone in the floodplain varies by at least 10 feet annually because of fluctuating groundwater and river levels. Portions of NA-4 in the floodplain may therefore be saturated at certain times. However, because NA-4 is unsaturated at other times, it renders a distinct NAPL architecture, and technology evaluations must consider the fluctuating water table conditions. NA-4 is subject to physical access limitations and propensity to flooding depending on the location. Access and construction limitations may also be posed by the presence of storage tanks, surrounding structures, underground utilities and railroad tracks. Certain NAPLs are more pumpable than others. NA-2 constitutes about 50 percent of the NAPL and appears to be pumpable. NA-4 constitutes about 15 percent of the NAPL and may also be pumpable but some of this may be difficult to access due to its location.

Vapor Intrusion: Results from the vapor intrusion investigation conducted during the RI indicated elevated levels of VOCs in the indoor air in nine of the 13 administrative buildings sampled. A comparison of the sub-slab data with the outdoor air data indicate that the elevated indoor air levels are likely from the outdoor ambient air rather than the subsurface Tennessee River. Results from the 2016 and 2017 offshore sampling events revealed that NAPL had migrated from beyond the facility boundary near the Propane Dock and Pond 2 area beneath the Tennessee River. Estimates indicate that the NAPL has spread over a 3-acre area. The NAPL is generally present in the sandy zones located between 7 and 25 feet below the river bottom. Associated with the NAPL in this area are zones of elevated levels of contaminated sediment. Contaminants detected generally include VOCs such as EDC and benzene and polycyclic aromatic hydrocarbons (PAHs) such as naphthalene. Although mercury was detected, it was observed at significantly lower levels than levels observed at onshore locations. The distribution of the mercury, total VOCs and NAPL contamination in the offshore sediment is shown in Figures 21, 22 and 23, respectively.

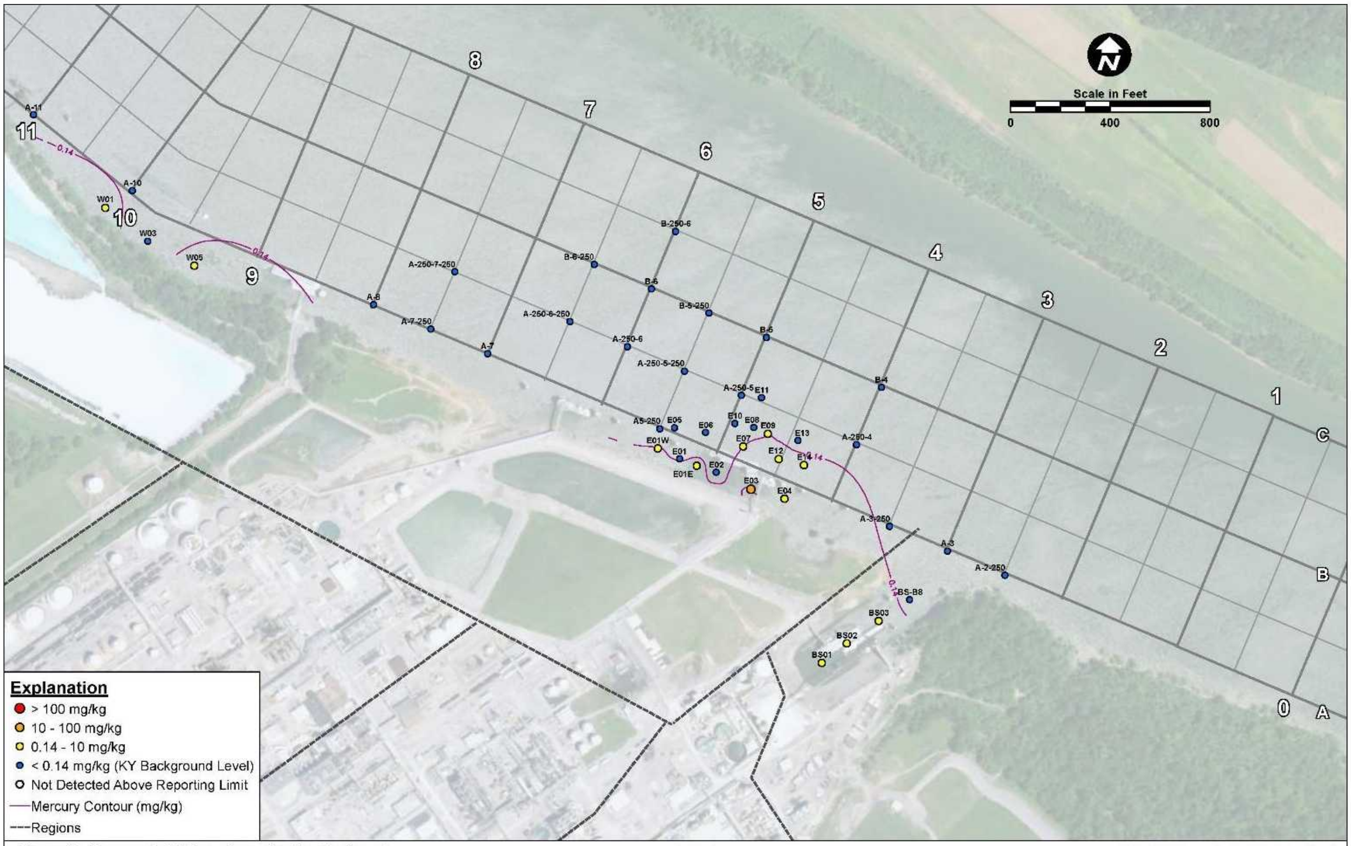


Figure 21. Mercury in Offshore Investigation Sediment

8/7/2018

Fig21_ROD_Mercury_SoilSed_2016Data_r09.mxd

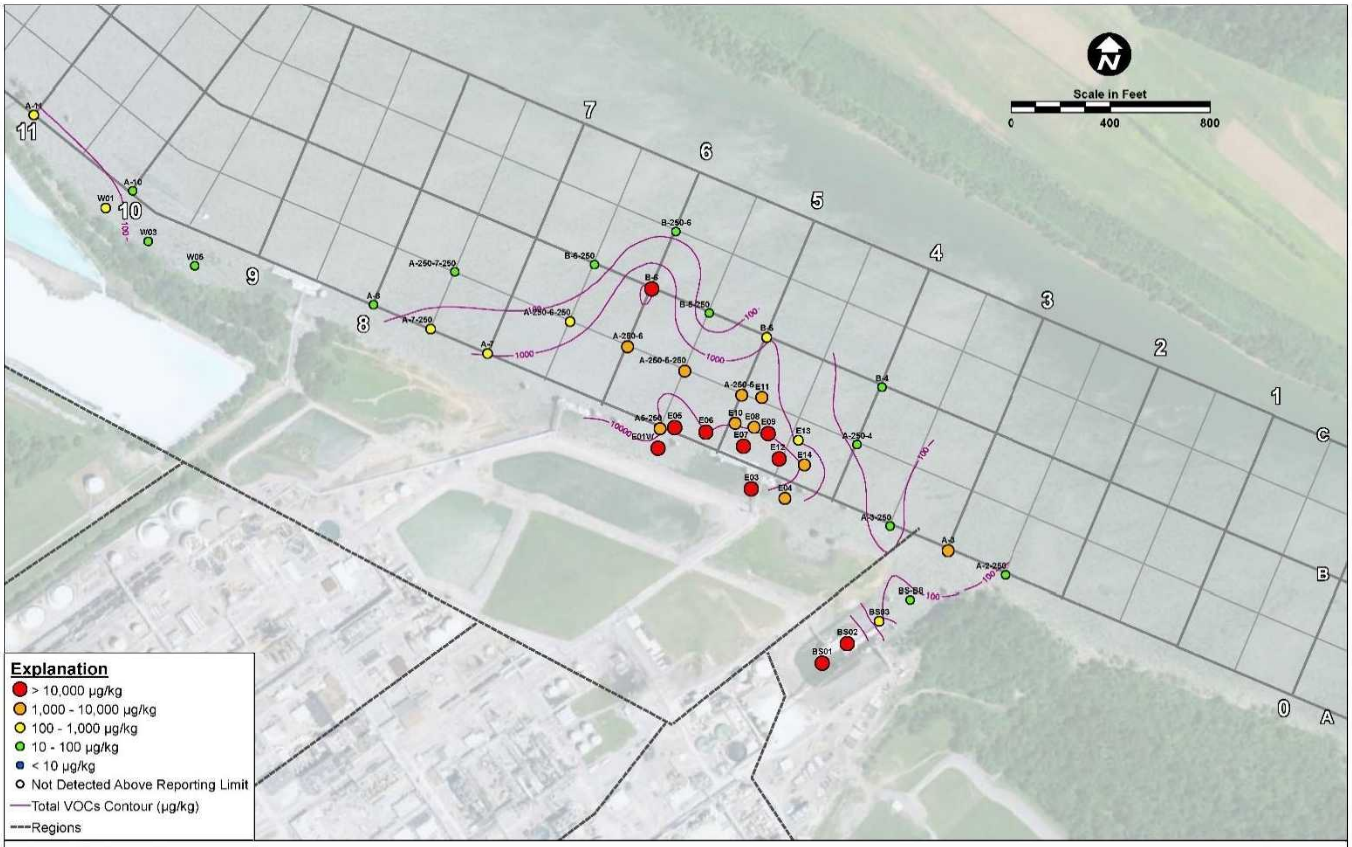


Figure 22. VOCs in Offshore Investigation Sediment

8/7/2018

Fig22_ROD_TotalVOCs_SoilSed_2016Data_r09.mxd

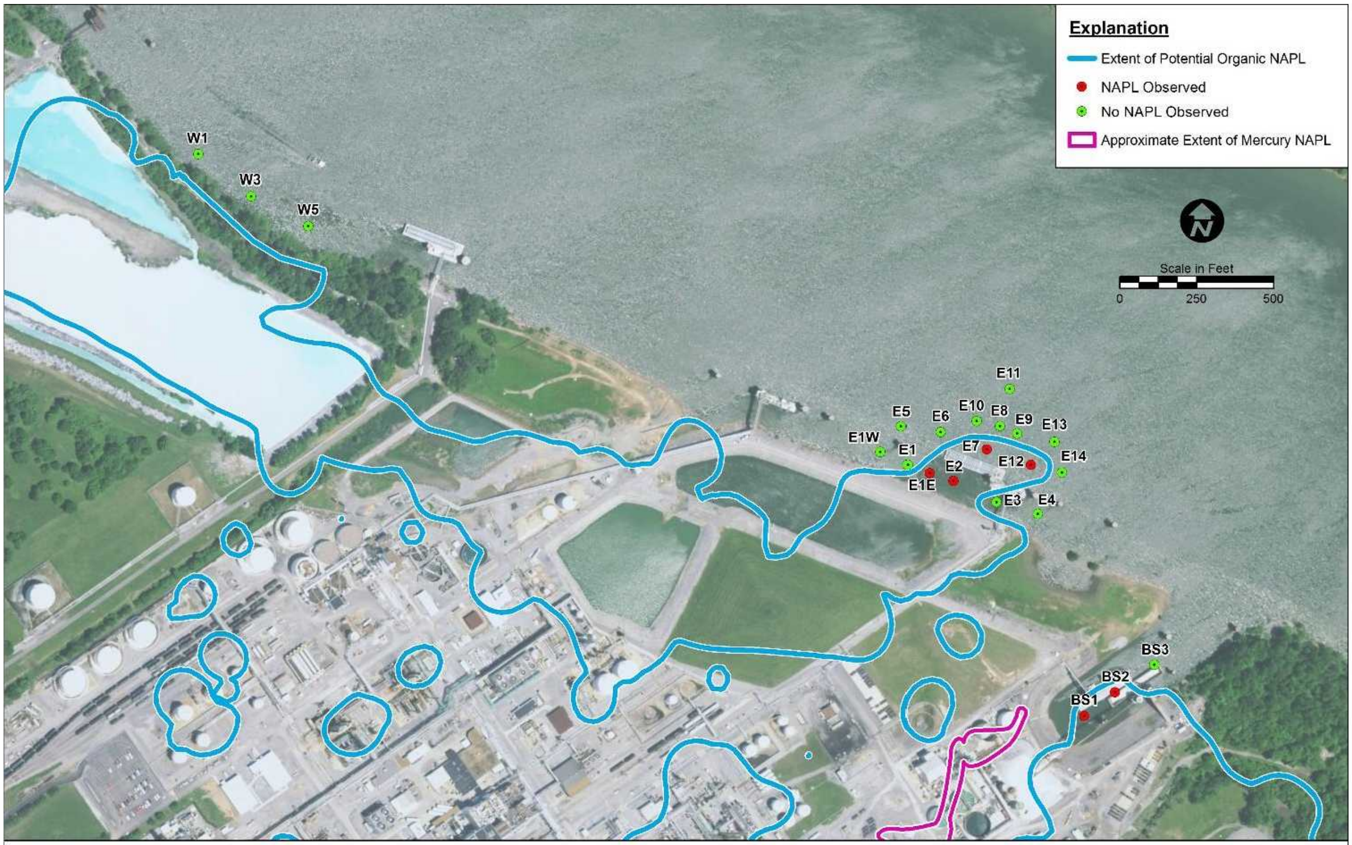


Figure 23. Offshore NAPL Distribution 08/18 23_ROD_OFFSHORE_NAPL_DISTRIBUTION02.MXD

In addition to the mass of NAPL and contaminated sediment beneath the river, a groundwater plume extends from beneath the Site underneath the river over an area approximately 50 acres in size. The groundwater plume exhibits the same types of contaminants observed in the NAPL and contaminated soil beneath the river. The distribution of total VOCs and mercury in offshore groundwater is shown in Figures 24 and 25, respectively.

5.7 Conceptual Site Model

From a review of the data presented in the RI and RI Addendum, it is evident that the contamination at the Site is widespread, affecting all media. The most prevalent contamination is the highly concentrated source material (i.e., NAPL) that has been released from leaking tanks, sewers, sumps, spills, unlined ponds and unlined burn pits, and migrated into the subsurface soils. The NAPL has generally migrated through the higher-permeability soils and come to rest on the intervening layers of lower-permeability soils. With time, the contaminants have diffused into the surrounding soil. Figure 26 shows different views of a 3D representation of the estimated extent of the NAPL-impacted soil at the Site.

As water encounters the NAPL and NAPL-contaminated soil at the Site, either as rainfall infiltration or groundwater flow, contaminants diffuse into the groundwater. Because groundwater flow is toward the Tennessee River, the contaminated groundwater not contained by the PCAP system enters the river either through upwelling, or during periods of low river elevation, through groundwater seeps along the river bank.

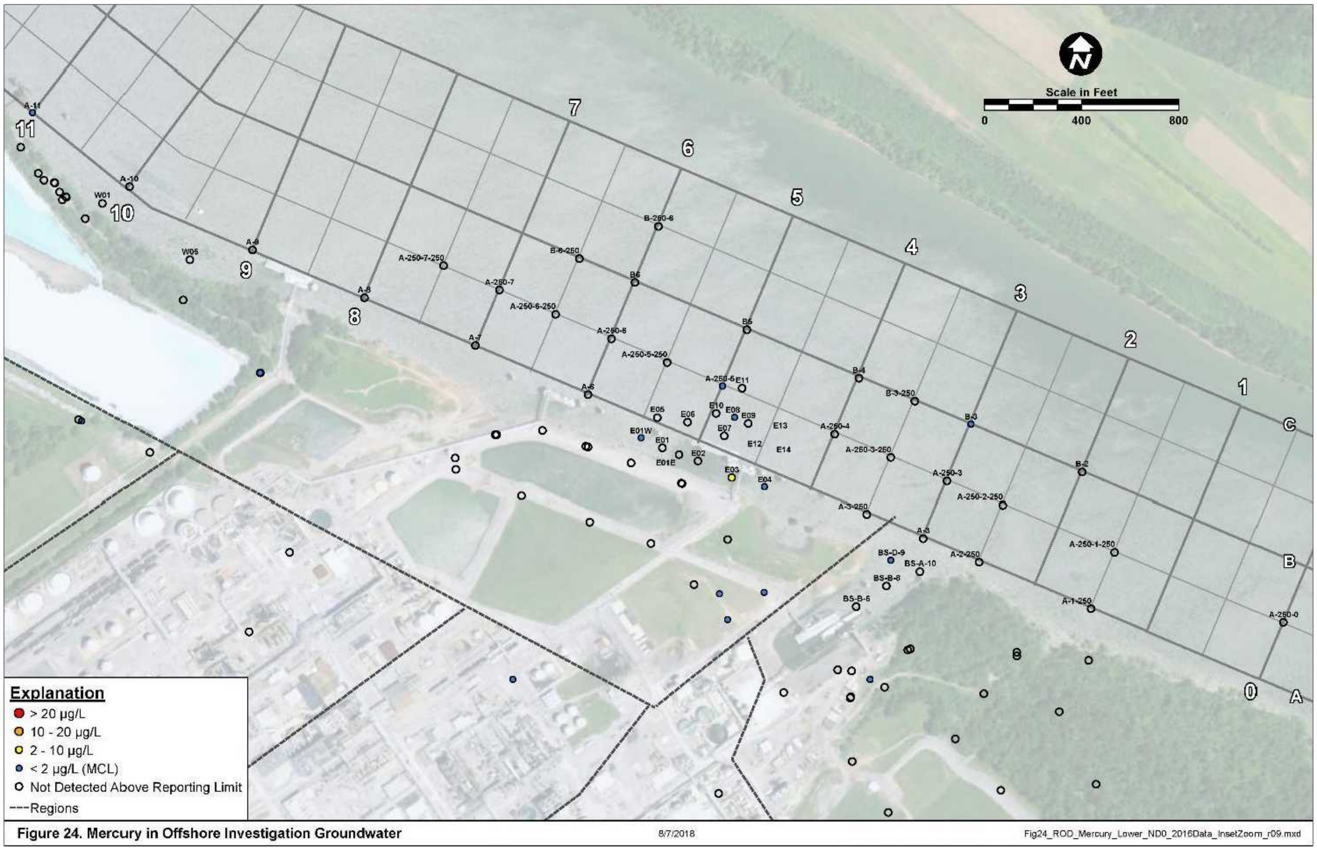


Figure 24. Mercury in Offshore Investigation Groundwater 8/7/2018 Fig24_ROD_Mercury_Lower_ND0_2016Data_InsetZoom_r09.mxd

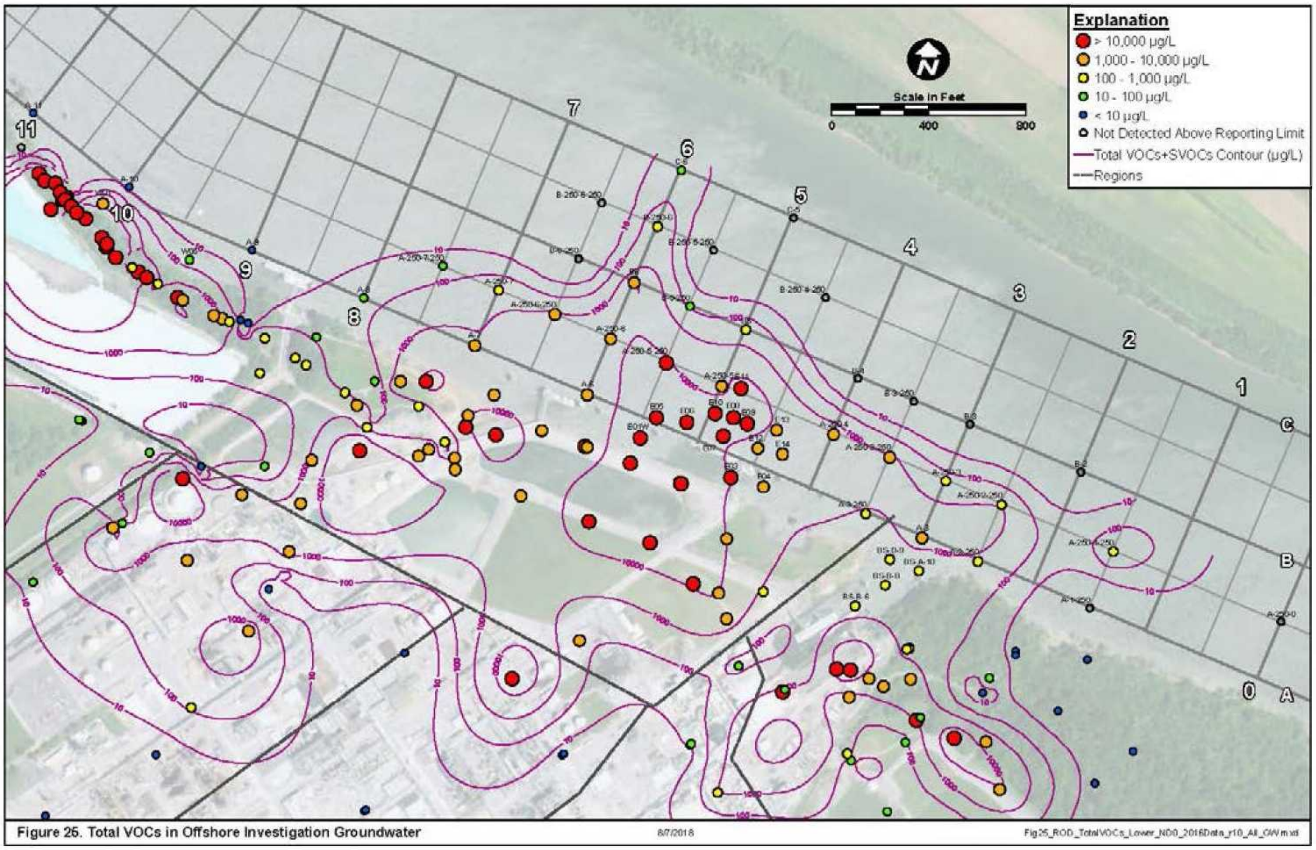


Figure 26. Total VOCs in Offshore Investigation Groundwater 8/7/2018 Fig25_ROD_TotalVOCs_Lower_ND0_2016Data_r10_All_OW.mxd

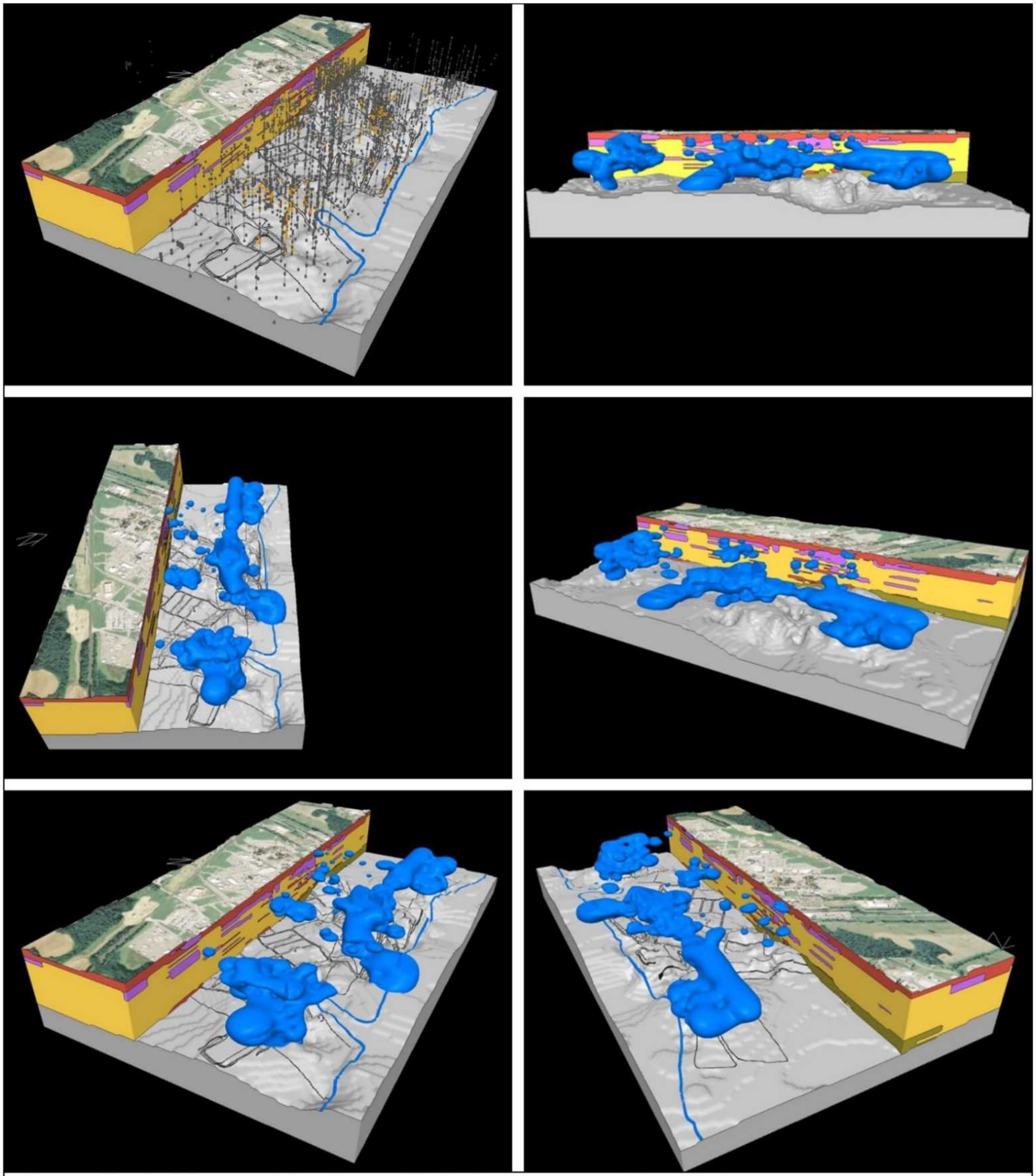


Figure 26. 3D Views of Simulated NAPL Source Zone Distribution 07/18 26_ROD_3D NAPL SZ02.CDR

Although the groundwater modeling indicates that groundwater from the Site and surrounding area within the model domain discharges at a rate of about 400 gpm, the massive flow of the Tennessee River and active hyporheic zone results in the rapid attenuation of groundwater contaminants discharging to the river.

There are comparatively low contamination levels in the sediments beneath the main portion of the Tennessee River adjacent to the Site. However, data collected from the investigation of the Barge Slip area indicate the presence of elevated levels of VOCs, SVOCs and mercury in the sediments accumulated in the southern end of the Barge Slip. The contaminated sediments are likely from discharge from the southern and eastern bank of the Barge Slip, where the organic NAPL and mercury is likely an expression of the horizontal migration from releases upgradient of the Barge Slip.

Contaminated soil and groundwater underlying the Site pose a potential for the occurrence of contaminated vapors in the vadose zone and intrusion of vapors to indoor air spaces. An investigation of indoor air in buildings occupied by administrative workers not regulated under Occupational Safety and Health Administration (OSHA) indicated elevated levels of VOCs. The maximum indoor air risks estimated was 5×10^{-4} for cancer risks and a hazard index (HI) of 20 for non-cancer risk. However, a comparison of the outdoor air and sub-slab data indicates an outdoor air source of the VOCs. The elevated levels of VOCs encountered in the outdoor air may be attributable to point and non-point emissions from plant operations.

6.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

6.1 Land Uses

The Site is located in a relatively industrialized area in Marshall County, Kentucky. Except for the industrial plants in the northern portion of the county, much of the economy is agriculturally based. As of the 2010 Census, about 31,000 people lived in the county. About 3,000 people live in Calvert City. The city limits encompass an area of approximately 14 square miles. The 16 industrial plants in the Calvert City area are a major contributor to the economy.

The Site is about 250 acres in size and active industrial facilities currently occupy much of the land. Figure 5 shows the current boundaries of these operating facilities. Westlake is the current owner/operator of the B.F. Goodrich facility. According to the company, it is the primary source of VCM in the eastern United States. Over the past decade, it has continued to expand facility operations eastward and northward, investing over $1 billion in capital improvements.

Kentucky has a rich Native American history. Culturally, the land that is now part of western Kentucky was part of the Jackson Purchase where the United States government purchased the land from the Chickasaw Indians in 1818. Marshall County was eventually created in 1842 by the Kentucky Legislature. Major tribes in the area included the Chickasaw, Cherokee and Shawnee. Indian artifacts such as arrowheads and pottery can be found in plowed fields and along the banks of the Tennessee and Cumberland Rivers. There are anecdotal reports of an Indian camp at the former Haddock Ferry crossing that was reportedly established in 1836 for the crossing of the Tennessee River. The former ferry crossing is about a mile downstream from the Site.[6]

---

[6] This information is the extent of the information found from a screening survey of the cultural resources in the area.

The Calvert City area remained primarily farmland until the construction of the Kentucky Lake Dam on the Tennessee River. The dam is located about 5 miles upstream from the Site. Figure 27 features a photo of the farmland along the south bank of the Tennessee River from *LIFE Magazine* (circa 1953)*,* prior to construction of the B.F. Goodrich facility. Construction of the hydroelectric plant at the Kentucky Dam in the early 1940s enabled the industrialization of the Calvert City area. Because of the extent of existing industrial uses in the area and the readily available supply of undeveloped land, future use of the site area is expected to remain commercial/industrial.

Figure 27. Photo of the Farmland
(LIFE Magazine, 1953)

6.2 Groundwater and Surface Water Uses

KDEP considers all groundwater in Kentucky to be a potential drinking water resource. The saturated zone beneath the Site is a potential drinking water aquifer (Class II) in accordance with EPA's 1986 Groundwater Classification Guidance. Groundwater is used locally for domestic and industrial purposes. Some private wells are located upgradient of the Site. The Calvert City drinking water supply wells are located approximately 3 miles southeast and upgradient of the Site and the other industrial complexes in Calvert City.

The main surface water body near the Site is the Tennessee River, which runs along the northern boundary. The headwaters of the Tennessee River form in eastern Tennessee, and the river is one of the few rivers in the United States that flows northward. The Tennessee River passes through several states, eventually merging with the Ohio River. At the Site, KDEP has assigned the following classifications to the Tennessee River pursuant to Kentucky Administrative Regulations (KAR) 401 10.026: WAH (warm water aquatic habitat), PCR (primary contact recreation), SCR (secondary contact recreation); and OSRW (outstanding resource water). Near the Site, the river is also designated as a critical habitat for endangered and threatened mussels. About 20 miles downstream of the Site, the City of Paducah has a raw water intake that is used to supply drinking water after treatment.

7.0 SUMMARY OF SITE RISKS

As identified through human health and ecological risk assessments performed as part of the RI, the greatest risk to human health and the environment is the exposure to contaminants that discharge to the Tennessee River through the groundwater seeps. Other environmental media evaluated in the risk assessments include groundwater, surface water and sediment associated with the Tennessee River and onshore surface water features such as soil and indoor and outdoor air. Potential human receptors include individuals who use the Tennessee River for recreational purposes or walk along the banks of the river, plant workers, and a hypothetical future resident. Ecological receptors include lower- and upper-level trophic organisms associated with the water and sediment of the Tennessee River, on-site ponds, and drainage features. NAPL serves a source of contamination to other exposure pathways and could also pose a significant risk should direct exposure occur.

An important point regarding the evaluation of potential risks to receptors associated with the Tennessee River is that the risk estimates are not representative of “baseline” conditions. There is currently a 600-gpm RCRA groundwater collection and treatment (PCAP) system that mitigates the potential risk from exposure to groundwater discharge to the river. Without the interception of the contaminated groundwater by the PCAP system, potential risks associated with exposures at the river would likely be much higher.

As such, the ecological and human health risk assessments conducted for the Site are not referred to as “baseline”, but rather in more general terms as an ecological risk assessment (ERA) and a human health risk assessment (HHRA).

7.1 Human Health Risk Assessment

Table 1 summarizes the results of the HHRA. As noted above, the greatest risk to potential human receptors is from exposure to the groundwater seeps along the banks of the Tennessee River. An adolescent receptor exposed to the groundwater seeps could experience an increased cancer risk of 6×10^{-3} and a non-cancer health hazard of 500. As shown in Table 1, the increased cancer risk is based on the inhalation of EDC and the increased non-cancer hazard from the inhalation of EDC and 1,1,2-TCA.

Potential risk to a hypothetical future resident was also evaluated for the purposes of demonstrating the need for covenants to restrict future use of the Site to commercial/industrial uses and to prevent the future use of the Site for residential purposes or to use groundwater within the site area for potable purposes. For a hypothetical future resident’s potential exposure to chemicals in surface soil, cancer risk is estimated to be 5×10^{-4} and the non-cancer health hazard is 5.

Table 1. Summary of Potential Cancer Risks and Non-Cancer Health Hazards to Human Receptors

Receptor	Cancer	HI	Media
Commercial/Industrial Worker	1×10^{-4}	3	Soil, Surface Water, Sediment, Ambient Air
Commercial/Industrial Worker	5×10^{-4}	20	Indoor Air[a]
Recreational, Adolescent	1×10^{-4}	0.3	Surface Water, Sediment
Recreational, Adolescent	3×10^{-5}	0.7	Fish, Shellfish Tissue
Recreational, Adult	4×10^{-5}	0.2	Surface Water, Sediment
Recreational, Adult	1×10^{-4}	0.7	Fish, Shellfish Tissue
Trespasser, Adolescent	6×10^{-3}	500	Groundwater Seeps
Construction Worker	1×10^{-5}	60	Subsurface Soil
Hypothetical Resident	5×10^{-4}	5	Surface Soil
Recreational Adolescent without Groundwater Intercept System	3×10^{-1}	10,085	Surface Water, Groundwater Seeps

[a] VI to an industrial/commercial worker was evaluated based on indoor air samples collected from 13 office buildings. The highest cancer risk and non-cancer hazard estimates (from Building 2) are presented.

Similarly, potential risks were evaluated for human receptors exposed to the Tennessee River water and the groundwater seeps as if there was no interception of groundwater prior to the discharge to the river. The cancer risk and non-cancer health hazard were estimated at 3×10^{-1} and 10,085, respectively, demonstrating the need to prevent the discharge of contaminated groundwater from the banks of the Tennessee River and into the Tennessee River proper.

A risk evaluation of the additional offshore investigative data suggested that there is no human health risk associated with contaminants detected in the shallow groundwater. Human direct contact exposure to river water discharging at the river bottom is not likely, given the depth of the river water in relation to a receptor swimming in the river and the dilution that would occur between the deep river water and the actual human health exposure point near the river's surface. For an indirect human exposure to shallow groundwater (i.e., through consumption of clams and fish) there may be potential risk associated with a single benzene detection of 280 micrograms per liter (µg/L) based on comparison to AWQC. However, comparison of a single elevated detection to the AWQC to evaluate human health risk associated with consumption of organisms is a very conservative approach, given mixing and dilution near the river-sediment interface and, more importantly, the fact that VOCs are not typically known to bioaccumulate.

Appendix D provides a summary of the information used to estimate the human health risks from exposure to contaminated groundwater.

7.2 Ecological Risk Assessment

The ERA modeled uptake of VOCs and SVOCs that cause a general narcosis response to estimate risk to aquatic organisms such as invertebrates and fish and compared media concentrations to literature-based screening benchmarks to evaluate risks due to phthalate (i.e., bis[ethylhexyl]phthalate) and metal exposure. Food chain modeling also was conducted to estimate risks to aquatic-dependent (e.g., great blue heron, raccoon and mink) and terrestrial (e.g., American woodcock, southeastern shrew and red-tailed hawk) wildlife. Finally, subsurface soil vapor data were compared to literature-based ecotoxicological benchmarks to evaluate potential risk to burrowing birds and mammals.

Table 2 provides a summary of the parameters considered in the development of the ERA. The ERA indicated the potential for increased risk to avian receptors from the ingestion of invertebrates and aquatic organisms contaminated by mercury near the Barge Slip and the Tennessee River. The ERA also indicated an increased risk to aquatic organisms near the seeps.

Under current conditions, a narcosis index of 338 was estimated for sedentary aquatic organisms (i.e., mussels, invertebrates, fish eggs) located near the groundwater seeps. Without the interception of the contaminated groundwater, the narcosis index for aquatic receptors near the seeps is estimated to increase to approximately 50,000.

The analysis of potential risks to ecological receptors has significant implications given the high-quality habitat provided by the river, floodplain and upland areas along the river. In addition to providing a recreational fishery, the river serves as a significant food source to local avian and mammalian receptors.

Table 2. Summary of ERA Parameters Evaluated

Exposure Area	Medium	Receptor	Contaminant of Potential Ecological Concern[a]
Tennessee River	Surface water	Aquatic invertebrate	Barium, lead, mercury[b]
	Sediment	Aquatic invertebrate	Bis(2-ethylhexyl) phthalate, arsenic, barium, chromium, copper, cyanide, mercury, nickel, vanadium
	Seeps	Aquatic invertebrate	1,1,2-TCA, 1,1-DCA, 1,1-DCE, 1,2-dichlorobenzene, EDC, benzene, chlorobenzene, chloroform, naphthalene, PCE, TCE, VC, barium, cadmium, cobalt, cyanide, lead, mercury[b], nickel, zinc
	Combined[c]	Great blue heron	Mercury[b]
Barge Slip	Surface water	Aquatic invertebrate	Bis(2-ethylhexyl) phthalate, barium, mercury[b]
	Sediment	Aquatic invertebrate	Bis(2-ethylhexyl) phthalate, chlorobenzene, naphthalene, mercury[b]
	Seeps	Aquatic invertebrate	1,2-Dichlorobenzne, EDC, 1,2-dichloroethene, chlorobenzene, naphthalene, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury[b], nickel, selenium, silver, vanadium, zinc
	Sediment Porewater	Aquatic invertebrate	Bis(2-ethylhexyl) phthalate, chlorobenzene, mercury[b]
Ponds 1A/2	Combined[c]	Great blue heron	Mercury[b]
Outfall 004 Ditch	Surface water	Aquatic invertebrate	Bis(2-ethylhexyl) phthalate, mercury[b]
	Sediment	Aquatic invertebrate	Bis(2-ethylhexyl) phthalate, copper, mercury[b], nickel, zinc
Terrestrial Habitat	Soil	Soil invertebrate	PCE, TCE, barium, chromium, mercury[b], vanadium, zinc
	Combined[d]	American woodcock, southeastern shrew	Mercury[b]

[a] Retained contaminants of potential ecological concern are those remaining following screening and refinement evaluations for those analytes with risk hazard quotient values exceeding 1.

[b] Mercury was retained for each medium where it was detected because of bioaccumulation hazard concerns.

[c] Includes surface water, surface soil and fish tissue.

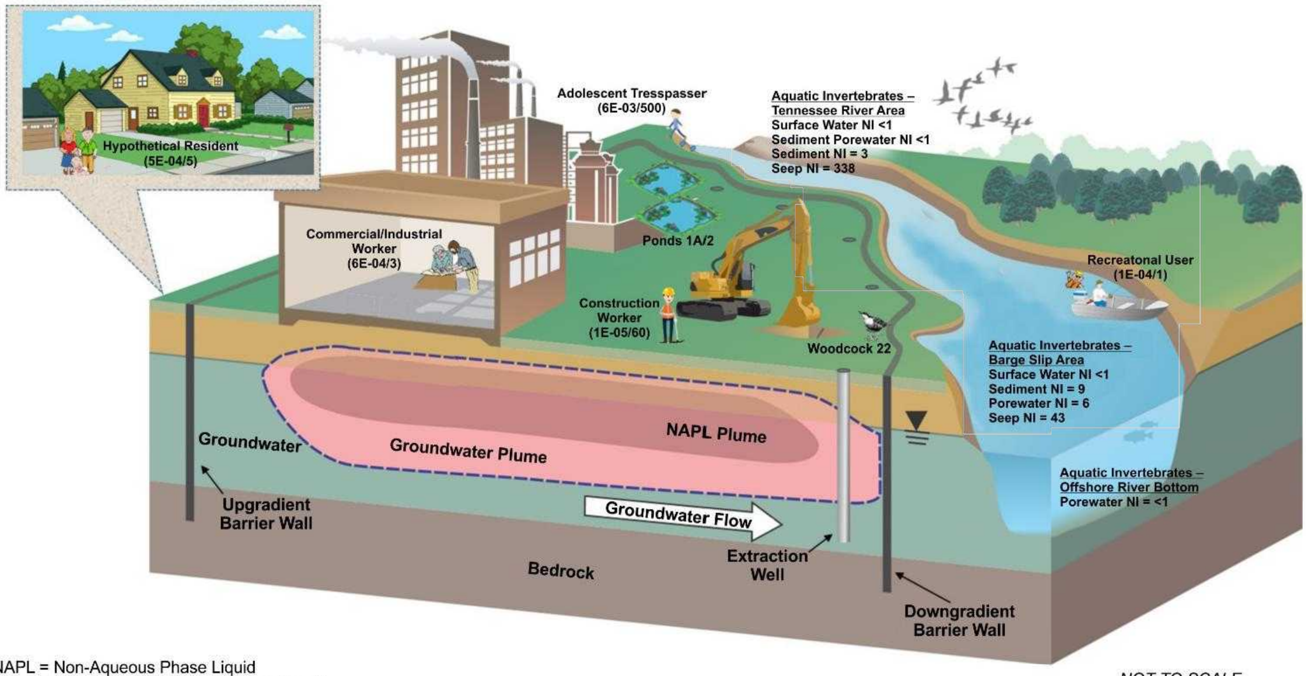
[d] Includes surface water, surface soil and earthworm tissue.

Bald eagles and osprey nest along the river near the Site. The blue heron has also been observed feeding along the river and the on-site ponds. These upper trophic receptors could be impacted through the ingestion of contaminated invertebrates or aquatic organisms. Narcosis effects could have an indirect impact to these receptors through the reduction in available food biomass.

Potential risks also were evaluated for the NAPL and groundwater contamination that extends beneath the main river channel. The offshore NAPL and related contaminated sediment is located roughly 7 to 25 feet below the river bottom and there is no evidence that ecological receptors are exposed to the NAPL and contaminated sediment under current conditions. Rather, the NAPL and contaminated sediment are serving as a reservoir of contaminants that could dissolve into groundwater and discharge to the river.

Sediment porewater samples collected from the river bottom, downward to a depth of 6 inches, indicated the presence of benzene, EDC and naphthalene in the low parts per billion (ppb) (e.g., µg/L) range. These data were collected to evaluate exposure to potential benthic organisms and better understand the correlation with groundwater VOC concentrations measured at greater depths beneath the river. Twenty-two VOCs were detected in sediment porewater and the maximum concentrations of benzene and naphthalene exceed their respective chronic surface water screening benchmarks. Naphthalene was detected only once at a concentration four-fold higher than the benchmark (i.e., hazard quotient of 4) and the hazard quotients based on maximum and average benzene concentrations are 1.8 and 0.23, respectively. In addition to comparing the concentrations to individual screening benchmarks, the combined narcosis effects associated with exposure to detected VOCs were estimated using narcosis-based chronic values (developed as described in the ERA). A narcosis index was estimated for each of the 20 porewater samples collected as part of the supplemental sampling program by summing the individual narcosis quotients (detected concentration divided by chemical-specific chronic value). Narcosis index values range from 0.00076 (25-PW1) to 0.026 (32-PW1), indicating narcosis-related effects are unlikely in river benthic biota currently exposed to sediment porewater. Narcosis effects do not appear to be a significant concern based on evaluation of current conditions in this supplemental sampling dataset. Figure 28 provides an illustrated summary of these risks along with the conceptual site model for the Site.

In addition to the calculation of potential risks to human and ecological receptors exposed to site-related contaminants, site data were also compared to maximum contaminant levels (MCLs) and AWQC, which are included in Appendix D.



NAPL = Non-Aqueous Phase Liquid
NI = Narcosis Index (maximum assumptions)
Ecological results are provided for the 95% UCL HQ_{NOAEL}
Human health results are provided for the cancer risk and noncancer hazard

NOT TO SCALE

Figure 28. Conceptual Site Model

28_ROD_CSM_RISK04.CDR

7.3 Basis for Action

The primary basis for undertaking a CERCLA action at the Site is the threat to the groundwater resource underlying the Site and the adjacent Tennessee River. The estimated 3.5 million cubic yards of NAPL and NAPL-impacted soil pose an almost infinite source of contamination to the groundwater. KDEP considers all groundwater within Kentucky to be a potential drinking water resource. Additionally, the groundwater beneath the Site is classified as a potential drinking water aquifer. As a result, CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) require restoration of potential drinking water resources to their beneficial use.

Near the Site, groundwater flows toward and discharges to the Tennessee River. This discharge presents a potential contaminant migration pathway, either through the seepage of groundwater from the riverbank, or upwelling of contaminated groundwater from below the riverbed. Groundwater emerging from the riverbank is a direct reflection of the groundwater quality in the area, which can be problematic if encountered by human or ecological receptors.

Although the upwelling of contaminated groundwater to the river represents a significant transfer of contaminant mass to the river, the large river-flow volume results in the rapid dilution of the contaminants. As a result, the potential risks to the ecological receptors in the river water from the discharge of contaminated groundwater are negligible at this time. The potential risk, however, would likely increase without the interception of contaminated groundwater and NAPL to the river.

8.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are identified following completion of the risk assessments and describe what the selected remedy is expected to achieve. These objectives are based on available information, unacceptable risks, standards such as ARARs and site-specific risk-based levels, if applicable.

To aid in the development of the RAOs, data collected from the Site were evaluated considering human health and ecological risk-based benchmarks and regulatory standards to identify the primary group of chemicals of concern (COCs).[7] Table 3 lists the media-specific COCs and associated cleanup criteria developed for the Site.

Based on this information, the RAOs for the Site are as follows:

<u>Groundwater/Seeps</u>

- Prevent migration of contaminated groundwater to surface water that could:
    - Pose a risk to human receptors through the ingestion of contaminated organisms.
    - Pose a risk to ecological organisms.
    - Degrade water quality based on its intended use.

---

[7] These are the primary COCs. Other chemicals are present at the Site that qualify as a COC, but were detected with less frequency or concentration. Mitigating risks from the primary COCs will address the risks posed by the chemicals observed during the RI. Groundwater restoration will require attainment of MCLs for all site-related contaminants.

- Prevent human exposure to contaminated groundwater through ingestion, direct contact or inhalation.
- Restore contaminated groundwater beneath the Tennessee River to its beneficial use for drinking water purposes.
- Prevent expansion of groundwater plumes onshore and offshore.

Table 3. Summary of Primary COCs and Cleanup Criteria[8]

Chemical Class	Chemical	Groundwater[a]	Seeps[b]	Surface Water[2]	Sediment Porewater[c]
VOCs	1,1-DCA	-[3]	-	-	-
	1,1,2-TCA	5	12	12	12
	1,1,2,2-TCA	-	1	1	1
	1,1-DCE	7	-	-	-
	EDC	5	13	13	13
	Benzene	5	6.2	6.2	6.2
	Chlorobenzene	100	600	-	600
	Naphthalene	-	-	-	-
	PCE	5	40	-	-
	TCE	5	4	4	4
	VC	2	0.68	0.68	0.68
Metals	Mercury	2	-	0.77	7.00

[a] Criteria are based on MCLs at the time of the RI/FS. Concentration units are in µg/L.
[b] Criteria are based on AWQC at the time of the RI/FS. Concentration units are in µg/L.
[c] "-" denotes that this chemical is not a COC for the corresponding media.

During the development of the Proposed Plan, EPA concluded that it is technically impracticable to restore groundwater beneath the onshore portion of the Site to drinking water quality in a reasonable timeframe. The large volume of NAPL, site-specific hydrogeologic properties and limited access because of plant infrastructure prevent the mitigation of the entire source contributing to groundwater contamination. Therefore, MCLs are waived as ARARs for the onshore groundwater. Appendix B provides a detailed discussion of the basis for the TI waiver.

Organic and Mercury NAPL

- Recover organic NAPL and mercury NAPL to the extent practicable.[9]
- Treat NAPL where practicable and necessary to mitigate unacceptable risks.

---

[8] No cleanup criteria are developed for site soils or sediments. For potential ecological exposures in the Outfall Ditch and Barge Slip Areas, soil and sediment are being removed to break the potential exposure pathway, rather than attain risk-based levels.

[9] The unique chemical properties of mercury NAPL make it significantly harder to recover than organic NAPL. Recovery of significant volumes of mercury NAPL would require a change to the vapor density accomplished by heating the soil impacted by mercury NAPL, which is beyond the scope of the RA presented in this ROD. Onshore recovery of NAPL is expected to be limited to passive means of recovery.

- Contain and prevent organic NAPL and mercury NAPL migration.
- Prevent human and ecological receptor exposure to NAPL to protective levels.

Other Media

- Prevent human exposure to contaminants in soil, sediment, sediment porewater and air that could cause an increased risk from ingestion or direct contact.[10]
- Prevent exposure of ecological receptors to contaminants in soil, sediment, sediment porewater or surface water that could pose an unacceptable risk.

These RAOs reduce risks to human health and the environment by restoring groundwater outside the facility to attain MCLs and protect surface water quality as measured by KDEP AWQC. Because no numerical concentration value is available for the identification of NAPL, a weight-of-evidence approach is being used to establish the NAPL extent as a cleanup decision is selected. This approach considers a combination of factors such as direct NAPL observations, qualitative indicators (i.e., a dye test) and measured chemical concentrations.

9.0 SUMMARY OF ALTERNATIVES

The following is a summary of the remedial alternatives developed in the FS based on the results from the RI and associated risk assessments. The FS Report should be consulted for specific details on the alternatives. Because of factors such as the size of the Site, the affected media and the potential cleanup technologies, the alternatives are organized into three general groups. Cleanup alternatives evaluated address: (1) onshore source area contamination beneath the active chemical complexes associated with the Site; (2) NAPL contamination beneath the river; and (3) groundwater contamination beneath the river, outside of the NAPL area. Appendix E presents remedial alternative cost summary tables.

In addition to the alternatives for these three areas, remedial elements common to the cleanup of the Site, regardless of the remedy selected for the three individual areas, were developed. These common elements are presented first in the discussion below. The costs for the common elements are generally expressed as capital costs and are presented separate from the costs for the remedial alternatives developed for the Site.

The remedial alternatives were developed based on CERCLA Section 121(b)(1), U.S.C. §9621(b)(1), which mandates that RAs be protective of human health and the environment, be cost effective, and use permanent solutions, alternative treatment technologies and resource recovery alternatives to the maximum extent practicable. Section 121(b)(1) also established a preference for RAs which use, as a principal element, treatment to permanently and significantly reduce the volume, toxicity or mobility of the hazardous substances, pollutants and contaminants at the Site. As noted above, CERCLA Section 121(d), 42 U.S.C. § 9621(d) specifies that a RA must require a level or standard of control of the hazardous substances, pollutants and contaminants which at least attains ARARs under federal and state laws, unless a waiver can be

---

[10] See the risk assessment section (Section 7.0) for a discussion of pathways of concern.

justified pursuant to CERCLA Section 121(d)(4), 42 U.S.C. §9621(d)(4). Remedial alternatives presented below may have various chemical-, action- or location-specific ARARs associated with the implementation of the remedy. Appendix F summarizes these ARARs.

9.1 Common Remedy Elements

Three remedy components were developed that are part of all of the alternatives developed for the Site. These remedial elements include excavation of shallow contaminated sediments from the Barge Slip, excavation of soil/sediments and relining of a drainage ditch, and closure of on-site ponds. General performance monitoring objectives and institutional controls (ICs) for the Site are also presented as part of the common elements.

Barge Slip Dredging

- Remedy components:
  - Excavation of an estimated 5,000 cubic yards of contaminated sediment (minimum of 2 feet).
  - Off-site disposal of the excavated contaminated material (an estimated 5,000 cubic yards). Much of the excavated material is expected to be contaminated with elevated concentrations of VOCs, SVOCs and mercury, and may need to be disposed of as RCRA hazardous waste, complying with applicable disposal regulations.
  - Backfilling of the excavated area with clean fill.
  - Re-establishment of mussel habitat due to alteration of resource.
- Estimated cost of construction: $2,400,000.
- Long-term monitoring requirements: Chemical monitoring of the porewater within the sand layer of the Barge Slip. Monitoring would be conducted, at a minimum, every five years to coincide with the FYR of the Site. Monitoring would be conducted to ensure that the remedy remains protective of ecological receptors.
- ICs: Uniform Environmental Covenants that prohibit dredging below a depth of 288 feet amsl.[11] The ICs prohibit the disturbance of the restored surface and contaminated material (e.g., NAPL) below the restored surface.
- Expected outcomes: The Barge Slip Area will no longer be a point of potential exposure of environmental receptors to elevated contaminants in the Barge Slip sediment.

Outfall 004 Ditch Lining

A drainage ditch, identified as Outfall 004, channels stormwater runoff from the eastern portion of the Site to the river. Runoff from the chemical manufacturing plants is discharged to the river through a Kentucky Pollutant Discharge Elimination System (KPDES) Permit. The ditch is unlined and is eroding, exposing potentially contaminated zones within the subsurface soil. Contaminated groundwater also has the potential to drain to the unlined ditch. To address this potential release and exposure pathway, the 2,000-foot-long drainage

---

[11] Some disturbance of the Barge Slip sand layer may be required to maintain existing or new plant infrastructure. This work will be coordinated and approved by EPA and KDEP. Disturbance of the sand layer would be restored to the specifications of the original CERCLA design.

ditch will be excavated and lined with pipe to prevent further erosion. Runoff from this area will be diverted to catch basins at the land surface and then to the underground pipe.

- Remedy components:
  - Excavation of contaminated soil along a 2,000-foot length of exposed ditch.[12]
  - Installation of 2,000 feet of pipe in the excavated ditch area.
  - Off-site disposal of contaminated soil/sediment.
  - Connection of existing catch basins and diversion structures to the newly installed pipeline.
  - Backfilling of the ditch with clean fill and establishment of a surface consistent with the other finished surfaces in the area (e.g., grass, gravel or pavement).
  - Discharge from the pipeline to the Tennessee River should be protective of human health and the environment and would continue to be managed by Westlake pursuant to a KPDES permit.
- Estimated cost of construction: $250,000.
- Long-term monitoring requirements: Visual inspection of the area, at least annually, to monitor for potential pipeline failures and erosional issues.
- ICs: Uniform Environmental Covenants that prohibit surface or subsurface work near the pipeline that could result in damage or reduced protectiveness of the remedy without prior notice and approval by EPA.
- Expected outcomes: Reduction in potential risks to human and/or ecological receptors to contaminants from the erosion and migration of the contaminants to the river.

Pond 1A and 2 Closure

Eight waste management ponds in the floodplain were closed in 1982 by a RCRA corrective action. Two of the ponds, 1A and 2, were RCRA-regulated hazardous waste surface impoundments that were initially closed as Interim Status units under KDEP oversight as part of facility RCRA corrective action activities. The wastes in the ponds were solidified and then removed and disposed in the constructed on-site RCRA Containment Cell.

- Remedy components: Although closure of Pond 1A and 2 appears to be a straightforward task, many factors must be evaluated during the RD that will determine the best approach for pond closures. For planning and cost estimating purposes, it is assumed that the ponds would be closed by installing a low-permeability liner and/or backfilling the ponds with clean fill.[13] However, the design of the pond closure may vary from the remedy elements described below.
  - Removal of mobile NAPL, to the extent practicable.

---

[12] Since the completion of the RI/FS, Westlake, the owner/operator for the area, has conducted facility improvements and installed piping and backfill in portions of the ditch. The work conducted by Westlake will be evaluated during the RD and the scope of the CERCLA work adjusted, as appropriate.

[13] Clean fill will not result in increased risk to human health or the environment or lead to further contamination of the groundwater.

  - Relocation of plant infrastructure along the perimeter of the Pond 2 dike and other areas, as necessary.
  - Excavation of the Pond 2 dike to an elevation near 320 feet amsl to facilitate a stable grade from the Pond 2 dike, toward the base of the RCRA closure cell and Pond 1A dike.
  - Backfilling of the Pond 2 dike, as necessary, to facilitate construction of the graded surface between the remaining Pond 2 dike and the RCRA landfill and Pond 1A dike.
  - Installation of a cover on the Pond 2 dike with a low-permeability layer that meets identified RCRA ARARs to prevent erosion and infiltration of rain water into the groundwater.
  - Installation of an erosion-resistant surface to protect the final cover of Pond 2 from river flooding.
  - Replacement and/or construction of plant infrastructure impacted by the closure of Pond 2.
  - Lining of Pond 1A with a low-permeability layer that meets identified RCRA ARARs to prevent infiltration of pond water into the groundwater.
- Estimated cost of construction: $5,500,000.
- Long-term maintenance and monitoring requirements:
  - Maintenance of the final covers for both ponds.
  - Annual visual inspection of former Pond 2 surface and dike for evidence of erosion and instability.
  - Monitoring of water levels in Pond 1A and groundwater levels around the perimeter of Pond 1A to verify that pond water is not leaking into the subsurface.
- ICs: Uniform Environmental Covenants that prohibit surface or subsurface work near the former Pond 2 or Pond 1A that could damage or reduce the protectiveness of the remedy without prior notice and approval of EPA.
- Expected outcomes: Reduce rainfall infiltration from Ponds 1A and 2 into the groundwater and the potential exposure to ecological receptors that may come in contact with contaminated pond water and sediments.

9.2 Description of Remedial Alternatives

9.2.1 No Action Alternative

Regulations governing the Superfund program require evaluation of that a “No Action” alternative to establish a baseline for comparison. Under this alternative, EPA would take no action to prevent the continued migration and potential exposure to site-related contamination. No action alternatives were developed in the FS for the Source Control (SC1), the River NAPL (RN1) and the River Groundwater (RG1) groups of remedial alternatives. As shown below, no costs are associated with the No Action alternative.

- Estimated capital cost: $0

- Estimated annual O&M cost: $0
- Estimated present worth cost: $0

9.2.2 Source Control Alternatives

In addition to a No Action alternative (SC1), the FS developed and screened nine different options to address the onshore NAPL, NAPL-contaminated soil and contaminated groundwater located beneath the active chemical plant complexes and to prevent further contaminant migration to the Tennessee River. The FS screened these nine alternatives and retained three alternatives for detailed analysis that rely on source treatment, source containment, and a combination of treatment and containment, respectively.

The remedy components, cost, long-term monitoring requirements, ICs and expected outcomes for each retained alternative are summarized below.

Alternative Source Control (SC) 3a: Containment of Contaminated Soil, NAPL and Groundwater with Focused Organic NAPL and Mercury NAPL Recovery

- Remedy components:
    - Installation of a 16,000-foot-long barrier wall around the perimeter of the chemical plants (see Figure 29). Depth of barrier wall installed from land surface into the underlying bedrock or competent low-permeability unit.
    - Construction of a barrier wall from a combination of sheet piling, in-situ soil/cement/ bentonite mixtures.
    - Extraction of groundwater from inside the containment to control flooding, soil desiccation, contaminant migration and groundwater gradients.
    - On-site treatment of extracted groundwater by air or steam stripping of contaminants.
    - Discharge of treated groundwater to the Tennessee River.
    - Recovery of organic and mercury NAPL to the extent practicable. Due to the nature of the chemicals present in the organic NAPL and mercury NAPL, and records associated with RCRA permits, it is expected that NAPL constitutes RCRA hazardous waste (listed and/or characteristic).
    - Treatment and disposal of recovered NAPL on site and/or off site at an EPA-approved RCRA-permitted facility, or recycled on site (with EPA approval).
    - Characterization, management, treatment and/or disposal of recovered NAPL in accordance with RCRA ARARs identified in Appendix F (action-specific ARARs table).

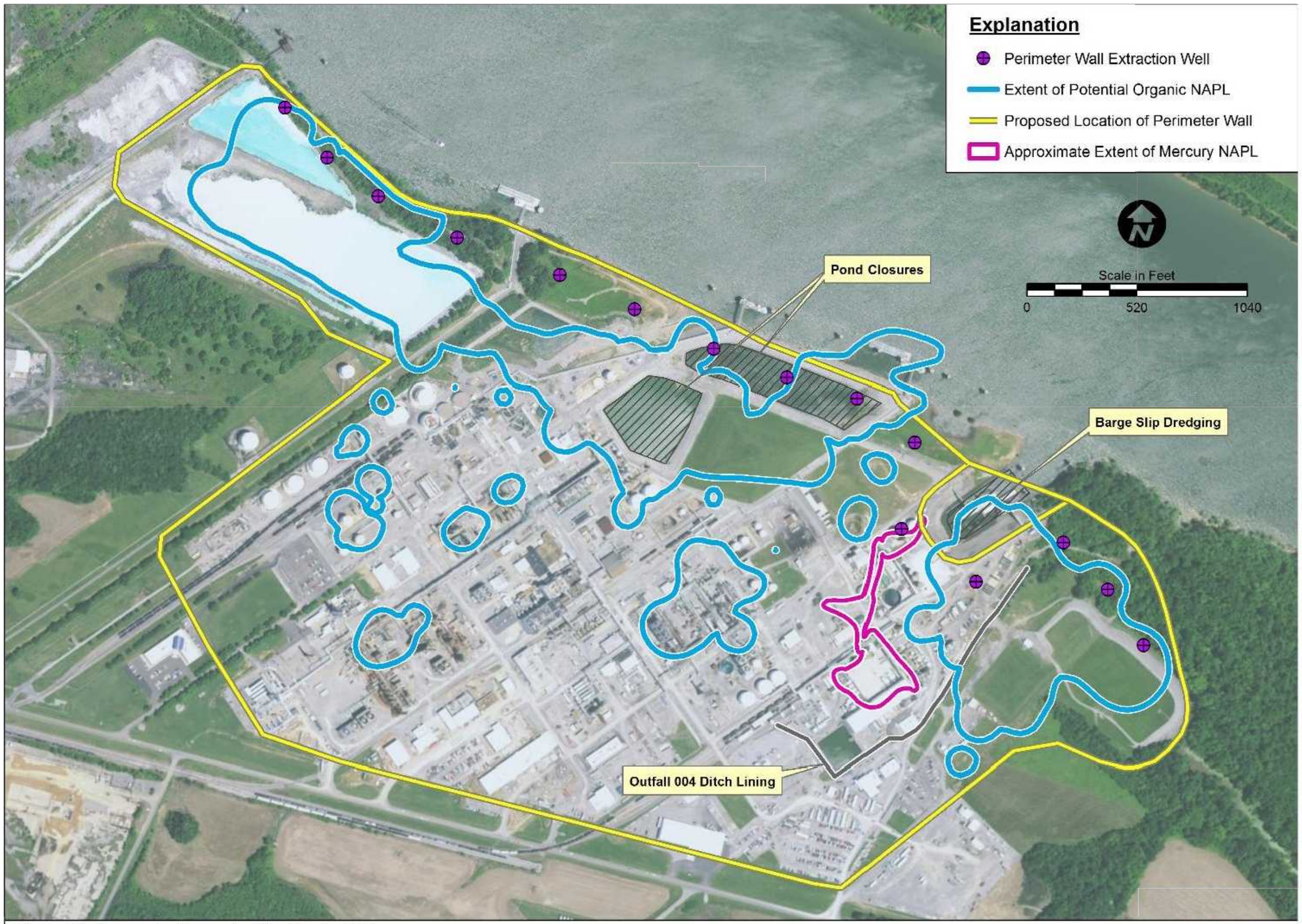


Figure 29. Conceptual Layout of the Barrier Wall 08/18 29_ROD_CONCEPTUAL LAYOUT OF THE BARRIER WALL02.MXD

- Attainment of ARARs and restoration of groundwater to drinking water standards for onshore areas, beyond the TI zone point of compliance.
- Invocation of a TI waiver under CERCLA Section 121(d)(4)(C) and 40 CFR 300.430(f)(1)(ii)(C)(3) for compliance with Safe Drinking Water Act National Primary Drinking Water regulation MCLs at 40 CFR 141.61 for contaminants in groundwater (identified as chemical-specific ARARs) for portions of groundwater at the Site (see Figure 30).[14]

  Factors contributing to the TI determination are listed below.

  - Analysis of the extensive and comprehensive database of geologic, hydrogeologic and chemical information indicates that approximately half of the approximately 3.5 million cubic yards of NAPL-impacted soils at the Site (approximately 13 million pounds of NAPL) is present within fine-grained sedimentary units such as silts, clays and interbed formations. The engineering difficulty of groundwater restoration considering the very large volumes of NAPL, coupled with the presence of the NAPL within complex interbedded and fine-

---

[14] The basis for the TI determination is documented in the attached TI determination (Appendix B).

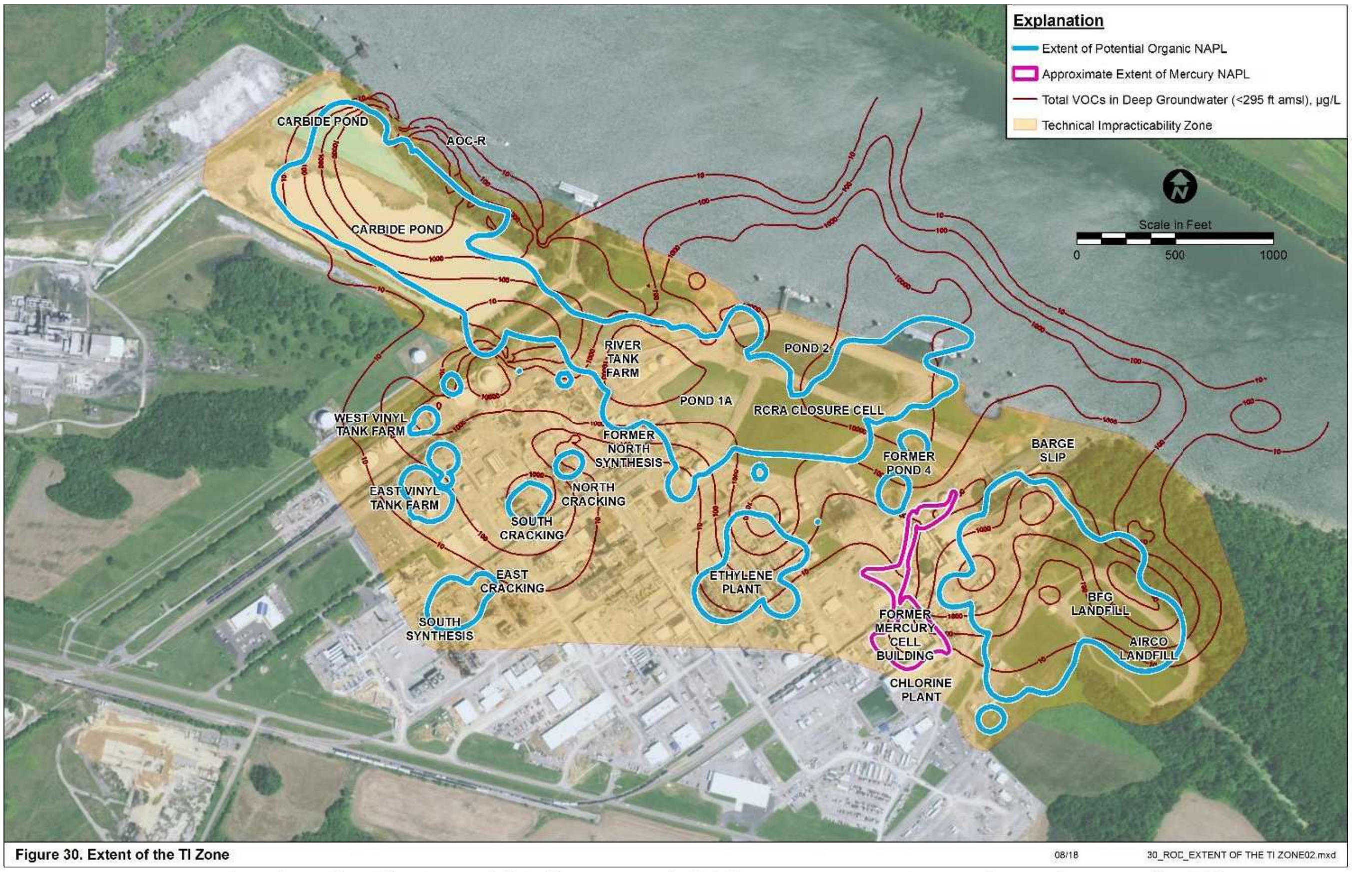


Figure 30. Extent of the TI Zone

08/18

30_ROD_EXTENT OF THE TI ZONE02.mxd

    grained units that could take over 1,000 years to extract (see Appendix B), are two of the major factors that demonstrate the need for a TI waiver. However, the complex sediment/soil architecture raises significant uncertainty whether 100 percent of the NAPL mass could be removed from the finer-grained interbeds.

    - Even if 100 percent of the recoverable NAPL could be removed from the finer-grained interbed units, significant mass still remains in the coarser-grained soil. The remaining NAPL mass associated with the coarse-grained sediments could take hundreds of years to achieve MCLs. These extensive timeframes illustrate that groundwater restoration cannot be completed in a reasonable timeframe.
    - Both of the two proceeding logics are complicated by the restriction on successfully extracting NAPL and groundwater due to the infrastructure at the Site prohibiting optimum extraction well access and placement.
  - ○ Based on the results from the RI indoor air investigation, all new buildings and building expansions within the site area will be constructed using VOC and mercury vapor intrusion-resistant construction. Existing administrative buildings will be retrofitted, as necessary, to prevent any unacceptable risk from potential vapor intrusion.
- Costs:
  - ○ Estimated capital cost: $71,235,000
  - ○ Estimated annual O&M cost: $924,000
  - ○ Estimated present worth cost: $84,417,000

  - Estimated construction timeframe: five years
  - Estimated Timeframe to Achieve RAOs: five years[15]
- Long-term monitoring requirements:
  - Monitoring of groundwater and surface water levels inside and outside of the barrier wall for evaluation of hydraulic control.
  - Monitoring of groundwater quality inside the barrier wall to evaluate long-term changes in contaminant mass removal and changes in groundwater quality.
  - Monitoring of groundwater quality beyond the TI zone to ensure attainment of ARARs for drinking water (i.e., MCLs).
  - Monitoring of porewater quality in the river and the Barge Slip to ensure the effectiveness of the barrier wall and the hydraulic control system.
  - Monitoring of indoor air quality in buildings located inside the barrier wall that are occupied by non-OSHA-regulated workers (i.e., administrative workers).
  - Monitoring of treated effluent for compliance with discharge standards.
- ICs:
  - Uniform Environmental Covenants that provide for the following land/activity use restrictions:
    - Prohibition on installation of groundwater wells within the TI zone.
    - Prohibition on the development of the areas within the TI zone for commercial, public or residential purposes.
    - Restriction on surficial or subsurface activities near the subsurface barrier wall that could compromise the integrity of the wall. Activities necessary to support the operation of industries located within the barrier wall may be conducted with prior notice and approval by EPA.
    - Use of vapor-resistant building methods for all new construction within the barrier wall and retrofitting of existing structures used by non-OSHA regulated workers to prevent vapor intrusion.
    - No disturbance of known areas of the Site with organic and/or mercury NAPL without EPA notice, and approval as necessary.
- Expected outcomes:
  - Prevention of further NAPL and/or contaminated groundwater migration beyond the perimeter of the onshore barrier wall.
  - Prevention of the discharge of NAPL and/or contaminated groundwater into the Tennessee River.

---

[15] As noted above, EPA determined that restoration of the groundwater to MCLs within a reasonable timeframe is technically impracticable. As a result, the timeframes to achieve RAOs for the Source Control Alternatives do not include restoration of groundwater and are based primarily on the time needed to construct the remedy and achieve the non-groundwater restoration RAOs.

    - Removal and treatment and/or disposal of NAPL to reduce the toxicity, mobility and/or volume of hazardous substances.
    - Prevention of human and/or ecological receptors to groundwater, surface water and/or sediments associated with groundwater seeps.
    - Restoration of groundwater to drinking water quality beyond the TI zone.

Alternative SC5a: Partial NAPL Treatment and Containment of Contaminated Soil, NAPL and Groundwater

- Remedy components:
    - Same remedy components as for Alternative SC3a.
    - Targeted treatment of approximately 1.5 million cubic yards of the most heavily contaminated source material.
    - Source treatment using a combination of in-situ thermal treatment (ISTT) for VOC-contaminated sources and in-situ stabilization for mercury-contaminated sources.
- Cost:
    - Estimated capital cost: $537,299,000
    - Estimated annual O&M cost: $1,309,000
    - Estimated present worth cost: $555,975,000
    - Estimated construction timeframe: 10 years
    - Estimated timeframe to achieve RAOs: 10 years[16]
- Long-term monitoring requirements:
    - Same long-term monitoring requirements as for Alternative SC3a.
- ICs:
    - Same ICs as for Alternative SC3a.
- Expected outcomes:
    - Same expected outcomes as for Alternative SC3a.
    - Removal of contaminant mass.[17]

Alternative SC6: Treatment of Contaminated Soil, NAPL and Groundwater

- Remedy components:
    - Treatment of approximately 2.5 million cubic yards of NAPL-contaminated soil using ISTT and in-situ stabilization for mercury-contaminated sources.

---

[16] See footnote 15.

[17] The focused source treatment alternative will result in contaminant mass removal, but a significant amount of contaminant mass would remain in the form of lower-concentration source material, contaminated soil and groundwater. Long-term operation and maintenance (O&M) of the barrier wall containment system is not expected to be appreciably shortened.

  - Treatment of approximately 1 million cubic yards of NAPL-contaminated soil using in-situ chemical oxidation (ISCO) for those less-accessible areas (i.e., beneath the RCRA closure cell, the Carbide Ponds, and Pond 1A and Pond 2).
  - Treatment of contaminated groundwater discharging to the Tennessee River using a chemically-reactive barrier installed along a 7,500-foot section of riverfront consistent with the footprint of groundwater contamination.
- Cost:
  - Estimated capital cost: $1,238,000,000
  - Estimated annual O&M cost: $1,424,000
  - Estimated present worth cost: $1,245,000,000
  - Estimated construction timeframe: 20 years
  - Estimated Timeframe to Achieve RAOs: 20 years[18]
- Long-term monitoring requirements:
  - Monitoring of groundwater, surface water and sediment porewater quality to assess remedy performance and protectiveness.
  - Monitoring of indoor air quality of buildings within the site area occupied by non-OSHA regulated workers.
- ICs:
  - Same long-term monitoring requirements as for Alternative SC3a.
- Expected outcomes:
  - Removal and treatment and/or disposal of NAPL and PTW to reduce the toxicity, mobility or volume of hazardous substances.
  - Prevention of the discharge of NAPL and/or contaminated groundwater into the Tennessee River.
  - Prevention of human and/or ecological exposure to groundwater, surface water and/or sediments associated with groundwater seeps.

9.2.3 River NAPL Alternatives

In addition to the No Action alternative (RN1) the FS Report (dated November 2017) developed three alternatives to address the 3-acre NAPL source zone that migrated from the facility beneath the Tennessee River. The alternatives were generally based on excavation, stabilization and containment of the NAPL source. EPA issued a Proposed Plan in November 2017 that identified excavation (Alternative RN2 – Excavation and Disposal) as the preferred alternative. Alternative RN2 generally included the excavation and off-site disposal of approximately 150,000 cubic yards of contaminated material, including zones of NAPL. Due to the depth of the excavation and the forces exerted by the high river flows, installation of a

---

[18] See footnote 15.

cofferdam would be necessary to support the excavation. Portions of the operating chemical plant infrastructure (e.g., the Propane Dock) also would have to be relocated. The present worth cost of this alternative was estimated at $144M.

Comments received by EPA during the public comment period expressed concern not only for the high cost, but for potential risk to workers and the environment during construction and disruptions to continuity of plant operations. Some of the commenters suggested other alternatives (e.g., recovery of NAPL) that they believed would be more suitable as a River NAPL alternative.

Based on consideration of the public comments, EPA issued an amendment to the November 2017 Proposed Plan. The amended plan, issued on June 20, 2018, presented an interim-based approach that focused on the removal of recoverable NAPL to the maximum extent practicable. After a period of NAPL recovery in the 3-acre source zone, a post-recovery investigation would be conducted to document the nature and extent of the remaining contaminant mass. Further development and evaluation of remedial alternatives would also be conducted to identify alternatives that would lead to the complete mitigation of the source and restoration of the groundwater in this area to its beneficial reuse. Based on the evaluation, a final remedy would be selected in a future decision document.

Public comment received on the amended Proposed Plan was generally supportive of the interim NAPL recovery. As a result, EPA modified the NAPL recovery approach from the November 2017 Proposed Plan to include interim NAPL recovery. The basic approach for this action is the recovery and treatment and/or recycling of the recovered NAPL. The remedy components, cost, long-term monitoring requirements, ICs and expected outcomes for the interim NAPL recovery remedy are summarized below.

Because the River NAPL strategy has been revised from the original Proposed Plan, a summary of the RN2, RN3 and RN4 alternatives is not presented here among the description of alternatives. The November 2017 Proposed Plan provides detailed information on these alternatives.

Interim NAPL Recovery

- Remedy components:
  - Pre-design study to fully document the horizontal and vertical extent of the NAPL zones. Initial characterization efforts would be made to document discrete zones of NAPL occurrence.
  - Installation of a network of recovery wells (permanent, temporary or a combination of the two) screened across NAPL zones.
  - Pumping of NAPL from wells and collection at the surface.
  - Depending on the volume and nature of the NAPL recovered, on-site or off-site treatment at an EPA-approved RCRA facility, or on-site recycling (with EPA approval).

    - Repeated recovery efforts and refinements in well locations to demonstrate removal of recoverable NAPL to the maximum extent practicable.
    - Application of surfactants, if appropriate, to enhance NAPL recovery. Use of enhanced controls such as hydraulic or physical barriers, as necessary, to prevent migration of the mobilized NAPL.
    - Assessment of NAPL recovery and post-NAPL recovery to document the nature and extent of remaining contamination.
    - Evaluation of additional treatment alternatives that could further mitigate any remaining contaminant mass and restore the groundwater to its beneficial reuse.
- Cost:
    - Estimated capital cost: $6,500,000
    - Estimated annual O&M cost: $0
    - Estimated present worth cost: $6,500,000
    - Estimated construction timeframe: two years
    - Estimated timeframe to achieve RAOs: 10 to 20 years
- Long-term monitoring requirements:
    - Because this approach constitutes an interim action, there would be no long-term monitoring requirements to ensure protectiveness and permanence. However, there would be short-term monitoring to evaluate the success of the NAPL recovery effort, and to determine the nature and extent of the remaining contaminant mass that would need to be addressed to facilitate the long-term restoration of groundwater.
- ICs:
    - Uniform Environmental Covenants that prohibit dredging below a depth of 288 feet amsl.[19]
- Expected outcomes:
    - Reduction in NAPL mass, prevention of expansion of source area and prevention of further contaminant migration to groundwater.
    - Identification of alternatives that will lead to the restoration of groundwater in the NAPL source zone to its beneficial reuse.

9.2.4 River Groundwater Alternatives

In addition to a No Action Alternative (RG1), two additional remedial alternatives were developed to address and restore the groundwater plume that extends offshore from the chemical manufacturing plant complexes associated with the Site. This offshore plume is believed to be a result of contaminated groundwater migration from beneath the chemical

---

[19] Some dredging or disturbance of the soils below an elevation of 288 feet amsl may be required to maintain existing or construct new plant infrastructure. This work will be coordinated and approved by EPA and KDEP. Measures would be implemented so as not to exacerbate the environmental issues posed by the NAPL source zone beneath the river.

manufacturing plant complexes and the NAPL source zone beneath the river. EPA believes that once the flow of groundwater and NAPL migration is stopped by any combination of the Source Control Alternatives and the interim River NAPL Alternative, the contaminated groundwater and contaminated sediment below the river bottom would naturally recover over time. One of the River Groundwater Alternatives is based on natural attenuation of the groundwater contaminants. The other is based on enhanced attenuation through the collection and treatment of a portion of the contaminated groundwater beneath the river. The basis for the attenuation is evaluated and documented in the FS Report.

Additionally, potential in-situ treatment options were considered during the FS as part of a review of potential treatment alternatives for the offshore groundwater. However, the injection of chemical or biological amendments below the river was determined to be impractical. As a result, in-situ treatment methods were not considered for the offshore groundwater.

Alternative River Groundwater (RG) 2: Monitored Natural Attenuation of Groundwater

- Remedy components:
    - Monitoring of groundwater beneath the Tennessee River to assess attainment of MCLs.
- Cost:
    - Estimated capital cost: $0
    - Estimated annual O&M cost: $47,000
    - Estimated present worth cost: $672,000
    - Estimated construction timeframe: five years (based on the time to construct the selected Source Control Alternative)
    - Estimated timeframe to achieve RAOs: 10 to 20 years
- Long-term monitoring requirements:
    - Monitoring of the surface water, sediment and porewater in the river and underlying groundwater to evaluate the effectiveness of the natural attenuation process.
- ICs:
    - Uniform Environmental Covenants that prohibit:
        - Pumping of groundwater from the plume area beneath the Tennessee River until such time the groundwater is restored to its beneficial reuse.
        - Activities that could induce further migration of the groundwater plume beneath the Tennessee River.
- Expected outcomes:
    - Restoration of the contaminated groundwater plume beneath the Tennessee River such that it may be used for potable purposes.

Alternative RG3: Monitored Natural Attenuation of Groundwater and Groundwater Extraction

- Remedy components:
  - Monitoring the contaminated groundwater plume area beneath the Tennessee River.
  - Pumping and treating groundwater exceeding a total VOC concentration of 1,000 µg/L to facilitate the reduction of the groundwater plume.
  - On-site treatment of extracted groundwater using air or steam to strip contaminants.
  - Discharge of treated groundwater to the Tennessee River.
- Cost:
  - Estimated capital cost: $11,726,000
  - Estimated annual O&M cost: $1,385,000 (four years)
  - Estimated present worth cost: $16,033,000
  - Estimated construction timeframe: five years (based on the time to construct the Source Control Alternative)
  - Estimated timeframe to achieve RAOs: 10 to 15 years
- Long-term monitoring requirements:
  - Monitoring of surface water, sediment and porewater in the river and underlying groundwater to evaluate the effectiveness of the natural attenuation process.
  - Monitoring of the groundwater pump-and-treat system to ensure the 1000 µg/L performance objective is achieved.
- ICs:
  - Same as for Alternative RG2, Monitored Natural Attenuation of Groundwater.
- Expected outcomes:
  - Same as for Alternative RG2, Monitored Natural Attenuation of Groundwater.

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

In selecting the remedy, EPA considered the factors set forth in Section 121 of CERCLA, 42 U.S.C. § 9621, by conducting a detailed evaluation of the remedial alternatives pursuant to the NCP, 40 CFR 300.430(e)(9). During the detailed evaluation of remedial alternatives, each alternative was assessed against nine evaluation criteria, which consist of two threshold criteria (overall protection of human health and the environment and compliance with ARARs), five balancing criteria (long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, short-term effectiveness, implementability, and cost) and two modifying criteria (state and community acceptance). The comparative analysis of the remedial alternatives is provided below.

10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether an alternative provides adequate protection and describes how risk posed through each exposure pathway (based on a reasonable maximum exposure scenario) is eliminated, reduced or controlled through treatment, engineering controls or ICs.

All of the alternatives, except for No Action, would provide adequate protection of human health and the environment by eliminating, reducing or controlling risk through treatment, engineering controls and/or ICs.

For the Source Control Alternatives, COCs would be treated to risk-based levels by Alternative SC6 (treatment of contaminated soil, NAPL and groundwater) and partially by Alternative SC5a (focused treatment of the NAPL source zone and containment). Alternative SC3a (containment of contaminated soil, NAPL and groundwater) would provide protection by preventing further migration and exposure to contaminants. However, it does not incorporate treatment as a primary component. Rather, it rather includes focused recovery of NAPL sources. Each Source Control Alternative would require long-term monitoring and ICs to ensure long-term protection and effectiveness.

River NAPL Alternatives RN2, RN3 and RN4 are all considered protective of human health and the environment. Each would achieve protectiveness through the reduction in volume, toxicity and mobility through treatment. The interim action, though not a final action, would reduce the volume, toxicity and mobility of a portion of the NAPL source through treatment.

Each of the River Groundwater Alternatives would be protective of human health and the environment. For Alternative RG2 (monitored natural attenuation) and Alternative RG3 (enhanced monitored natural attenuation), protection of human health and the environment would be accomplished through the biological and physical attenuation mechanisms in the environment once the continued discharge of contaminants from the source zones beneath the B.F. Goodrich chemical manufacturing plant complex and river has stopped. Alternative RG3 could reduce the timeframe required to achieve RAOs by removing and treating highly contaminated groundwater.

Because No Action would not be protective of human health and the environment for any remedial category, it was eliminated from consideration under the remaining criteria.

10.2 Compliance with ARARs

Compliance with ARARs addresses whether an alternative will meet all of ARARs of other federal and state environmental statutes and requirements or provides grounds for invoking a waiver.

All Source Control, River NAPL and River Groundwater Alternatives would meet their respective federal and state ARARs.

However, since conducting the FS and analysis of the practicability for the onshore groundwater response actions, EPA has concluded that it is technically impracticable to restore the onshore groundwater to drinking water standards. Although the Source Control Alternatives (SC3a, SC5a and SC6) would achieve RAOs, for the reasons presented in the TI determination (Appendix B), EPA does not believe that these alternatives will be able to reduce groundwater contaminant levels to MCLs within a reasonable period of time. Table 4 lists specific chemicals for which ARARs are waived. Groundwater outside the TI zone would be restored to MCLs. Appendix F provides a summary of the ARARs.

It should also be noted that for the interim response to the NAPL source beneath the river, there are no chemical-specific ARARs for the remedy to attain. However, the remedy will comply with appropriate action- and location-specific ARARs. For all other parts of the Site, the ARARs will be achieved.

Table 4. Summary of Contaminants for which the MCL Is Waived as an ARAR

Contaminant	Maximum Concentration (µg/L)	MCL (µg/L)
Antimony	450	6
Arsenic	1,800	10
Barium	3,200	2,000
Beryllium	51	4
Cadmium	49	5
Chromium	7,300	100
Lead	380	15
Mercury	35	2
Selenium	1,800	50
Aroclor 1016	58	0.5
Benzo(a)pyrene	11	0.2
Hexachlorobenzene	4.3	1
1,1,2-TCA	270,000	5
1,1-DCA	1,000	7
1,2-Dichlorobenzene	2,500	600
EDC	6,200,000	5
Cis-1,2-Dichloroethene	3,100	70
Trans-1,2-Dichloroethene	3,100	100
1,2-Dichloropropane	5.3	5
Benzene	300,000	5
Carbon Tetrachloride	90,000	5
Chlorobenzene	17,000	100
Trichloromethane	280,000	80
Ethylbenzene	7,400	700
Methylene Chloride	2,500	5
Styrene	10,000	100
Tetrachloroethene	7,000	5
Toluene	72,000	1,000
Trichloroethene	7,900	5
VC	29,000	2

This list of contaminants is based on the data collected at the time of the completion of the RI/FS in 2017.

Two contaminants, naphthalene and 1,1-dichloroethane, do not have promulgated standards (i.e., MCLs). As such, risk-based protective levels (an HI of 1 or a cancer risk of 10^{-4} to 10^{-6}) are selected for these chemicals.

10.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the ability of an alternative to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. It also addresses the magnitude and effectiveness of the measures that may be required to manage the risks posed by treatment residuals and/or untreated wastes.

Overall, each of the Source Control, River NAPL and River Groundwater Alternatives could be designed, implemented and monitored to provide for long-term effectiveness and permanence. For the Source Control alternatives, Alternatives SC6 and SC5a, which provide actual reduction in mobility, toxicity and/or volume of the NAPL source through treatment and/or stabilization, would provide a higher degree of long-term effectiveness and permanence. Alternative SC3a, which primarily relies on containment, would require a more robust performance monitoring program and financial assurance to ensure long-term effectiveness. Alternatives that provide for the removal and subsequent treatment of wastes (SC5a and SC6) provide a higher degree of long-term effectiveness and permanence.

River NAPL Alternatives RN2 and RN4 would provide the highest degree of long-term effectiveness and permanence through the removal and stabilization of the NAPL, respectively. The interim offshore NAPL recovery is not intended to provide a permanent solution to the NAPL source beneath the river. Both of the River Groundwater Alternatives (RG2 and RG3) are long-term effective and permanent.

10.4 Reduction of Toxicity, Mobility or Volume through Treatment

Reduction in toxicity, mobility or volume of contamination through treatment is the anticipated performance of the treatment technologies, with respect to these parameters, which an alternative may employ.

Among the Source Control Alternatives, Alternative SC6 (treatment of NAPL source material and groundwater) would provide the highest degree of reduction in toxicity, mobility or volume through treatment, followed to a lesser degree by Alternative SC5a (containment with focused NAPL source treatment). Although the primary goal of Alternative SC3a (NAPL source and groundwater containment) is not restoration, this alternative would provide for treatment through the removal of approximately 7,000 pounds of contaminant mass annually through the collection and treatment of groundwater inside the barrier wall. In addition, Alternative SC3a includes recovery of recoverable organic and mercury NAPL to the extent practicable.

Alternatives RN2 and RN4 would provide the highest reduction in toxicity, mobility and volume through treatment. The interim action would result in partial reduction in the volume of NAPL, but would not fully address all of the NAPL or contaminants in the sediment matrix.

Among the River Groundwater Alternatives evaluated, RG3 (groundwater extraction) would provide the highest reduction in toxicity, mobility or volume of contaminants through treatment.

10.5 Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to achieve protection and adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

The evaluation of short-term effectiveness is one of the criteria that provides a significant distinction among each of the alternative groups. With regard to the Source Control Alternatives, Alternative SC3a (NAPL source and groundwater containment) would achieve protection of human health and the environment and would pose the least amount of short-term risk to workers and the community during implementation. Because the barrier wall would be constructed around the perimeter of the facility (not through process areas), there would be a much lower risk of releasing hazardous or toxic chemicals (e.g., chlorine gas) during the construction process. It is also estimated that the remedy could be designed and constructed within five years, thus providing the greatest degree of short-term effectiveness among the Source Control Alternatives. In contrast, Alternative SC6 (NAPL source and groundwater treatment) and Alternative SC5a (focused NAPL source treatment and groundwater containment) could require 20 years for remedy implementation. Most importantly, the two Source Control Alternatives would require access to areas of contamination beneath highly industrialized areas of the Site. The primary treatment technology for the NAPL would require heating the soil and collecting the contaminant vapors. This treatment approach could increase risk to workers and the community through exposure to contaminant vapors or from fire/explosion should the remedy damage plant infrastructure.

River NAPL Alternative RN2 would require major civil construction work in a riverine environment. It would also require major alterations to the plant operator’s infrastructure along the river. Similarly, Alternatives RN3 and RN4 also would involve major construction work in the river but are expected to involve fewer disruptions to plant operations. The interim action presented in the 2018 Amended Proposed Plan would pose minimal short-term risks. With regard to the time to achieve protectiveness, all of the alternatives would take several years.

As for the two River Groundwater Alternatives, the monitored natural attenuation alternative (Alternative RG2) would pose the lesser degree of short-term risk because there is no construction component.

10.6 Implementability

Implementability is the technical and administrative feasibility of the alternative, including the availability of materials and services needed to implement the alternative.

Evaluation of the alternatives based on implementability is similar to the evaluation of the alternatives based on short-term effectiveness in that alternatives incorporating treatment are generally more difficult to implement. For the Source Control Alternatives, the containment-based alternative, Alternative SC3a (NAPL source and groundwater containment), would rely on common engineering and construction methods and does not include a treatment component; therefore, it would be the most easily implemented. Conversely, Alternative SC6 (NAPL source and groundwater treatment) and Alternative SC5a (focused NAPL treatment and containment) would be more difficult to implement and, in some areas, may not be achievable. Based on multiple inspections of the active chemical plant complexes and the layout of site infrastructure, it is highly questionable whether all of the NAPL-contaminated soil could be safely accessed for treatment without causing greater harm to workers or nearby residents, and implementation could cause significant interruptions to plant operation unless the remedy implementation was delayed until the area is decommissioned.

Moreover, the implementation of the source treatment approaches could span 20 years, greatly increasing the period that the chemical plants may have to alter plant operations and be susceptible to disruptions as a result of the remedy implementation. Implementation of source treatment remedies also could pose an increased risk to workers and the community by causing fires, explosions and/or releases of toxic chemicals by damage to the extensive underground piping or other infrastructure that supports the chemical plants. As noted above, implementation of some portions could be delayed until some future time in which the area might be decommissioned.

River NAPL Alternative RN2 would be the most technically complex and difficult to implement. The most challenging portion of the construction would be the installation of a cofferdam robust enough to withstand the seasonal forces of the river. The construction also would cause major disruptions to plant operations. Although Alternatives RN3 and RN4 would be more easily implemented than RN2, they would still pose significant implementation issues. The interim action River NAPL Alternative would not require major civil works construction or significant disruptions to plant operations.

RG3 (monitored natural attenuation and with groundwater extraction and treatment) would be more difficult to implement than Alternative RG2, which relies on monitored natural attenuation alone. However, the RG3 groundwater extraction technology is available for implementation.

10.7 Cost

Cost includes estimated capital and O&M costs as well as present worth costs.

Onshore Source Control Alternatives ranged from $84M to $1,245M. The two River NAPL Alternatives that involve major civil works construction range from $112M to $144M. The River NAPL interim alternative cost is estimated at $6.5M. River Groundwater Alternatives ranged from $700,000 to $16M. The cost estimates were based on a 7 percent discount rate.

10.8 State Acceptance

State acceptance indicates whether the Commonwealth of Kentucky concurs with the Selected Remedy.

The Commonwealth of Kentucky was consulted during the development of the Proposed Plan, Proposed Plan Amendment and ROD. Appendix G documents Commonwealth's concurrence with the ROD.

10.9 Community Acceptance

Community acceptance refers to the public's general response to the results of the RI and the alternatives described in the FS Report and Proposed Plan.

Community acceptance of the preferred alternative is addressed in the Responsiveness Summary (Appendix C).

11.0 PRINCIPAL THREAT WASTES

The NCP establishes the expectation that EPA will use treatment to address the principal threat posed by a site wherever practicable (NCP at 40 CFR Section 300.430(a)(1)(iii)(A)). The principal threat concept is applied to the characterization of source materials at a Superfund site. Source material or waste includes or contains hazardous substances, pollutants or contaminants and acts as a reservoir for migration of contaminants to groundwater, surface water or air, or acts as a source for direct exposure.

The PTW at the Site is the approximately 1.1 million to 3.5 million cubic yards of NAPL and NAPL-contaminated soil underlying the terrace and floodplain area (Figure 18). Although alternatives were evaluated in the FS and Proposed Plan to treat the PTW, many factors would have to be overcome to implement treatment remedies beneath operating chemical plants. The heavily industrialized property and ongoing operations greatly restrict access to the PTW and increase the risk of disruption of plant operations and the potential for releases of hazardous substances or fire and/or explosion should infrastructure be damaged during remedy implementation.

To further meet the expectation for treatment of PTW to the extent practicable, NAPL recovery and treatment elements were included among the SC3a and the Interim River NAPL Alternatives.

12.0 SELECTED REMEDY

12.1 Summary of Rationale for the Selected Remedy

Based on consideration of the requirements of CERCLA, the results of the RI/FS and the public comments, EPA, in consultation with KDEP, has selected a combination of Alternatives SC3a and RG3, along with interim NAPL recovery from the offshore NAPL source zone beneath the Tennessee River to protect human health, welfare and the environment at the Site. Figure 31 illustrates the layout of the Selected Remedy for the Site. These alternatives provide for the recovery of onshore NAPL to the extent practicable, long-term containment of the remaining, non-recoverable NAPL, removal of the NAPL beneath the river to the maximum extent practicable, and the enhanced monitored natural attenuation of contaminated groundwater beneath the river.

As noted previously, EPA is invoking a TI waiver under CERCLA Section 121(d)(4) for MCLs (identified as chemical-specific ARARs) in portions of the groundwater because EPA determined that restoration in those areas is not technically practicable from an engineering perspective due to site-specific circumstances. Figure 31 shows the boundary of the TI zone. Table 4 lists contaminants for which MCLs are waived.

Based on consideration of all of the relevant factors used in the evaluation of the alternatives, EPA believes that the Selected Remedy provides the best balance of tradeoffs among the remedial alternatives with respect to the NCP's nine evaluation criteria of 40 CFR Section 300.430(e)(9).

12.2 Description of the Selected Remedy

The description of the Selected Remedy is organized into onshore and offshore components. This section describes the elements of the Selected Remedy. These elements will be used to prepare the RD. To the extent practicable, performance objectives are described along with reference to ARARs. Specific remedy details will not be determined until the RD is developed.

Based on consideration of the requirements of CERCLA, the results of the RI/FS and public comments, EPA, in consultation with KDEP, has selected a combination of Alternatives SC3a and RG3, along with interim NAPL recovery from offshore NAPL source zone to protect human health, welfare and the environment at the Site. These alternatives together will provide for the

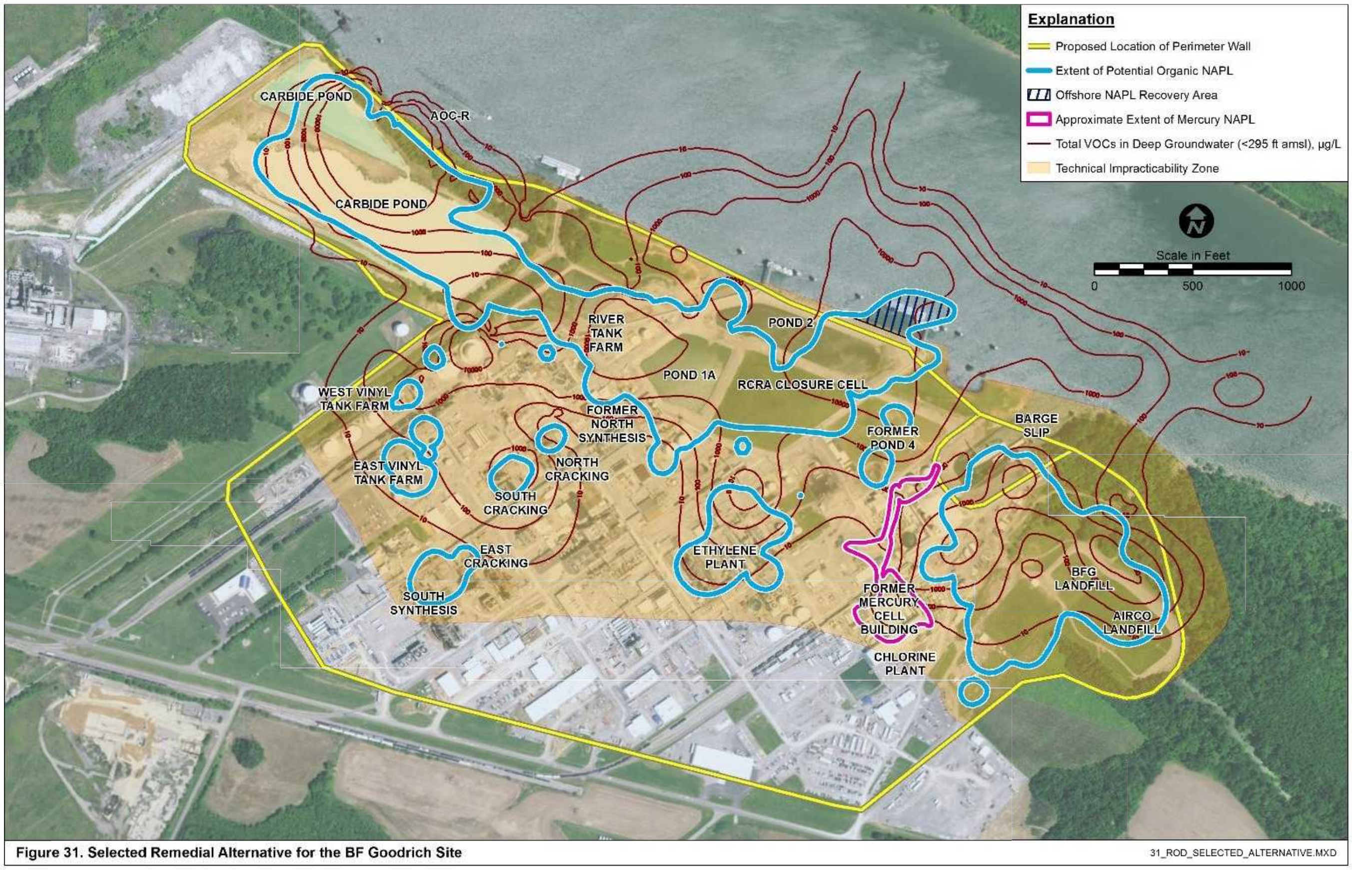


Figure 31. Selected Remedial Alternative for the BF Goodrich Site

31_ROD_SELECTED_ALTERNATIVE.MXD

removal of recoverable NAPL on shore to the extent practicable, long-term containment of the remaining, non-mobile NAPL, removal of the NAPL beneath the river to the maximum extent practicable, and the enhanced monitored natural attenuation of contaminated groundwater beneath the river.

The onshore containment remedy includes a TI waiver that identifies a TI zone within the barrier wall where attainment of groundwater MCLs will be waived as ARARs. Appendix B provides detailed information on the TI zone. EPA is invoking a TI waiver under CERCLA Section 121(d)(4) to attain MCLs (identified as chemical-specific ARARs) in portions of the groundwater because EPA has determined that restoration in those areas is technically impracticable from an engineering perspective due to site-specific circumstances.

Based on consideration of all of the relevant factors used in the evaluation of the alternatives, EPA believes that the Selected Remedy provides the best balance of tradeoffs among the remedial alternatives with respect to the NCP's nine evaluation criteria in 40 CFR Section 300.430(e)(9).

12.2.1 Onshore Components

12.2.1.1 Outfall 004 Ditch

A drainage ditch, identified as Outfall 004, channels stormwater runoff from the eastern portion of the Site to the river. Runoff from the chemical manufacturing plants is discharged to the river through a KPDES permit. The ditch is unlined and is eroding, exposing potentially contaminated zones within the subsurface soil. Contaminated groundwater also has the potential to drain to the unlined ditch. To address this potential release and exposure pathway, the portions of the 2,000-foot-long drainage ditch will be excavated and lined with pipe to prevent further erosion. Excavated soil will be characterized and disposed of off site at an EPA-approved RCRA facility.

Catch basins at the land surface will be connected to the underground pipe. Stormwater runoff collected through the pipe will continue to be managed through the KPDES permit. Discussions with the current property owner indicate that long-term capital improvements include the eventual lining of the Outfall 004 Ditch. Should the lining of the ditch be completed prior to the implementation of the remedy, this common element will not be necessary.

12.2.1.2 Pond 1A and 2 Closure

Ponds 1A and 2 remain on site after the closure of the floodplain ponds shown in Figure 19. Both ponds will be closed so that they no longer serve as a source of groundwater recharge or a potential point of exposure to ecological receptors. Closure of the ponds will be complex, requiring coordination with the current owners and operators in proximity of plant infrastructure and the RCRA closure cell.

The material from the Pond 2 dike will be removed to an elevation of 320 feet amsl and placed in Pond 2 as fill material. Additional fill material will be placed in Pond 2 and along the river side of the Pond 2 dike to create a stable slope that grades upwards toward the base of the RCRA closure cell and Pond 1A dike. The final surface for Pond 2 will be protective of human health and the environment through the installation of a low-permeability layer that meets identified RCRA ARARs to reduce the amount of contaminated groundwater to be managed as part of the site-wide groundwater containment system.

Closure of Pond 1A by filling with clean material is not expected to be needed. It is anticipated that Pond 1A can be closed through the placement of a bentonite-based (or other low-permeability) liner that meets identified RCRA ARARs to prevent infiltration of stormwater from Pond 1A into the groundwater. A final decision regarding the backfilling of Pond 1A will be made during the RD.

12.2.1.3 Barrier Wall

The containment alternative will rely on a barrier wall installed around the perimeter of the NAPL-contaminated soil and contaminated groundwater to prevent exposure and further migration. The barrier wall may be constructed using a combination of materials such as sheet piling, soil bentonite slurry or other suitable material, and will extend from land surface downward, and be keyed into the bedrock. Where competent layers of low-permeability clay overlie the bedrock, the bottom of the barrier wall may be set into the overlying low-permeability clay. The actual depth of the barrier wall will be based on extensive geological testing along the proposed wall alignment. Figure 31 shows the projected layout of the barrier wall. The actual wall alignment will be determined during the RD and will be based on data collected from a pre-design geotechnical study.

12.2.1.4 Hydraulic Control

Groundwater will be collected from inside the barrier wall to maintain hydraulic control. The groundwater pumping system will be designed such that wells will be placed in locations that facilitate hydraulic control and plume stability and maximize NAPL recovery. The extracted groundwater will be treated and discharged to the river. Depending on the contaminant levels, the groundwater may be treated by air or steam stripping. The groundwater may also require pre-treatment to physically separate NAPL from the groundwater. Extracted NAPL may be treated on site, disposed of off site at an EPA-approved facility or recycled by one of the on-site chemical plants (with EPA approval).

12.2.1.5 NAPL Recovery

Lastly, in addition to the removal of NAPL through the operation of the hydraulic control system, an effort will be made to collect recoverable NAPL from within the barrier wall to the extent practicable. Extracted NAPL may be treated on site, disposed of off site at an EPA-approved facility or recycled on site (with EPA approval). Figure 32 shows the location where NAPL has been observed to accumulate in monitoring wells or was observed in soil borings in sufficient quantity that it seeped out of the soil cores. These locations are inferred as areas where NAPL is present at such volumes that it may be potentially recoverable though conventional vertical and/or horizontal well technology. Practicability of NAPL recovery may be

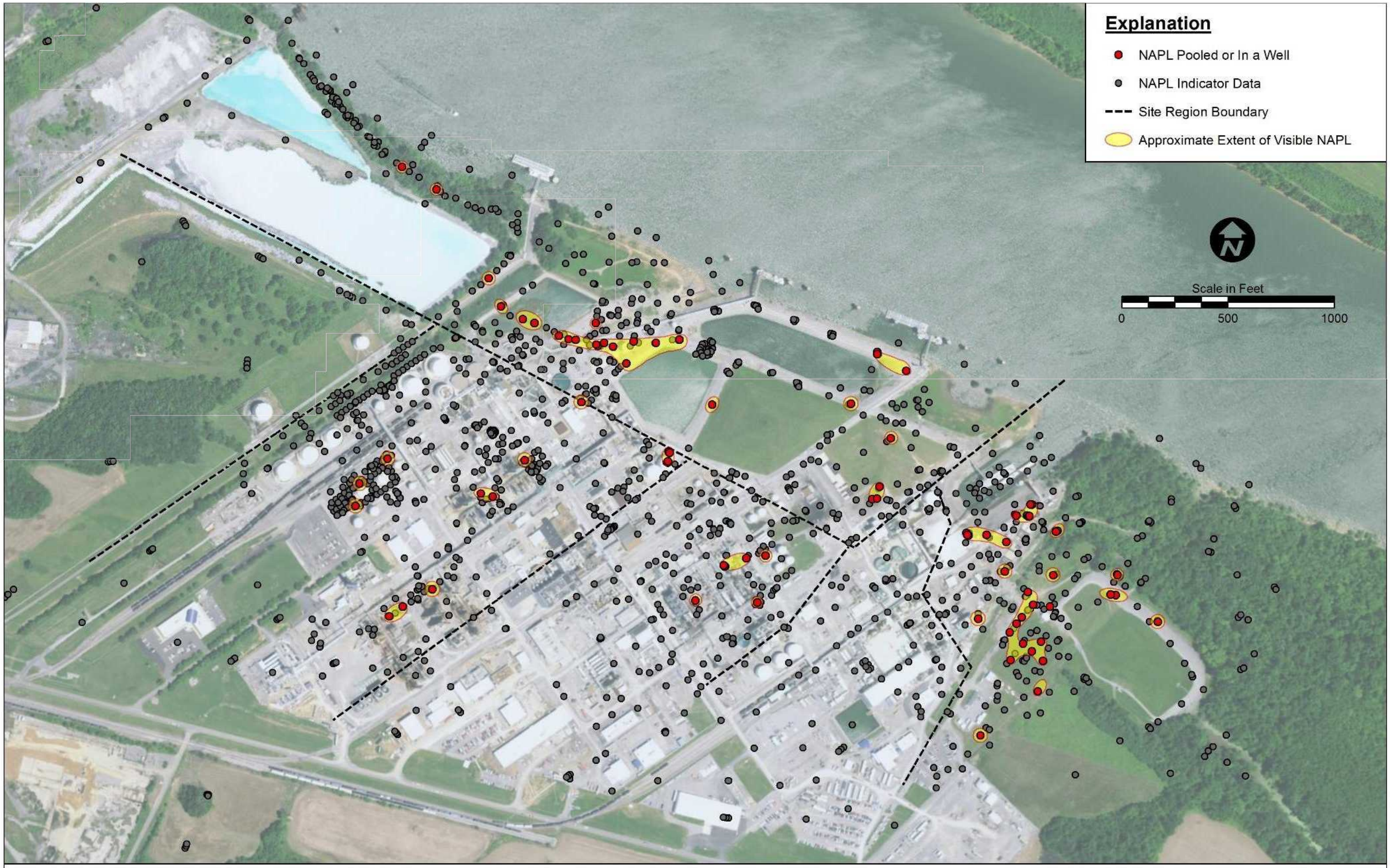


Figure 32. Visible NAPL Delineation – Horizons 1 to 6

32_ROD_NAPL_POOLED_AND_INWELL_GSTTOBEDROCK03.MXD limited by plant infrastructure, hydrogeologic features, chemical parameters or other unique factors. This information will be used to design and implement a system to recover NAPL from these areas to the extent practicable.

12.2.1.6 Performance Monitoring

Performance monitoring will be conducted on a regular basis to evaluate the effectiveness and long-term protectiveness of the onshore component of the remedy. A major aspect of the monitoring will be effectiveness of the onshore containment, which relies both on the integrity of the wall and hydraulic control inside the barrier wall. The primary method of assessing the effectiveness of the system will be the monitoring of groundwater elevations and the collection and analysis of groundwater and/or surface water samples inside and outside of the barrier wall. Details regarding the location, number and frequency of sample collection will be further developed in the RD and the O&M Plan. The O&M Plan will also evaluate methods to monitor the physical integrity of the barrier wall components.

12.2.2 Offshore Components

12.2.2.1 Barge Slip

Contaminated material will be removed from the bottom of the Barge Slip to create a riverbed surface that is protective of ecological receptors. Removal will include a minimum of 2 feet of Barge Slip sediments to establish a clean zone that allows the development of a benthic habitat.

An estimated 5,000 cubic yards of contaminated sediment will be excavated and replaced with clean material to achieve the desired thickness and maintain a navigation channel. The actual thickness of the excavation and clean layer will be verified during the RD. Although not required at this time, the design may determine that a liner is needed in combination with the clean material to achieve the desired protectiveness for ecological receptors and long-term permanence of the remedy.

A bottom elevation of 288 feet amsl is required in the Barge Slip channel for adequate barge operations. The backfilled zone will need to be between 287 and 285 feet amsl. This elevation will provide adequate distance for future maintenance dredging of future non-contaminated (e.g., sediment deposition) material that may accumulate, without disturbing the backfilled Barge Slip riverbed surface.

If the area to be dredged is heavily contaminated, the corresponding water generated from hydraulic dredging would be expected to be contaminated, requiring temporary storage for analysis and treatment. Conversely, the clam shell dredging method generates less water, but also creates more suspension of contaminated material in the water column, requiring greater control of suspended solids within the water body.

Treatment and disposal of the dredge spoils and water generated from the dewatering of the spoils will be determined based on the characterization of the material and applicable regulatory requirements. Where practicable, treatment will be conducted on site, but may be shipped off site for treatment and/or disposal at an EPA-approved RCRA facility.

As part of the RD, a pre-design study will be conducted and, at a minimum, include the installation of borings into the bottom of the Barge Slip to characterize the nature and vertical and horizontal extent of contamination. The soil borings will be completed down to a minimum elevation of 280 feet amsl. As a minimum, the samples from the cores will be visually inspected to document the soil type and presence of NAPL. Samples also will be collected from the cores to document chemical concentrations.

Because this portion of the river is a critical habitat for mussels, a benthic survey will be conducted to document the benthic community so that it is restored to pre-construction conditions.

After completion of the Barge Slip dredging, monitoring will be conducted to ensure that there is no re-introduction of contaminated material.

12.2.2.2 River NAPL

Interim recovery of recoverable NAPL from the source zone beneath the river will be conducted through pumping and on-site or off-site treatment of the NAPL at an EPA-approved RCRA facility, or recycling of the NAPL. The most appropriate method(s) for implementing this approach will be determined through the RD.

The first phase of the work will be to define the horizontal and vertical extent of the NAPL beneath the Tennessee River that extends from the onshore NAPL, northward beneath the Tennessee River. Information from the RI indicates that the NAPL occurs along permeable beds that overlie lower permeability zones. Determining the depth and aerial extent of these zones will be critical to the design of an effective NAPL recovery system.

Potential well configurations include temporary vertical or permanent vertical or horizontal wells (or a combination thereof) to recover the NAPL. It may be possible to enhance the recovery of offshore NAPL through the injection of chemicals referred to as “surfactants”, which can increase the mobility of NAPL. During design and/or implementation of the NAPL recovery remedy, installation of a containment wall and/or a cap may be beneficial to supplement the effectiveness of the NAPL recovery. If an offshore containment wall is deemed necessary to support the NAPL source area remedy implementation, the public will be notified of the change through an Explanation of Significant Differences.

After it is demonstrated that NAPL has been recovered to the maximum extent practicable, and that no additional NAPL can be recovered from the offshore NAPL source zone, post-recovery sampling will be conducted to assess the nature and extent of the remaining contamination in the sediment, sediment porewater and groundwater.[20] These data will then be used to develop and evaluate a range of alternatives to further address the contamination, eventually leading to the attainment of MCLs for the River NAPL portion of the Site. The data will also be evaluated to assess whether it is technically practicable to remediate any remaining offshore NAPL and contaminant mass in order to restore the groundwater to drinking water quality. The results from the evaluation will be documented in a final cleanup decision for this portion of the Site.

12.2.2.3 River Groundwater

This alternative relies on natural attenuation to reduce contaminant levels in the groundwater to drinking water standards (i.e., MCLs). It is anticipated that after the flux of contaminants ceases with the containment of the onshore source and recovery of the offshore NAPL, biological processes and interaction of groundwater with the Tennessee River will rapidly attenuate (i.e., dispersion, dilution and/or biodegradation) contaminants in the plume beneath the river.

If at the time of the first FYR, EPA determines that natural attenuation of the groundwater contaminants beneath the river is not effective in reducing contaminant levels and achieving MCLs, the attenuation would be supplemented by the pumping and treating of groundwater to shorten the timeframe to attainment of MCLs. Because of access issues, it is assumed that horizontal wells would be installed from the shore beneath the river. The capture zone would target the area with a total VOC groundwater concentration greater than 1,000 µg/L. Groundwater contamination below the 1,000 µg/L threshold would continue to attenuate naturally and be monitored to ensure that MCLs can be achieved.

Implementation of this portion of the Selected Remedy is not expected to occur until after the implementation of the onshore and River NAPL components. Otherwise, the effectiveness of the pump-and-treat method is expected to be diminished due to the continued flux of contaminants from the NAPL source areas.

12.3 Institutional Controls

ICs will be used to support the long-term permanence and protectiveness of the remedy by limiting and/or preventing exposure to contamination and residual waste at the Site. ICs and the use of existing facility security procedures will prevent unauthorized intrusive activities or groundwater use. Uniform Environmental Covenants established by Kentucky Revised Statutes (KRS) 224.80 will be drafted and recorded to memorialize the land and activity use restrictions. The environmental covenants will include, at a minimum:

- Prohibit the use of groundwater beneath the Site, including for potable, agricultural, industrial and commercial purposes.
- Prohibit the use of the property within the site area for purposes other than industrial

---

[20] Maximum extent practicable is the standard which defines the acceptable amount of NAPL recovery. The criteria for quantifying this standard will be established in the RD. The criteria will rely on factors such as repeated pumping efforts at the same location, an integrated pumping well location design that progressively targets areas for NAPL recovery while also documenting areas where NAPL recovery is complete, and a statistically-based approach for analysis of the recovery results.

uses.

- Notify EPA, KDEP and other owners/operators within the boundary of the Site of any construction activities that may result in the disturbance of contaminated media.
- Prohibit the dredging of the river bottom within the Barge Slip or the Propane Dock area of the Site below an elevation of 288 feet amsl or installation of structures that may result in the exposure of contaminated media beneath the Tennessee River without EPA notification and approval.

12.4 Vapor Intrusion

Based on the results from the RI indoor air investigation, all new buildings and building expansions within the site area will be constructed using VOC- and mercury vapor intrusion-resistant construction. Existing administrative buildings will be retrofitted, as necessary, to prevent any unacceptable risk from potential vapor intrusion.

12.5 RCRA Elements

12.5.1 RCRA Closure Cell

In 1982, B.F. Goodrich removed wastes and closed eight floodplain ponds, consolidating the material in a 240,000-acre RCRA landfill. This landfill is and will continue to be regulated by KDEP pursuant to RCRA.

Implementation of the Selected Remedy, specifically those portions of the remedy that will be adjacent to or in proximity to the RCRA landfill, will require coordination with KDEP.

12.5.2 PCAP System

As part of the early management of the Site under RCRA in 1992, a PCAP system was implemented. The PCAP system includes a series of groundwater collection wells installed to control the migration of the groundwater plume. The recovery wells are primarily located between the chemical plants and the Tennessee River. Groundwater is currently collected and processed by an on-site steam stripping system prior to discharge to the Tennessee River.

The implementation of the CERCLA remedy will be coordinated with the operation of the RCRA PCAP. The PCAP will be maintained until the CERCLA remedy has been implemented.

12.6 Summary of the Estimated Remedy Costs

Table 5 summarizes the estimated cost for the cleanup. The total present worth cost of the Selected Remedy is estimated at $107M. The present worth cost includes the capital cost for construction and the long-term O&M costs. The present worth cost also includes the time-value of money and adjusts the O&M cost based on the assumption that the total cost of the remedy would be invested, and the return would be used to supplement the initial investment. This cost estimate is highly dependent on the final RD. As a result, the accuracy of the cost estimate is expected to be within a range of plus 50 percent to minus 30 percent.

12.7 Performance Criteria and Objectives

The overall performance objective for the Selected Remedy is to restore groundwater to beneficial use outside of the TI zone, prevent continued contaminant migration, and ensure protection of human health and the environment. Other objectives include the recovery of NAPL to the extent practicable and restoration of groundwater to its beneficial use outside of the TI zone and beneath the river.

Table 5. Summary of Remedy Costs

Description	Cost Type	Cost
Onshore Components		
Pond 1A and 2 Closure	Capital	$5,450,000
Barge Slip Dredging	Capital	$2,400,000
Outfall 004 Ditch Relining	Capital	$250,000
Barrier Wall Installation	Capital	$35,270,000
Groundwater Extraction and Treatment	Capital	$3,470,000
Contingency	Capital	$14,050,000
Project Management/Technical Services	Capital	$10,350,000
Groundwater Extraction and Treatment	O&M	$36,790,000
Long-term Monitoring/ICs	O&M	$25,000,000
Contingency	O&M	$18,540,000
Project Management/Technical Services	O&M	$12,049,000
Offshore Components		
NAPL Recovery and Treatment	Capital	$6,500,000
Groundwater Extraction and Treatment	Capital	$7,580,000
Contingency	Capital	$2,270,000
Project Management/Technical Services	Capital	$1,870,000
Groundwater Extraction and Treatment	O&M	$3,610,000
Long-term Monitoring/ICs	O&M	$380,000
Contingency	O&M	$1,190,000
Project Management/Technical Services	O&M	$880,000
	Total Cost	**$187,800,000**
	Total Present Value Cost	**$106,900,000**

In general, performance monitoring will address:

- Onshore groundwater gradients, pond and monitoring well water levels, and groundwater contaminant levels to verify plume stability beneath the chemical manufacturing plant complexes and hydraulic control.
- Groundwater contaminant levels beneath the river to evaluate plume reduction and stability.
- NAPL and groundwater contaminant levels in monitoring wells and other monitoring points.

- Sediment porewater and surface water contaminant levels at the groundwater/river interface.
- Potential seep occurrence along the shoreline.
- Indoor air VOC in administrative buildings (including mercury for administrative buildings near the former MCB) that are constructed without vapor intrusion barriers.
- Sediment and sediment porewater contaminant levels in the Barge Slip.

The specification of individual performance criteria will be developed during the RD, along with the design of the individual remedy elements. Appendix F includes chemical-, location- and action-specific ARARs that will be evaluated and selected during the RD, as appropriate performance criteria and objectives.

12.8 Expected Outcomes of the Selected Remedy

Implementation of the Selected Remedy will result in the protection of human health and the environment through the containment and reduction in exposure of contaminated soil, groundwater, surface water, sediment porewater and sediment. Containing the onshore contamination will prevent the future migration of contaminated groundwater and NAPL from on shore into and beneath the Tennessee River and surrounding area.

Installation of the onshore barrier wall will significantly lower the estimated risks to human and ecological receptors, which may be exposed to contaminated groundwater and soil in seep areas along the river bank. Estimates from the risk assessment indicated potential risks to human exposure as high as 6×10^{-3} excess cancer risk and a non-cancer health hazard as high as 500. Risk to ecological receptors was estimated based on a narcosis index of 388. Installation of the barrier wall will prevent further seep occurrence and remove this as a pathway of exposure to human and ecological receptors.

Recovery of NAPL and excavation of sediments in the Barge Slip will remove contaminated sediments that are estimated to pose a risk to ecological receptors based on a narcosis index of 9 and further reduce sources to groundwater contamination.

Recovery of NAPL from beneath the Tennessee River is expected to significantly reduce the source and migration of contaminants into the groundwater and facilitate the natural attenuation of the groundwater plume beneath the Tennessee River.

Timeframes for attainment of these objectives is difficult to estimate. It will take an estimated two to four years to conduct the pre-design data collection and complete the design. Depending on design requirements, NAPL recovery and dredging of the Barge Slip could be conducted first, or done in conjunction with the construction of the onshore barrier wall and the hydraulic containment system.

13.0 STATUTORY DETERMINATIONS

Pursuant to CERCLA Section 121, 42 U.S.C. § 9621 and the NCP, 40 CFR Section 300.430(f)(1)(ii), the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a waiver is justified, which is included and part of this ROD), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Section 121(b)(1), 42 U.S.C. § 9621(b)(1) also establishes a preference for RAs that employ treatment to permanently and significantly reduce the volume, toxicity or mobility of the hazardous substances, pollutants or contaminants at the Site. For the reasons discussed below, EPA has determined that the Selected Remedy meets these statutory requirements.

13.1 Protection of Human Health and the Environment

The Selected Remedy is expected to be protective of human health and the environment. It will meet the RAOs identified in Section 8.0 through a combination of physical containment and removal of contaminated soil, sediment and groundwater, and collection and treatment of NAPL. ICs will be used to prevent unacceptable exposure to remaining contamination and help ensure long-term effectiveness and permanence.

13.2 Compliance with ARARs

Section 121(d) of CERCLA, as amended, specifies, in part, that RAs for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs) to the hazardous substances or particular circumstances at a site or obtain a waiver (see also 40 CFR § 300.430(f)(1)(ii)(B) and 430(f)(5)(ii)(B) and (C)). ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. Compliance with OSHA standards is required by 40 CFR § 300.150. Therefore, the CERCLA requirement for compliance with or wavier of ARARs does not apply to OSHA standards.

Under CERCLA Section 121(e)(1), federal, state or local permits are not required for the portion of any removal action or RA conducted entirely on a site as defined in 40 CFR § 300.5 (see also 40 CFR §§ 300.400(e)(1) & (2)). Also, CERCLA actions must only comply with the “substantive requirements”, not the administrative requirements of a regulation. Administrative requirements include permit applications, reporting, record keeping and consultation with administrative bodies. Although consultation with state and federal agencies responsible for issuing permits is not required, it is recommended for determining compliance with certain requirements such as those typically identified as location-specific ARARs.

“Applicable requirements”, as defined in 40 CFR § 300.5, means those cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant or contaminant, RA, location, or other circumstance at a CERCLA site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be applicable. “Relevant and appropriate requirements”, as defined in 40 CFR § 300.5, means those cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal or state environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant or contaminant, RA, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

In addition to ARARs, the lead and support agencies may, as appropriate, identify other advisories, criteria, or guidance to be considered for a particular release. The "to-be-considered" (TBC) category consists of advisories, criteria or guidance that were developed by EPA, other federal agencies or states that may be useful in developing CERCLA remedies (see 40 CFR § 300.400(g)(3)).

13.2.1 ARAR Categories

For purposes of ease of identification, EPA has created three categories of ARARs: chemical-, location- and action-specific.

13.2.1.1 Action-specific ARARs

Action-specific ARARs are usually technology-based or activity-based requirements or limitations that control actions taken at hazardous waste sites. Action-specific requirements often include performance design and controls or restrictions on particular kinds of activities related to management of hazardous substances. Action-specific ARARs are triggered by the types of remedial activities and types of wastes that are generated, stored, treated, disposed of, emitted, discharged or otherwise managed.

13.2.1.2 Chemical-specific ARARs

Chemical-specific ARARs are usually health- or risk-based numerical values limiting the amount or concentration of a chemical that may be found in, or discharged to, the environment. The Safe Drinking Water Act (SDWA) MCLs at 40 CFR Part 141 and the state or federal AWQC established under Section 303 or 304 of the Clean Water Act are examples of chemical-specific ARARs used to establish remediation levels for restoration of groundwater and surface water that are current or potential sources of drinking water (see 40 CFR §§ 300.430(e)(2)(i)(B), (C) & (E)).

13.2.1.3 Location-specific ARARs

Location-specific requirements establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations (e.g., wetlands, floodplains, critical habitats, streams). Location-specific ARARs/TBC guidance typically include Executive Orders on federal actions in floodplains and Clean Water Act regulations for discharges of dredged material or activities affecting aquatic resources such as wetlands.

13.2.2 ARAR Waiver

EPA is invoking a waiver under CERCLA Section 121(d)(4)(C) for compliance with the MCLs for VOC and SVOC contaminants at 40 CFR 141.61(a) and (c) (identified as chemical-specific ARARs) for groundwater cleanup based upon a demonstration of TI. The basis and justification for this TI waiver have been developed in the TI waiver demonstration that is included in Appendix B and the AR index (Appendix A) for the Site. Based on site conditions, the past implementation of a pump-and-treat recovery system, and modeling, EPA has determined that, from an engineering perspective, the ability of achieving the remedial objective of restoration of the aqueous contaminant plumes to attain the MCLs within a reasonable timeframe throughout the plumes is technically impracticable given the location of NAPL sources and hydrogeologic conditions at the Site. The waiver of these ARARs for groundwater cleanup is being invoked for certain zones within the onshore barrier wall that are depicted in Figure 30.

The Selected Remedy will comply with the chemical- (other than the MCLs waived under Section 121(d)(4)(C) for identified zones), location- and action-specific ARARs, and other criteria, advisories or guidance presented in Appendix F.

13.3 Cost-Effectiveness

A cost-effective remedy is one where costs are proportional to the overall effectiveness (NCP at 40 CFR Section 300.430(f)(1)(ii)(D)). Overall effectiveness is based on the evaluation of the following: long-term effectiveness and permanence, reduction in toxicity, mobility or volume through treatment, and short-term effectiveness. Costs for each alternative were evaluated in detail. Capital and annual O&M costs were estimated and used to develop present worth costs. For the present worth costs, annual O&M costs were calculated for the life of the alternative using a 7 percent discount rate. Based on the comparison of overall effectiveness and cost, the Selected Remedy meets the statutory requirement that Superfund remedies be cost effective. The Selected Remedy is the least costly alternative that will achieve RAOs. The estimated capital cost of the Selected Remedy is $89.5M. The annual O&M cost is $2.3M (total cost of $98.4M). The total present worth cost is estimated at $107M.

13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The Selected Remedy provides the best balance of tradeoffs among the alternatives with respect to the balancing criteria set forth in the NCP at 40 CFR Section 300.430(f)(1)(i)(B), such that it represents the maximum extent to which permanent solutions and technologies can be utilized in a practicable manner at the Site. NAPL will be recovered from beneath the river to the maximum extent practicable. Where practicable, NAPL will also be recovered from onshore areas and treated on site or at an off-site, EPA-approved facility, or recycled (with EPA approval). The remaining onshore contamination will be contained in perpetuity by the onshore barrier wall.

13.5 Preference for Treatment

CERCLA Section 121(b)(1) statutory preference for treatment of PTW has been considered in selecting this remedy. The recovery and treatment of NAPL from beneath the Tennessee River and onshore areas (where practicable) does not satisfy the statutory preference for treatment as a principal element of the remedy through the reduction in toxicity, mobility or volume of hazardous substances, pollutants or contaminants. Treatment will also occur for the estimated annual recovery of 7,000 pounds of contaminant mass through the collection and treatment of contaminated groundwater in support of the onshore hydraulic control system. Onshore and offshore recovery of the NAPL will permanently remove NAPL to the extent practicable and reduce the toxicity, mobility and volume through treatment and/or recycling (with EPA approval).

13.6 Five-Year Review Requirement

Because this remedy will result in hazardous substances, pollutants or contaminants remaining above levels that allow for unlimited uses and unrestricted exposure, EPA will conduct statutory reviews, pursuant to CERCLA Section 121(c) and the NCP at 40 CFR 300.430(f)(4)(ii), every five years after the initiation of the RA for the Site to ensure that the remedy is, or will be, protective of human health, welfare and the environment. If results of the FYR reveal that remedy integrity is compromised and not protective of human health and the environment, additional RAs may be evaluated by EPA and selected in amended decision documents.

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES

Over the course of the preparation of the FS, the Proposed Plan and the Proposed Plan Amendment, certain concepts initiated through the FS were refined in the Proposed Plan and, based on public comment, refined again in the Proposed Plan Amendment and the final approach documented in the ROD. The following is a summary of changes that EPA determined to be significant and should be documented in the ROD.

14.1 Offshore NAPL Source Zone

Comments received during the public comment period for the November 2017 Proposed Plan led to the issuance of an amendment to the Proposed Plan. The June 2018 Proposed Plan Amendment addressed a change in strategy for the preferred alternative approach to the NAPL source beneath the river. The preferred alternative was revised to incorporate an interim approach that involves recovery of NAPL from beneath the river to the maximum extent practicable rather than excavation and off-site disposal.

14.2 Technical Impracticability Determination

Another significant change has been the evolution in the assessment of the technical practicability of restoration of the groundwater beneath the onshore portion of the Site. The FS contemplated the feasibility of groundwater restoration with the development of Alternative SC6. However, along with the development of the Proposed Plan, the technical practicability for the restoration of groundwater beneath the onshore portion of the Site was fully analyzed and documented in a TI determination (see Appendix B) and depicted in Figure 30. EPA concluded that given the access limitations posed by the operating chemical plants, the complex hydrogeologic setting and the presence of extraordinarily large NAPL mass, it would be technically impracticable to restore the onshore groundwater to drinking water standards, even with extensive treatment, within a reasonable timeframe.

14.3 Extent Practicable versus Maximum Extent Practicable

During the development of the ROD, EPA determined that it was necessary to distinguish between the scope of the NAPL recovery efforts in the offshore and onshore areas. Although the Proposed Plan used the phrase “maximum extent practicable” to define the level of effort for both the offshore and onshore NAPL recovery, the ROD incorporates a lower level of effort for the onshore NAPL recovery.

The ROD defines the level of effort for the onshore NAPL recovery as “extent practicable” and “maximum extent practicable” for the offshore NAPL. This terminology recognizes the differences in the RAOs for the offshore and onshore areas. The long-term goal for the offshore response is the restoration of groundwater to drinking water standards, whereas it is technically impracticable to restore the onshore groundwater (within the TI zone defined in the ROD) to drinking water standards. Similarly, the offshore remedy relies on treatment of the NAPL sources, while the onshore remedy relies on containment of the NAPL source zone.

The Selected Remedy does not satisfy the statutory preference for treatment pursuant to 121(b)(1) for PTW. For the offshore NAPL, efforts will be made to recover the NAPL to the maximum extent practicable. It is anticipated that additional treatment alternatives will be developed for the residual NAPL source beneath the river and documented in a future ROD for offshore contamination. Onshore and offshore recovery of the NAPL will permanently remove NAPL to the extent practicable and reduce the toxicity, mobility and volume through treatment.

APPENDIX A

ADMINISTRATIVE RECORD INDEX

[Draft]

Administrative Record Index
for the
B.F. GOODRICH NPL Site
(SECOND RECORD OF DECISION)
KYD006370167

3.0 REMEDIAL INVESTIGATION (RI)

3. 1 Correspondence

1. Letter from Anthony Limke and Jennifer Krueger, URS to Brad Jackson, USEPA. Subject: Clarification on Alternate Concentration Limits (ACLs). (October 31, 2007)
2. Letter from Franklin Hill, USEPA to R. Bruce Scott, Kentucky Department of Environmental Protection (KYDEP). Subject: Notifying the KYDEP of the Agency's plans for future investigations at the site. (November 26, 2007)
3. Letter from Charles Newell, GSI Environmental to Brad Jackson, USEPA. Subject: The Location of SWMU 3 and the Former Slough at the Site. (June 13, 2008)
4. Letter from Kevin Sheridan, Westlake Chemical Corporation to Brad Jackson, USEPA. Subject: June 17, 2008 Focused Remedial Investigation/Feasibility Study Work Plan meeting. (June 19, 2008)
5. Letter from Henry List, Kentucky Energy and Environment Cabinet to A. Stanley Meiburg, USEPA Subject: Request for assistance in addressing historic contamination at the site. (May 22, 2009)
6. Letter from A. Stanley Meiburg, USEPA to Henry List, Kentucky Energy and Environment Cabinet. Subject: Request for assistance in addressing historic contamination at the site. (May 29, 2009)
7. Letter to Brad Jackson, USEPA. Subject: CPT/MIP Calibration Plan. (July 23, 2010)
8. Technical Memorandum Revision 1 for AOI 8B former Process Sewer Line from Respondents to Brad Jackson, USEPA. Subject: Process Sewer Inspection Procedure Modification. (January 13, 2012)
9. Letter from Brad Jackson, USEPA to Addressees. Subject: EPA Approval - Technical Memorandum, AOI8B Former Process Sewer Line. (January 20, 2012)
10. Memorandum from Respondents to Bradley Jackson, USEPA. Subject: Delineation of Confirmed and Potential NAPL Zones. (February 02, 2012)
11. Letter from Brad Jackson, USEPA to Addressees. Subject: EPA Approval - Delineation of Confirmed and Potential NAPL Zones. (February 20, 2012)
12. Memorandum from Respondents to Bradley Jackson, USEPA. Subject: Proposed Tributary Sampling Downstream of Outfall 004. (July 05, 2012)
13. Letter from Brad Jackson, USEPA to Addressees. Subject: EPA Approval & Notice to Proceed - Proposed Tributary Sampling Downstream of Outfall 004. (July 16, 2012)
14. Technical Memorandum from Respondents to Bradley Jackson, USEPA. Subject: Air Pathway Assessment. (May 16, 2013)
15. Letter from Brad Jackson, USEPA to Addressees. Subject: Notice of Disapproval - Draft RI Reports. (July 24, 2013)
16. Letter from Brad Jackson, USEPA to Addressees. Subject: Re-submittal of Draft RI Report. (September 18, 2013)
17. Letter from Respondents to Brad Jackson, USEPA. Subject: Request for Extension. (October 18, 2013)

[Draft]

Administrative Record Index
for the
B.F. GOODRICH NPL Site
(SECOND RECORD OF DECISION)

3.0 REMEDIAL INVESTIGATION (RI)

3. 1 Correspondence

18. Letter from Brad Jackson, USEPA to Addressees. Subject: Request for Extension - Submittal of Draft RI Report. (October 22, 2013)
19. Letter from Respondents to Brad Jackson, USEPA. Subject: Request for Extension. (November 18, 2013)
20. Letter from Brad Jackson, USEPA to Addressees. Subject: Request for Extension - Remedial Investigation Report. (November 25, 2013)
21. Letter from Respondents to Brad Jackson, USEPA. Subject: Request for Extension. (January 08, 2014)
22. Letter from Brad Jackson, USEPA to Addressees. Subject: Notification of Non-Compliance. (January 16, 2014)
23. Letter from Davina Pujari, Barg Coffin Lewis & Trapp and Heidi Goldstein, Thompson Hines to Addressees. Subject: Invocation of Dispute Resolution. (February 18, 2014)
24. Letter from Carol Monell, USEPA to Addressees. Subject: Dispute Resolution of Work Takeover. (March 18, 2014)
25. Memorandum from Ben Bentkowski, USEPA to Brad Jackson, USEPA. Subject: Final Evaluation of Monitored Natural Attenuation and Monitored Natural Recovery. (October 30, 2017)

3. 2 Sampling and Analysis Data

1. Letter from Bradley Jackson, USEPA to Christian Orsborn, Jr., PolyOne Corporation. Providing EPA's comments on updated data analysis dated June 19, 2007. (August 31, 2007)
2. Letter from Jennifer Krueger and Anthony Limke, URS to Bradley Jackson, USEPA. Subject: Responses to EPA's comments dated August 31, 2007 on updated data analysis. (December 19, 2007)
3. Letter from Bradley Jackson, USEPA to Ernie Schaub, PolyOne Corporation. Subject: EPA's review comments on the draft Sampling and Analysis Plan and providing conditional notice to proceed. (October 30, 2008)
4. "Sampling and Analysis Plan, Revision 1, for Focused Remedial Investigation/Feasibility Study Work Plan, Revision 3, BFGoodrich Superfund Site, Calvert City, Kentucky," URS. (November 25, 2008)
5. Letter from Brad Jackson, USEPA to Ernie Schaub, PolyOne. Subject: EPA Approval - Final Sampling and Analysis Plan - November 25, 2008. (January 27, 2009)
6. "Sampling and Analysis Plan for Area of Investigation 4, Tennessee River, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (June 09, 2010)
7. "Sampling and Analysis Plan for Areas of Investigation 1-3, AOI 1 - Northwest Area (T-AOC R), AOI 2 - Ponds, and AOI 3 - Vinyl Tank Farm/Shore Tank Farm, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (June 09, 2010)
8. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval & Notice to Proceed - SAP AOI 1-3 and AOI 4. (June 10, 2010)

3.0 REMEDIAL INVESTIGATION (RI)

3. 2 Sampling and Analysis Data

9. "Sampling and Analysis Plan for Area of Investigation 7, AOI 7 - Cracking/Synthesis Areas, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (March 28, 2011)
10. "Sampling and Analysis Plan for Area of Investigation 5, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (April 01, 2011)
11. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval & Notice to Proceed - SAP AOI 5 and 7. (April 01, 2011)
12. "Sampling and Analysis Plan for Area of Investigation 6, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (April 25, 2011)
13. "Sampling and Analysis Plan for Area of Investigation 8, AOI 8 - Chlorine/Ethylene Plant Areas, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (April 25, 2011)
14. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval & Notice to Proceed - SAP AOI 1 (Phase III) and AOI 6. (May 02, 2011)
15. "Sampling and Analysis Plan for Area of Investigation 8, AOI 8 - Ethylene Plant Area, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (July 19, 2011)
16. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval & Notice to Proceed - SAP AOI 8a. (August 04, 2011)
17. "Sampling and Analysis Plan for Area of Investigation 8B, Chlorine Plant Area, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (October 26, 2011)
18. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval & Notice to Proceed - SAP AOI 8b. (October 26, 2011)
19. "Sampling and Analysis Plan for Characterization of Barge Slip, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (May 30, 2012)
20. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval & Notice to Proceed - Sampling and Analysis Plan; Characterization of Barge Slip. (May 31, 2012)
21. "Sampling and Analysis Plan for Vapor Intrusion, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp. and PolyOne. (January 07, 2013)
22. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval & Notice to Proceed - Sampling and Analysis Plan; Vapor Intrusion. (January 08, 2013)

3. 3 Scopes of Work

1. Work Description for Delineation Field Activities - March/April 2009, B.F. Goodrich Superfund Site, Calvert City, Kentucky. (DATE UNKNOWN)
2. Statement of Work for the Focused Remedial Investigation, Feasibility Study and Baseline Risk Assessment, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky. (March 01, 2008)

[Draft]

Administrative Record Index
for the
B.F. GOODRICH NPL Site
(SECOND RECORD OF DECISION)

3.0 REMEDIAL INVESTIGATION (RI)

3. 3 Scopes of Work

3. Statement of Work for the Remedial Investigation, Feasibility Study and Baseline Risk Assessment, B.F. Goodrich Site, Calvert City, Marshall County, Kentucky. (June 01, 2009)

3. 4 Work Plans and Progress Reports

1. Letter from Bradley Jackson, USEPA to Christian Orsborn, Jr. Subject: EPA's comments on the Pilot Test Work Plan dated April 2005. (January 18, 2006)
2. Letter from Bradley Jackson, USEPA to Ernie Schaub, PolyOne Corporation. Subject: EPA's interim comments on the draft RI/FS Work Plan. (June 12, 2008)
3. Letter from Bradley Jackson, USEPA to Ernie Schaub, PolyOne Corporation. Subject: EPA's final comments on the draft RI/FS Work Plan. (June 25, 2008)
4. Letter from Bradley Jackson, USEPA to Ernie Schaub, PolyOne Corporation. Subject: EPA's review comments on the draft RI/FS Work Plan, revision 1. (July 09, 2008)
5. "Focused Remedial Investigation/Feasibility Study Work Plan, Revision 3, BFGoodrich Superfund Site, Calvert City, Kentucky," URS. (July 16, 2008)
6. "Remedial Investigation / Feasibility Study (RIFS) Work Plan, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Goodrich Corp., PolyOne, and Westlake Vinyls. (April 22, 2010)
7. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval & Notice to Proceed - RI/FS Work Plan. (April 22, 2010)

3. 8 Interim Deliverables

1. "Health and Safety Plan (HASP) for Focused Remedial Investigation and Feasibility Study (RI/FS) Work Plan Implementation, BFGoodrich Superfund Site, Calvert City, Kentucky," URS. (November 25, 2008)
2. "Quality Assurance Project Plan (QAPP) for Focused Remedial Investigation/Feasibility Study Work Plan, Revision 3, BFGoodrich Superfund Site, Calvert City, Kentucky," URS. (November 25, 2008) [Note: Due to the Confidential nature, a portion of this document has been withheld. Withheld material is available, for Judicial review only, at EPA Region 4, Atlanta, Georgia].
3. "Focused Remedial Investigation/Feasibility Study (RI/FS) Technical Memorandum - Screening Method Evaluation, BFGoodrich Site, Calvert City, Kentucky," URS. (February 20, 2009)
4. "General Management Approach, Attachment D, BF Goodrich Site, Calvert City, Marshall County, Kentucky" EPA Region 4. (August 01, 2009)
5. "Quality Assurance Project Plan, Remedial Investigation/Feasibility Study, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," CRS. (July 16, 2010)
6. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval - Quality Assurance Project Plan. (August 03, 2010)
7. "Site Health and Safety Plan for Subsurface Investigations, Revision 1, B.F. Goodrich Superfund Site, Calvert City, Kentucky". (May 04, 2011)
8. "Final Quality Assurance Project Plan, Tennesssee River NAPL Investigation, Revision 2, B.F. Goodrich Superfund Site, Calvert City, Kentucky," US Army Corps of Engineers. (April 01, 2016)

[Draft]

Administrative Record Index
for the
B.F. GOODRICH NPL Site
(SECOND RECORD OF DECISION)

3.0 REMEDIAL INVESTIGATION (RI)

3. 8 Interim Deliverables

9. "Site Safety and Health Plan for B.F. Goodrich Superfund Site, Calvert City, Kentucky" US Army Corps of Engineers. (June 01, 2016)

3.10 Remedial Investigation (RI) Reports

1. "Remedial Investigation/Feasibility Study (RI/FS) Candidate Technologies Memorandum, Source Zone Treatability Studies, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Goodrich Corp., PolyOne and Westlake Vinyls. (January 30, 2012)
2. Letter from Brad Jackson, USEPA to Respondents. Subject: EPA Approval - RI/FS Candidate Technologies Memorandum, Source Zone Treatability Study. (February 21, 2012)
3. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [01 of 22]. (July 12, 2013)
4. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [02 of 22]. (July 12, 2013)
5. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [03 of 22]. (July 12, 2013)
6. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [04 of 22]. (July 12, 2013)
7. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [05 of 22]. (July 12, 2013)
8. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [06 of 22]. (July 12, 2013)
9. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [07 of 22]. (July 12, 2013)
10. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [08 of 22]. (July 12, 2013)
11. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [09 of 22]. (July 12, 2013)
12. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [10 of 22]. (July 12, 2013)

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

13. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [11 of 22]. (July 12, 2013)

14. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [12 of 22]. (July 12, 2013)

15. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [13 of 22]. (July 12, 2013)

16. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [14 of 22]. (July 12, 2013)

17. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [15 of 22]. (July 12, 2013)

18. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [16 of 22]. (July 12, 2013)

19. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [17 of 22]. (July 12, 2013)

20. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [18 of 22]. (July 12, 2013)

21. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [19 of 22]. (July 12, 2013)

22. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [20 of 22]. (July 12, 2013)

23. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [21 of 22]. (July 12, 2013)

24. Letter from Ernie Schaub, PolyOne and Bruce Amig, Goodrich, Corp. to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report, Version 2 for the B.F. Goodrich Site in Calvert City, Kentucky. [22 of 22]. (July 12, 2013)

25. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [01 of 96]. (July 12, 2013)

26. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [02 of 96]. (July 12, 2013)

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

27. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [03 of 96]. (July 12, 2013)
28. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [04 of 96]. (July 12, 2013)
29. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [05 of 96]. (July 12, 2013)
30. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [06 of 96]. (July 12, 2013)
31. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [07 of 96]. (July 12, 2013)
32. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [08 of 96]. (July 12, 2013)
33. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [09 of 96]. (July 12, 2013)
34. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [10 of 96]. (July 12, 2013)
35. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [11 of 96]. (July 12, 2013)
36. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [12 of 96]. (July 12, 2013)
37. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [13 of 96]. (July 12, 2013)
38. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [14 of 96]. (July 12, 2013)
39. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [15 of 96]. (July 12, 2013)
40. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [16 of 96]. (July 12, 2013)
41. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [17 of 96]. (July 12, 2013)
42. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [18 of 96]. (July 12, 2013)
43. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [19 of 96]. (July 12, 2013)
44. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [20 of 96]. (July 12, 2013)

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

45. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [21 of 96]. (July 12, 2013)
46. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [22 of 96]. (July 12, 2013)
47. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [23 of 96]. (July 12, 2013)
48. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [24 of 96]. (July 12, 2013)
49. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [25 of 96]. (July 12, 2013)
50. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [26 of 96]. (July 12, 2013)
51. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [27 of 96]. (July 12, 2013)
52. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [28 of 96]. (July 12, 2013)
53. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [29 of 96]. (July 12, 2013)
54. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [30 of 96]. (July 12, 2013)
55. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [31 of 96]. (July 12, 2013)
56. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [32 of 96]. (July 12, 2013)
57. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [33 of 96]. (July 12, 2013)
58. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [34 of 96]. (July 12, 2013)
59. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [35 of 96]. (July 12, 2013)
60. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [36 of 96]. (July 12, 2013)
61. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [37 of 96]. (July 12, 2013)
62. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [38 of 96]. (July 12, 2013)

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

63. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [39 of 96]. (July 12, 2013)

64. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [40 of 96]. (July 12, 2013)

65. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [41 of 96]. (July 12, 2013)

66. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [42 of 96]. (July 12, 2013)

67. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [43 of 96]. (July 12, 2013)

68. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [44 of 96]. (July 12, 2013)

69. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [45 of 96]. (July 12, 2013)

70. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [46 of 96]. (July 12, 2013)

71. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [47 of 96]. (July 12, 2013)

72. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [48 of 96]. (July 12, 2013)

73. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [49 of 96]. (July 12, 2013)

74. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [50 of 96]. (July 12, 2013)

75. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [51 of 96]. (July 12, 2013)

76. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [52 of 96]. (July 12, 2013)

77. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [53 of 96]. (July 12, 2013)

78. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [54 of 96]. (July 12, 2013)

79. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [55 of 96]. (July 12, 2013)

80. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [56 of 96]. (July 12, 2013)

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

81. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [57 of 96]. (July 12, 2013)
82. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [58 of 96]. (July 12, 2013)
83. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [59 of 96]. (July 12, 2013)
84. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [60 of 96]. (July 12, 2013)
85. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [61 of 96]. (July 12, 2013)
86. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [62 of 96]. (July 12, 2013)
87. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [63 of 96]. (July 12, 2013)
88. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [64 of 96]. (July 12, 2013)
89. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [65 of 96]. (July 12, 2013)
90. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [66 of 96]. (July 12, 2013)
91. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [67 of 96]. (July 12, 2013)
92. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [68 of 96]. (July 12, 2013)
93. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [69 of 96]. (July 12, 2013)
94. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [70 of 96]. (July 12, 2013)
95. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [71 of 96]. (July 12, 2013)
96. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [72 of 96]. (July 12, 2013)
97. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [73 of 96]. (July 12, 2013)
98. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [74 of 96]. (July 12, 2013)

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

99. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [75 of 96]. (July 12, 2013)

100. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [76 of 96]. (July 12, 2013)

101. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [77 of 96]. (July 12, 2013)

102. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [78 of 96]. (July 12, 2013)

103. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [79 of 96]. (July 12, 2013)

104. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [80 of 96]. (July 12, 2013)

105. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [81 of 96]. (July 12, 2013)

106. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [82 of 96]. (July 12, 2013)

107. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [83 of 96]. (July 12, 2013)

108. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [84 of 96]. (July 12, 2013)

109. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [85 of 96]. (July 12, 2013)

110. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [86 of 96]. (July 12, 2013)

111. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [87 of 96]. (July 12, 2013)

112. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [88 of 96]. (July 12, 2013)

113. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [89 of 96]. (July 12, 2013)

114. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [90 of 96]. (July 12, 2013)

115. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [91 of 96]. (July 12, 2013)

116. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [92 of 96]. (July 12, 2013)

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

117. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [93 of 96]. (July 12, 2013)

118. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [94 of 96]. (July 12, 2013)

119. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [95 of 96]. (July 12, 2013)

120. Letter from Kevin Sheridan, Westlake Vinyls to Brad Jackson, USEPA. Subject: Draft Remedial Investigation Report for the B.F. Goodrich Site in Calvert City, Kentucky. [96 of 96]. (July 12, 2013)

121. "Steady-State Groundwater Flow Model Report, B. F. Goodrich Superfund Site RI/FS, Calvert City, Kentucky," McDonald Morrissey Associates, Inc. (September 2013)

122. Letter from Bradley Jackson, USEPA to Respondents. Subject: RI, HHRA, and BERA Reports. (December 12, 2014)

123. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [01 of 12]. (August 01, 2015)

124. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [02 of 12]. (August 01, 2015)

125. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [03 of 12]. (August 01, 2015)

126. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [04 of 12]. (August 01, 2015)

127. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [05 of 12]. (August 01, 2015)

128. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [06 of 12]. (August 01, 2015)

129. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [07 of 12]. (August 01, 2015)

130. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [08 of 12]. (August 01, 2015)

131. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [09 of 12]. (August 01, 2015)

132. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [10 of 12]. (August 01, 2015)

133. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [11 of 12]. (August 01, 2015)

134. "Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. [12 of 12]. (August 01, 2015)

[Draft]

Administrative Record Index
for the
B.F. GOODRICH NPL Site
(SECOND RECORD OF DECISION)

3.0 REMEDIAL INVESTIGATION (RI)

3.10 Remedial Investigation (RI) Reports

135. Letter from Ernie Schaub, PolyOne to Brad Jackson, USEPA. Subject: NAPL Source Zone Delineation in the Remedial Investigation Report. (December 10, 2015)

136. "Remedial Investigation Addendum, Summary of 2016/2017 Offshore Investigation at the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. (November 01, 2017)

4.0 FEASIBILITY STUDY (FS)

4. 1 Correspondence

1. Letter from Brad Jackson, USEPA to Respondents. Subject: EPA Notification of Treatability Study Requirement. (June 10, 2010)

2. Technical Memorandum from PolyOne and Goodrich Corporations to Brad Jackson, USEPA. Subject: Identification of Waste Management Area and Groundwater Containment Zones. (September 12, 2014)

3. Technical Memorandum from Westlake Vinyls to Brad Jackson, USEPA. Subject: Groundwater Containment Zone Technical Memorandum. (September 12, 2014)

4. Letter from Respondents to Brad Jackson, USEPA. Subject: EPA assuming responsibility for completion for the Feasibility Study. (July 31, 2015)

5. Letter from Franklin Hill, USEPA to Respondents. Subject: Work Takeover of the Completion of the Feasibility Study. (September 22, 2015)

6. Presentation to the EPA by PolyOne Corporation. (April 24, 2018)

4. 4 Work Plans and Progress Reports

1. "Remedial Investigation / Feasibility Study (RIFS) Treatability Study Scoping, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Goodrich Corp., PolyOne and Westlake Vinyls. (October 22, 2010)

2. Technical Memorandum from Respondents to Brad Jackson, USEPA. Subject: Scope of Work - Bedrock Investigation. (April 10, 2014)

3. Technical Memorandum from Respondents to Brad Jackson, USEPA. Subject: Scope of Work - Bedrock Investigation. (May 05, 2014)

4. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval - Scope of Work - Bedrock Investigation. (May 27, 2014)

5. Letter from Bradley Jackson, USEPA to Respondents. Subject: Approval - Work Plan Modification, Scope of Work - Bedrock Investigation. (June 24, 2014)

4. 9 Feasibility Study (FS) Reports

1. "Bedrock Investigation Report, Feasibility Study - Appendix A, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls, Goodrich Corp., and PolyOne. (October 10, 2014)

2. Letter from Bradley Jackson, USEPA to Respondents. Subject: EPA Approval - Bedrock Investigation Report. (November 10, 2014)

4.0 FEASIBILITY STUDY (FS)

4. 9 Feasibility Study (FS) Reports

3. "Bedrock Investigation Report - Addendum, Feasibility Study - Appendix A, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Goodrich Corp., and PolyOne. (June 22, 2015)
4. "Bedrock Investigation Report - Addendum, Feasibility Study - Appendix A, B.F. Goodrich Superfund Site, Calvert City, Kentucky," Westlake Vinyls. (June 22, 2015)
5. "Final Feasibility Study Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," Battelle. (November 2017)
6. "Draft Final Technical Impracticability Waiver Demonstration, Onshore Groundwater, Former B.F. Goodrich Site, Calvert City, Kentucky," USEPA. (December 19, 2017)

4.10 Proposed Plans for Selected Remedial Action

1. "Proposed Plan, B.F. Goodrich Superfund Site, Calvert City, Kentucky," USEPA. (November 2017)
2. Letter from Ernie Schaub, PolyOne to Brad Jackson, USEPA. Subject: Request for Extension of Public Comment Period. (December 06, 2017)
3. Letter from Kevin Sheridan, Westlake to Brad Jackson, USEPA. Subject: Request for Extension of Public Comment Period. (December 06, 2017)
4. Letter from Bruce Amig, United Technologies to Brad Jackson, USEPA. Subject: Request for Extension of Public Comment Period. (December 07, 2017)
5. Letter from Bradley Jackson, USEPA to Addressees. Subject: Proposed Plan Public Comment Period Extension. (December 19, 2017)
6. Letter from Ernie Schaub, PolyOne to Brad Jackson, USEPA. Subject: PolyOne Initial Comments regarding EPA's 30 November 2017 Proposed Plan. (December 21, 2017)
7. Proposed Plan Public Comments, Comment Period: November 30, 2017 through February 13, 2018. (February 22, 2018)
8. "Superfund Program Proposed Plan Amendment, BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," USEPA. (June 2018)

5.0 RECORD OF DECISION (ROD)

5. 1 Correspondence

1. Memorandum from Amy Legare, USEPA to Franklin Hill, USEPA. Subject: National Remedy Review Board (NRRB) Recommendations. (February 17, 2017)
2. Memorandum from Franklin Hill, USEPA to Amy Legare, USEPA. Subject: Regional Response to NRRB Comments and Recommendations. (April 11, 2017)
3. Letter from Anthony Hatten, KYDEP to Franklin Hill, USEPA. Subject: Concurrence with the Proposed Preferred Alternative. (November 03, 2017)

8.0 SITE CLOSEOUT

8. 1 Correspondence

1. Letter from Bradley Jackson, EPA Region 4 to Christian Orsborn, Jr., PolyOne Corporation. Subject: Second Five-Year Review Follow-up Actions. (May 02, 2007)

8. 6 Long Term Response

1. "Five-Year Review Report for BF Goodrich Landfill / AIRCO Landfill, Calvert City, Marshall County, Kentucky," URS. (July 16, 2001)
2. "Final Second Five-Year Review Report for BF Goodrich Landfill / AIRCO Landfill, Calvert City, Marshall County, Kentucky," US Army Corps of Engineers. (September 19, 2006)
3. Letter from Anthony Limke and Gautam Trivedi, URS to Christian Orsborn, Jr., PolyOne Corporation. Transmitting URS' comments on the Second Five-Year Review Report. (January 31, 2007)
4. "Third Five-Year Review Report for BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," USEPA. (September 19, 2011)
5. "Fourth Five-Year Review Report for BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," USEPA. (April 06, 2017)

9.0 STATE COORDINATION

9. 1 Correspondence

1. Letter from Bradley Jackson, EPA Region 4 to Cliff Hall, Kentucky Department of Environmental Protection. Subject: State notification of RI/FS negotiations. (June 26, 2009)

10.0 ENFORCEMENT

10.11 EPA Administrative Orders

1. Administrative Settlement Agreement and Order on Consent for Focused Remedial Investigation/Feasibility Study, In the Matter of B.F. Goodrich Superfund Site, Goodrich Corporation and PolyOne Corporation, Respondents, Docket No. 04-2008-3775. (August 28, 2008)
2. Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study, In the Matter of B.F. Goodrich Superfund Site, Goodrich Corporation, PolyOne Corporation, and Westlake Vinyls, Inc., Respondents, Docket No. 04-2010-3761. (December 09, 2009)

11.0 POTENTIALLY RESPONSIBLE PARTIES (PRP)

11. 9 PRP-Specific Correspondence

1. Letter from Carol Monell, USEPA to Bruce Amig, Goodrich Corporation. Subject: General and Special Notice Letter. (June 26, 2009)
2. Letter from Carol Monell, USEPA to Ernie Schaub, PolyOne Corporation. Subject: General and Special Notice Letter. (June 26, 2009)

11.0 POTENTIALLY RESPONSIBLE PARTIES (PRP)

11. 9 PRP-Specific Correspondence

3. Letter from Carol Monell, USEPA to Jean Schneiderman, Lubrizol Advanced Materials, Inc. Subject: General and Special Notice Letter. (June 26, 2009)
4. Letter from Carol Monell, USEPA to Kevin Sheridan, Westlake Chemical Corporation. Subject: General and Special Notice Letter. (June 26, 2009)
5. Letter from Carol Monell, USEPA to Paul Petitt, Cymetech LLC. Subject: General and Special Notice Letter. (June 26, 2009)

13.0 COMMUNITY RELATIONS

13. 6 Community Relations Plans

1. "Community Involvement Plan, B.F. Goodrich Corporation Superfund Site, Calvert City, Kentucky," USEPA. (November 06, 2017)

13. 8 Public Meetings

1. Presentation - Proposed Plan Public Meeting. (December 07, 2017)

13. 9 Fact Sheets

1. "Remedial Investigation/Feasibility Study Fact Sheet, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," USEPA. (May 2010)
2. "Remedial Investigation/Feasibility Study Fact Sheet, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," USEPA. (November 2011)
3. "Remedial Investigation/Feasibility Study Fact Sheet, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," USEPA. (October 2015)
4. "Fact Sheet - National Remedy Review Board Briefing Report, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," USEPA. (July 07, 2016)
5. "Proposed Plan Fact Sheet, B.F. Goodrich Superfund Site, Calvert City, Marshall County, Kentucky," USEPA. (November 2017)
6. "Proposed Plan Amendment Fact Sheet, B.F. Goodrich Site, Calvert City, Kentucky," USEPA. (June 2018)

16.0 NATURAL RESOURCE TRUSTEE

16. 1 Correspondence

1. Letter from Bradley Jackson, USEPA to Anthony Velasco, US Fish and Wildlife Service. Subject: Notification of a Release or Threatened Release of Hazardous Substances and of RI/FS Negotiations. (March 10, 2008)
2. Letter from Bradley Jackson, USEPA to Anthony Velasco, US Fish and Wildlife Service. Subject: Notification of the Initiation of Negotiations for the Remedial Investigation/Feasibility Study for the Site. (June 19, 2009)

[Draft]

Administrative Record Index
for the
B.F. GOODRICH NPL Site
(SECOND RECORD OF DECISION)

17.0 SITE MANAGEMENT RECORDS

17. 4 Site Audio-Visuals

1. Figure - RN Area Cross-Section. (April 25, 2018)
2. Figure - River Investigation - RN & RG Borings, Boring Locations - Noting Refusal. (April 25, 2018)
3. Figure - River Investigation - RN & RG Borings, NAPL Observations. (April 25, 2018)

17. 7 Reference Documents

1. RCRA Permit Appeal Fact Sheet. (November 01, 1989)
2. Memorandum from Steven Herman and Elliot Laws, USEPA to Addressees. Regarding Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities. (September 24, 1996)
3. Fact Sheet - Ethylene Dichloride (1,2-Dichloroethane). (January 2000)
4. "Final - Best Demonstrated Available Technology (BDAT) Background Document for Chlorinated Aliphatics Production Wastes - K174 and K175," USEPA. (August 2000)
5. Federal Register 65 FR 67068 - EPA Final Rule for Listing K174 and K175. (November 08, 2000)
6. "Training Module - Introduction to Hazardous Waste Identification (40 CFR Parts 261)," USEPA. (September 2005)
7. 40 CFR 261.32 - Hazardous Wastes from Specific Sources. (July 01, 2011)
8. Hazardous Waste Listings - A User-Friendly Reference Document. (September 2012)

17. 8 State and Local Technical Records

1. Letter from Michael Welch, KYDEP to Bruce Amig, Goodrich. Subject: RCRA Post Closure Permit Minor Modification. (April 14, 2004)

APPENDIX B
FINAL
TECHNICAL IMPRACTICABILITY WAIVER DEMONSTRATION
ON-SHORE GROUNDWATER
FORMER B.F. GOODRICH SITE
CALVERT CITY, KENTUCKY

AUGUST 20, 2018

R4 Scientific Support Section

United States Environmental Protection Agency

Contents

LIST OF TABLES

LIST OF FIGURES

APPENDICES

ACRONYMS

AIRCO	Air Reduction Company
amsl	above mean sea level
ATSDR	Agency for Toxic Substances and Disease Registry
ACL	alternate concentration limit
ARAR	Applicable or Relevant and Appropriate Requirement
AOC	area of concern
AR	Administrative Record
AWQC	ambient water quality criteria
B	Bedrock
bgs	below ground surface
CRH	Clay-Rich Heteroliths
C	Clay/Silty
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CGF	Coarse-Grained Fill
CGS	Coarse-Grained Sand
CSM	Conceptual Site Model
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
DCE	dichloroethane
DCPD	dicyclopentadiene
DNAPL	dense non-aqueous phase liquid
DPE	dual phase extraction
EDC	ethylene dichloride
EPA	United States Environmental Protection Agency
FS	Feasibility Study
FGF	Fine-Grained Fill
FGS	Fine-Grained Sand
G	Gravel

gpm	gallon per minute
HC	Hydrocode
HDPE	high density polyethylene
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendment
HTDC	high temperature direct chlorination
I	Interbeds
lbs/day	pounds per day
KDEP	Kentucky Department of Environmental Protection
KDWM	Kentucky Division of Waste Management
LOE	Line of Evidence
LNAPL	light non-aqueous phase liquid
MCB	Mercury Cell Building
MCL	Maximum Contaminant Level
ND	Non-detect
NCP	National Contingency Plan
NAPL	non-aqueous phase liquid
O&M	operation and maintenance
ORP	oxidation reduction potential
OSHA	Occupational Safety and Health Administration
PCE	perchloroethene/tetrachloroethene
PCAP	Plant-wide Corrective Action Program
PI	Potential Indicator
PVC	polyvinyl chloride
PTW	principal threat waste
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RG	river groundwater
RI	Remedial Investigation
SC	source control

SVE	soil vapor extraction
SVOC	Semi-volatile Organic Compound
SWMU	Solid Waste Management Unit
TCA	trichloroethane
TCE	Trichloroethene
TI	Technical Impracticability
USGS	United States Geological Survey
VCM	vinyl chloride monomer
VOC	volatile organic compound

EXECUTIVE SUMMARY

Restoration of the groundwater to drinking water standards (maximum contaminant levels [MCLs]) is required by the Safe Drinking Water Act and the Clean Water Act, where practicable. Both laws are applicable or relevant and appropriate requirements (ARARs). Thirty compounds exceed their respective MCL in the groundwater under the former B.F. Goodrich plant. Using provisions provided by the National Contingency Plan, a waiver is applied for due the technical impracticability (TI) of meeting the drinking water standards.

The site has a long and complex manufacturing history which began in 1953. Accidental chemical releases or those conducted by practice are part of the 60+ year history. Previous remedial/removal actions include wastewater pond closure, installation of the Plant-wide Corrective Action Program (PCAP) system, and remedial actions at the BF Goodrich Landfill and Burn Pit Area.

Analysis of the extensive and comprehensive database of geologic, hydrogeologic and chemical information yields the fact that approximately half of the 3.5 million cubic yards (yd^3) of dense, non-aqueous phase liquid (DNAPL)-impacted soils at the site comprised of fine-grained sedimentary units such as silts, clays and interbed formations (approximately 13,000,000 pounds). The engineering difficulty of groundwater restoration with these **very large volumes of DNAPL** in these **complex interbedded fine-grained units** are **two of the major factors** in demonstrating the need for a TI waiver.

A simple mass discharge/back diffusion model was run using the basic parameters of the site. The results indicated that even after 100% mass removal from the coarser-grained sediments, groundwater concentrations would still be 10 to 25 times the MCL after 100 years. Other calculations extend the restoration timeframe into the hundreds of years. The **extended duration for groundwater restoration is beyond a reasonable timeframe**. This is the **third major factor** for demonstrating the need for a TI waiver.

Four additional lines of evidence for the TI waiver were also provided in the document.

It is the conclusion of this document that, from an engineering perspective, it has been demonstrated that restoration of the groundwater in a reasonable timeframe is technically impracticable. It is the recommendation of this document that a TI waiver for the restoration of the groundwater for the 30 specified compounds be granted for specified volume, known as the TI zone, in conjunction with the signing of the Record of Decision (ROD) for the Former B.F. Goodrich site in Calvert City, Kentucky.

1.0 INTRODUCTION

This technical impracticability (TI) evaluation is based primarily on-site information contained in the 2015 Remedial Investigation Report (RI Report) and the 2017 Feasibility Study (FS) for the on-shore groundwater at the Former B.F. Goodrich facility. These reports interpret data from investigations performed by the responsible parties: Westlake Vinyls, Inc., PolyOne, Inc., and B.F. Goodrich. Other information from the decades of environmental work at this site will be included as it supports the evaluation. A conceptual site model (CSM) is presented in this report that incorporates site data and interpretations from the Environmental Protection Agency (EPA)-led 2015 RI and 2017 FS Reports. The CSM forms the basis of the evaluation of whether groundwater restoration is technically impractical and will be used to support the TI waiver determination. This evaluation is consistent with EPA's *Guidance for Evaluating the Technical Impracticability of Groundwater Restoration, Interim Final* (EPA, 1993).

This TI evaluation provides the justification for a TI waiver for restoration to maximum contaminant levels (MCLs) for the groundwater underneath the former B.F. Goodrich facility in Calvert City, Kentucky as provided in the National Contingency Plan, 40 CFR § 300.430(f)(1)(ii)(C)(3). The evaluation will follow the *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (EPA/540-93-080) and will include the following components (arranged in a standardized outline), based on site-specific information and analyses from the extensive Administrative Record (AR):

> "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstance of the site."

Under the Superfund program, restoration cleanup levels are established by applicable or relevant and appropriate requirements (ARARs), such as federal or state drinking water standards. However, as explained in the EPA TI Guidance, EPA acknowledges that restoration to drinking water quality may not always be achievable due to several situational limitations. The EPA TI Guidance identifies three general categories of factors that may inhibit groundwater restoration (EPA, 1993):

- Hydrogeologic limitations such as complex sedimentary deposits, aquifers of very low permeability, fractured bedrock aquifers and other factors that make extraction or in situ treatment of contaminated groundwater extremely difficult.
- Contaminant-related factors including properties that allow the contaminants to become sorbed onto or lodged within the soil or rock aquifer that may limit the success of an extraction or in situ treatment process. For example, in limited circumstances, the presence of dense non-aqueous phase liquids (DNAPL) is one example that, depending on site-specific circumstances, can contribute to difficulties in restoring the aquifer to beneficial use.
- Inadequate remediation system design and implementation can inhibit groundwater restoration, but it is generally not considered by EPA to be sufficient justification for a determination of TI.

Limitations related to the first two items exist within onshore groundwater at the BFG Site. Manufacture of chlorinated solvents at the former B.F. Goodrich facility has resulted in releases of a very large volume of DNAPL to a hydrogeologically complex environment that includes a thick sequence of highly permeable sediments with embedded low permeability lenses. DNAPL, primarily ethylene dichloride (EDC), mercury and 28 other compounds, have been detected in sediment and other subsurface strata.

A review of the existing data and CSM in regard to the hydrogeologic and contaminant-related properties provides the basis to assess the likelihood that site groundwater can be restored to beneficial use within a reasonable timeframe. The purpose of this report is to present the results of the TI evaluation.

It is important to note that the TI waiver applies to a large portion of the groundwater at the site to be circumscribed by the containment wall, but not all of the site and not all areas within the containment wall. There are areas to the south end of the industrial area that are to be within the proposed circumferential containment wall which do not have MCL exceedances in the groundwater. There are areas beyond the wall to the east and west and under the river where the groundwater will be required to meet the MCL. Figure 16 of this document (see Page 56) was taken from the Proposed Plan and provides the layout and the TI waiver coverage area.

2.0 SITE LOCATION AND HISTORY

The Site is located in Calvert City, Marshall County, Kentucky, on the southern side of the Tennessee River approximately 4 miles downstream from the Kentucky Dam (RI Figure 1-1). The B.F. Goodrich Chemical Corporation (now Goodrich Corporation) acquired farmland in Calvert City, Kentucky in 1951 to construct and operate a chemical manufacturing facility. Westlake Vinyls, Inc. purchased the EDC-Vinyl Chloride Monomer (VCM) Plant in 1990 and purchased the Ethylene Plant and the Chlorine Plant in 1997. Operations at the Site commenced in 1953, with the production of VCM through a reaction of acetylene and hydrogen chloride in the presence of a mercuric chloride catalyst. The process used acetylene purchased from the adjacent National Carbide facility to the west.

The Site is bordered on the north by the Tennessee River, on the south by Kentucky Highway 1523, on the west by areas owned by Air Products & Chemicals, Inc. (Air Products), Carbide Industries LLC (Carbide), and Wacker Chemical Corporation (Wacker), and on the east by areas owned by PolyOne, The Linde Group (Linde), and Westlake, including the Air Reduction Company (AIRCO) Superfund Site owned by Linde (RI Figure 1-4). The Site can be accessed from Kentucky Highway 1523. The area of the Site undergoing investigation under the Superfund program is approximately 200 acres. The primary chemical manufacturing facilities and related areas at the Site include the following (RI Figure 1-2):

- The EDC)/VCM Plant, which produces VCM as well as EDC for use in the production of VCM
- The Ethylene Plant, which produces ethylene for use in the production of VCM
- The Chlorine Plant, which produces chlorine for use in the production of VCM
- The Ultrene® Plant, which produces dicyclopentadiene (DCPD)
- The Carbopol® Plant, which produces Carbopol® and other cross-linked polymers.

2.1 Past and Present Site Manufacturing Processes

The following subsections describe the chemical manufacturing processes that have been and/or continue to be conducted at the Site (see 2015 RI for more detail).

2.1.1 VCM Manufacturing

As noted above, VCM was first produced at the site in 1953 through the reaction of acetylene and hydrogen chloride in the presence of a mercuric chloride catalyst. In 1964, the facility switched from acetylene-based to EDC-based VCM production. To manufacture VCM using EDC, EDC is first produced by direct chlorination and oxychlorination reactions, and the EDC is subsequently dehydrohalogenated in cracking furnaces to produce VCM. The EDC production facility currently does not manufacture all of the EDC that is required to produce VCM at the Site; additional EDC is purchased from off-site sources to supplement production. EDC product, or "crude", is either dry crude (lower water content) from the direct chlorination process or wet crude (greater water content) from the oxychlorination process.

Direct chlorination, also referred to as "EDC manufacturing," involves reacting ethylene and chlorine in the presence of a ferric chloride catalyst to produce dry crude EDC. Dry crude EDC from the direct chlorination reactor is passed through acid, caustic, and neutral wash water tanks to remove impurities, and the resulting wash waters from these tanks contain the impurities intended to be removed as well as EDC and other chlorinated organic compounds. A modification to the direct chlorination process was implemented in 1982 with the addition of a high temperature direct chlorination (HTDC) reactor at the South Synthesis Unit. Using the HTDC reactor, dry crude EDC is generated as a vapor, which is then purified through distillation.

Fractional distillation is performed for dry crude EDC, wet crude EDC, and a portion of the EDC that has not reacted in the cracking furnaces. The distillation first removes low-boiling point impurities such as "light-end" gases and water vapor. EDC is then separated from high-boiling point impurities. The high-boiling point impurities consist of chlorinated organic compounds, which are referred to as “heavy ends”. This material is also referred to as chlorinated byproduct, and is a DNAPL.

Following distillation, purified dry EDC is thermally dehydrohalogenated (or "cracked") in furnaces in the North/South Cracking Unit and the East Cracking Unit. This process creates VCM and hydrogen chloride.

Liquid and vapor streams from the cracking furnace quench sections are fractionally distilled to purify VCM and to recover hydrogen chloride and unreacted EDC for reuse. Distilled VCM product is stored in five VCM spheres in the Vinyl Tank Farm. VCM in the spheres is shipped offsite by pipeline or railcar to polyvinyl chloride (PVC) manufacturing plants.

2.1.2 Ethylene Manufacturing

The Ethylene Plant, which was constructed in 1964, produces high purity ethylene by thermally cracking propane and/or ethane feedstock. Other products from the cracking process include propylene, mixed C-4s, crude benzene, aromatic gasoline, and fuel oil.

The process feedstock is combined with steam in one of nine high-temperature furnaces. Effluent gas from the furnaces is cooled by heat transfer to control and stabilize effluent reactions using a series of transfer line exchangers that use boiler feed water as a coolant. Condensates generated from the cooling process are drained to concrete pads and piped to the Ethylene Plant wastewater pretreatment system.

2.1.3 Chlorine Manufacturing

The Chlorine Plant produces chlorine gas for use in EDC manufacturing. From 1966 to 2001, chlorine gas was produced at the Chlorine Plant using a mercury cell process. The mercury cell process consisted of 36 cells that converted brine to chlorine, hydrogen, and sodium hydroxide. The cells each contained a titanium anode coated with ruthenium oxide and a cathode comprised of a sloped pool of flowing liquid mercury.

Filter cake resulting from the secondary treatment process was disposed offsite. Prior to its closure in 1985, wastewater and brine sludge containing mercury from the Chlorine Plant were sent to Pond 4. Effluent from Pond 4 was treated in the former sulfide treatment system for final removal of precipitated mercuric sulfide.

In 2001, the Chlorine Plant was converted to a membrane cell process that does not use mercury. The membrane cell process uses sodium chloride salt, which is brought to the Site via barge. The salt is unloaded at the barge dock in the Barge Slip and stored in a large outdoor pile before being conveyed to a saturator, where it is combined with depleted brine and water to form a saturated brine solution.

2.1.4 DCPD Manufacturing

The Ultrene® Plant, which was constructed in 1996, produces high purity (>97% pure) DCPD from a crude stream containing 40% to 60% DCPD. Other commercial products are also produced from this process, including methylcyclopentadiene dimmer, resin oil heavies, and DCPD heavies.

2.1.5 Carbopol® Manufacturing

Carbopol® has been produced at the Site since 1958. The thickener is produced using an organic solvent, which may be benzene, ethyl acetate, or a co-solvent mixture.

2.2 Site Waste Management

Waste management features that have existed and/or continue to exist at the Site include wastewater ponds, burn pits, and landfills and other disposal areas. Certain waste management features at the Site have been identified as Solid Waste Management Units (SWMUs) under the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. RI Figure 1-5 presents the locations of SWMUs (along with other areas of concern [AOCs]) that have been identified at the Site, and RI Table 1-1 identifies and describes the SMWUs and AOCs.

2.2.1 Wastewater Ponds

Several wastewater ponds were used at the Site at various times after 1953, as discussed below. The majority of the ponds were closed by 1984 while Ponds 1A and 2 remain open for stormwater management. The ponds were constructed of native earthen material with no liner, and were used to contain/treat wastewater from the various manufacturing plants. RI Figure 1-6 (1957 to 1964) and RI Figure 1-7 (1971 to 2000) depict the general outlines of the ponds at various time periods.

Pond P-1 (SWMU 15), which was constructed in 1954, was the first wastewater pond at the Site and was used to treat waste from the VCM manufacturing process. Pond P-1 was later also used to treat wastewater from the Carbopol® Plant. The pond had a storage volume of

15.9 million gallons and a surface area of about 5.44 acres, and received wastewater containing acrylic acid and benzene. Pond P-1 was closed around 1963.

In 1957, two settling ponds, collectively referred to as Pond P-2 (SWMU 16), were constructed in the area of the present Ethylene Plant Tank Farm. The ponds were together approximately 2.4 acres in size and received ammonium sulfate waste. Pond P-2 was closed in 1962.

Pond 0 (SWMU 7) was constructed in 1958. The pond was 1.3 acres in size and was used as a settling basin for waste streams from the EDC/VCM production units. In 1974, Pond 0 was no longer used for waste disposal.

In 1959, Pond P-4 (SWMU 17) was constructed in the area of the present Ethylene Plant Tank Farm. Similar to Pond P-2, Pond P-4 was 2.4 acres in size and received ammonium sulfate waste. Pond P-4 was closed in 1962.

Plant expansions in the 1960s required the increase of water treatment capacity and the construction of new ponds to store and treat brine and mercury sludges. Ponds 1, 2 (SWMU 10), 3A (SWMU 11), 3B (SWMU 13), and 3C (SWMU 14) were constructed and began operating in 1963. Pond 4 (SWMU 12) was constructed in 1965. Pond 1 was later subdivided into two ponds, known as Pond 1A (SWMU 8) and Pond 1B (SWMU 9).

Pond 1A (2.1 acres) was used to manage wastewater, as a stormwater diversion basin for the EDC/VCM and ethylene production units, and as a settling basin for the waste stream from the acrylic acid polymer production unit. Pond 1A was constructed in the southwestern portion of the pond with a sump in it. The pond was used to accumulate organic byproduct (DNAPL) originating from releases at process pads and from sump and storage tank overflows. The thickness of organic byproduct in the Pond 1A sump was monitored, and the organic byproduct was periodically recovered and reused in the manufacturing process. During recovery events, all of the organic material was reportedly removed. The sludge was comprised of dirt, ferric chloride, ferric hydroxide, reboiler drillings, chlorinated polymers, and tar residues also accumulated in Pond 1A. The sludge eventually accumulated to a total thickness of approximately 9 to 12 feet by the early 1980s.

Pond 1B (0.86 acres) was constructed in the 1970s and used as an equalization basin for all surface impoundments prior to discharging waters to Pond 2. Historically, other ponds existed in the location where Pond 1B was constructed.

Pond 2 (3.3 acres, 10.2 million gallons of storage) was used as a final stabilization basin for plant waters. Water was discharged to the Tennessee River from Pond 2.

Pond 3A (0.5 acres, 1.5 million gallons of storage) was used as a skim basin for process and stormwaters from the Ethylene Plant. Pond 3B (0.5 acres, 1.2 million gallons of storage) was constructed to manage iron and copper hydroxide sludge. Pond 3C (0.4 acres, 2 million gallons of storage) was constructed to receive acrylic acid polymer sludge and wastewater from the Ethylene Plant, and later was used to settle dredge spoils from the barge slip.

Pond 4 (2.5 acres, 14 million gallons of storage) was used as a stormwater diversion basin and a treatment and settling basin for brine waste materials, wastewater, and other materials from the Chlorine Plant, including the Mercury Cell Building (MCB).

In the early 1980s, BF Goodrich installed a new wastewater treatment system for EDC/VCM Plant discharges that resulted in a major reduction of EDC discharges to the ponds. In 1984, BF Goodrich took steps to close remaining wastewater ponds, and discharges of EDC to Ponds 1A, 1B, 2, and 3A ended in November 1985. BF Goodrich prepared a RCRA Interim Status Closure Plan (Goodrich, 1986), which was approved by the Kentucky Division of Waste Management (KDWM) for the closure of Ponds 0, 1A, 1B, 2, 3A, and 4. The closure involved removing, stabilizing, and burying the hazardous waste sludge in closure cells. Closure of the ponds was completed in March 1988. BF Goodrich submitted a certification of closure for the ponds on February 23, 1989. The KDWM and EPA jointly issued a hazardous waste Post-Closure Permit and a Hazardous and Solid Waste Amendment (HSWA) Permit for the closure cells on September 29, 1989 (KDWM, 2003). Non-regulated Ponds 3B and 3C were closed at the same time as the six regulated ponds.

The National Carbide Settling Pond and Recycle Pond were constructed in the late 1950s. These ponds were reportedly used for the storage of lime and coke slurry from the carbide furnace. After a property transfer in 1964, the eastern end of the National Carbide Settling Pond was separated by a berm constructed along the new property line to form the Sand Filter Backwash Pond. After 2002, the Settling and Recycle Ponds were used to collect stormwater for use in the acetylene manufacturing process, and possibly to collect non-contact cooling water and noncontact process water.

2.2.2 Waste Volumes

It is difficult to provide an accurate tally of waste volumes from individual waste streams being disposed of into specific ponds. Two of the responsible parties have differing accounts of the amount of mass that has been released and how much may remain in the ground. Between 1959 to 1987 146 million pounds of EDC were released and 72 million pounds were estimated to have been released from Pond 1 to the subsurface and likely entered the groundwater. A further evaluation estimates that 78% of the waste released into the ponds between 1965 and 1978 was in the form of DNAPL (Newell, 2006). That suggests that 56 million pounds of EDC entered the subsurface as DNAPL.

For its RI report, PolyOne prepared a ponds material balance that corrected what it perceived as the errors in the mass balance model (Newell, 2006). Results from the PolyOne 2013 material balance are summarized below for the 1959 through 1987 period prior to pond closure. These results have been rounded for simplicity.

- From 1959 through mid-1982 (i.e., prior to startup of the A stripper), a total of 104M pounds of EDC were discharged to concrete process sumps upstream from the ponds. EDC discharged to the ponds includes both DNAPL and aqueous phases.

- From 1969 through mid-1982, 35M pounds of EDC DNAPL were recovered from process sumps for re-working and re-use in the manufacturing process. This recovered EDC never entered the ponds.
- From 1959 through 1985, a total of 75M pounds of EDC (DNAPL and aqueous phases) was discharged to the ponds from direct pumping at concrete process sumps, effluent from the wastewater strippers, and waste materials and spills. Up to 60% of this EDC discharged to the ponds was present as DNAPL.
- From 1959 through 1987, at least 46M pounds left the ponds due to removal of materials from the ponds by pumping or excavation, volatilization, biodegradation, and dissolved-phase discharge to the river.
- Up to 28.5M pounds of EDC are unaccounted for in the ponds material accounting mass balance. A portion of the unaccounted-for EDC may have migrated into the subsurface.

The PolyOne estimate of 28.5M of unaccounted for EDC from the ponds is generally consistent with the amount of DNAPL estimated to be remaining in the West Floodplain Area (10M pounds, see PolyOne, 2013, Figure 4.80), taking into account the depletion of DNAPL over time and contributions from sources other than the ponds.

The 2015 RI report prepared by Battelle (EPA, 2015) employed a different approach estimating the volume of DNAPL-impacted soil. This is based upon the extensive RI and the DNAPL focused investigation which followed an EPA-authored approach. These results were expressed as a confidence interval for the detection of DNAPL at a given point. The confidence values are 30, 50 and 70 corresponding to 1.1M yd^3, 2,0M yd^3 and 3.5M yd^3 of NAPL-impacted soil.

One might argue about the precision of these DNAPL estimations from tens of millions of pounds to millions of cubic yards. Clearly, a very significant amount of DNAPL has entered and remains in the subsurface.

Releases have occurred at the Site since operations began in the 1950s. The location, circumstances, volume of, and response to each release vary. Releases have occurred in multiple areas of the Site, and recent releases (i.e., post-1990) have resulted in the significant discharge of EDC and other contaminants to the environment. The Respondents interpret the available information about releases very differently, primarily in regard to release volumes and subsequent removal/remedial actions. In 2012, the Respondents provided EPA with a substantial amount of information related to release events through separate submissions, all of which is part of the AR.

For example, a spreadsheet of reported releases and other practices was provided by the Westlake Vinyls, Inc. (Westlake, 2012b) This spreadsheet has over 1,800 rows of information. The quantities are sometimes given in ranges (e.g., 5,000 to 10,000 gallons). Sometimes the release is characterized as 1,000 gallons per day but the duration is not provided. Sometimes the release is reported in pounds, sometimes in gallons. For reference, one gallon of EDC weighs 10.4 pounds. There is one particularly dramatic entry from Row 281 which is several paragraphs in length and is reproduced in the three paragraphs below. It describes releases in amounts of millions of pounds and summarizes the earlier days of plant operations and use of the ponds for disposal:

> Goodrich constructed eleven surface impoundments at the Calvert City facility that were designed to receive chemical wastes. Various combinations of the ponds received chemical wastes from 1953 to 1985. Pond P-1 was constructed in 1953 and reconstructed and designated as Pond 1 in 1963 to accommodate wastewater that was to be generated by North Cracking, North Synthesis, and the Ethylene Plant. From approximately 1963 until 1985, Pond 1 received various hazardous substances from all of the plants at the facility except for the Chlorine Plant. In 1976, Goodrich built a dike within Pond 1, dividing this impoundment into Pond 1A and Pond 1B (SWMU 9). Pond 1A contained a depression, or sump (approximately 100 feet by 150 feet), dug in the soil in the southwest corner of the pond. The hazardous substances sent to Pond 1A included wastewater contaminated with EDC and other chlorinated organic liquids. Additional hazardous substances sent to Pond 1A included chlorinated organic liquid in the separate phase (the DNAPL form), contaminated sludge, chlorinated byproduct material, and process wastewater and oil from the Ethylene Plant. Closure activities of Pond 1A (stabilization and excavation to the water table) took place between December 1985 and March 1988.
>
> ------------------
>
> From 1963 to 1985 Pond 1A received wastewater containing EDC and other chlorinated compounds, separate phase EDC, contaminated sludge, chlorinated byproduct/intermediate feedstock, and process water and oils from the Ethylene Plant. Former Goodrich personnel have testified that Pond 1A was “designed to seep” (Orsborn, 2006)[1]. In 1967, Goodrich drilled Test Well #2 near the northwest corner of Pond 1A and observed a separate dense hydrocarbon layer at the bottom of the well. Goodrich concluded “It would appear that there is seepage of EDC from No. 1 pond.” In 1969, 3.5 million pounds of separate phase oil (90% EDC) was measured in Pond 1a. In 1970, 3.75 million pounds of oil at 91% EDC was measured. In 1971, 4.5 million pounds of chlorinated organics (85-90% EDC), and 50 million pounds of "contaminated and toxic" sludge were reported to be in Pond 1A, and "The underground water contamination with chlorinated organics has worsened and recently mercury contamination has also been determined with our well sampling." In 1971 Goodrich reported "On the subject of taking action on known pollution problems, I guess the worse problems related to #1 Pond are the EDC and the mercury seepage." In 1972, 3.5 million pounds of free-phase oil (65% EDC) was found in sump of Pond 1A. In 1977 Goodrich reported "Pond 1A is the main settling pond and it has been in service since 1964, accumulating a wide variety of types of solids until it is now over 75% full", with the sludge containing 600,000 gallons of chlorinated organics (mainly

---

[1] This reference is within a larger document and was not attached to that document. The larger document is referenced as Westlake 2012b.

EDC), heavy oil, carbopol polymer, gravel, iron and copper hydroxide, mercury. In 1979 approximately 2 million pounds of chlorinated organics were measured in Pond 1A, comprised of 88% EDC. In 1981 Goodrich personnel concluded: " Investigations by either agency would uncover that Pond 1A was the probable source of contamination. Therefore, it is reasonable to expect that in a short time the integrity on all the ponds will be questioned and possibly corrective action will be requested." In 1981 Pond 1A contained 3.2 million pounds (of) organics at 42% EDC. Also in 1981, Goodrich concluded that “Pond 1A is the major source of EDC that has been detected in alarming concentrations in the plant site’s underground water.” A Goodrich document from approximately 1982 describes an environmental strategy of "Stop utilizing the Pond for Hazardous Waste." In 1982 a Goodrich memo stated "Reportedly the Pond (1) was constructed in alluvial material without a liner. The pond is believed to be the most probable source affecting the groundwater." Regarding downgradient wells, "The measured values of total organic halogen (primarily ethylene dichloride), sodium, sulfate, and total organic carbon were found to increase dramatically. This data concurs with the hypothesis that Pond 1A is a probable source of leachate."

In 1980 Goodrich calculated that "In addition, over 7,000,000 lbs. of EDC (are) lost each year in the untreated wastewater discharged to the pond system." Pond 1A was also used for disposal of spilled or released material: for example, in 1972, 900,000 pounds of byproduct were pumped to Pond 1a; in 1974, 303,400 pounds of byproduct sludge were disposed in Pond 1A. There are numerous instances of sludge, spilled material, contaminated soil being disposed in Pond 1A in the 1980s (see separate line items in AOI-2 inventory). For example, in May 1985, 1.8 million pounds of solids were transferred from No. 2 River Tanks to Pond 1A. In September 1985, 5.4 million pounds of solids were transferred from No. 6 River tank to Pond 1A.

2.2.3 Burn Pits

From 1959 until September 1967, chlorinated byproduct (DNAPL), plant trash, and other waste materials were disposed of in burn pits located at the Site. Over this course of time four burn pit areas were utilized. The approximate locations of the burn pits are shown on RI Figure 1-5, #126 lower right.

SWMU 1, also known as “Landfill L-1” and the 'First Plant Trash Burning Pile', was located below what is currently the northwest portion of the Pond 2 dike.

SWMU 2, also known as “Landfill L-2” and the 'Boiler Fly Ash Disposal Area', was located below the area that was later partially covered by the River Tank Farm. The primary use of this area was for disposal of fly ash sluiced out of coal boilers. An unknown number of pits were dug into the northern portion of this area (SWMU 2A) and used to burn chlorinated organics from the EDC pilot plant from 1959 to 1963.

SWMU 3, also known as “Landfill L-3” and the ‘Second Plant Trash Burning Pile’, operated from 1964 to mid-1965 and was located east of the current barge slip. SWMU 3 was an unlined area used for the disposal of chlorinated organic wastes, plant materials, catalyst tubes, and non-chlorinated organic materials, including oil from the Ethylene Plant and hexane from the Carbopol® Plant. In 1966, the non-combustible contents of this area were bulldozed into the B.F. Goodrich Landfill. This area is now covered with approximately 10 to 20 feet of fill and compacted clay (placed later as part of the new Chlorine Plant construction).

SWMU 126, also known as “Landfill L-6” and the ‘Burn Pit Area’, operated from mid-1965 to mid-1967 and was located south of the B.F. Goodrich Landfill. Liquid chlorinated organics, scrap lumber, fuel oil (used for fire training exercises), oil from the Ethylene Plant, and hexane from the Carbopol® Plant were disposed of in this area.

2.2.4 Disposal Areas

The B.F. Goodrich Landfill (SWMU 125) occupies the westernmost portion of the original AIRCO landfill and comprises approximately 1 acre directly west of the area now known as the AIRCO Landfill. During the facility expansion in 1964, B.F. Goodrich purchased additional land from AIRCO. The additional land acquired included a portion of AIRCO's industrial landfill, which had operated since 1951. From 1965 to 1973, B.F. Goodrich used the landfill to dispose of an estimated 54,000 tons of waste. The landfill was used for the disposal of construction debris, general waste materials, excavated soil, spent catalyst tubes, and chlorinated and non-chlorinated organic materials and sludges. From 1973 to 1980, the only material disposed of in the landfill was excavated soil from the adjoining manufacturing areas.

In June 1980, the B.F. Goodrich Landfill was closed in accordance with a State-approved plan. Clay was used to seal the north face of both the B.F. Goodrich Landfill and the AIRCO Landfill and to cap the disposal areas. The combined closed landfill was graded to promote surface water drainage to the west and away from the AIRCO property. In September 1980, the B.F. Goodrich Landfill was re-vegetated to control erosion. In addition to the B.F. Goodrich Landfill, other areas of the Site were used for burial of organic and chlorinated organic wastes, mercury-containing brine sludge, coal ash, and plant refuse.

SWMU 6, or the L-10 unit, was also known as the “Inert Material Landfill Salt Dock”. This landfill operated from 1981 to 1991, and served as a disposal area for potentially contaminated soil excavated from various locations at the Site.

SWMU 4, or the L-8 unit, was also known as the “Brine Sludge Burial Area” or “Brine Sludge Disposal Area”. This small area within the coal ash fill disposal area (SWMU 2B) was used for the disposal of brine sludge from the Chlorine Plant in 1972, and the sludge was reportedly removed “shortly afterwards”. This area was located on the west property boundary in a former lime settling pond. Following disposal of the sludge, it was covered with sand and anthracite coal periodically dredged from Pond P-11 (SWMU 18).

SWMU 127, or the L-5 unit, was also known as the “Brine Sludge Burial Area Next to Burn Pit Area”. This area was used for a one-time disposal of brine sludge from the Chlorine Plant in 1972. It was located south of the SWMU 126 Burn Pit Area.

SWMU 128, or the L-8 unit, was also known as the “Landfill Ethylene Plant Oily Sludge”. This area was an earthen trench used to receive oil/water separator sludge from the Ethylene Plant in the late 1960s.

The location of this unit is reported to be on the eastern boundary of the Site and south of the B.F. Goodrich Landfill (SWMU 125).

2.3 Site Infrastructure

The manufacturing facilities at the Site are supported by an extensive infrastructure network. Infrastructure systems at the Site include subsurface sumps and catch basins to collect spilled or overflowing liquids, pipelines and trenches to convey fluids to storage or discharge, and various treatment systems. Waste acid, vinyl chloride, telephone, tank feed, sulfuric acid, steam, sprinkler, soft water, industrial sewer, sanitary sewer, sanitary water, river water, relief, propylene, propane, potable water, plant air, natural gas, methane, instrument air, industrial sewer, incinerator, hydrogen, hydrogen chloride, groundwater, ethylene, electrical, fuel gas, foam, fire water, factory air, cooling water, clarified water, blowdown, barge unloading, and various other lines are present at the Site. Pipelines exist as both active and abandoned systems in aboveground and subsurface installations. In addition, a number of aboveground tanks exist at the Site. Additional infrastructure features at the Site include various footings, foundations, and pilings support structures throughout the developed portions of the Site.

2.3.1 Industrial Sewer System

There are four primary industrial sewer systems in the manufacturing areas at the Site: the Chlorine Plant Process Sewer (SWMU 116); the Ethylene Plant Process Sewer (SWMU 117); the EDC/VCM Plant Process Sewer (SWMU 118); and the Carbopol® Plant Process Sewer (SWMU 119). RI Figure 1-8 shows the location of the industrial sewer systems.

2.3.2 Water Treatment Systems

Wastewaters from the chlorine process area are treated by the chlorine wastewater treatment system. Prior to 2001, the chlorine wastewater treatment system was operated to remove mercury from the wastewaters generated in the Chlorine Plant.

Modifications to the chlorine wastewater treatment system were made following the conversion of the Chlorine Plant to membrane technology, in response to changes in wastewater quality and associated treatment requirements. Effluent from the chlorine wastewater treatment system is discharged to Outfall 003. Waters from Outfall 003 are discharged through Outfall 001 to the Tennessee River.

The Ethylene Plant wastewater pretreatment system treats process wastewater and product tank drawdown.

The Primary Wastewater Treatment System treats wastewater generated in the EDC/VCM Plant. The primary treatment system consists of a stormwater storage tank, a contaminated water storage tank, and two stripper units that remove volatile organic compounds (VOCs) from wastewater. The water used in the cleaning of the stripper units is stored in a tank and reprocessed through the stripper units and discharged to the Secondary Wastewater Treatment System.

The Secondary Wastewater Treatment System is a biological treatment system composed of a primary clarifier, secondary clarifier, equalization tank, two bioreactors in series, thickener, belt filter, and polishing filters.

The Groundwater "C" Stripper System (SWMU 182) receives groundwater pumped from 51 groundwater extraction wells and consists of a groundwater feed tank, preheating heat exchangers, a stripping column, overhead vapor condensers, an overhead decanter, carbon beds for emission control, and associated pumps and piping. The system strips organics from extracted groundwater from around the Site. The "C" Stripper Sump Tank (SWMU 183) is an outdoor concrete-lined sump used to collect stormwater runoff, drainage from concrete pads, and decanter water. Wastes from this unit are pumped back into the Groundwater "C" Stripper System. Treated water from the Groundwater “C” Stripper System is discharged to Outfall 009. Waters from Outfall 009 are then discharged through Outfall 001 to the Tennessee River.

2.3.3 Stormwater Management System

The Stormwater Management System is designed to control impacted surface runoff over portions of the Site and divert it to the Tennessee River. This system is also designed to divert potentially impacted runoff to storage tanks and treatment processes. Contaminated stormwater management is integrated into the water treatment systems. The Stormwater Management System is composed of underground sewers, sumps, diversion boxes, and lift stations. Berms and other containment structures are used in combination with sumps where stormwater is contained for treatment. The layout of the Stormwater Management System is shown on RI Figure 1-9.

Stormwater from the EDC/VCM process area is collected in subsurface concrete pipes (SWMU 115A). Occasional releases of contamination in the form of dissolved or separate phase organics (DNAPL) may occur to concrete pads around process equipment and subsequently may be washed or drained into the stormwater system. Therefore, storm sewers may occasionally transport DNAPL.

2.3.4 Aboveground Storage Tanks

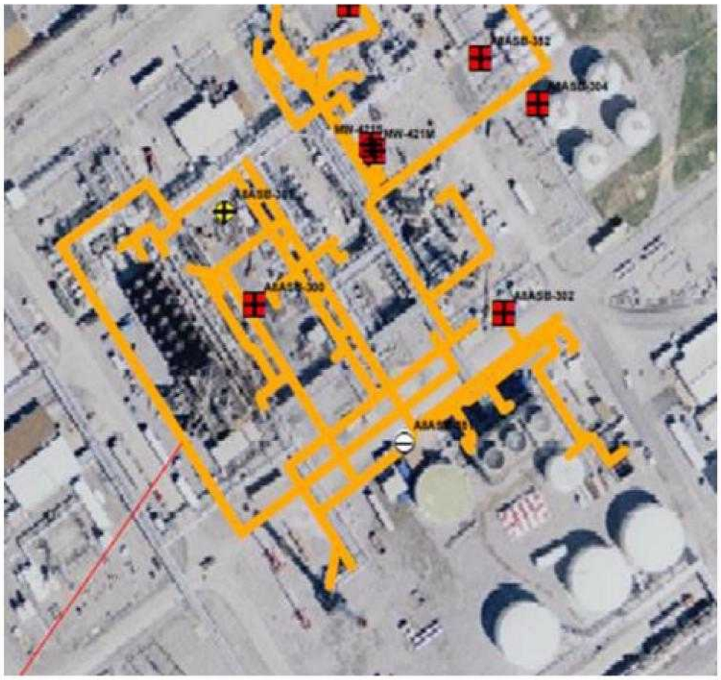
RI Table 1-2 provides a summary of aboveground tanks that have been or currently are in use at the Site, including, where known, the materials stored, years of operation, dimensions, and nominal or calculated capacities. Generally, the tanks include those used for storage of product, intermediates, wastewater, separated oils, stormwater, and fuel, and range in size from 1,000 to 1,500,000 gallons. RI Figure 1-10 shows the location of these tanks. The Intermediate Tank Farm, River Tank Farm, and Vinyl Tank Farm are associated with the EDC/VCM Plant. The Intermediate Tank Farm is located on the southwestern side of Pond 1A. The Ethylene Plant Tank Farm contains four ethylene spheres, four propylene bullets, two C-4 spheres, two aromatic gasoline tanks, and two fuel oil tanks.

Since 1990, holes have been discovered in the floors of at least eight storage tanks: Shore Tank 1 (1995 and 2005), Shore Tank 2 (1995), former Shore Tank 4 (1992), Shore Tank 7 (2005), Contaminated Water Storage Tank (2009), River Tank 3, River Tank 6 (1996), (2014), and Fuel Oil Tank 3 (2015). Investigations were conducted at five of these tanks after the holes were discovered (Shore Tank 4, River Tank 3, River Tank 6, Contaminated Water Storage Tank, and Fuel Oil Tank 3), leading to the discovery of DNAPL below the floor of each of these tanks.

2.3.5 Infrastructure Failures

An additional factor in the TI of remediating the DNAPL at the former B.F. Goodrich site is the physical location of releases such as the former industrial sewer line under the still active EDC-VCM plant. This sewer line was installed under the plant when it was built in the 1960s. The engineers of the time were apparently unaware of the corrosive nature of the wastes as there were subsequent, frequent reports of the complete loss of the lower third of the sewer line. This would have allowed the wastes a pathway for direct and repeated release into the subsurface. Please see the excerpted figure immediately below and the associated excerpted report citations.

> "the trench and sumps were connected with underground pipes that have indicated failures in several areas." (Goodrich, 1979d)
>
> "Additional paving [is needed] to eliminate ground seepage..." (Goodrich, 1967a)
>
> "The condition of these sewers is very bad with the bottom third of the pipe completely deteriorated away in some places. However, it will be more economically feasible to utilize the existing sewers rather than build a new, separate sewer for the sump overflows." (Goodrich, 1978a)



ETHYLENE PLANT FORMER UNDERGROUND SEWER LINE
(reference in AOI6-8 binder)

"The process sewer system is believed to have contaminated all parts of the ground throughout which it runs, therefore making the areas through which the process sewer runs potential SWMU areas " (Goodrich, 1994a)

"At the time when the sewer was abandoned in place, there was evidence of much deterioration of the various sewer lines, and much leakage from these lines was evident." (Goodrich, 1994b)

This image taken from a larger figure: Plan View of Visual Observations of DNAPL and DNAPL Dye Test Results from Ground Surface to Bedrock for March 2012 MPR with Release Locations. Westlake Chemical Company, B.F. Goodrich Superfund Site, Calvert City, Kentucky, April 19, 2012 (Westlake, 2012a)

Figure 1. Active Chemical Plant with Deteriorated Industrial Sewer Line

3.0 CONCEPTUAL SITE MODEL

Every environmental investigation or evaluation needs a CSM to provide the framework for understanding the site and how to best address the matters at hand. The site has a long history of environmental investigations starting in 1983, which has resulted in approximately 7,000 pieces of data of all types. With this abundance of data, a reasonable CSM can be assembled.

3.1 Site Physical Characteristics

Near the Site, the land slopes to the north from an approximate elevation of 355 feet above mean sea level (amsl) to 325 feet amsl. This sloped area abuts a bluff that drops to the floodplain of the Tennessee River, which is approximately 302 feet amsl at normal pool stage (United States Geological Survey [USGS], 1993). The Site has two general landforms, known as the floodplain and terrace areas. The floodplain is a low-lying, narrow strip adjacent to the Tennessee River that is characterized by gently sloping topography, sandy beaches, and woodlands. A barge slip, docks, and other marine improvements associated with the Site are in the floodplain. The terrace is a broad, flat plain situated approximately 25 feet above the floodplain. The main production areas at the Site are located on the terrace area (see RI Figures 1-14, 1-15 and 1-17).

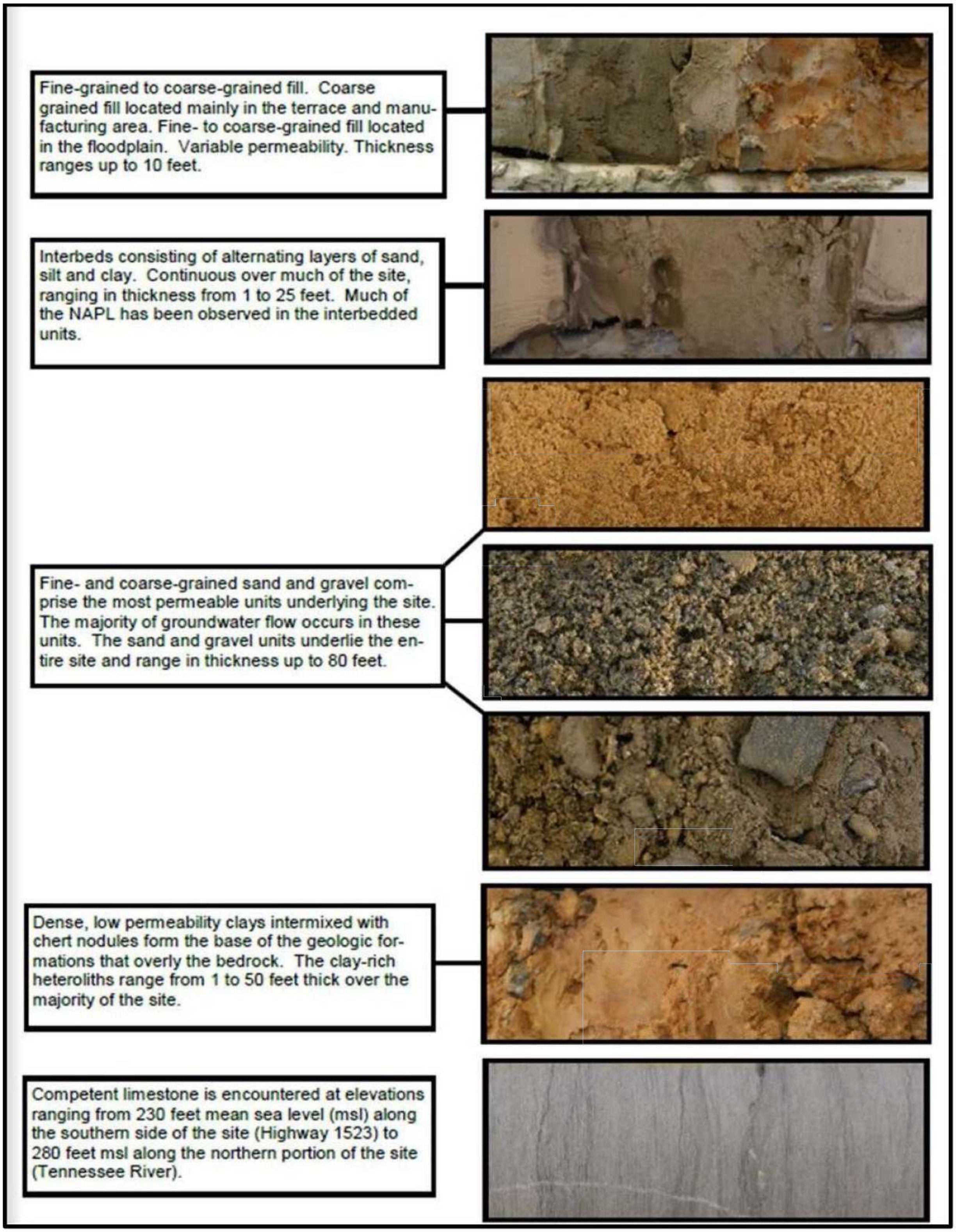
3.1.1 Geology and Hydrogeology

The numerous investigations over the years have amassed an extensive amount of data regarding the geology, hydrogeology and contaminant distribution. To understand how these three factors affect the site's CSM, separate systems were devised to better understand the relationship between them. Hydrocodes (HCs) were devised to take the extensive site data and fit it into a three-dimensional lithologic model. The hydrogeologic data were divided into aquifers and confining and vadose zones. The contaminant distribution is explained in terms of its presence or absence in a particular lithology (HC) and presence or absence in a particular part of the aquifer system (zone). DNAPL zones are described as zones where the RI identified sufficient lines of evidence to identify DNAPL.

2015 RI Figures 3-4, 3-5, and 3-6 show the distribution of the borings and monitoring wells across the Site. For example, there were 175 soil borings that went from the surface through the entire unconsolidated section and stopped at the subadjacent bedrock (2015 RI Figure 4-3). Information from discrete borings related to subsurface physical characteristics from various investigations at the Site was integrated into a three-dimensional lithologic model to better understand and illustrate the local geology at the Site. The model consolidated the stratigraphic and lithologic information into nine specific and distinct HC categories based on their relative hydraulic conductivity, as described below in order of increasing depth below ground surface (bgs) and seen in the following Figure 2, Geologic Units (pg. 18).

- *Fine-Grained Fill (FF) and Coarse-Grained Fill (CF) Hydrocodes.* Consist of non-native surficial material that is present primarily in the central portion of the terrace and is present throughout the floodplain. Coarse fill is primarily present in the manufacturing and storage areas on the terrace and a mixture of coarse and fine-grained fill is present in the floodplain area. Coarse-grained fill may be highly permeable, and could potentially act as a preferential pathway for surface releases to migrate vertically to underlying units. The extent of this unit is shown on RI Figure 4-16.

- *Clay/Silt (C) Hydrocode.* Consists of clay, silt, silty clay, and/or clayey silt, which in the floodplain area, were assigned the term Elongate Floodplain Clay/Silts because the clay bodies are elongated parallel to the Tennessee River. This unit is continuously present throughout the entire Site, ranging in thickness from less than a foot to roughly 40 feet, with an overall low bulk hydraulic conductivity that likely acts to inhibit vertical migration of chemical releases from the surface. The extent of this unit is shown on RI Figure 4-13.
- *Interbeds (I) Hydrocode.* Consists of alternating layers of sand, silt and clay; certain interbeds in the floodplain area were assigned the term Elongate Floodplain Interbeds because the interbeds are elongated parallel to the Tennessee River and possess an overall lower bulk hydraulic conductivity and a greater percentage of clay and silt than other interbeds. This unit is fairly continuous throughout the entire site, ranging in thickness from less than a foot to roughly 25 feet. The Elongate Floodplain Interbeds represent a significant feature in terms of horizontal contaminant transport at the Site in that they are the uppermost significant permeable unit (consisting of alternating clay, silt, and fine sands) beneath the Clay/Silt unit and underneath major release areas. The extent of this unit is shown on 2015 RI Figure 4-11.
- *Fine-Grained Sand (FS), Coarse-Grained Sand (CS), and Gravel (G) Hydrocodes.* Consist of sand and gravel and represent the most permeable unconsolidated material at the Site. The majority of groundwater flow at the Site occurs in the sand and gravel units. This unit is consistently present throughout the Site, and ranges in thickness up to 80 feet. The extent of this unit is shown on RI Figure 4-7.
- *Clay-Rich Heterolithics (CRH) Hydrocode.* Consists of very dense low permeability materials that directly overly limestone bedrock. This unit is present in a majority of the Site at thicknesses of up to roughly 50 feet, and is relatively continuous in the Western Floodplain Area. The extent of this unit is shown on RI Figure 4-5.
- *Bedrock (B) Hydrocode.* Competent limestone is encountered at an elevation of approximately 230 feet amsl at the southern portion of the Site and an elevation of approximately 280 feet amsl in the northern portion of the Site, near the Tennessee River. RI borings that penetrated bedrock revealed that the upper portion of the bedrock at the Site can be weathered, fractured, and porous. Recent geophysical testing and lithologic observations indicate the bedrock beneath the site is competent with a low density of fractures, many of which are filled with calcite (Respondents, 2014). The top of the bedrock contour map is shown in RI Figure 4-1.



Fine-grained to coarse-grained fill. Coarse grained fill located mainly in the terrace and manufacturing area. Fine- to coarse-grained fill located in the floodplain. Variable permeability. Thickness ranges up to 10 feet.

Interbeds consisting of alternating layers of sand, silt and clay. Continuous over much of the site, ranging in thickness from 1 to 25 feet. Much of the NAPL has been observed in the interbedded units.

Fine- and coarse-grained sand and gravel comprise the most permeable units underlying the site. The majority of groundwater flow occurs in these units. The sand and gravel units underlie the entire site and range in thickness up to 80 feet.

Dense, low permeability clays intermixed with chert nodules form the base of the geologic formations that overly the bedrock. The clay-rich heteroliths range from 1 to 50 feet thick over the majority of the site.

Competent limestone is encountered at elevations ranging from 230 feet mean sea level (msl) along the southern side of the site (Highway 1523) to 280 feet msl along the northern portion of the site (Tennessee River).

Figure 2. Geologic Units

3.1.2 Hydrogeologic Units

As noted above, the Site is underlain by unconsolidated sediments[1] that generally coarsen downwards and extend from the ground surface to either the low permeability CRH unit or directly to bedrock. The overall thickness of unconsolidated overburden at the Site ranges from approximately 80 to 120 feet, increasing in thickness from north to south with the dip of the underlying bedrock surface. Surficial fill has also been placed in localized areas during development of the Site. There is generally an increase in hydraulic conductivity with depth as the overburden coarsens downward until the CRH unit or bedrock is encountered. The groundwater beneath the Site has been divided into five hydrostratigraphic units as summarized below:

- *Vadose Zone.* Generally consists of the Fill units, shallow portions of the Clay/Silt HC unit, and unsaturated portions of the shallow portions of the Interbeds unit. Discontinuous perched water zones have been observed within the Clay/Silt and Fill HC units. Portions of the vadose zone also can become more extensively saturated when the Tennessee River floods.
- *Shallow Groundwater.* Unconfined groundwater that includes the saturated shallow portions of the Interbeds HC unit, the Clay/Silt HC unit, and the Fine Sand unit, generally above 295 feet amsl. Shallow groundwater flows toward and discharges to the Tennessee River. Although the shallow groundwater is unconfined, it can appear semi-confined due to the heterogeneity of the alluvial deposits, primarily within the Interbeds HC unit.
- *Intermediate Zone*. Generally consists of lower hydraulic conductivity materials in the Interbeds HC unit and Clay/Silt HC unit between shallow and deep groundwater. Groundwater flows preferentially in sand and silty sand zones toward and discharges to the Tennessee River. Flow within the Intermediate Zone is predominantly horizontal with specific flow paths driven by the depositional layer geometry. Due to its discontinuous and heterogeneous nature, the Intermediate Zone is not an effective Site-wide barrier to vertical flow between the shallow and deep groundwater.
- *Deep Groundwater.* Comprised of a heterogeneous mix of the Fine and Coarse Sand HC units, the Gravel HC unit, and the basal CRH HC unit, generally below 295 feet amsl. This unit has a higher hydraulic conductivity compared to other hydrostratigraphic units at the Site and accounts for the majority of the groundwater flux at the Site. Deep groundwater flows toward and discharges to the Tennessee River.
- *Bedrock.* The uppermost bedrock stratigraphic unit in the regional geologic sequence at the Site is generally the Fort Payne Formation limestones. Previous investigations identified iron-stained horizontal and vertical fractures in the upper portion of the bedrock, suggesting groundwater movement. At depths greater than 194.4 feet amsl, the observed fractures were sealed with calcite, indicating that the bedrock acts as a

---

[1] As per the Glossary of Geology, 4th Ed., sediment in this document is defined as solid fragmental material that originates from weathering of rocks and is transported or deposited by air, water or ice and that forms in layers on the Earth's surface at ordinary temperatures in a loose, unconsolidated form. As this TI waiver is focused on the on-shore portions of the Site, the use of the word sediment does not refer to the second definition, that is, sediment as solid material that has settled down from a state of suspension in a liquid.

lower confining unit below this point. Recent geophysical testing and lithologic observations (Respondents, 2014) indicate that the bedrock beneath the site is competent with a low density of fractures (many of which are filled with calcite), and occasional potential higher flow zones are present within the bedrock.

The depth to groundwater at the Site generally varies from approximately 5 to 10 feet bgs on the terrace to a few feet bgs within the portions of the floodplain close to the Tennessee River. The shallowest depth to water is expected in the main plant area and directly along the river with the greatest depth to water in transition from the terrace down to the river shore. As shown in the map below, the groundwater elevations range in elevation from 320 feet to 304 feet amsl. The overall groundwater flow direction is toward the Tennessee River, with a relatively steep gradient within the floodplain area and a relatively shallow gradient within the terrace area, as seen in Figure 3, which was taken from the 2015 RI. At normal pool stage, the horizontal component of the hydraulic gradient in the terrace area is generally on the order of 0.002. Across the floodplain, the horizontal component of the hydraulic gradient is typically on the order of 0.02 under normal pool stage. The water table is locally influenced by the presence of pumping wells in the Plant-wide Corrective Action Program (PCAP) system. More significant and widespread effects on groundwater level result from changes in the stage of the Tennessee River, which typically fluctuates by approximately 30 feet annually but can fluctuate by up to as much as 40 feet annually and can cause a short-term reversal in groundwater flow direction in the floodplain.

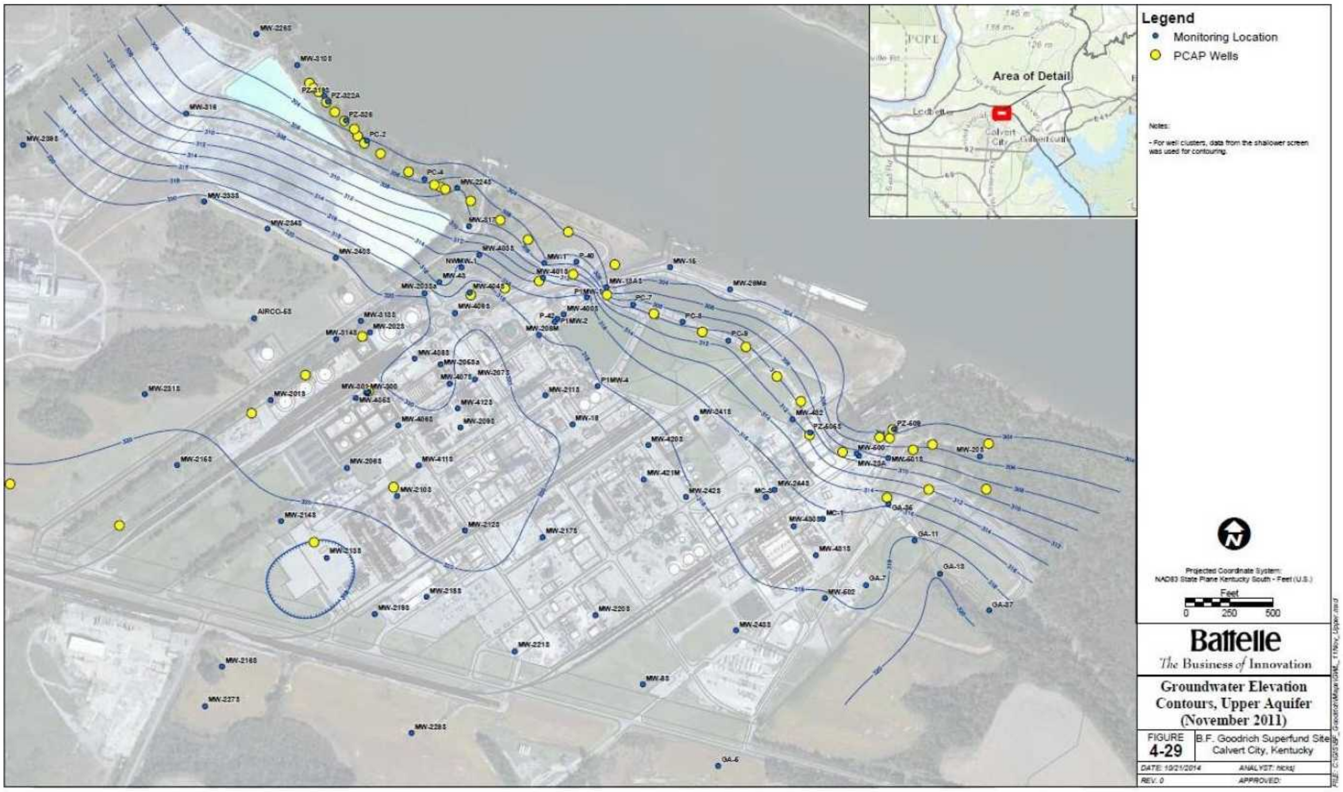


Figure 3. Groundwater Elevation Contours, Shallow Groundwater (November 2011) (From RI; Figure 4-29)

Groundwater flow at the Site can have a significant vertical component due to lithologic heterogeneity, Tennessee River stage, operation of the PCAP pumping system, and operation of other remedial systems in place at the Site. During normal pool stage, a downward vertical gradient exists southwest of the Site that diminishes to the northeast and reverses near the Tennessee River, indicating groundwater within both the Upper and Lower Aquifers flows into the river during times of normal pool stage (Figure 4). During high river stage, a vertical gradient reversal is observed, suggesting that during times of flooding, the Tennessee River infiltrates into the alluvial aquifer to some distance upgradient of the shoreline. Generally, there is an upward gradient from the bedrock into the sediments directly above it.

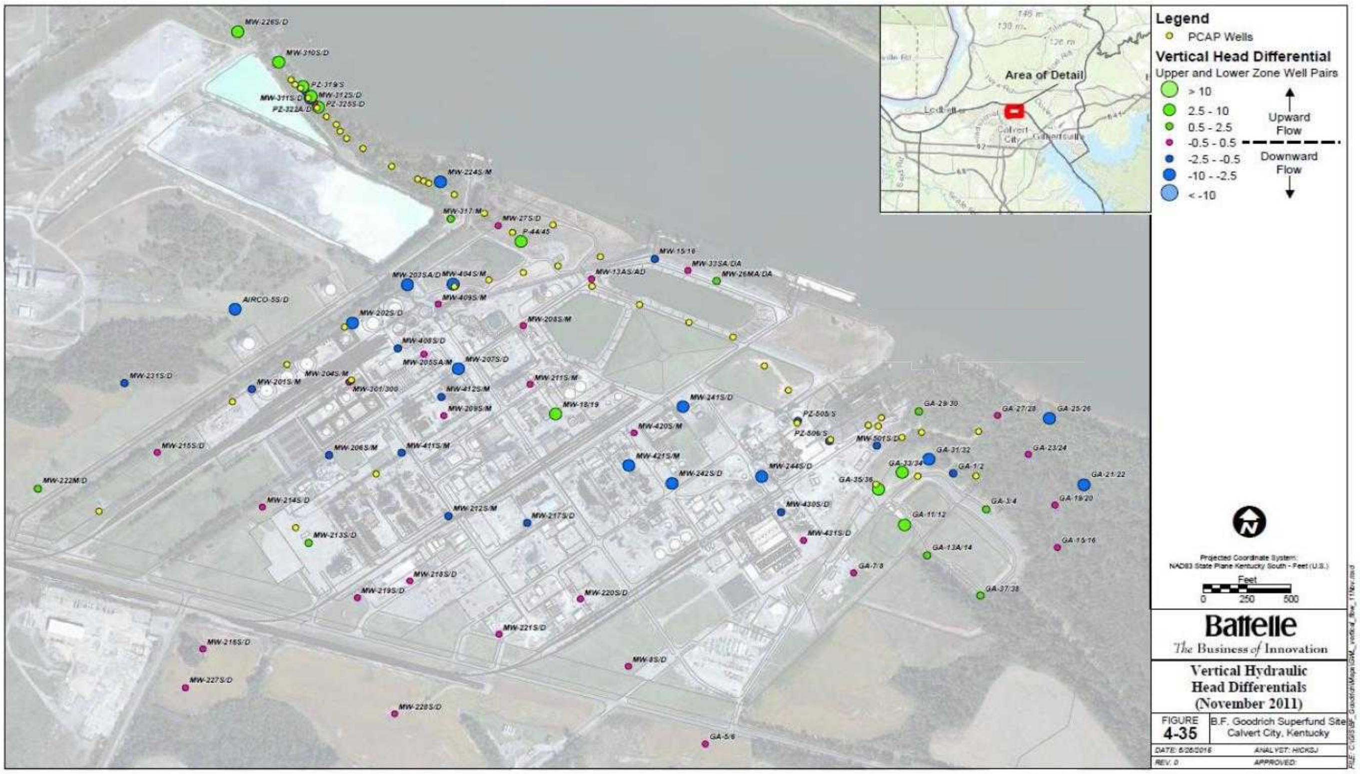


Figure 4. Vertical Hydraulic Head Differentials (November 2011) (From RI; Figure 4-35)

3.2 Contaminant Nature and Extent

3.2.1 NAPL at the former B. F. Goodrich Site

This property has been an operating chemical plant since 1953 and historically disposed of organic chemical waste in unlined ponds for approximately 30 years. Those ponds and the locations of various other releases are shown in Figure 5.

As a note of explanation, the concentric lines of blue, green and gold represent a gradational scale that is the output of the DNAPL identification methodology tailored for this project, Potential Indicator (PI). The delineation of DNAPL was guided by the approach outlined in Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites (EPA, 2009a) and the NAPL Delineation Memorandum (RI report, Appendix 5-3). Lines of evidence (LOEs; i.e., the various DNAPL indicators) were used to determine the presence of DNAPL at a given monitoring location. Eight different DNAPL LOEs were evaluated for each monitoring station, with the strongest being visual observation of pooled DNAPL. A total of 4,069 unique sample locations were identified and evaluated using an EPA DNAPL protocol. Using the information calculated and compiled in the 2015 RI Report, each location was assigned a DNAPL status. Of the 4,069 DNAPL locations, 309 were assigned Confirmed DNAPL, 493 were assigned Potential DNAPL, and 3,267 were assigned No DNAPL status. As an aid in understanding and mapping, the summarized data were divided into a distribution of a 30%, 50% or 70 % occurrence of DNAPL. As seen in Figures 5 and 6, the highest values for the presence of organic DNAPL are associated with the manufacture, transfer and storage of chemicals as well as the historical disposal of chemical wastes in unlined ponds adjacent to the river.

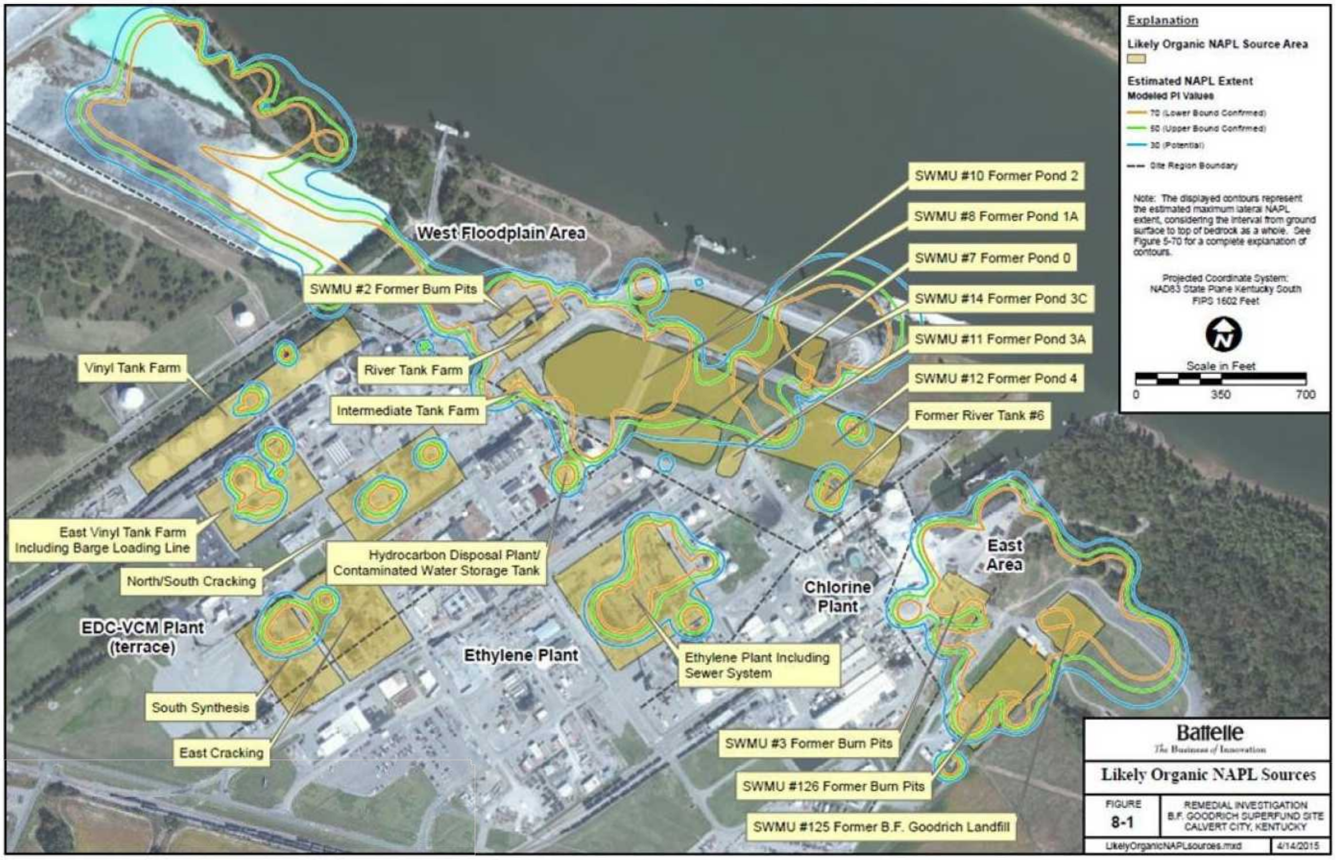


Figure 5. Likely Organic NAPL Sources (From RI; Figure 8-1)

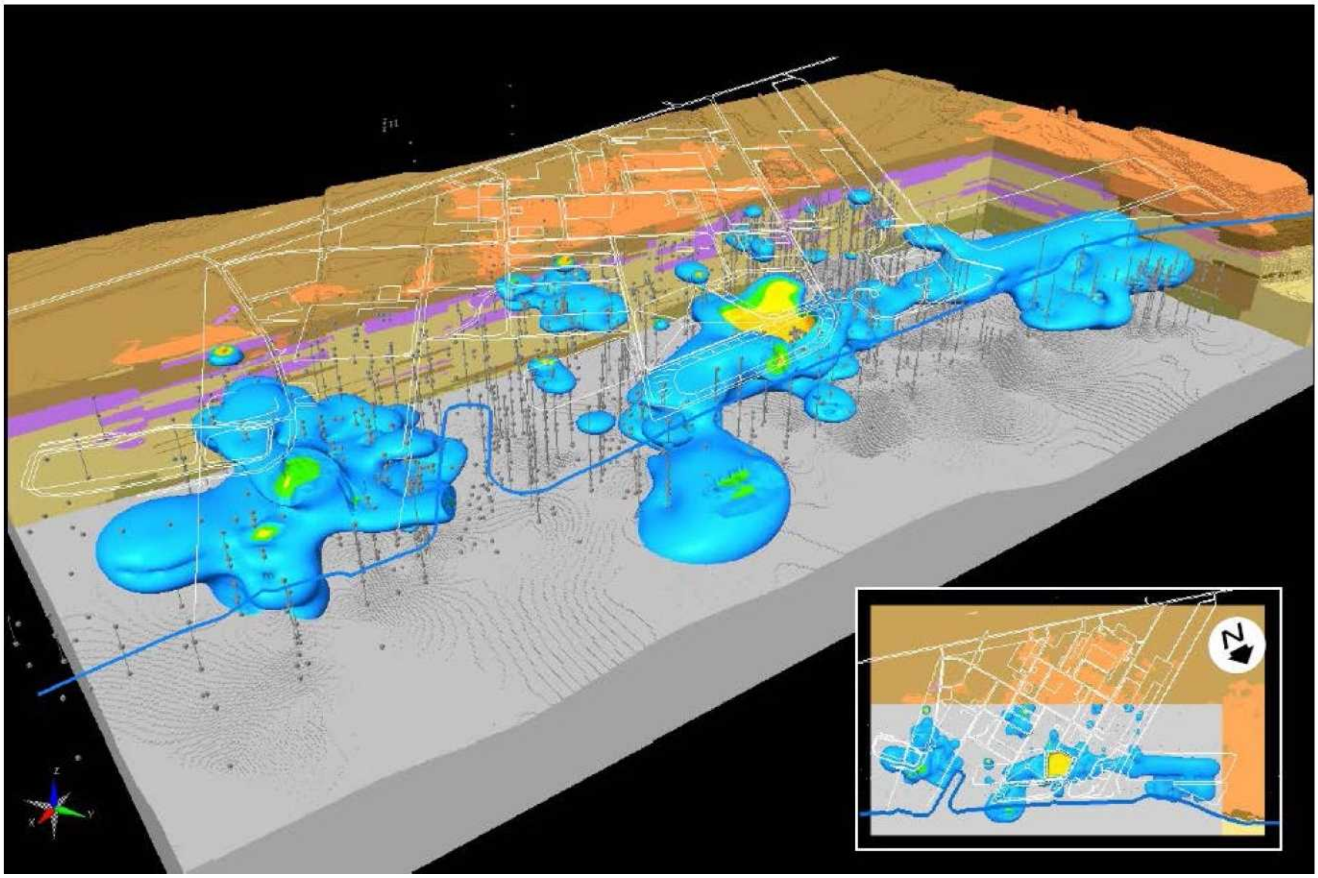
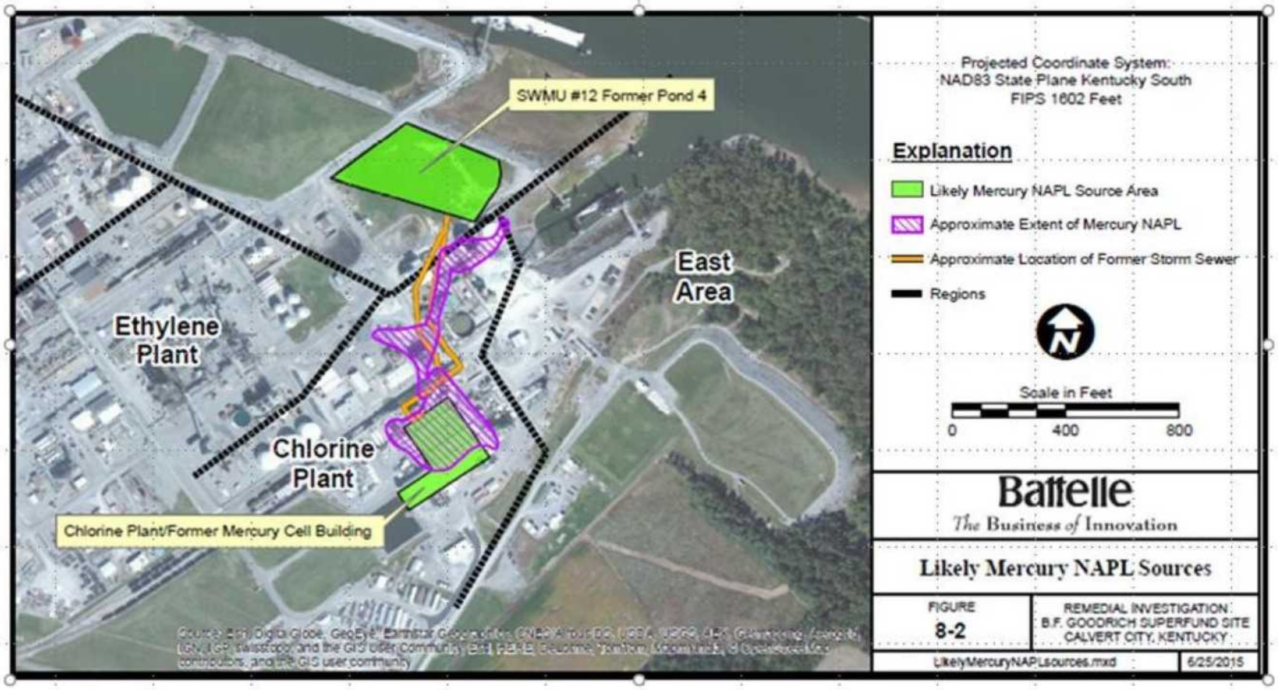


Figure 6. Oblique View of NAPL-Impacted Volumes with Overhead View (From RI, Figure 5-80 in Appendix A)



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community; Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Figure 7. Likely Mercury NAPL Sources (From RI; Figure 8-2)

3.2.2 Summary of DNAPL Distribution

Based on the results of the DNAPL modeling approach, the majority of DNAPL impacts occur on the floodplain either in the West Floodplain Area (62 to 66% of the total volume) around the historical pond system and extending westward into the floodplain or in the East Area (28 to 31% of the total volume) near the former burn pits and a former landfill (see 2015 RI Figure 5-70 and RI Table 5-11). One of the most important features in the floodplain with respect to DNAPL transport is a unit of laterally extensive interbedded sand, silt and clay lenses known as the Elongate Floodplain Interbeds. Significant quantities of DNAPL are present within the Elongate Floodplain Interbeds unit (between 16 and 23% of the total volume). As seen in Figure 13 later in the document, the 1-inch DNAPL saturated sand layers are bound by 6-inch-thick clay layers. These small-scale layers represent differences in the type of sediment deposition. The sands represent a period of greater flow velocity such as the river in an elevated or flood stage. The clays represent a period of low water velocity when the river would be under normal conditions. This cycle of high and low water velocity happened repeatedly such that this interbed HC achieved a thickness of as much as 25 feet over much of the site but not with uniform complete coverage. These individual features are likely continuous over a scale of only tens of feet. As a group, these interbedded sand bodies are sufficiently interconnected to have facilitated lateral DNAPL migration away from the points of DNAPL entry. Additionally, identifying all DNAPL saturated sand stringers within these laterally extensive clay layers over a large portion of the site is extremely difficult.

The EDC-VCM Plant Area has several disconnected DNAPL zones, mainly around the South Synthesis Unit, East Cracking Unit, the North/South Cracking Units, and the Vinyl Tank Farm/Shore Tank Farm. The total volume of DNAPL-contaminated soil across all intervals in this area was estimated at 120,000 yd^3 using the DNAPL PI (PI value ≥ 30). This is shown in the plan view horizon map (RI Figure 5-70) and in the three-dimensional oblique views of the Upper Bound Confirmed, Lower Bound Confirmed, and Potential DNAPL extents (see RI Figures 5-78 through 5-80, respectively). Several of the DNAPL zones in the northern portion of the Site are small segments of larger plumes located in the West Floodplain Area to the north. Although the majority of the DNAPL contamination is in the upper three horizons (ground surface to 10 feet bgs, 10 feet bgs to groundwater table, and groundwater table to 295 feet amsl), DNAPL contamination extends through Horizon 5 (280-265 feet amsl or 65-80 feet below land surface). The DNAPL-impacted soil volume estimates for the EDC-VCM Plant area represent between 1.8 and 3.4% of the total DNAPL-impacted soil at the site.

The Ethylene Plant Area has one primary DNAPL-impacted zone, located beneath the Ethylene Plant and extending to the northeast toward the RCRA Closure Cell, as shown in the plan view horizon maps (RI Figures 5-64 to 5-69) and in the three-dimensional oblique views of the Upper Bound Confirmed, Lower Bound Confirmed, and Potential DNAPL extents (see RI Figures 5-78 through 5-80, respectively). The total amount of NAPL-impacted soil across all intervals in this area was estimated at 130,000 yd^3 using the DNAPL PI (PI value ≥ 30) thresholds. The contamination in this area is only found in the first three horizons (ground surface to 10 feet bgs [RI Figure 5-64], 10 feet bgs to groundwater table [RI Figure 5-65], and groundwater table to 295 feet amsl [RI Figure 5-66]) with most of the contamination found from 10 feet bgs to the groundwater table. The DNAPL-impacted soil volume estimates for the

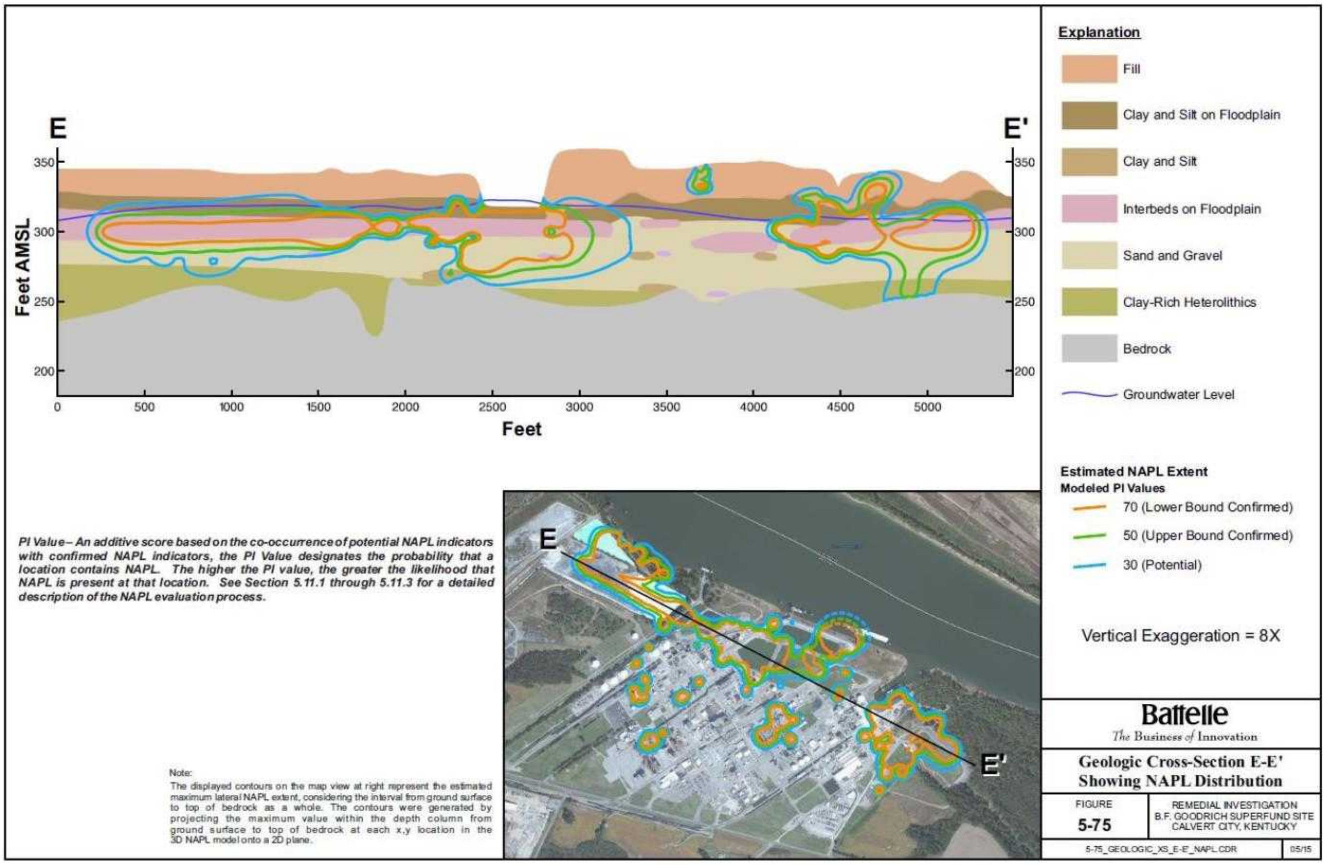
Ethylene Plant area represent between 3.2 and 3.7% of the total DNAPL-impacted soil at the site.

The West Floodplain Area has the highest volume of DNAPL-impacted soil of all areas (between 62 and 66%). In Horizon 3 (RI Figure 5-66), the DNAPL-impacted area extends nearly the entire length of the area. The total amount of DNAPL-impacted soil across all intervals in this area was estimated at 2,300,000 yd^3 using the DNAPL PI (PI value ≥ 30) thresholds. In other horizons, two distinct NAPL-impacted extents can be divided, one in the eastern portion of the Site, located near Pond 1A, Pond 2, and the RCRA Closure cell, and one in the western portion of the Site, located near the rectangular and triangular Carbide Ponds. The DNAPL zone is shown in three-dimensional oblique view for the Upper Bound Confirmed (PI value ≥ 50), Lower Bound Confirmed (PI value ≥ 70), and Potential DNAPL (PI value ≥ 30) thresholds (RI Figures 5-78 through 5-80, respectively). Although the DNAPL contamination in this area spans all depth intervals, the majority of the contamination can be found in the three intervals between the water table and 265 feet amsl with the highest amount of contaminated soil occurring in the 295 to 280 feet amsl interval.

The East Area has the second highest volume of DNAPL-impacted soil of all areas (between 28 and 31% of the total volume), although spanning a much smaller area than that of the West Floodplain Area. The total amount of contaminated soil across all intervals in this area was estimated at 990,000 yd^3 using the DNAPL PI (PI value ≥ 30) thresholds. The DNAPL-impacted volume is centered on the AIRCO and B.F. Goodrich Landfills, and the former burn pits in the eastern portion of the area and the SWMUs in the western portion of the area, where it extends to the Barge Slip. Although the DNAPL contamination spans all depth intervals, the majority of the contaminated soil volume is found in the three horizons between 10 feet bgs and 280 feet amsl (see RI Figures 5-65 through 5-67), with most of the contaminated soil found in the groundwater table to 295 feet amsl interval (RI Figure 5-66). In this interval, DNAPL-impacted soil is present in the adjacent area in the DNAPL PI (PI value ≥ 30) extent, leading to an estimated 430 yd^3 of DNAPL-impacted soil in the Chlorine Plant Area. The DNAPL-impacted zone is shown in three-dimensional oblique view for the Upper Bound Confirmed (PI value ≥ 50), Lower Bound Confirmed (PI value ≥ 70), and Potential DNAPL (PI value ≥ 30) thresholds (RI Figures 5-78 through 5-80, respectively). A cross section showing NAPL distribution in the floodplain perpendicular to the river is shown in Figure 8.

As seen in Figure 7 (RI Figure 8-2) above, elemental mercury is observed near the Chlorine Plant, located in the center of AOI 8B. In general, elemental mercury is found near the ground surface around the former MCB and at increasing depths to the north and northwest of the MCB.

In summary, the 2015 RI report estimated the site-wide total DNAPL volume at the PI of 30% to be 3,500,000 yd^3 (see RI Table 5-11).



PI Value– An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Note:
The displayed contours on the map view at right represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. The contours were generated by projecting the maximum value within the depth column from ground surface to top of bedrock at each x,y location in the 3D NAPL model onto a 2D plane.

Figure 8. Geologic Cross Section E-E' Showing NAPL Distribution (From RI; Figure 5-75)

An example cross section showing the location of the largest source zones centered on the fine grained interbeds hydrocode also known as the elongate floodplain interbeds.

Groundwater sample analytical reports are provided in Appendix 5-2 of the RI report. The groundwater data in the RI report was collected between January 2010 and July 2012. The RI groundwater analytical data are summarized in RI Table 5-2, which also compares the groundwater analytical data to the chemical specific MCLs. As shown in RI Table 5-2, the following chemicals were identified as chemicals of potential concern (COPCs):

- VOCs: EDC, 1,1,2-trichloroethane (TCA), 1,1-dichloroethene (DCE), benzene, carbon tetrachloride, chlorobenzene, chloroform, perchloroethene (PCE), trichloroethene (TCE), and vinyl chloride
- Metals: arsenic and mercury.

Figures illustrating the concentrations and distribution of the COPCs in groundwater in this section are provided for the following depth intervals: shallow groundwater (water table to 295 feet amsl) and deep groundwater (below 295 feet amsl), as determined by the elevation of the midpoint of the screened interval. A total of 30 compounds are included in the list of MCLs to be waived. These 12 are the compounds explained and mapped in detail in the RI report and the following subsections describe the extent of contamination of the primary COPCs detected in groundwater during the RI. The additional 18 compounds associated with this TI waiver are compounds that are present above their respective MCL. There have been no compounds identified as contaminants of concern (COCs) because there is no current or expected use of groundwater; therefore, the additional step to identify groundwater COCs was not required.

3.2.3 1,2-Dichloroethane/Ethylene Dichloride

EDC was the most widely detected VOC in groundwater beneath the Site and was detected in over 60% of the groundwater samples collected during the RI. The MCL for EDC (5 µg/L) was exceeded in 45.2% of the groundwater samples collected during the RI, with an average detected concentration of 175,099 µg/L. In the shallow zone, EDC concentrations ranged from non-detect (ND) to 6,200,000 µg/L (MW-400S). In the deep zone, EDC concentrations ranged from ND to 1,500,000 µg/L (MW-312S). The distribution of EDC in the shallow and deep groundwater zones is shown on RI Figures 5-28 and 5-29, respectively. RI Figure 5-28 shows that EDC in the shallow zone is present in all five areas, with the highest concentrations of EDC focused in three main areas of the Site: the East Area, the EDC-VCM Plant Area, and the West Floodplain Area. In the deep zone (RI Figure 5-29), EDC is less widespread than in the shallow zone, and is present in the East Area, the EDC-VCM Plant Area, and the West Floodplain Area, with the highest concentrations focused in the West Floodplain Area and the East Area.

3.2.4 1,1,2-Trichloroethane

1,1,2-TCA was detected in over 46% of the groundwater samples collected during the RI. The MCL for 1,1,2-TCA (5 µg/L) was exceeded in nearly 40% of the groundwater samples collected, with an average detected concentration of 8,371 µg/L. In the shallow zone, 1,1,2-TCA concentrations ranged from ND to 270,000 µg/L (MW-400S). In the deep zone, 1,1,2TCA concentrations ranged from ND to 45,000 µg/L (MW-312S and PZ-324). The distribution of 1,1,2-TCA in the shallow and deep groundwater zones is shown on RI Figures 5-24 and 5-25, respectively. RI Figure 5-24 shows that 1,1,2-TCA in the shallow zone is present in all five areas, with the highest concentrations of 1,1,2-TCA focused in three main areas of the Site: the East Area, the EDC-VCM Plant Area, and the West Floodplain Area. In the deep zone (RI Figure 5-25), 1,1,2-TCA is present in the East Area, the EDC-VCM Plant Area, and the West Floodplain Area, with the highest concentrations focused in the West Floodplain Area and the East Area.

3.2.5 1,1-Dichloroethene

1,1-DCE was detected in over 34% of the groundwater samples collected during the RI. The MCL for 1,1-DCE (7 µg/L) was exceeded in 23.9% of the groundwater samples collected during the RI, with an average detected concentration of 100 µg/L. In the shallow zone, 1,1-DCE concentrations ranged from ND to 760 µg/L (PC-8). In the deep zone, 1,1-DCE concentrations ranged from ND to 1,100 µg/L (PZ-319). The distribution of 1,1-DCE in the shallow and deep groundwater zones is shown on RI Figures 5-26 and 5-27, respectively. As shown on these figures, the concentrations of 1,1-DCE are slightly higher in the deep groundwater zone, whereas the distribution of elevated concentrations is more widespread in the shallow groundwater zone. RI Figure 5-26 shows that 1,1-DCE in the shallow zone is present in all five areas, with the highest concentrations of 1,1-DCE focused in three main areas of the Site: the Chlorine Plant Area, the EDC-VCM Plant Area, and the West Floodplain Area. In the deep zone (RI Figure 5-27). 1,1-DCE is present in the East Area, the EDC-VCM Plant Area, and the West Floodplain Area, with the highest concentrations focused in the West Floodplain Area and the East Area.

3.2.6 Benzene

Benzene was detected in over 43% of the groundwater samples collected during the RI. The MCL for benzene (5 µg/L) was exceeded in 36.8% of the groundwater samples collected during the RI, with an average detected concentration of 5,194 µg/L. In the shallow zone, benzene concentrations ranged from ND to 300,000 µg/L (MW-421S). In the deep zone, benzene concentrations ranged from ND to 32,000 µg/L (MW-420M). The distribution of benzene in the shallow and deep groundwater zones is shown on RI Figures 5-30 and 5-31, respectively. As shown on these figures, the concentration of benzene is slightly higher and the distribution across the Site is slightly more widespread within the shallow groundwater zone. RI Figure 5-30 shows that benzene in the shallow zone is present in all five areas, with the highest concentrations of benzene focused in three main areas of the Site: the East Area, the EDC-VCM Plant Area, and the West Floodplain Area. In the deep zone (RI Figure 5-31), benzene is again present in all five areas, with the highest concentrations focused in the central portion of the West Floodplain Area and the East Area.

3.2.7 Carbon Tetrachloride

Carbon tetrachloride was detected in over 7% of the groundwater samples collected during the RI. The MCL for carbon tetrachloride (5 µg/L) was exceeded in 6.2% of the groundwater samples collected during the RI, with an average detected concentration of 3,296 µg/L. In the shallow zone, carbon tetrachloride concentrations ranged from ND to 90,000 µg/L (P1MW-4). In the deep zone, carbon tetrachloride concentrations ranged from ND to 990 µg/L (GA-2). The distribution of carbon tetrachloride in the shallow and deep groundwater zones is shown on RI Figures 5-32 and 5-33, respectively. As shown on these figures, the concentration of carbon tetrachloride is higher and the distribution across the Site is more widespread within the shallow groundwater zone. RI Figure 5-32 shows that the highest concentrations of carbon tetrachloride in the shallow zone are focused in two main areas of the Site: the EDC-VCM Plant Area and the Chlorine Plant Area.

3.2.8 Chlorobenzene

Chlorobenzene was detected in over 40% of the groundwater samples collected during the RI. The MCL for chlorobenzene (100 µg/L) was exceeded in 17.7% of the groundwater samples collected during the RI, with an average detected concentration of 633 µg/L. In the shallow zone, chlorobenzene concentrations ranged from ND to 17,000 µg/L (MW-501S). In the deep zone, chlorobenzene concentrations ranged from ND to 6,500 µg/L (BW-1952). The distribution of chlorobenzene in the shallow and deep groundwater zones is shown on RI Figures 5-34 and 5-35, respectively. As shown on these figures, the concentration of chlorobenzene is slightly higher and the distribution across the Site is slightly more widespread within the shallow groundwater zone. RI Figure 5-34 shows that chlorobenzene is present in all five areas in the shallow zone, with the highest concentrations focused in three main areas of the Site: the East Area, the EDC-VCM Plant Area, and the West Floodplain Area. In the deep zone (RI Figure 5-35) the highest concentrations occur in the East Area and in the West Floodplain Area.

3.2.9 Trichloromethane/Chloroform

Chloroform was detected in over 43% of the groundwater samples collected during the RI. The MCL for chloroform (80 µg/L) was exceeded in 28.8% of the groundwater samples collected during the RI, with an average detected concentration of 4,000 µg/L. In the shallow zone, chloroform concentrations ranged from ND to 280,000 µg/L (P1MW-4). In the deep zone, chloroform concentrations ranged from ND to 14,000 µg/L (MW-32SA and PZ-324). The distribution of chloroform in the shallow and deep groundwater zones is shown on RI Figures 5-36 and 5-37, respectively. As shown on these figures, the distribution of elevated chloroform concentrations is more widespread within the shallow groundwater zone. RI Figure 5-36 shows that the concentrations of chloroform above the MCL in the shallow zone are present in all areas except the Ethylene Plant Area, with the highest concentrations focused in the East Area, the EDC-VCM Plant Area, and the central portion of the West Floodplain Area. In the deep zone (RI Figure 5-37), concentrations above the MCL are present in the West Floodplain Area, the EDC-VCM Plant Area, and the East Area, with the highest concentrations located in the central and northwestern portion of the West Floodplain Area.

3.2.10 Tetrachloroethene/Perchloroethene

PCE was detected in nearly 35% of the groundwater samples collected during the RI. The MCL for PCE (5 µg/L) was exceeded in 24.5% of the groundwater samples collected during the RI, with an average detected concentration of 519 µg/L. In the shallow zone, PCE concentrations ranged from ND to 6,700 µg/L (MW-501S). In the deep zone, PCE concentrations ranged from ND to 7,000 µg/L (MW-311S). The distribution of PCE in the shallow and deep groundwater zones is shown on RI Figures 5-38 and 5-39, respectively. As shown on these figures, the distribution of PCE across the Site is slightly more widespread within the shallow groundwater zone. RI Figure 5-38 shows that PCE is present in all five areas in the shallow zone, with the highest concentrations focused in three main areas of the Site: the East Area, the EDC-VCM Plant Area, and the West Floodplain Area. In the deep zone (RI Figure 5-39) the highest concentrations occur in the West Floodplain Area and in the East Area.

3.2.11 Trichloroethene/TCE

TCE was detected in nearly 50% of the groundwater samples collected during the RI. The MCL for TCE (5 µg/L) was exceeded in 32.9% of the groundwater samples collected during the RI, with an average detected concentration of 397 µg/L. In the shallow zone, TCE concentrations ranged from ND to 7,900 µg/L (MW-401S). In the deep zone, TCE concentrations ranged from ND to 5,500 µg/L (MW-311S). The distribution of TCE in the shallow and deep groundwater zones is shown on 2015 RI Figures 5-40 and 5-41, respectively. As shown on these figures, the distribution of TCE is slightly more widespread in the shallow groundwater zone, whereas concentrations are generally higher in the deep groundwater zone. 2015 RI Figure 5-40 shows that concentrations of TCE above the MCL are located in all five areas, with the highest concentrations located in the northern portion of the East Area, the EDC-VCM Plant Area, and the West Floodplain Area. In the deep zone (RI Figure 5-41), elevated TCE concentrations are located in the northern portion of the East Area, the EDC-VCM Plant Area, and the West Floodplain Area, with the highest concentrations occurring in the northwestern portion of the West Floodplain Area.

3.2.12 Vinyl Chloride

Vinyl chloride was detected in nearly 50% of the groundwater samples collected during the RI. The MCL for vinyl chloride (2 µg/L) was exceeded in 43.4% of the groundwater samples collected during the RI, with an average detected concentration of 1,406 µg/L. In the shallow zone, vinyl chloride concentrations ranged from ND to 29,000 µg/L (PC-7). In the deep zone, vinyl chloride concentrations ranged from ND to 13,000 µg/L (BW-1928). The distribution of vinyl chloride in the shallow and deep groundwater zones is shown on RI Figures 5-42 and 5-43, respectively. As shown on these figures, the concentration of vinyl chloride is slightly higher and the distribution across the Site is slightly more widespread within the deeper groundwater zone except for the EDC-VDM Plant Area, where vinyl chloride is more widespread in the upper groundwater zone. RI Figure 5-42 shows that the highest concentrations of vinyl chloride in the shallow zone are present in four of the five areas (except for the Ethylene Plant Area), with the highest concentrations focused in the EDC-VCM Plant Area, the East Area, and the West Floodplain Area. In the deep zone (RI Figure 5-43), a similar distribution is observed.

3.2.13 Arsenic

Arsenic is naturally occurring in the unconsolidated deposits at the site, and was detected in over 95% of the groundwater samples collected during the RI. The MCL for arsenic (10 µg/L) was exceeded in 24.3% of the groundwater samples collected during the RI, with an average detected concentration of 23 µg/L. In the shallow zone, arsenic concentrations ranged from ND to 53 µg/L (MW-421S). In the deep zone, arsenic concentrations ranged from ND to 1,800 µg/L (BW-1927B). The distribution of arsenic in the shallow and deep groundwater zones is shown on RI Figures 5-44 and 5-45, respectively. As shown on these figures, arsenic is not widely detected above the MCL in either zone, with slightly higher concentrations observed in the lower aquifer zone. RI Figure 5-44 shows that the arsenic detections above the MCL were present in three main areas of the site: the Ethylene Plant Area, the East Area, and the West Floodplain Area. In the deep zone (RI Figure 5-45) the spatial distribution of arsenic is similar, with the highest concentrations occurring in the northwestern portion of the West Floodplain Area. It is likely that the elevated arsenic corresponds to the portions of the aquifer which have reducing conditions. It was not an objective of the RI to discern between naturally-occurring reducing conditions and contamination-induced reduced conditions. These reducing conditions have the potential to alter the geochemical environment and generally increase the concentration of dissolved metals.

3.2.14 Mercury

Mercury was detected in over 10% of the groundwater samples collected during the RI. The MCL of mercury (2 µg/L) was exceeded in 5.9% of the groundwater samples collected during the RI, with an average detected concentration of 3.2 µg/L. In the shallow zone, mercury concentrations ranged from ND to 35 µg/L (PC-10). In the deep zone, the concentrations ranged from ND to 1.7 µg/L (PC-11). The distribution of mercury in the shallow and deep groundwater zones is shown on RI Figures 5-46 and 5-47, respectively. As shown on RI Figure 5-46, mercury is present above the MCL in the eastern portion of the West Floodplain Area, and in the northern portion of the Chlorine Plant Area. Mercury is not present above the MCL in the deep zone (RI Figure 5-47).

3.3 Fate and Transport

This section describes the migration pathways and physical and chemical processes that affect the fate and transport of contaminants in various environmental media at the Site. An understanding of the fate and transport of contaminants is necessary to develop a comprehensive and thorough CSM and was used to evaluate remedial technologies and overall strategies during the FS stage. There is extensive detail in this section as it was derived from the longer Fate and Transport section in the 2015 RI report.

As discussed, the primary COPCs identified at the Site include the VOCs EDC and 1,1,2-TCA, the petroleum constituent benzene, and the metal mercury. Other VOCs, semi-volatile organic compounds (SVOCs) (primarily polycyclic aromatic hydrocarbons), and metals are widespread in various media at the Site. Contaminant fate and transport is discussed in this section in terms of certain Site-specific chemicals, based on those chemicals identified as primary COPCs. The contaminant fate and transport assessment presented here is qualitative in nature. Quantitative analyses to demonstrate or predict the rate of contaminant migration were not prepared, in part due to the complexities associated with the presence and distribution of DNAPL at the Site.

3.3.1 Potential Routes and Processes of Contaminant Migration/Transport

The potential routes and processes of contaminant migration associated with COPCs and environmental media at the Site include:

- Soil/sediment transport
- NAPL migration
- Desorption/dissolution
- Groundwater/surface water migration
- Surface water infiltration
- Adsorption
- Degradation

- Volatilization.

3.3.2 NAPL Migration

The subsurface migration of separate-phase DNAPL is a complex process that is strongly influenced by surface soil properties, subsurface geology, properties of the DNAPL, and release location. At the Site, non-aqueous phase liquid (NAPL) consists of both DNAPL and light non-aqueous phase liquid (LNAPL). DNAPLs consist of EDC (crude and purchased) and chlorinated byproducts. Elemental mercury also is present at the Site and behaves as a DNAPL. LNAPLs at the Site include aromatic gasoline, fuel oil, and Solvesso™ (where benzene and/or naphthalene are primary constituents). Upon release to the subsurface, separate-phase NAPL migrates downward through the unsaturated zone primarily driven by gravity. Depending on the volume released, the separate-phase NAPL can be trapped by capillary forces within the vadose zone often as disconnected blobs and in ganglia (i.e., residual NAPL). If sufficient volume is released, separate-phase NAPL migration to the water table and beyond can occur. The NAPL migrates until encountering sufficiently resistant layers that will impede further mass vertical/lateral movement. NAPL can form more continuous distributions (i.e., pooled NAPL) and disconnected blobs and ganglia (i.e., residual NAPL) in the aquifer. In addition, NAPL constituents can dissolve into groundwater and sorb to the aquifer matrix as the NAPL migrates. Within a saturated aquifer, water is typically a wetting fluid and occupies void space whereas NAPL is a non-wetting fluid, and a minimum NAPL head is required to overcome the capillary entry pressure of the void. The percent of void space occupied by NAPL (NAPL saturation) is reflected in the capillary pressure curve for NAPL.

For DNAPL, pooling and spreading tend to occur above capillary barriers, which are typically formations, layers, or lenses of relatively less permeable material. However, pooling can occur at any elevation in the subsurface and not necessarily only at the base of a permeable zone. The orientation of stratigraphic features (e.g., sandy beds, bedding planes) largely determines the degree of lateral and vertical spreading.

For this site, this degree of spreading is most readily observed with the migration of the DNAPL from the Pond 1 area as shown in three figures from the 2015 RI. Figure 9 (RI Figure 5-7) shows the greatest soil concentrations of EDC to be in the area of Pond 1, located just slightly above the center of the figure.

As seen in Figure 10 (RI Figure 5-28), the maximum groundwater EDC concentrations are underneath the disposal area of Pond 1. The amounts of EDC in Pond 1 have been reported in the millions of pounds (page 7). The plume of EDC has migrated off the former Goodrich facility property and underneath the Carbide Ponds to the northwest. As seen in Figure 3 (RI Figure 4-29) on Page 20, the groundwater flow direction in this area is to the northeast, towards the river. It is accepted DNAPL behavior that it flows under the effect of gravity, not under the effect of groundwater flow direction. Additionally, with a mass of 3 to 4 million pounds of EDC historically in Pond 1, there would have been a considerable driving head force pushing the EDC DNAPL into areas and HCs beyond the release location. This is apparent in

Figure 9 (RI Figure 5-75) below. Note that Pond 1 is the basin indicated at approximately 2,600 feet along Section E-E' (see Figure 8) and the maximum DNAPL indications below Pond 1 continue to the left (to the northwest) within the Interbeds on Floodplain HC. These interbeds with their alternating sand, silt and clay layers provide a higher permeability layer (the sand) for the EDC DNAPL to migrate through while putting the EDC DNAPL in contact with the lower permeability beds (the silt and clay). This will allow the EDC DNAPL to diffuse into the lower permeability beds which, over time, allow the EDC to back diffuse into the sandy zones. It is this specific relationship of DNAPL pushed into interbed formations that is a major contributing factor to the TI of groundwater restoration at this Site.

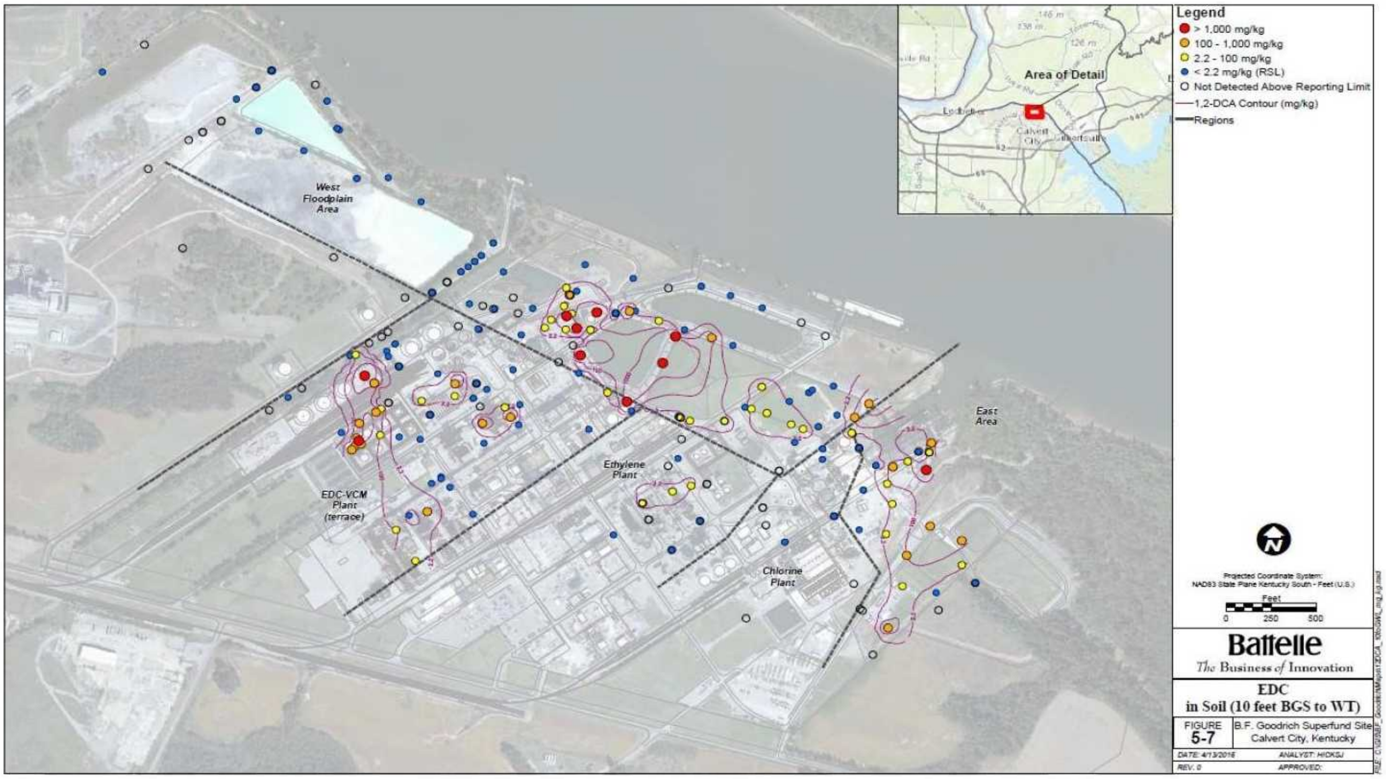


Figure 9. EDC in Soil (10 feet BGS to WT) (From RI; Figure 5-7)

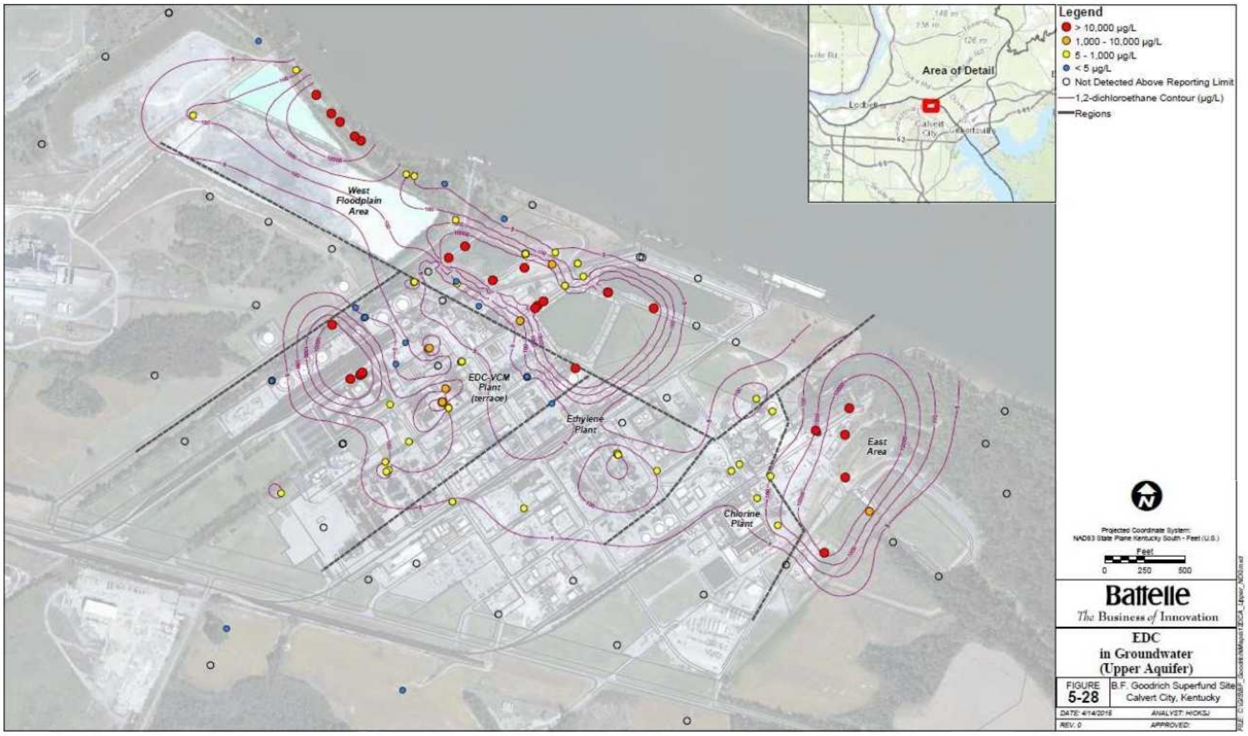


Figure 10. EDC in Groundwater (Shallow Groundwater) (From RI; Figure 5-28)

LNAPL migrates until it encounters a low permeability geologic unit or the water table. LNAPL that migrates vertically downward to the water table tends to spread out on the surface of the water table, but also penetrates to some depth into groundwater. As groundwater levels rise and fall in the system, more LNAPL can become entrapped below the water table. The LNAPL may move laterally as a continuous, free-phase layer along the upper boundary of the water saturated zone due to gravity and capillary forces. Although principal migration may be in the direction of groundwater flow, some migration may occur in other directions.

The various types of DNAPL encountered at the Site, combined with the influence of weathering, results in preferential dissolution of chemicals. Chemicals with higher effective solubilities, such as EDC, will be dissolved faster than compounds with lower effective solubilities, such as 1,1,2TCA. Less soluble chemicals in DNAPL persist longer than the more soluble compounds with higher effective solubilities. One of the most important features in the floodplain area of the Site with respect to DNAPL transport is a unit of interbedded sand, silt, and clay lenses that comprise the Elongate Floodplain Interbeds unit (I Hydrocode lithologic unit). For DNAPL located in the floodplain in the Elongate Floodplain Interbeds unit, less flushing with fresh groundwater occurs as compared to sandy formations, and hence, the rate of dissolution for DNAPL in this unit is expected to be lower.

3.3.3 Groundwater/Surface Water Migration

Contaminants in groundwater or surface water have the potential to migrate with prevailing flow conditions (i.e., advection), to migrate due to finer-scale characteristics of porous media or finer-scale variations in surface water velocity (i.e., dispersion), and/or to migrate along a concentration gradient (i.e., diffusion). Contaminants in groundwater also have the potential to reach sediment porewater and/or surface water through discharge of groundwater to a surface water body, such as the Tennessee River. Groundwater transport represents the primary route of contaminant migration at the Site aided by the influx of clean groundwater from the south side of the site.

In general, groundwater flows across the Site from southwest to northeast toward the Tennessee River (see Figure 3 [2015 RI Figure 4-29] on Page 20). Hydraulic gradients at the Site are generally highest near the river and lower in the terrace area. At normal pool stage, the horizontal component of the hydraulic gradient in the terrace area is generally on the order of 0.002. Across the floodplain, the horizontal component of the hydraulic gradient is typically on the order of 0.02 under normal pool stage. Under normal river elevation (normal pool) conditions, groundwater would discharge (absent capture by the PCAP system) from the Site toward the Tennessee River. However, if the river elevation is high, surface water will move into the banks of the river, causing a temporary reversal of flow. At river stages higher than approximately 310 to 315 feet amsl, the horizontal component of the hydraulic gradient near the Tennessee River reverses, which causes water to infiltrate into the river banks and some small distance inland.

The vertical component of the hydraulic gradient at the Site is also affected by changes in the Tennessee River stage. When the river stage approaches normal pool, downward vertical hydraulic gradients are more frequently observed for groundwater beneath the terrace and upward vertical hydraulic gradients are more frequently observed beneath the floodplain (see RI Figure 4-34). These vertical gradients can reverse when the river stage is high (see RI Figure 4-33). Once the containment wall is in place, the groundwater hydraulics within the wall will be isolated from the effect of the river stages. At that time, rainfall infiltration plus the NAPL recovery and water level maintenance pumping will be the primary factors for the groundwater hydraulics within the wall.

Significant quantities of DNAPL are present within the Elongate Floodplain Interbeds. Such interbedded deposits have facilitated DNAPL migration away from the NAPL sources. However, generally, groundwater plumes created by the DNAPL zones at the Site remain close to the source areas because half of the NAPL is located within interbedded deposits whereas the majority of groundwater flow occurs in fine and coarse sands generally beneath these interbedded deposits.

3.4 Contaminant Behavior and Persistence

The fate of chemicals in the environment and the movement of chemicals through various media are dictated by the physical and chemical properties of the chemicals and the media through which the chemicals are conveyed. Solubilities, solid-liquid partitioning coefficients, Henry's Law constants, and other parameters can be used to evaluate contaminant persistence and behavior in the environment. In addition, degradation and other attenuation processes can influence the fate of chemicals. Organic constituents can degrade biotically under common environmental conditions. In the discussions below concerning persistence and behavior, certain COPCs have been selected as representative of various classes of contaminants.

3.4.1 NAPL

As summarized in Section 6.2 of the RI report (EPA, 2015), the fate of DNAPL in the environment depends on the properties of the specific NAPL constituents and the environment in which it exists. Furthermore, the composition of the NAPL at the Site is spatially variable because of variation in the types of liquids that were disposed at the Site and released to the subsurface. Not only did the DNAPL in the West Floodplain Area and the East Area originate from a variety of sources, but in some cases the DNAPL also has undergone substantial weathering which causes preferential dissolution of compounds such as EDC that have higher effective solubility. As a result, there are wide ranging fractions of EDC in the NAPL mixtures in these areas. Additionally, the mole fraction of the individual constituents within a multicomponent NAPL will influence their effective solubility and how the NAPL acts as a source for groundwater contamination. DNAPL can remain in the environment for several decades or longer as a free-phase NAPL and residual NAPL. As separate-phase NAPL, the contamination undergoes limited degradation in the subsurface and persists for long periods while slowly releasing soluble organic constituents to groundwater through dissolution (back diffusion).

Given its density, elemental mercury behaves as a DNAPL, generally moving in response to gravity and dispersing as fine droplets or small pools until it meets a barrier to movement. Where mercury is present in the elemental form, and not exposed to an atmosphere where it can volatilize and move as vapor, it will tend to remain as metal droplets and may only transform and migrate with long-term weathering within the capacity of the system to oxidize the mercury to a more mobile form.

3.4.2 Chlorinated VOCs

The following subsections describe the persistence and behavior of different chlorinated VOCs present at the Site.

3.4.2.1 EDC and 1,1,2-TCA

EDC released to land surfaces is expected to volatilize rapidly to the atmosphere or migrate into the subsurface. The high density of this compound makes it sink in a vertical gravity-driven process. EDC is not expected to adsorb to soil particles and is available for transport into groundwater. EDC tends to migrate slightly slower than groundwater, and is not expected to adsorb strongly to suspended solids and sediment in the water column. Volatilization losses occur at a much slower rate for EDC present in subsurface soil, surface water, or groundwater. In groundwater and surface water, biodegradation is the primary degradation process for the removal of EDC (Agency for Toxic Substances and Disease Registry [ATSDR], 2001), with EDC prone to both aerobic and anaerobic degradation. Aerobic cometabolism of EDC produces carbon dioxide. EDC can also degrade aerobically to produce 1,2-dichloroethanol or 2-chloroethanol and be further hydrolytically transformed to ethanol. 2-Chloroethanol can be further degraded to chloroacetaldehyde, chloroacetic acid, and glycolate under aerobic conditions (Janssen et al., 1985). Under aerobic or anaerobic conditions, dehaloelimination results in the conversion of EDC to ethene (Lee et al., 1999). Under anaerobic conditions, dechlorination results in the conversion of EDC to chloroethane (Wild et al., 1995).

Chloroethane and ethene will both biodegrade to ethane under anaerobic conditions (Suarez and Rifai, 1999). However, the production of ethene through the dehaloelimination process is often the primary pathway under anaerobic conditions (Lee et al., 1999).

Abiotic degradation of EDC through oxidation and hydrolysis processes is too slow to be environmentally significant (ATSDR, 2001). In a study performed under anaerobic conditions, it was found that 1,1,2-TCA did not degrade via abiotic dehalogenation (ATSDR, 1989).

1,1,2-TCA has a moderately high vapor pressure, and is expected to volatilize rapidly from soil surfaces. 1,1,2-TCA does not adsorb appreciably to soil, sediment, and suspended solids in the water column and would be expected to readily leach into subsurface soil and groundwater (ATSDR, 1989). Several studies have determined that 1,1,2-TCA is resistant to biodegradation (EPA, 2010b). Biodegradation in groundwater or subsurface regions may occur, but appears to be very slow. However, reductive dechlorination of 1,1,2-TCA can increase as the redox potential decreases under iron-reducing, sulfate-reducing, and methanogenic conditions (Aronson and Howard, 1997). Hydrolysis is not expected to be significant for 1,1,2-TCA. At the Site, the anaerobic conditions present are conducive to the biodegradation of chlorinated ethanes.

3.4.2.2 PCE, TCE, Vinyl Chloride, and 1,1-DCE

Laboratory studies have demonstrated that PCE volatilizes rapidly from water, while volatilization rates for PCE from soil are much lower. In general, losses of PCE from soil resulting from volatilization are generally between l0 and l00 times slower than from water, depending on soil type, which directly affects the amount of sorption. PCE transport in groundwater is complicated by the sorption effect of organic and inorganic solids. PCE has a relatively low water solubility, which suggests that it is less mobile when compared to other VOCs.

The major route of removal of TCE from water is volatilization, and TCE partitions rapidly to the atmosphere from surface soil and surface water. Volatilization of TCE from soil is slower than it is from water but more rapid than that of many other VOCs. TCE is moderately to highly mobile in soil.

The primary transport process for vinyl chloride in natural systems is volatilization into the atmosphere, and vinyl chloride partitions rapidly to the atmosphere from both water and soil. The presence of various salts in natural water systems may affect the volatility of vinyl chloride significantly. Vinyl chloride has a very low sorption tendency, meaning that this compound would be highly mobile in soil, and is highly soluble in water. Many salts have the ability to form complexes with vinyl chloride and can increase its water solubility; therefore, the presence of salts may significantly influence the amount of vinyl chloride remaining in solution. In situations where organic solvents exist in relatively high concentrations (e.g., landfills or hazardous waste sites), co-solvent effects tend to reduce the volatility of vinyl chloride, causing it to have even greater mobility (ATSDR, 2006).

1,1-DCE is likely to partition readily into the atmosphere from water. Because of this, 1,1-DCE is generally not found in surface water in high concentrations. 1,1-DCE spilled onto surface soil will also tend to partition to the atmosphere, while some of the chemical may migrate into subsurface soil. Once in subsurface soil, 1,1-DCE will partition between soil and water. 1,1-DCE will migrate through soil without significant attenuation by adsorption to organic carbon, and has a relatively higher water solubility. 1,1-DCE migrates relatively freely within groundwater (ATSDR, 1994).

Biodegradation of chlorinated ethenes is mediated through a series of redox reactions, in which electrons are transferred between electron donors and electron acceptors. PCE is the most oxidized of the chlorinated ethenes and is not susceptible to oxidation mechanisms (electron donor) for biodegradation (i.e., PCE cannot be used as a primary substrate) unless it is via a cometabolic pathway. However, PCE is degraded through the reductive dechlorination pathway. Therefore, PCE is biologically recalcitrant under aerobic conditions and typically requires an anaerobic environment to undergo biodegradation. TCE also is highly oxidized and is typically not susceptible to oxidation reactions. TCE is mainly biodegraded by reductive dechlorination under anaerobic conditions. However, TCE may, in some cases, undergo aerobic cometabolism resulting in partial dechlorination.

1,1-DCE and vinyl chloride (the most reduced chlorinated ethenes) are susceptible to both aerobic degradation (through oxidation) and anaerobic degradation (through oxidation or reduction). 1,1-DCE and vinyl chloride biodegradation has been documented to occur by each of the three principal biodegradation mechanisms (i.e., anaerobic, aerobic, and cometabolic). Vinyl chloride is the most susceptible of the chlorinated ethenes to electron donor reactions. Oxidation (also referred to as mineralization) of 1,1-DCE and vinyl chloride is associated with transformation to carbon dioxide, water, and chloride. Aerobic oxidation of 1,1-DCE and vinyl chloride is characterized by a loss of mass and a decreasing molar ratio of 1,1-DCE and vinyl chloride compared to that of other chlorinated ethenes.

1,1-DCE and vinyl chloride are the least susceptible to electron acceptor (i.e., reduction) reactions because they are the most reduced forms of the chlorinated ethenes; therefore, reductive dechlorination of 1,1-DCE and vinyl chloride is slow relative to other degradation mechanisms. Reductive dechlorination of 1,1-DCE and vinyl chloride has been documented in anaerobic environments, and is characterized by reductions in mass, increased concentrations of chloride ions, and production of daughter products (vinyl chloride for 1,1-DCE, and ethane for vinyl chloride). The occurrence of reductive dechlorination relies on the presence of a primary substrate (i.e., electron donor).

A natural attenuation evaluation for the Site was completed by PolyOne in June 2014 (see Appendix 6-1 of the EPA RI). As part of this evaluation, redox parameters were evaluated, and the data show that oxidation-reduction potential (ORP) values are generally less than 50 mV across the Site (i.e., in the upgradient, a portion of the source area, and most of the downgradient sample locations). Dissolved oxygen was measured at low concentrations in background monitoring wells upgradient of the NAPL source zones as well as across the majority of the Site, nitrate concentrations were below detection limits in all sampled locations, dissolved manganese was detected in almost all sampled locations, dissolved iron concentrations were above 1 mg/L, and methane was detected in almost all of the sampled wells. These results suggest that reducing conditions are prevalent at the Site, and further indicate that Site groundwater is generally between the ferrogenic and methanogenic reducing range. The data also indicate that conditions become more reducing in the areas of high organic COPC concentrations, and the presence of methane suggests that conditions are conducive to reductive biodegradation of organic COPCs.

3.4.3 Petroleum Constituents

Benzene is the primary petroleum constituent present at the site. Benzene is highly volatile and moderately soluble in water. Benzene partitions readily to the atmosphere from surface soil and surface water. Benzene released to soil surfaces can also reach surface water through runoff and groundwater because of leaching. Benzene is highly mobile in soil and readily leaches into groundwater. Benzene tends to migrate slightly slower than groundwater. Benzene is also expected to sorb moderately to suspended solids and sediment in the water column.

Greater soil adsorption is observed with increasing organic matter content (ATSDR, 2007). Benzene will volatilize moderately from groundwater to air.

Benzene is readily degraded in water under aerobic conditions. Microbial degradation of benzene in aquatic environments is influenced by many factors, including microbial population, dissolved oxygen, nutrients, other sources of carbon, inhibitors, temperature, pH, and initial concentration of benzene. At very high levels, as may be the case with a petroleum spill, benzene and other compounds contained in petroleum are toxic to microorganisms and the rate of degradation is slow compared to low initial starting concentrations. Laboratory studies on microbial degradation of benzene with mixed cultures of microorganisms in gasoline contaminated groundwater have revealed that both oxygen and nitrogen concentrations are major controlling factors in the biodegradation of benzene (ATSDR, 2007).

Benzene biodegradation under anaerobic conditions does not readily occur, and is slower than under aerobic conditions. When dissolved oxygen is depleted, an alternative electron acceptor such as nitrate, carbonate, or Fe^{3+} must be available, and microbes capable of using the alternative electron acceptor to degrade benzene must be present (ATSDR, 2007); these microbes are normally present at most sites. Benzene can degrade abiotically, but generally does so under oxidizing conditions, and therefore this degradation pathway is unlikely to be widespread at the Site.

3.4.4 Metals

Soils have the capability to attenuate metals under specific chemical conditions through processes including precipitation (fixation), specific adsorption, covalent bonding, chelation, and redox transformation. The primary factors controlling attenuation are metal chemistry and soil characteristics. Inorganic constituents such as metals can also geochemically interact within the groundwater system. These processes can lead to partial or total immobilization in soil and groundwater.

3.4.4.1 Arsenic

Arsenic is mobile under both oxidizing and reducing redox conditions. Arsenic sorbs to the surface of metal oxide (e.g., iron hydroxide) coatings on soil particles and therefore the mobility of arsenic can also be affected by changes in the geochemical conditions that affect the solubility of the metal oxides. Under oxidizing conditions, iron oxides will form solids and provide sorption sites for arsenates, but under reducing conditions, the iron oxides will dissolve, reducing the number of available sorption sites for arsenic species, thereby releasing arsenic into solution. Redox conditions at the Site are generally reducing and therefore iron oxides tend to dissolve, increasing the amount of arsenic in solution.

3.4.4.2 Mercury

Mercury is transformed in the environment through redox reactions, bioconversion of inorganic and organic forms, and photolysis of organo-mercury compounds. Inorganic mercury can be methylated by microorganisms. Most of the mercury deposited in unsaturated soils is adsorbed to the soil and does not leach into groundwater. Soil adsorption of mercury is decreased with increasing pH. Chloride, when present in abundance, changes the stability relationships among mercury forms. The effect of chloride on mercury stability relationships can be observed at chloride concentrations as low as 500 mg/L, but are most significant at chloride concentrations in the 5,000 to 50,000 mg/L range.

Mercury in NAPL form (elemental mercury) has a relatively low solubility, and the dominant factor influencing its distribution in the subsurface is geologic structure. A wide range of solubility is exhibited by both inorganic and organic forms of mercury, from relatively insoluble for mercuric sulfide (inorganic) and dimethyl mercury (organic) to more soluble for mercuric chloride (inorganic) and mercuric acetate (organic). The most soluble form of mercury is mercuric chloride, which has been part of past plant operations. Volatile forms of mercury, such as elemental mercury and dimethyl mercury, can partition to the atmosphere, whereas stable forms such as mercuric sulfide (a mercury salt) partition to particulates in soil or surface water (and can be transported within surface water to sediments). Methyl mercury and mercuric chloride partition more strongly to water and sediments, respectively (EPA, 2000).

4.0 TECHNICAL IMPRACTICABILITY EVALUATION

4.1 Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121(d) of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 U.S.C. Section [§] 9621[d]), as amended, states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria or limitations that are determined to be legally applicable or relevant and appropriate. ARARs are identified on a site-specific basis for remedial actions where CERCLA authority is the basis for cleanup.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address circumstances at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs.

Groundwater response actions under CERCLA are governed in part by the following mandate established by Congress in CERCLA 121 (d)(2)(A):

> ... Such remedial action shall require a level or standard of control which at least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act and water quality criteria established under section 304 or 303 of the Clean Water Act, where such goals or criteria are relevant and appropriate under the circumstances of the release or potential release.
>
> This requirement is reflected in the National Contingency Plan (NCP) as follows: "Maximum contaminant level goals (MCLGs), established under the Safe Drinking Water Act, that are set at levels above zero, ...' or "maximum contaminant level (MCL) shall be attained where relevant and appropriate to the circumstances of the release..." (EPA, 2009a)

It is expected that residual NAPL would remain as a continuing source of contaminant releases and prevent the groundwater from being restored to beneficial use in a reasonable timeframe even with mobile DNAPL removal. Additionally, it is unlikely that groundwater drinking water standards would be achieved even with the aggressive treatment of the source and groundwater. Furthermore, some of the NAPL and groundwater plumes are located beneath several operating components (i.e. cracking towers) of the chemical manufacturing plants as seen in RI Figure 5-70 in Appendix A.

Pursuant to 40 CFR 300.430(f)(1)(ii)(C)(3) of the NCP and CERCLA Section 121(d)(4), the EPA proposes to waive compliance with the MCLs for certain groundwater contaminants (considered chemical-specific ARARs that are the basis for the groundwater cleanup levels) in the zone of groundwater at the site where EPA has determined compliance with the ARARs is technically impracticable from an engineering perspective. Figure 16 identifies the TI zone and

Table 1 lists the contaminants for the proposed TI waiver. This waiver would be based on a determination that compliance of the ARAR would be technically impracticable from an engineering perspective.

Consistent with Section 300.430(a)(1)(iii)(F), EPA developed an alternative that addresses source material, which constitutes a principal threat waste (PTW), prevents further migration of the plume, prevents exposure to the contaminated groundwater, and considers further ways to reduce exposure and risk. EPA guidance defines PTW as “source material considered to be highly toxic or highly mobile and generally, cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.” EPA and the Kentucky Department of Environmental Protection (KDEP) support a containment-based approach to prevent further contaminant discharge to the Tennessee River in order to protect human health and the environment.

Table 1. The Contaminants for which the MCL Waiver is to be Granted

CONTAMINANT	MAXIMUM CONCENTRATION (µg/L)	MCL (µg/L)
Antimony	450	6
Arsenic	1800	10
Barium	3,200	2,000
Beryllium	51	4
Cadmium	49	5
Chromium	7,300	100
Lead	380	15
Mercury	35	2
Selenium	1,800	50
Aroclor 1016	58	0.5
Benzo(a)pyrene	11	0.2
Hexachlorobenzene	4.3	1
1,1,2-Trichloroethane	270,000	5
1,1-Dichloroethene	1,000	7
1,2-Dichlorobenzene	2,500	600
1,2-Dichloroethane	6,200,000	5
1,2-Dichloroethene, cis-	3,100	70
1,2-Dichloroethene, trans-	3,100	100
1,2-Dichloropropane	5.1	5
Benzene	300,000	5
Carbon Tetrachloride	90,000	5
Chlorobenzene	17,000	100
Trichloromethane	280,000	80
Ethylbenzene	7,400	700
Methylene Chloride	2,500	5
Styrene	10,000	100

Table 1. The Contaminants for which the MCL Waiver is to be Granted (continued)

CONTAMINANT	MAXIMUM CONCENTRATION (µg/L)	MCL (µg/L)
Tetrachloroethene	7,000	5
Toluene	72,000	1,000
Trichloroethene	7,900	5
Vinyl Chloride	29,000	2
Note: This list of contaminants is based on the data collected at the time of the completion of the RI/FS in 2017.		

4.2 Previous Remedial/Removal Actions

The following paragraphs summarize the previous remedial/removal actions, including wastewater pond closure, installation of the PCAP system, and remedial actions at the BF Goodrich Landfill and Burn Pit Area.

4.1.1 Wastewater Pond Closure

Eleven wastewater ponds were previously used in conjunction with the production facilities at the Site. Pond P-1 was closed in approximately 1963, and Pond P-2 (comprised of two smaller, individual ponds) was closed in 1962. Six ponds (0, 1A, 1B, 2, 3A, and 4) were constructed after Ponds P-1 and P-2 were regulated under RCRA. Two other ponds, Ponds 3B and 3C, were not regulated. Closure of the six RCRA-regulated ponds and two non-regulated ponds was performed voluntarily by B.F. Goodrich between December 1985 and March 1988. The work performed during pond closure included the removal of waste materials from the ponds by a process of decanting, dewatering, stabilization, and excavation. A closure cell was constructed within the original perimeter limits of Ponds 0, 1B, 3A, and 3B. Ponds 1A and 2 remain open as part of the site's stormwater management system. Ponds 1A and 2 were RCRA closed in the 1980s and will be physically closed as part of the selected remedy. This will remove them as a potential ecological exposure point and a source of groundwater recharge.

4.1.2 PCAP System

B.F. Goodrich initiated the extraction and treatment of impacted groundwater in 1985 in response to the identification of groundwater impacts at the RCRA Facility and at the B.F. Goodrich Superfund Site. In 1992, B.F. Goodrich submitted a draft Corrective Action Work Plan, pursuant to RCRA, to the KDEP which detailed the initial design, implementation, and monitoring of the PCAP system (Dames & Moore, 1992). The PCAP system was designed to meet the following objectives:

- Create a hydraulic barrier to prevent migration of groundwater with chemical concentrations exceeding RCRA alternate concentration limits (ACLs) (established in 1988) into the Tennessee River

- Reduce levels of EDC contamination in off-facility groundwater to below the MCL of 5 micrograms per liter (µg/L)
- Modify groundwater flow patterns to prevent off-facility migration of contaminated groundwater
- Reduce contamination in source areas to minimize future residual contribution to the Tennessee River and off-facility areas.

The PCAP system has been in operation since 1985. Since startup, a total of nearly 8 billion gallons of groundwater have been extracted, treated, and discharged, resulting in the removal of over 11.5 million pounds of EDC. While these are impressive extraction numbers, current estimates indicate that there are still over 22 million pounds of DNAPL remaining. 2017 analytical results from the RCRA monitoring program report 21 VOC detections, 10 SVOC detections and four inorganic detections. This approximates the Appendix IX analytical results provided in the 2010 RCRA monitoring report. While EDC is the primary COC, there are other compounds present in the groundwater extracted by the PCAP system.

Extraction rates for EDC have decreased over the years. At the beginning of PCAP operation in 1992, the mass removal was estimated to be 1,743 pounds per day (lbs/day). The estimated mass removal rate for EDC during the first half of 2010 was approximately 378 lbs/day. The estimated mass removal rate for EDC during the first half of 2017 was approximately 99 lbs/day, which is a decrease of approximately 29 lbs/day when compared to the 128 lbs/day of EDC removed during the second half of 2016. Hypothetically, if this daily DNAPL extraction rate could be sustained, it would take 608 years to remove the mobile DNAPL by extraction. Expanding this estimated recovery to include the dissolved-phase contamination would push the estimated timeframe to well over 1,000 years. This duration is not a reasonable timeframe for groundwater restoration.

Extraction rates have ranged from approximately 200 gallons per minute (gpm) in the late 1980s, when the system consisted of seven to eight extraction wells, to 600 to 800 gpm in the mid to late 1990s, when 50 additional extraction wells were installed and incorporated into the system. Extraction rates have averaged approximately 600 gpm since 2000. RI Figure 2-2 depicts the cumulative groundwater pumped and combined average annual PCAP groundwater extraction rates.

The PCAP system continues to operate and currently comprises three networks of groundwater extraction wells and an on-Site treatment system. The extraction well networks operate to meet the current cleanup objectives for the RCRA Permit and CERCLA Consent Decree, and evaluation of the system for long-term Site remediation is ongoing. RI Figure 2-1 shows the locations of the PCAP system extraction wells and other pertinent Site features.

The PCAP system includes extraction wells arranged in three well networks and a 1,000-gpm capacity steam stripper for treatment of contaminated groundwater. The steam stripper is known as the "C-Stripper" and includes a 10,000-gallon surge tank into which pumped groundwater is collected prior to treatment. Five of the PCAP system extraction wells are regulated under both RCRA and CERCLA. From 1985 to 1989, extraction wells PW-1 through

PW-7 were installed and operated in the vicinity of Pond 1A. An eighth extraction well (PW-8) was installed in 1989 in the Vinyl Tank Farm and is now known as SW-1921.

The "BW" series of PCAP system extraction wells are Tennessee River Barrier Wells. This series of wells includes 35 extraction wells. The main purpose of these wells is to provide hydraulic containment of groundwater with chemical concentrations exceeding ACLs prior to any discharge to the Tennessee River. The "SW" series of PCAP system extraction wells are Source Remediation Wells. This series includes eight extraction wells (SW-1918, SW-1920, SW-1921, SW-1924, SW-1925, SW-1926D, SW-1942, and SW-1943), which are designed to extract contaminated groundwater from known source areas at the Site. The "OW" series of PCAP system extraction wells are Off-Site Remediation Wells. This series includes four extraction wells located in the southwest and four extraction wells located in the east (see RI Figure 2-1). The main purpose of these wells is to mitigate potential migration of groundwater with chemical concentrations exceeding MCLs beyond the EDC/VCM Plant and Chlorine Plant boundaries.

4.1.3 BF Goodrich Landfill/Burn Pit Area

Remedial actions at the BF Goodrich Landfill and Burn Pit Area have proceeded in accordance with the 1988 ROD and 1992 Consent Decree. Remedial actions in this area include:

- Installation of a 100-year flood protection dike at the BF Goodrich Landfill and adjacent AIRCO Landfill
- Upgrade of the cap on the BF Goodrich and AIRCO Landfills using clay
- Installation of a RCRA cover system consisting of a 2-foot thick layer of engineered fill overlain by a geosynthetic clay liner, a 40-mil high density polyethylene (HDPE) liner, a 1-foot thick granular drainage layer, and a 2-foot thick vegetative cover layer over the Burn Pit Area
- Installation of a soil vapor extraction (SVE) system in the Burn Pit Area
- Extraction of the high-concentration core of the shallow groundwater VOC plume (ACLs were developed as remediation criteria for the CERCLA program in 1992)
- Installation of a barrier in the shallow aquifer zone to intercept lateral migration of contaminants from the source area.
- Waste was not removed from the landfills at the time of closure.

In the Burn Pit Area, the original SVE wells (BP-1 through BP-13) were converted to dual phase extraction (DPE) wells with the installation of 'sipper tubes' in 2002-2003. At the same time, 10 additional DPE wells (BP-14 through BP-23) were installed at locations adjacent to the Burn Pit Area on the northwest.

4.2 Impracticability Analysis

The B.F. Goodrich site has been extensively characterized and this report has summarized important aspects of the site that are necessary in evaluating the TI of the restoration of the groundwater in a reasonable time. For this site three main factors define the impracticability of groundwater restoration: the large amount of NAPL mass in the subsurface, the complexity of the hydrogeology of where that NAPL is located, and the very long duration required to restore the groundwater. There are secondary LOEs which by themselves would not necessarily be sufficient to demonstrate TI. They will be described here to support the main LOEs.

4.2.1 NAPL Mass

In 2006 file material and records provided logic regarding the EDC releases to the environment at this facility (Newell, 2006). Part of that document included a mass balance calculation for how much EDC was disposed of into ponds, primarily Pond 1. Between 1959 and 1987 146 million pounds of EDC were released and 72 million pounds were estimated to have been released to the subsurface and likely entered the groundwater. A further evaluation estimates that 78% of the waste released into the ponds between 1965 and 1978 was in the form of DNAPL. That suggests that 56 million pounds of EDC entered the subsurface as DNAPL.

In July 2013, the draft RI report investigated the site in some different and informative ways. This report included estimates of NAPL-contaminated soil volumes, total NAPL mass and the portion of that mass composed of EDC. Additionally, individual source zones were identified by depth. Those details are provided in Table 2. These estimates are for organic NAPL, not mercury NAPL, which is only found in the Chlorine Plant Area. While no mass estimate is provided, there is an estimated 124,000 yd^3 of mercury source zone soil in the Chlorine Plant Area.

Table 2. DNAPL Volume, Mass and Source Zone Estimates by Depth

Depth Horizon	Soil Volume (yd^3)	NAPL Mass (lbs)	EDC Mass (lbs)	Source Zones
Ground Surface to 10' bls	243,779	1,560,595	407,832	23
10 ft bls to Water Table	716,421	5,634,113	1,301,479	21
Water Table to 295 ft msl	1,223,064	9,477,063	3,227,537	15
295 ft to 280 ft msl	542,396	4,167,357	914,480	10
280 ft to 265 ft msl	218,524	1,646,127	208,292	7
Below 265 ft msl	24,263	158,958	10,205	3
Totals	2,968,447	22,644,213	6,069,825	79

(EPA. 2015)

The 2015 RI report used the DNAPL PIs to provide estimates of DNAPL volume by areas of the Site. The sum of those volumes at the 30% PI is 3,500,000 yd^3. There is some imprecision in the three mass estimates owing to the different methodologies used at different times.

Whether Dr. Newell's estimate is considered on behalf of Westlake Vinyls of 72 million pounds of EDC released into the ponds, or the PolyOne 2013 estimate of 2,968,447 yd^3 and 22,644,213 pounds of NAPL in the subsurface or the EPA 2015 estimate of 3,500,000 yd^3 of DNAPL in the subsurface, these are all substantial volumes of DNAPL.

A major implication of having this much NAPL mass is the difficulty in providing sufficient remediation to restore the groundwater. Senior groundwater professionals providing research publications of in-situ remediation effectiveness on DNAPL often refer to reductions of the mass by orders of magnitude. Reductions in mass of two orders of magnitude, 99%, is considered very good and claims of reductions of three orders of magnitude, 99.9%, are met with considerable skepticism (ITRC, 2011; Newell, 2011). If such an ideal treatment could be implemented at the B. F. Goodrich site, there would still be between 226,000 and 22,600 pounds of NAPL left in the subsurface.

4.2.2 Complex Hydrogeology and NAPL Distribution

The B.F. Goodrich site has a complex mixture of fine-grained and coarse-grained sediments. In some cases, they are separate bodies and, in other cases, they are interbedded. The NAPL is distributed between these hydrogeological units (HCs). This complexity of the NAPL distribution within these hydrogeologic units is a major factor in the TI of this site. This LOE is explained more fully in the paragraphs below.

4.2.2.1 NAPL Distribution

The main component in organic NAPL present at the Site is EDC. The delineation of NAPL was guided by the approach outlined in *Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites* (EPA, 2009b) and the NAPL Delineation Memorandum. LOEs (i.e., the various NAPL indicators) were used to determine the presence of NAPL at a given monitoring location. Eight different NAPL LOEs were evaluated for the Site including visual observation, DNAPL saturation, soil partitioning, dye testing, vapors, groundwater concentration, site use history and other (membrane interface probe, sheens). By the methodology laid out in the NAPL Delineation Memorandum, a numerical score was assigned to each of the 4,069 locations assessed; these scores were then input into a three-dimensional model. This allowed estimation of NAPL volumes by both depth and HC (sediment type). Dozens of maps show the various distributions available in the RI reports and even a three-dimensional printed model. Some summary statistics displayed by pie chart (see Figures 11 and 12) hopefully focus the reader on the main points.

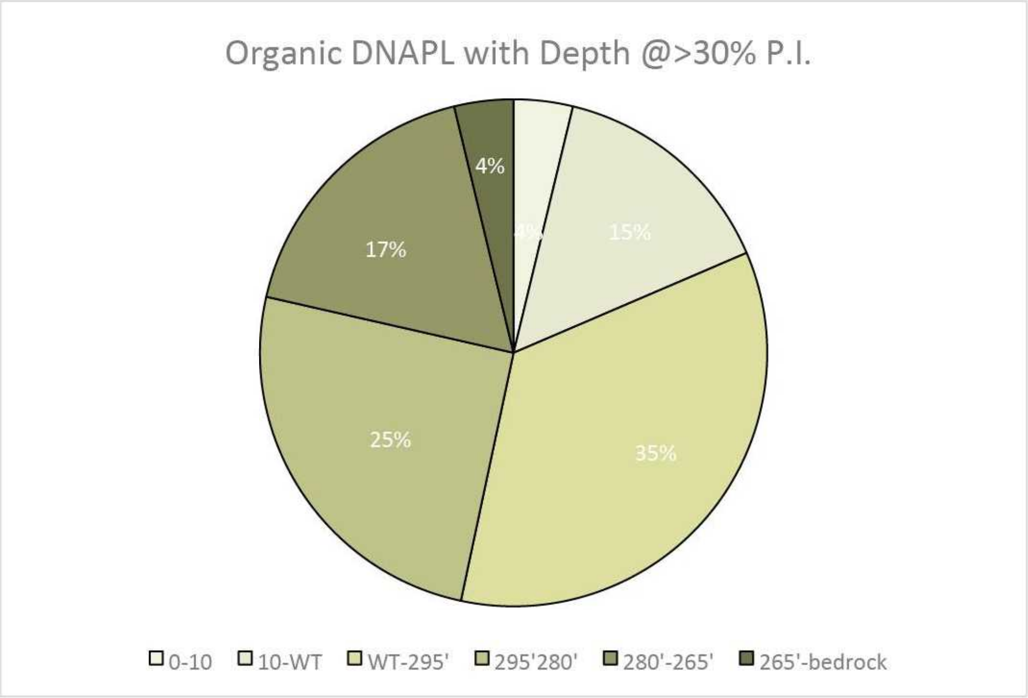


Figure 11. Organic DNAPL with Depth at >30% PI

The water table at the facility varies but as a general statement, is about 25 feet below the land surface and at an elevation of 325 feet amsl. That makes 60% of the NAPL between 325 feet and 280 feet amsl and 77% between 325 feet and 265 feet amsl. Normal pool for the river is 302 feet amsl.

As mentioned earlier, in the 2015 RI report, the subsurface sediments have been subdivided into 10 HCs based upon their grain size and the hydraulic characteristics, from gravels to clays. The distribution is approximately equal with 48.3% of the NAPL present in the coarser-grained gravels, sands and fill material and 51.7% of the NAPL present in the finer-grained materials of the silts, clays and interbeds (layers of clay and sand/silt). This distribution is presented in Table 3.

Table 3. DNAPL Distribution by Hydrocode

Hydrocode	Site-Wide Total Cubic Yards	Percentage of Total
fine grained sand	1,298,000	37.1%
coarse grained sand	450,000	12.9%
coarse grained fill	34,000	1.0%
gravel	28,000	0.8%
Coarse Subtotal	**1,810,000**	**51.7%**
clay and silt	170,000	4.9%
clay-rich heterolithics	190,000	5.4%

Hydrocode	Site-Wide Total Cubic Yards	Percentage of Total
fine grained fill	190,000	5.4%
interbeds	210,000	6.0%
elongate clay and silt	350,000	10.0%
elongate interbeds	580,000	16.6%
Fine Subtotal	**1,690,000**	**48.3%**
Total Cubic Yards	**3,500,000**	**100%**

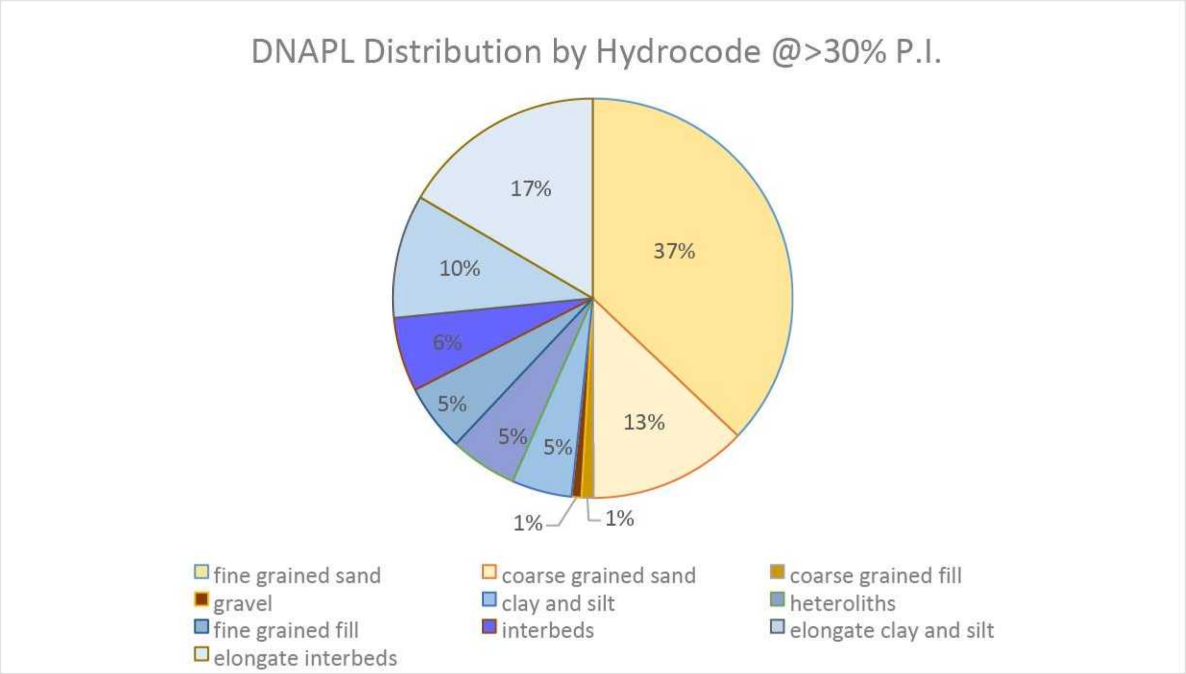


Figure 12. DNAPL Distribution by Hydrocode at >30% PI

4.2.2.2 NAPL Inaccessibility

In general, the greater the porosity of the sediments, the more NAPL can be stored or trapped in a given volume and the lower the effective porosity, the harder it is to remediate NAPL or groundwater contamination in a given sediment or rock unit. Porosity is the ratio of void space to the total volume of a rock or soil. An additional measurement is the percentage of effective porosity of a sample (i.e., that portion of the porosity available to contribute to fluid flow through the soil, rock or sediment). The 2015 RI report provided a table of these reference values tailored for the specific HCs at the Site. As seen in Table 4, the finer-grained sediments such as clays and silts have greater porosity than the coarser sediments such as sands and gravels. Conversely, the finer-grained sediments such as clays and silts have lower effective porosity than the coarser sediments and lower hydraulic conductivity along with other properties that make extraction challenging.

Table 4. Hydrocode Porosity and Effective Porosity

Hydrocode	Ratio of Porosity to Total Porosity	Total Porosity	Effective Porosity
Bedrock	0.13	0.2	0.0255
Clay/Silt	0.13	0.47	0.06
Clay-Rich Heterolithics	0.13	0.47	0.06
Elongate Clay/Silt on Floodplain	0.14	0.44	0.06
Elongate interbeds on Floodplain	0.41	0.49	0.2
Interbeds	0.47	0.43	0.2
Fill-Coarse	0.78	0.385	0.3
Coarse Sands	0.78	0.385	0.3
Fine Sands	0.80	0.41	0.33
Gravel	0.89	0.315	0.28
Fill Fine	1.02	0.315	0.32

(EPA. 2015)

Related to effective porosity is the concept in fluid mechanics of permeability; a measure of the ability of a porous material to allow fluids to pass through it. Generally, sediments with a lower effective porosity will also have a lower permeability. Less connected porosity (effective porosity) results in greater resistance to fluid flow (lower permeability).

A very important aspect of this lower effective porosity and lower permeability is the way in which these sediments respond to engineered remediation. During the initial stages of a NAPL release, gravity forces it downward through the aquifer aided by the weight of the continuous stream (head) of NAPL from above. This drives the NAPL from the zones of higher effective porosity, porosity and permeability into the zones of lower effective porosity, porosity and permeability – ‘tight’ zones. With the lower ability to transmit fluids in a remedial situation, there is a lower ability to pump or remove NAPL from these tight volumes and there is a lower ability to push treatment chemicals into these low permeability zones and more difficult to draw them out due to capillarity and other forces. It is these physical and hydraulic properties that make the engineering of effective groundwater remediation back to below MCLs technically impracticable. Specifically, for the former B.F. Goodrich site, half of the estimated 3.5 million yd^3 of NAPL contamination is bound in these zones of lower porosity, lower effective porosity and lower permeability. This is one of the factors that contributes to the TI of groundwater restoration at this site.

As an example of the complex interbedded lithologies with NAPL, Figure 13 is a photograph of a core taken from an interbed hydrocode. There are approximately 6-inch intervals of clay with thin, 1 to 0.5-inch sand stringers that contain DNAPL. In this photo, the sand has been scooped out and placed in a jar with OILRED to indicate the presence of DNAPL. In its undisturbed state, the DNAPL has saturated in the sand and has been sorbing into the clay as long as the NAPL has been in this interval.

DNAPL zones 1-inch-wide are difficult to identify and treat. The NAPL that has sorbed into the clays at depth is technically impracticable to treat and will back diffuse contamination for a very long time. This supports the TI of groundwater restoration due to complex hydrogeology and interbedded NAPL zones for half of the NAPL mass.

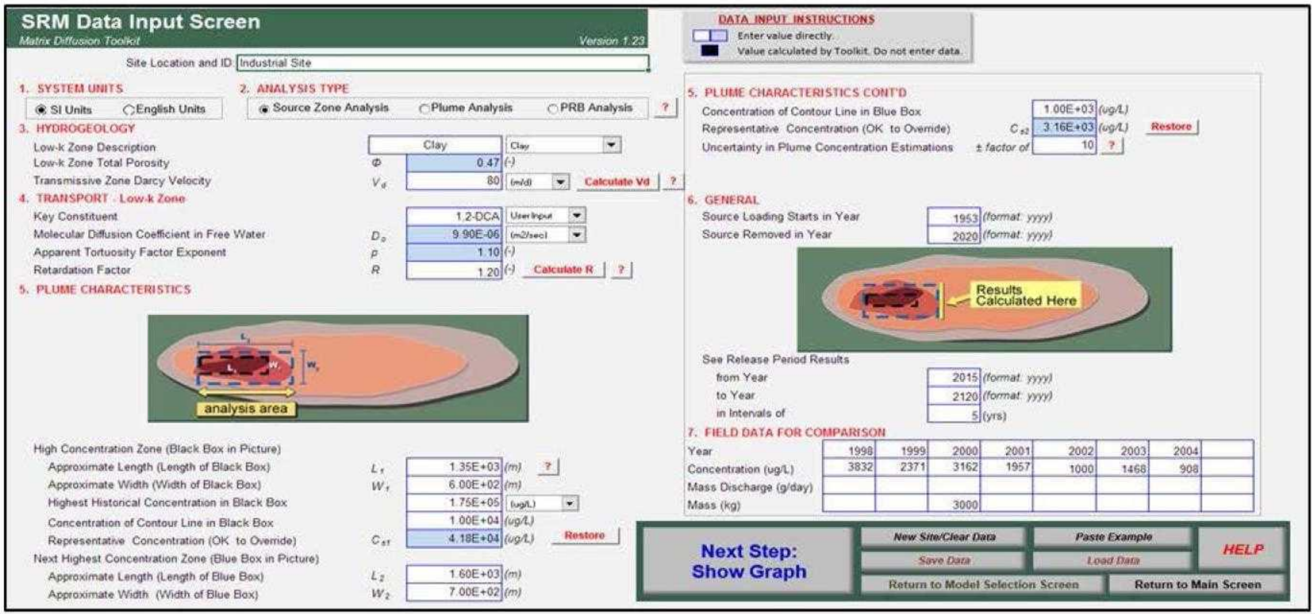
Figure 13. NAPL from a Sand Stringer within an Interbed Hydrocode

4.2.3 Modeled Restoration Timeframe

One of the most difficult parts of groundwater remediation from an engineering perspective is the back diffusion of contaminant mass that emanates from low permeability clays that have been in contact with DNAPL. As discussed earlier, approximately half of the DNAPL at this site is present in the finer-grained sediments of silt, clay and interbeds. For years the DNAPL has been in contact with these fine-grained beds allowing the DNAPL to be sorbed into these low permeability units. If a hypothetical treatment process could remove all the mass from the coarser-grained sediments, contamination would back diffuse at concentrations above the MCL for decades to come.

Strategic Environmental Research and Development Program/Environmental Security Technology Certification Program (SERDP/ESTCP) Research Project ER-201126 produced the Decision Support System for Matrix Diffusion Modeling, better known as the Matrix Diffusion Toolkit.[1] Within this Excel-based model there are two models, the simpler one being the Square Root model. This model can provide planning-level estimates of the mass discharge (in units of grams per day) caused by release from a low-k diffusion-dominated unit (typically silt or clay) into a high permeability advection-dominated unit (typically sand or gravel). Estimates of concentration and mass remaining in the high permeability unit, after the source is removed, are also provided.

The basic parameters about EDC contamination concentrations in the Pond 1 area were obtained from Section 5.5.1.3 of the 2015 RI report and RI Figure 5-28 of the RI report (see Figure 14). It was estimated that the releases started in 1953 when the plant became operational. For the purpose of this model it is assumed that maximum remediation was complete in the year 2020. Using the maximum EDC value of 6,200,000 µg/L (as suggested by the model's User Guide) results in a modeled groundwater concentration of 249 µg/L in the year 2120 (see Figure 15). Using the average concentration within the higher concentration portion of the plume of 175,000 µg/L results in a modeled groundwater concentration of 49 µg/L in the year 2120. These results are between 10 and 50 times greater than the MCL for EDC of 5 µg/L 100 years after hypothetical complete source removal from the coarser-grained sediments. This demonstrates the very long-term effect of back diffusion on the inability to achieve groundwater restoration. This supports the TI of groundwater restoration from an engineering perspective due to extended remediation duration beyond a reasonable timeframe.



Site Location and ID: Industrial Site

1. SYSTEM UNITS
● SI Units ○ English Units

2. ANALYSIS TYPE
● Source Zone Analysis ○ Plume Analysis ○ PRB Analysis

3. HYDROGEOLOGY
Low-k Zone Description: Clay (Clay)
Low-k Zone Total Porosity Φ: 0.47 (-)
Transmissive Zone Darcy Velocity V_d: 80 (m/d)

4. TRANSPORT - Low-k Zone
Key Constituent: 1.2-DCA (User Input)
Molecular Diffusion Coefficient in Free Water D_o: 9.90E-06 (m2/sec)
Apparent Tortuosity Factor Exponent p: 1.10 (-)
Retardation Factor R: 1.20 (-)

5. PLUME CHARACTERISTICS
High Concentration Zone (Black Box in Picture)
Approximate Length (Length of Black Box) L_1: 1.35E+03 (m)
Approximate Width (Width of Black Box) W_1: 6.00E+02 (m)
Highest Historical Concentration in Black Box: 1.75E+05 (ug/L)
Concentration of Contour Line in Black Box: 1.00E+04 (ug/L)
Representative Concentration (OK to Override) C_{s1}: 4.18E+04 (ug/L)
Next Highest Concentration Zone (Blue Box in Picture)
Approximate Length (Length of Blue Box) L_2: 1.60E+03 (m)
Approximate Width (Width of Blue Box) W_2: 7.00E+02 (m)

5. PLUME CHARACTERISTICS CONT'D
Concentration of Contour Line in Blue Box: 1.00E+03 (ug/L)
Representative Concentration (OK to Override) C_{s2}: 3.16E+03 (ug/L)
Uncertainty in Plume Concentration Estimations ± factor of: 10

6. GENERAL
Source Loading Starts in Year: 1953 (format: yyyy)
Source Removed in Year: 2020 (format: yyyy)
See Release Period Results
from Year: 2015 (format: yyyy)
to Year: 2120 (format: yyyy)
in Intervals of: 5 (yrs)

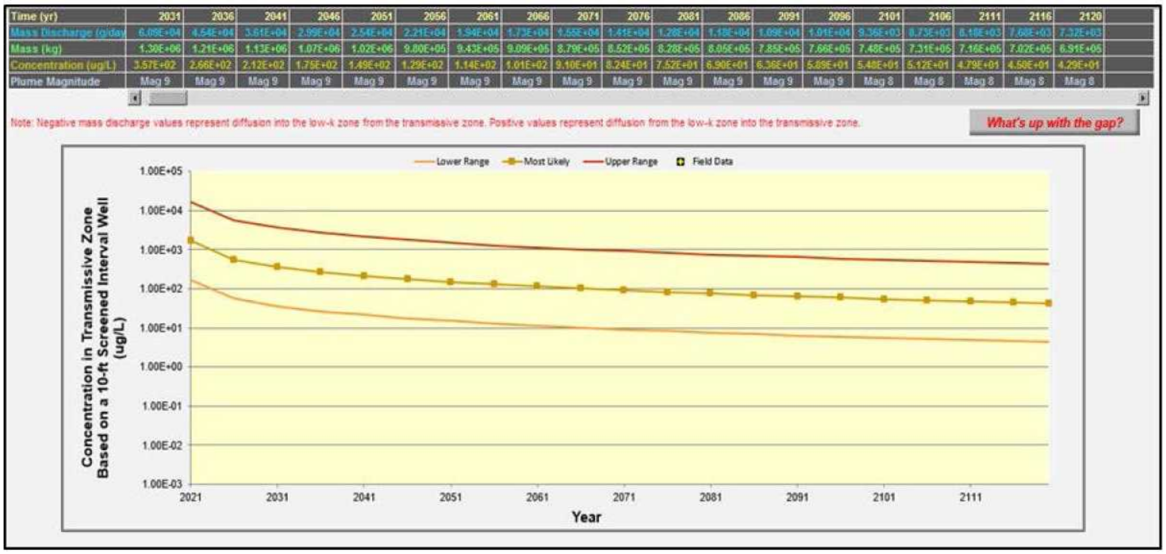
7. FIELD DATA FOR COMPARISON

Year	1998	1999	2000	2001	2002	2003	2004	
Concentration (ug/L)	3832	2371	3162	1957	1000	1468	908	
Mass Discharge (g/day)								
Mass (kg)			3000					

Figure 14. Data Screen for the Square Root Model, Matrix Diffusion Toolkit

---

[1] https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Groundwater/Persistent-Contamination/ER-201126



Time (yr)	2031	2036	2041	2046	2051	2056	2061	2066	2071	2076
Mass Discharge (g/day	6.09E+04	4.54E+04	3.61E+04	2.99E+04	2.54E+04	2.21E+04	1.94E+04	1.73E+04	1.55E+04	1.41E+04
Mass (kg)	1.30E+06	1.21E+06	1.13E+06	1.07E+06	1.02E+06	9.80E+05	9.43E+05	9.09E+05	8.79E+05	8.52E+05
Concentration (ug/L)	3.57E+02	2.66E+02	2.12E+02	1.75E+02	1.49E+02	1.29E+02	1.14E+02	1.01E+02	9.10E+01	8.24E+01
Plume Magnitude	Mag 9	Mag 9	Mag 9	Mag 9	Mag 9	Mag 9	Mag 9	Mag 9	Mag 9	Mag 9

Time (yr)	2081	2086	2091	2096	2101	2106	2111	2116	2120
Mass Discharge (g/day	1.28E+04	1.18E+04	1.09E+04	1.01E+04	9.36E+03	8.73E+03	8.18E+03	7.68E+03	7.32E+03
Mass (kg)	8.28E+05	8.05E+05	7.85E+05	7.66E+05	7.48E+05	7.31E+05	7.16E+05	7.02E+05	6.91E+05
Concentration (ug/L)	7.52E+01	6.90E+01	6.36E+01	5.89E+01	5.48E+01	5.12E+01	4.79E+01	4.50E+01	4.29E+01
Plume Magnitude	Mag 9	Mag 9	Mag 9	Mag 9	Mag 8	Mag 8	Mag 8	Mag 8	Mag 8

Note: Negative mass discharge values represent diffusion into the low-k zone from the transmissive zone. Positive values represent diffusion from the low-k zone into the transmissive zone.

Figure 15. Output Screen of the Square Root Model, Matrix Diffusion Toolkit

Additional LOEs for a TI waiver at the Former B.F. Goodrich site include:

1. Pilot- or full-scale remedial demonstrations of impracticability, such as 30 years of groundwater pump and treat which is demonstrating diminishing returns, as well as several decades of multiphase extraction from shallow interbeds which is also showing diminishing returns with significant DNAPL mass remaining. See Section 4.2.2.
2. Extensive infrastructure, above and below grade, associated with active chemical manufacturing operations. These features lead to significant engineering challenges associated with technology implementation. Additionally, some of these sewer lines have been sources of releases almost since their construction. Engineering steps have been taken to eliminate the releases but some of the lines are inaccessible and they are underneath chemical plant components still operating since the earliest days (see Section 2.3 and FS Figures 1-7 and 1-8 in Appendix B). Additionally, working within an operating chemical manufacturing plant could have significant safety issues for explosivity and flammability.
3. Deep contamination, with DNAPL source zones extending from just below the ground surface in some areas, to depths of close to 80 feet bgs in other areas. Deeper DNAPL source zones are more challenging and costly to treat (see Section 4.3, Pages 42 & 43).
4. Chemical properties, such as low solubility constituents in multicomponent DNAPLs and high sorption coefficients that reduce chemical mobility in groundwater (see Section 3.4, Starting on Page 33).

4.3 Technical Impracticability Zone

4.3.1 Horizontal Extent of the TI Zone

The spatial area for the TI decision is shown in Figure 16 as the area highlighted in gold. A major element of the proposed remedial decision is a containment structure encompassing the entire manufacturing site, as seen on the following page. This wall will be variously constructed of sheet piling and bentonite slurry and will extend from the surface to the bedrock surface. The purpose of the wall is primarily two-fold. It will be a containment system for the majority of the soil and groundwater contamination at the site. Additionally, it will stop contaminated groundwater from leaving the site and going into the Tennessee River and stop clean groundwater from coming onto the site and becoming contaminated. The TI zone does not cover the entire area within the wall. The TI zone is bound by the wall on the east and the west and on the north by the river shore at its normal pool elevation of 302 feet. There are areas to the south within the wall where the groundwater does not exceed the MCL for any of the 30 contaminants listed in Table 1. In addition, groundwater in the areas beyond the wall will be expected to meet MCLs.

4.3.2 Vertical Extent of the TI Zone

The geology of this area is an interval of unconsolidated sediments (sands, silts, clays) of relative recent age overlying a bedrock of the Warsaw Formation (where present) and the underlying Fort Payne Formation, both of which are limestones. The formations were deposited approximately 350 million years ago during the Mississippian Period.

Bedrock was encountered during drilling at 174 borehole locations during the RI. During RI field work, the top of bedrock was verified based on the occurrence of significant limestone as indicated by its reaction with hydrochloric acid. Based on available data, including that generated through the RI, a topographic map was developed demonstrating the top of bedrock at the site (see RI Figure 4-1). Consistent with Amos and Finch (1968), RI Figure 4-1 shows the upper surface of the bedrock at an elevation of approximately 230 feet amsl at the southern portion of the Site and an elevation of approximately 280 feet amsl in the northern portion of the Site, near the Tennessee River. The bedrock surface elevation is variable, however, consisting of local bedrock highs and lows. Locally, the bedrock surface was found to be as deep as 185.9 feet amsl (RI boring location A2SB-331) and as high as 281.7 feet amsl (RI boring BW-1927G) (EPA, 2015, Figure 4-1). RI borings that penetrated bedrock revealed that the upper portion of the bedrock at the Site can be weathered, fractured, and porous (see RI Figure 4-2).

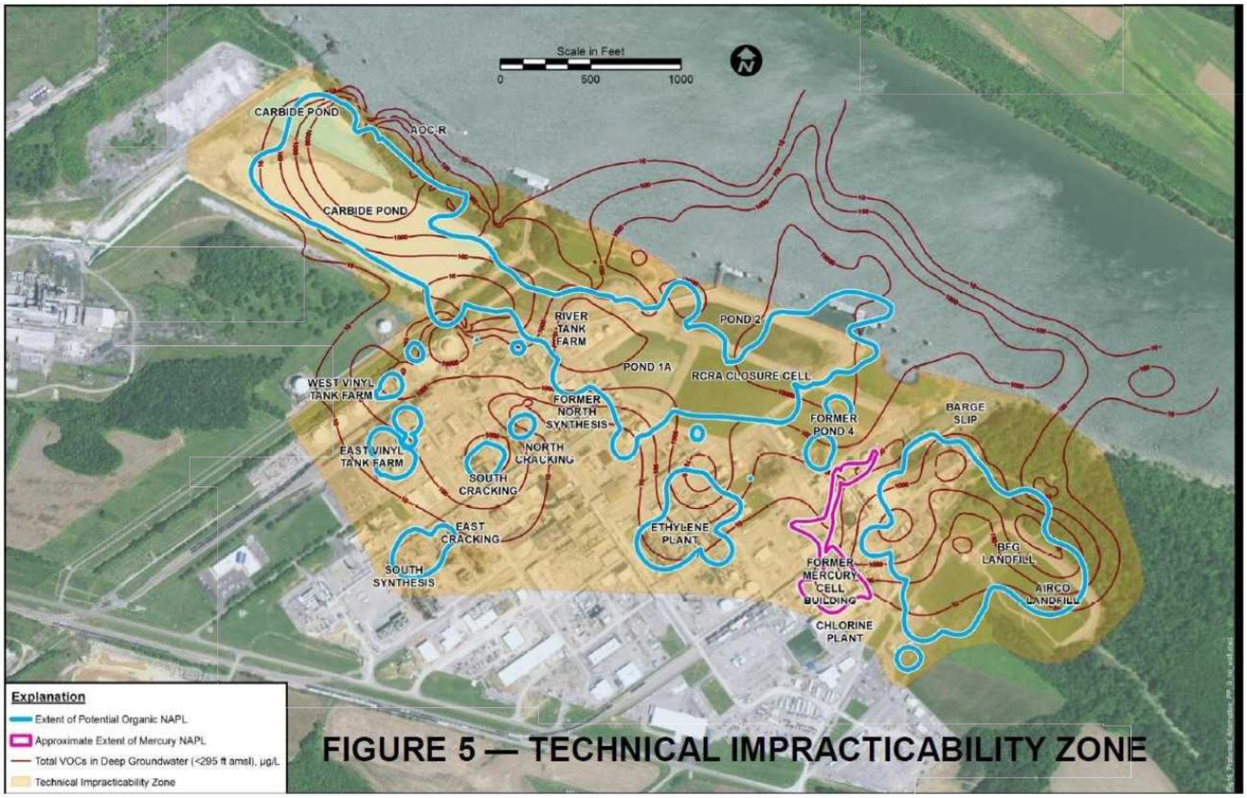


Figure 16. Lateral Extent of the TI Zone (Figure 5 from the Proposed Plan)

A bedrock investigation was performed in 2014 to determine the site-specific hydraulic conductivity of the upper bedrock across the site and investigate potential fault traces that may traverse the site (Respondents, 2014). Geophysical testing and lithologic observations conducted during the investigation indicate that the bedrock beneath the site is competent with a low density of fractures, many of which are filled with calcite. Previous investigations identified iron-stained horizontal and vertical fractures in the upper portion of the bedrock, suggesting groundwater movement. At depths greater than 194.4 feet amsl, the observed fractures were sealed with calcite, indicating that the bedrock acts as a lower confining unit below this point. No evidence of faulting was observed during the investigation.

During this 2014 bedrock investigation the detailed DNAPL screening procedures were employed and no signs of chemical impacts or potential DNAPL were observed during the bedrock coring. During the hydraulic testing of the bedrock wells, all wells had an upward hydraulic gradient.

For the definition of the vertical limit of the TI zone, it is recommended that the lower limit of the TI zone be the top of the limestone as shown in Figure 17 (RI Figure 4-1).

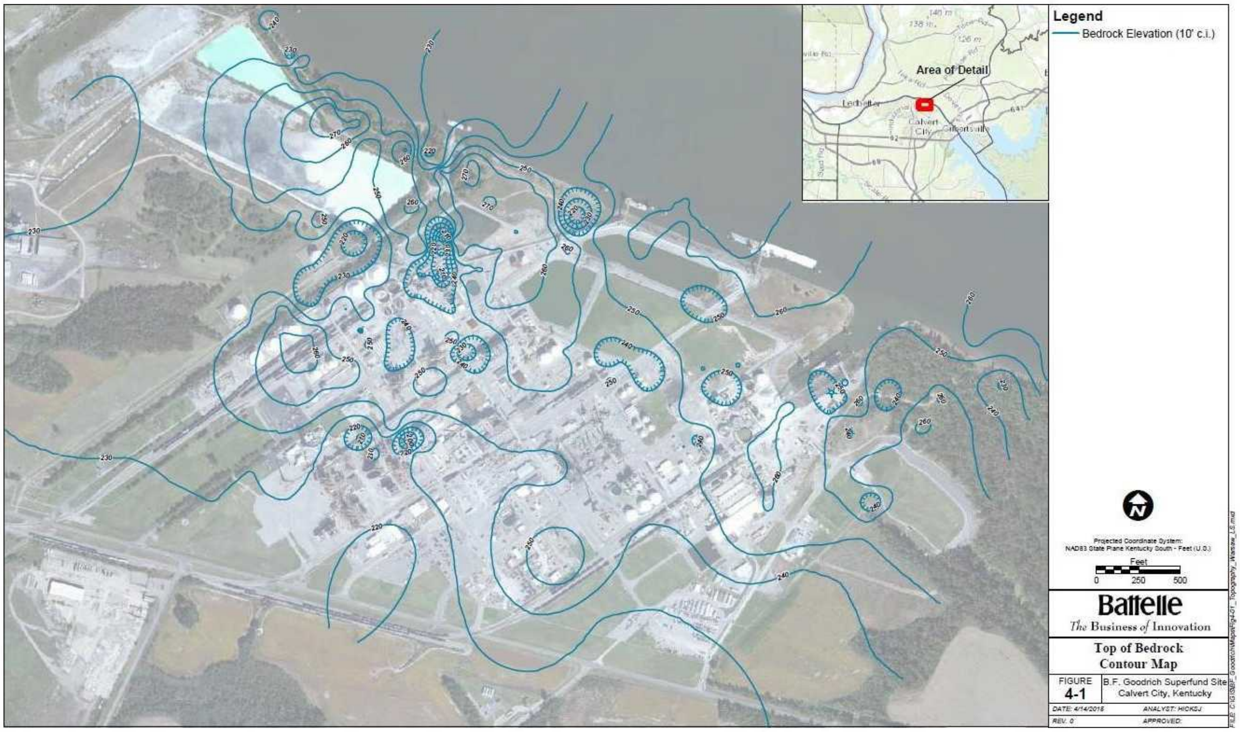


Figure 17. Top of Bedrock Contour Map (From RI; Figure 4-1)

5.0 ALTERNATIVE REMEDIAL STRATEGY

The remedial action objectives (RAOs) for the B.F. Goodrich site are as follows:

Soils

- Prevent exposure of non-Occupational Safety and Health Administration (OSHA)-regulated workers to contaminated soils at levels that could pose an excess cancer risk above 10^{-6} to 10^{-4} or a hazard quotient (HQ) > 1 for non-carcinogens through ingestion, inhalation or direct contact.

Groundwater/Seeps

- Prevent discharge of contaminated groundwater to surface water that could: 1) pose a risk to human receptors based on compliance with chronic ambient water quality criteria (AWQC) for the protection of human health from ingestion of water column organisms; 2) pose a risk to ecological receptors based on narcosis-based benchmarks, or 3) degrade water quality based on its designated use in the Kentucky Administrative Code.
- Prevent future migration of contaminated groundwater (above MCLs or resulting in an excess cancer risk of greater than 10^{-6} to 10^{-4} or a HQ >1 for non-carcinogens or to natural background) beyond the Site boundary.
- Prevent human exposure to contaminated groundwater (above MCLs or resulting in an excess cancer risk of greater than 10^{-6} to 10^{-4} or a HQ >1 for non-carcinogens or natural background) through ingestion/inhalation or direct contact.
- Restore groundwater[1] that is considered by the State of Kentucky to be an available drinking water resource (e.g., groundwater that is not physically isolated in a self-contained inoperable aquifer sub-unit) to its beneficial use (i.e., reduce groundwater contaminant levels to MCLs or an excess cancer risk of 10^{-6} to 10^{-4} or a HQ of 1 for non-carcinogens or to natural background).

DNAPL and Mercury

- Recover pooled or mobile DNAPL and mercury, to the extent practicable.
- Treat DNAPL where practicable and necessary to mitigate unacceptable risks.
- Contain and prevent DNAPL and mercury migration.
- Prevent human and ecological receptor exposure to DNAPL to protective levels.

Other Media

- Prevent exposure of ecological receptors to contaminants in sediment pore water or the water column at levels in excess of narcosis-based criteria for organics or chronic AWQC for mercury.

---

[1] Groundwater includes both water occurring beneath the lands surface and beneath water bodies, including the adjacent Tennessee River.

- Prevent exposure to industrial/commercial workers to contaminants in indoor air that originate from subsurface contamination at levels that could pose an excess cancer risk above 10^{-6} to 10^{-4} or a HQ >1 for non-carcinogens.
- Prevent human exposure to contaminants in soil, sediment, sediment porewater, and air that could cause an increased risk from ingestion, direct contact.

A key component for the TI waiver alternate strategy is the removal of pooled or mobile DNAPL (organic and mercury) on the facility property and excavation or removal of the DNAPL outside the facility property under the river. The source of contamination would be removed to the extent practicable given the limitations of the on-Site structures.

The alternatives were developed to address the project-specific RAO by creating assemblages of technologies and process options deemed potentially suitable for the site. The following 10 remedial alternatives for source control within the on-shore groundwater for the main BF Goodrich facility were part of the initial evaluation of remedial alternatives. This list was later refined to three alternatives which underwent a detailed evaluation resulting in the proposed remedy, SC3a.

1. SC1: No action
2. SC2: Hydraulic containment
3. SC3: Combined hydraulic and physical containment
    a. SC3a: Containment of Contaminated Soil, DNAPL, and Groundwater with focused organic and mercury NAPL recovery
    b. SC3b: Barrier wing-wall along entire Tennessee River frontage with limited pumping for mass removal and water management
    c. SC3c: Partial barrier walls along Tennessee River with limited pumping for mass removal and water management
4. SC4: DNAPL source zone treatment with hydraulic containment
5. SC5: DNAPL source zone treatment with combined hydraulic and physical containment
    a. SC5a: DNAPL source zone treatment with barrier wall surrounding entire site with limited pumping for mass removal and water management
    b. SC5b: DNAPL source zone treatment with barrier wing-wall along entire Tennessee River frontage with limited pumping for mass removal and water management
    c. SC5c: DNAPL source zone treatment with partial barrier walls along Tennessee River with limited pumping for mass removal and water management
6. SC6: Complete treatment of potential and confirmed DNAPL zones and targeted groundwater treatment

The preferred remedy includes removal of pooled and mobile organic and mercury DNAPL on the facility property to the extent practicable and extraction of the NAPL underneath the river. The NAPL is accessible within the river and there is less certainty that the NAPL can be contained. The groundwater under the river would achieve MCLs through a combination of source control, monitored natural attenuation and groundwater extraction and treatment, if required. The TI zone is limited to contaminated groundwater on the facility property that currently exceeds MCLs within the planned walled off area. A hydraulic gradient is expected to be maintained to prevent the groundwater plume from expanding and to draw the plume away from the river.

The BF Goodrich three-dimensional numerical groundwater flow model (McDonald Morrissey Associates, 2013) was used to assist in the evaluation of remedial alternatives that include a containment component (SC2, SC3, SC4, and SC5). Prior to use, the groundwater flow model was updated as follows to include new lithologic information and incorporate selected common elements as identified in Section 5.1 of the RI report (EPA, 2015). The on-shore bedrock surface was updated with the results of the 2016 bedrock investigation.

Model simulations were performed to evaluate several alternative-specific remedy components, including wall placement and the number, location, and pumping rate of groundwater extraction wells, with the goal of eliminating contaminated groundwater discharge to the river. Groundwater flow conditions associated with implementation of the complete barrier wall remedial alternative were evaluated using forward and reverse particle tracking in multiple layers of the groundwater flow model.

5.1 The Preferred Remedy

The preferred remedy, as presented in the Proposed Plan of November 30, 2017, the Proposed Plan Amendment of June 2018 and the Record of Decision (estimated date September 2018), is intended to address the entire site and be the final action for the onshore and river groundwater portions of the BFG site. The river NAPL portions of the site are being addressed under an Interim Decision. This remedy will augment the 1988 ROD that addressed a burn pit and landfill by addressing contamination omitted in the 1988 ROD and by addressing new contamination documented beyond the scope of the 1988 ROD. The Preferred Remedy for mitigating the risk to human health, welfare and the environment posed by the BFG site is a combination of Alternatives SC3a, RN2, and RG2:

- Alternative Source Control (SC)3a: Containment of Contaminated Soil, NAPL, and Groundwater with focused organic and mercury DNAPL recovery (FS Figure 5-6)
- Interim recovery of the DNAPL to the extent practicable from the source zone beneath the river (RN2)
- Alternative River Groundwater (RG) 3: Monitored Natural Attenuation of Groundwater with groundwater extraction

The ROD describes these remedy components, the common elements of all alternatives evaluated and estimated costs in much greater detail. Please consult that document for further information.

6.0 SUMMARY

In summary, restoration of the groundwater to drinking water standards (MCLs) is required by the Safe Drinking Water Act and the Clean Water Act, where practicable. Both laws are ARARs. Thirty compounds exceed their respective MCL in the groundwater under the former B.F. Goodrich plant. Using provisions provided by the National Contingency Plan, a waiver is applied for due to the technical impracticability of meeting the drinking water standards.

The site has a long and complex manufacturing history which began in 1953. Chemical releases by accident or by practice are part of the 60+ year history. Previous remedial/removal actions include wastewater pond closure, installation of the PCAP system, and remedial actions at the BF Goodrich Landfill and Burn Pit Area.

Analysis of the extensive and comprehensive data base of geologic, hydrogeologic and chemical information yields the fact that approximately half of the 3.5 million yd^3 of DNAPL-impacted soils at the site are comprised of fine-grained sedimentary units such as silts, clays and interbed formations (approximately 13,000,000 pounds). The engineering difficulty of groundwater restoration with these **very large volumes of DNAPL** in these **complex interbedded fine-grained units** are **two of the major factors** in demonstrating the need for a TI waiver.

A simple mass discharge/back diffusion model was run using the basic parameters of the site. The results indicated that even after 100% mass removal from the coarser-grained sediments, groundwater concentrations would still be 10 to 25 times the MCL after 100 years. Other calculations extend the restoration timeframe into the hundreds of years. The **extended duration for groundwater restoration is beyond a reasonable timeframe**. This is the **third major factor** for demonstrating the need for a TI waiver. Four additional LOEs for the TI waiver were also provided.

It is the conclusion of this document that, from an engineering perspective, it has been demonstrated that restoration of the groundwater in a reasonable timeframe is technically impracticable. It is the recommendation of this document that a TI waiver for the restoration of the groundwater for the 30 specified compounds be granted for specified volume, known as the TI zone, in conjunction with the signing of the ROD for the Former B.F. Goodrich site in Calvert City, Kentucky.

7.0 REFERENCES

Amos, D.H., and W.I. Finch, 1968. Geology of the Calvert City Quadrangle, Livingston and Marshall Counties, Kentucky. U.S. Geological Survey Geologic Quadrangle Map GQ-731, scale 1:24.000.

Aronson, D. and Howard, P.H., 1997. Anaerobic Biodegradation of Organic Chemicals in Groundwater: A Summary of Field and Laboratory Studies, Environmental Science Center Syracuse Research Corporation.

ATSDR, December 1989. Toxicological Profile for 1,1,2-Trichloroethane, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR, May 1994. Toxicological Profile for 1,1-Dichloroethene, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR, September 2001. Toxicological Profile for 1,2-Dichloroethane, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR, July 2006. Toxicological Profile for Vinyl Chloride, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR, August 2007. Toxicological Profile for Benzene, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

Dames & Moore, 1997. Groundwater and Surface Water Monitoring Program. BF Goodrich/Airco Superfund Site. Calvert City, Kentucky. June 4, 1997.

EPA, 1993. Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration, OSWER Dir 9234.2-25, September 1993.

EPA, 2000. Implementation Issues: *Mercury Transport and Fate Combustion Risk Assessments in Region 6.* Cynthia J Kalari, presented at International Incineration Conference. May.

EPA, 2009a. Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites. United States Environmental Protection Agency, EPA/600/R-09/19.

EPA, 2010b. Technical Factsheet on: 1,1,2-Trichloroethane. National Primary Drinking Water Regulation. ttp://water.epa.gov/drink/contaminants/basicinformation/historical/upload/Archived-Technical-FactSheet-on-1-1-2-Trichloroethane.pdf.

EPA, 2015. FINAL Remedial Investigation Report for the BF Goodrich Superfund Site, Calvert City, Marshall County, Kentucky, Contract No. EP-C-11-038, Task Order No. 26, Battelle Institute, August 2015.

Goodrich. 1986. RCRA Interim Status Closure Plan. KYD 006-370-167. B.F. Goodrich Company. February 28.

ITRC, 2011. Integrated DNAPL Site Strategy, The Interstate Technology & Regulatory Council, Integrated DNAPL Site Strategy Team, November 2011.

Janssen, D.B., A. Scheper, L. Dijkhuizen, and B. Witholt. 1985. Degradation of halogenated aliphatic compounds by Xanthobacter autotrophicus GJ10. Applied and Environmental Microbiology 49, no. 3:673-677.

KDWM, 2003. Hazardous Waste Management Permit. Goodrich Corporation. 2468 Industrial Parkway Calvert City, Kentucky. Kentucky Natural Resources and Environmental Protection Cabinet Department for Environmental Protection Division of Waste Management. Post Closure Permit. Permit No. KYD 006370 167. Effective Date October 30, 2003.

Lee, M., Sahayek, L., Sleep, B., Vandell, T., 1999. Investigation and Remediation of a 1,2-Dichloroethane Spill Part II: Documentation of Natural Attenuation. Summer 1999 Groundwater Monitoring and Remediation (GWMR).

McDonald Morrissey Associates, 2013. Steady-State Groundwater Flow Model Report March 2013.

Newell, 2006. Expert Opinion of Charlies J. Newell, Ph.D., P.E. Concerning Origin and Fate of Soil and Groundwater Contamination at the Westlake Vinyls, Inc. Facility, Calvert City, Kentucky. November 21, 2006.

Newell, 2011. Overview of Matrix Diffusion Processes and Its Effects on Managing Chlorinated Solvent Sites by Charles Newell, Ph.D., P.E., GSI Environmental Inc., Presentation to U.S. EPA, 5 May 2011.

Respondents, 2014. Bedrock Investigation Report Feasibility Study – Appendix A, B.F. Goodrich Superfund Site, Calvert City, Kentucky, Westlake Vinyls, Inc., Goodrich Corporation, PolyOne Corporation, October 10, 2014.

Suarez, M. P., and H. S. Rifai, 1999. Biodegradation Rates for Fuel Hydrocarbons and Chlorinated Solvents in Groundwater. Bioremediation Journal, 3(4):337-362.

USGS, 1993. Calvert City, Kentucky Quadrangle Contour Map 37088-A3-TF-024. United States.

PolyOne, 2013. Remedial Investigation Report, BF Goodrich Site, Calvert City, KY, July 12, 2013.

Westlake Chemical Company, 2012a. B. F. Goodrich Superfund Site, Calvert City, Kentucky, April 19, 2012.

Westlake Vinyls, Inc., 2012b. Historical Releases Summary, (in Excel), September 20, 2012.

Wild, A.P., W. Winhelbauer, and T. Leisigner. 1995. Anaerobic dechlorination of trichloroethene, tetrachloroethene, and 1,2-dichloroethane by an acetogenic mixed culture in a fixed bed reactor. Biodegradation 6, 309-318.

Appendix A The following figures and tables from the 2015 Remedial Investigation report are included as a reference.

Figure 1-1	Site Location
Figure 1-2	Site Facilities and Areas
Figure 1-4	Current Ownership of Industrial Properties
Figure 1-5	Site Plan with RCRA SWMUs and AOCs
Figure 1-6	Pond Locations (1957-1964)
Figure 1-7	Pond Locations (1971-2000)
Figure 1-8	Known Active and Abandoned Underground Piping, Westlake, Lubrizol, Cymtech, and PolyOne Properties
Figure 1-9	EDC/VCM Plant Stormwater and Contaminated Water System
Figure 1-10	Location of Current and Former Tanks
Figure 1-14	Regional Topographic Map
Figure 1-15	Approximate Floodplain Terrace Contact
Figure 1-17	Regional Geology Map
Figure 2-1	PCAP Extraction Wells
Figure 2-2	Average Annual Total PCAP Pumping Rate and Cumulative Volume
Figure 3-4	RI Soil Boring Locations
Figure 3-5	RI Monitoring Wells, Piezometers, and Temporary NAPL Extraction Well Locations
Figure 3-6	Groundwater Sampling Locations
Figure 4-1	Top of Bedrock Contour Map
Figure 4-2	Example of Bedrock (B) Hydrocode
Figure 4-3	Lithologic Data Locations
Figure 4-5	Extent of Clay-Rich Heterolithic (CRH) Hydrocode
Figure 4-7	Extent of Sand and Gravel (FS, CS, and G) Hydrocodes
Figure 4-11	Extent of Interbeds (I) Hydrocode
Figure 4-13	Extent of Clay/Silt (C) Hydrocode
Figure 4-16	Extent of Fill (FF and FC) Codes
Figure 4-29	Groundwater Elevation Contours, Upper Aquifer (November 2011)
Figure 4-33	Vertical Hydraulic Head Differentials (March 2011)
Figure 4-34	Vertical Hydraulic Head Differentials (August 2011)
Figure 4-35	Vertical Head Differentials (November 2011)
Figure 5-7	EDC in Soil (10 ft bgs to WT)
Figure 5-24	1,1,2-TCA in Groundwater (Upper Aquifer)
Figure 5-25	1,1,2-TCA in Groundwater (Lower Aquifer)
Figure 5-26	1,1-DCE in Groundwater (Upper Aquifer)
Figure 5-27	1,1-DCE in Groundwater (Lower Aquifer)
Figure 5-28	EDC in Groundwater (Upper Aquifer)
Figure 5-29	EDC in Groundwater (Lower Aquifer)
Figure 5-30	Benzene in Groundwater (Upper Aquifer)
Figure 5-31	Benzene in Groundwater (Lower Aquifer)
Figure 5-32	Carbon Tetrachloride in Groundwater (Upper Aquifer)
Figure 5-33	Carbon Tetrachloride in Groundwater (Lower Aquifer)
Figure 5-34	Chlorobenzene in Groundwater (Upper Aquifer)
Figure 5-35	Chlorobenzene in Groundwater (Lower Aquifer)
Figure 5-36	Chloroform in Groundwater (Upper Aquifer)
Figure 5-37	Chloroform in Groundwater (Lower Aquifer)
Figure 5-38	PCE in Groundwater (Upper Aquifer)
Figure 5-39	PCE in Groundwater (Lower Aquifer)

Figure 5-40	TCE in Groundwater (Upper Aquifer)
Figure 5-41	TCE in Groundwater (Lower Aquifer)
Figure 5-42	Vinyl Chloride in Groundwater (Upper Aquifer)
Figure 5-43	Vinyl Chloride in Groundwater (Lower Aquifer)
Figure 5-44	Arsenic in Groundwater (Upper Aquifer)
Figure 5-45	Arsenic in Groundwater (Lower Aquifer)
Figure 5-46	Mercury in Groundwater (Upper Aquifer)
Figure 5-47	Mercury in Groundwater (Lower Aquifer)
Figure 5-64	NAPL Delineation, Horizon 1 (0 -10 ft bgs)
Figure 5-65	NAPL Delineation, Horizon 2 (10 ft bgs - WT)
Figure 5-66	NAPL Delineation, Horizon 3 (WT to 295 ft amsl)
Figure 5-67	NAPL Delineation, Horizon 4 (295 to 280 ft amsl)
Figure 5-68	NAPL Delineation, Horizon 5 (280 to 265 ft amsl)
Figure 5-69	NAPL Delineation, Horizon 6 (265 ft amsl to bedrock)
Figure 5-70	NAPL Delineation Horizons 1 to 6
Figure 5-71	Geologic Cross Section A-A′ Showing NAPL Distribution
Figure 5-72	Geologic Cross Section B-B′ Showing NAPL Distribution
Figure 5-73	Geologic Cross Section C-C′ Showing NAPL Distribution
Figure 5-74	Geologic Cross Section D-D′ Showing NAPL Distribution
Figure 5-75	Geologic Cross Section E-E′ Showing NAPL Distribution
Figure 5-76	Geologic Cross Section F-F′ Showing NAPL Distribution
Figure 5-78	3-D NAPL Delineation Showing Upper Bound Confirmed (PI Value ≥ 50)
Figure 5-79	3-D NAPL Delineation Showing Lower Bound Confirmed (PI Value ≥ 70)
Figure 5-80	3-D NAPL Delineation Showing Potential NAPL (PI Value ≥ 30)
Figure 8-1	Likely Organic NAPL Sources
Figure 8-2	Likely Mercury NAPL Sources

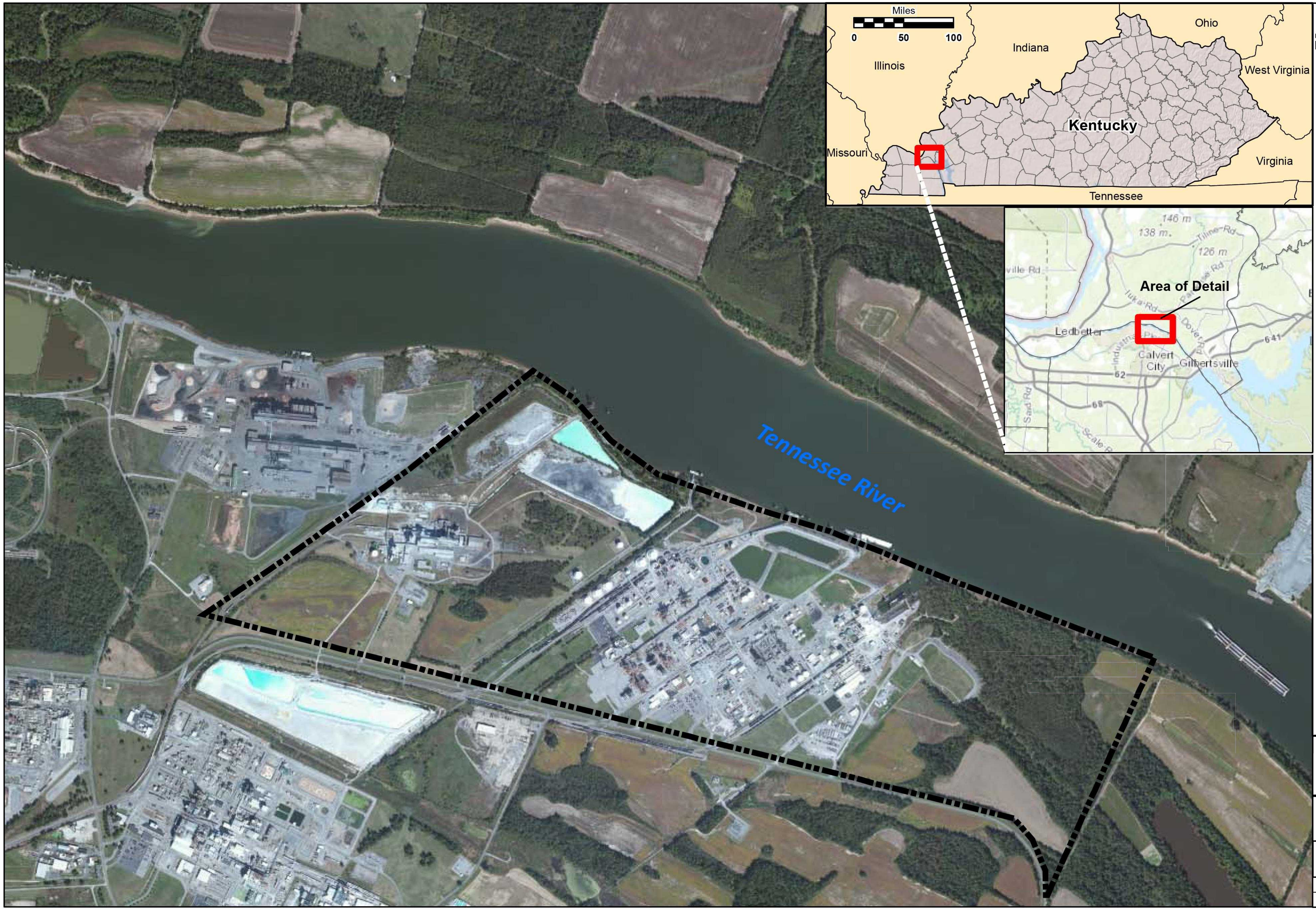
Table 1-1	SWMUs and AOCs
Table 5-2	Summary of Groundwater Sample Analytical Results
Table 5-11	Horizon-Specific NAPL-Impacted Soil Volume Estimates (yd^3)

Appendix B	The following figures from the 2017 Feasibility Study are included as a reference.
Figure 5-6	Remedial Alternative SC3a: Complete Barrier Wall
Figure 5-7	Remedial Alternative SC3A: Particle Tracking Results in Model 17

Appendix A

Figures and Tables from the 2015 Remedial Investigation

Former B. F. Goodrich Site



Legend

▬ ▬ Site Location

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Battelle
The Business of Innovation

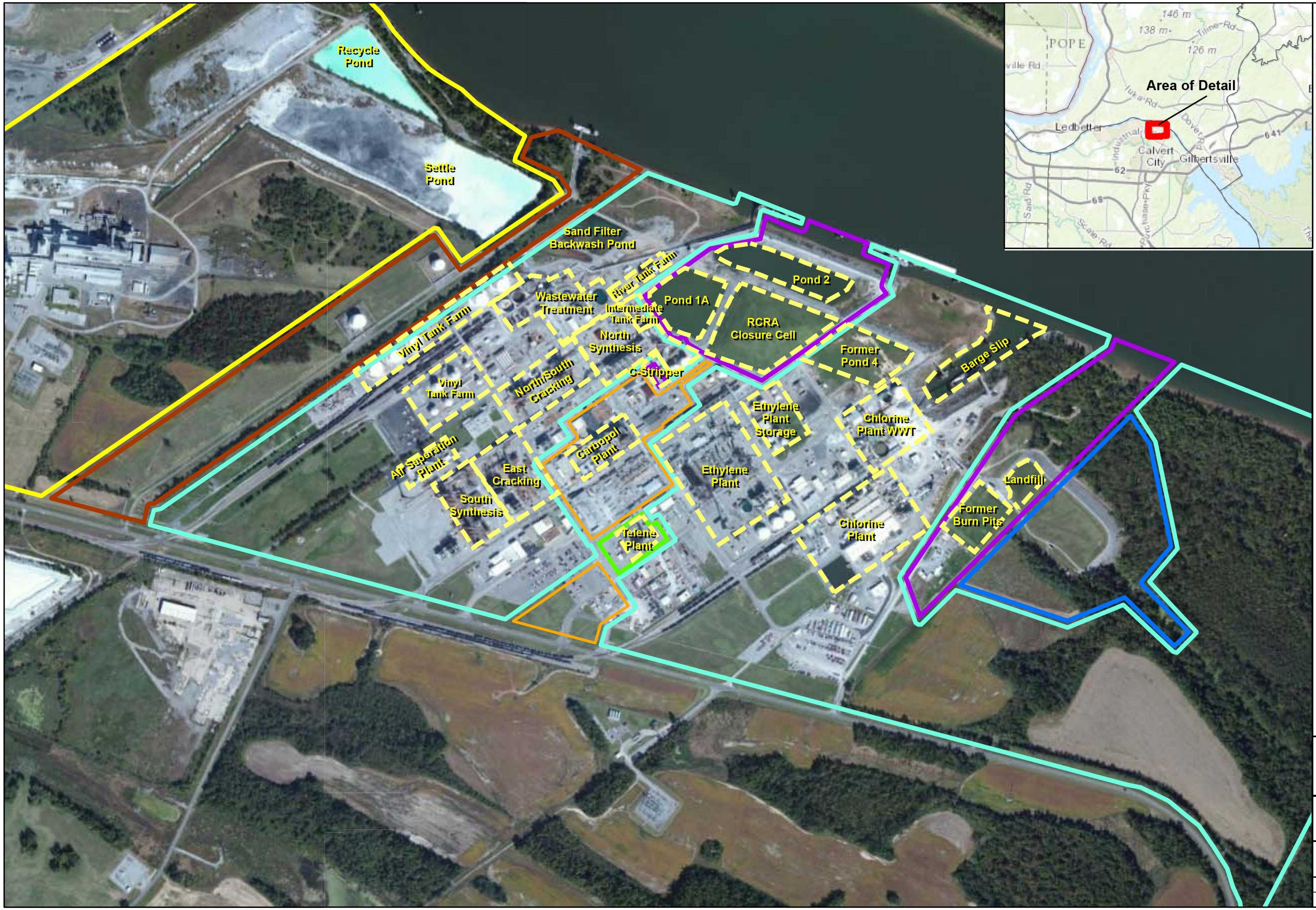
Site Location

FIGURE
1-1

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/10/2015 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\Fig1-01_Sitemap_Battelle.mxd



Legend

Site Features
Polyone
Air Products
Carbide
Cymetech
Linde
Lubrizol
Westlake

Sources:
Westlake Vinyls, Draft RI report (July 2013)
PolyOne, Draft RI report (June 2013)

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

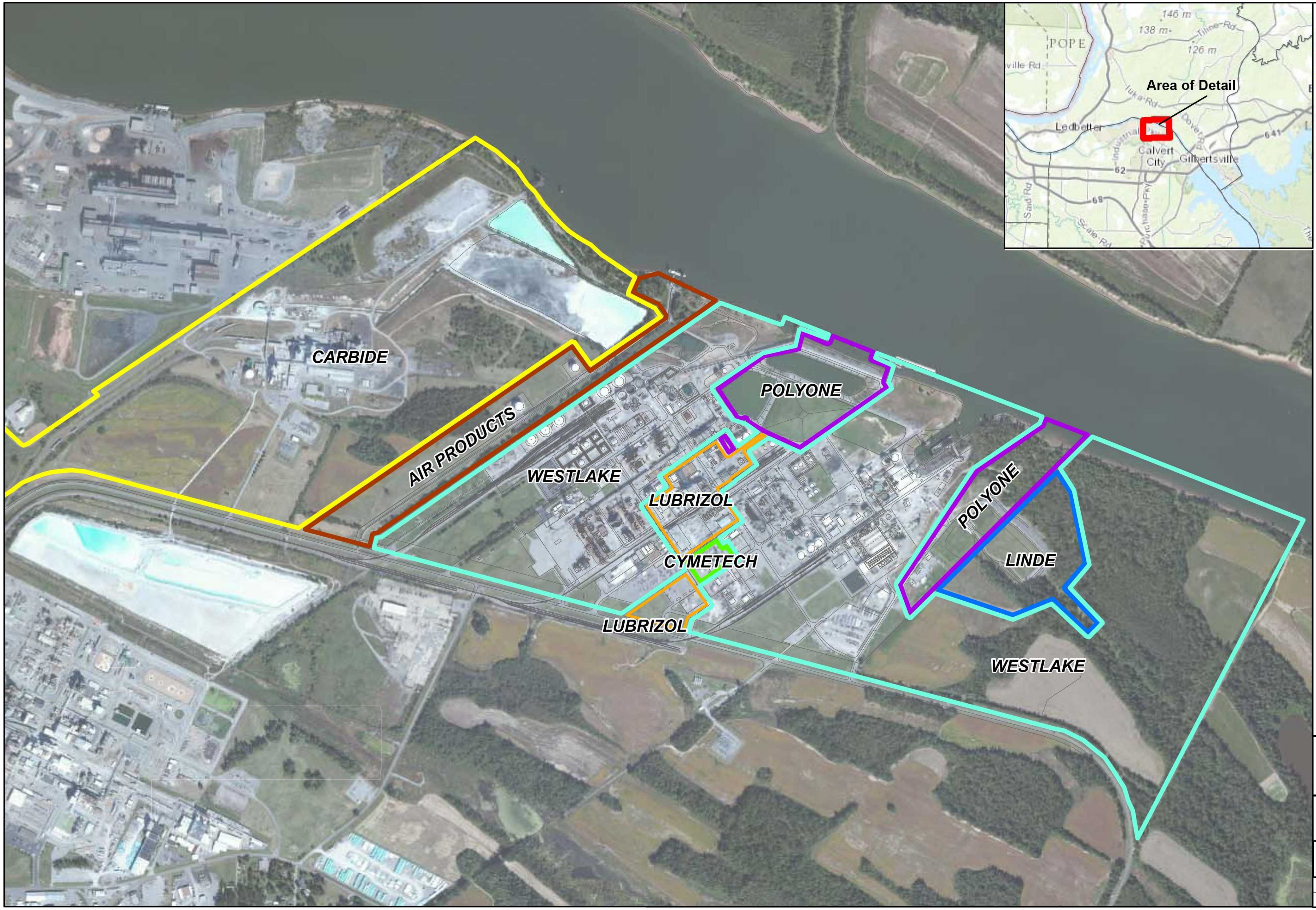
Site Facilities and Areas

FIGURE
1-2

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 10/13/2014
ANALYST: HICKSJ
REV. 0
APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\Fig1-02_Facilities_Areas_SP.mxd



Legend

- □ Polyone
- □ Air Products
- □ Carbide
- □ Cymetech
- □ Linde
- □ Lubrizol
- □ Westlake

Source:
Westlake Vinyls, Draft RI report (July 2013)

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 500 1,000

Battelle
The Business of Innovation

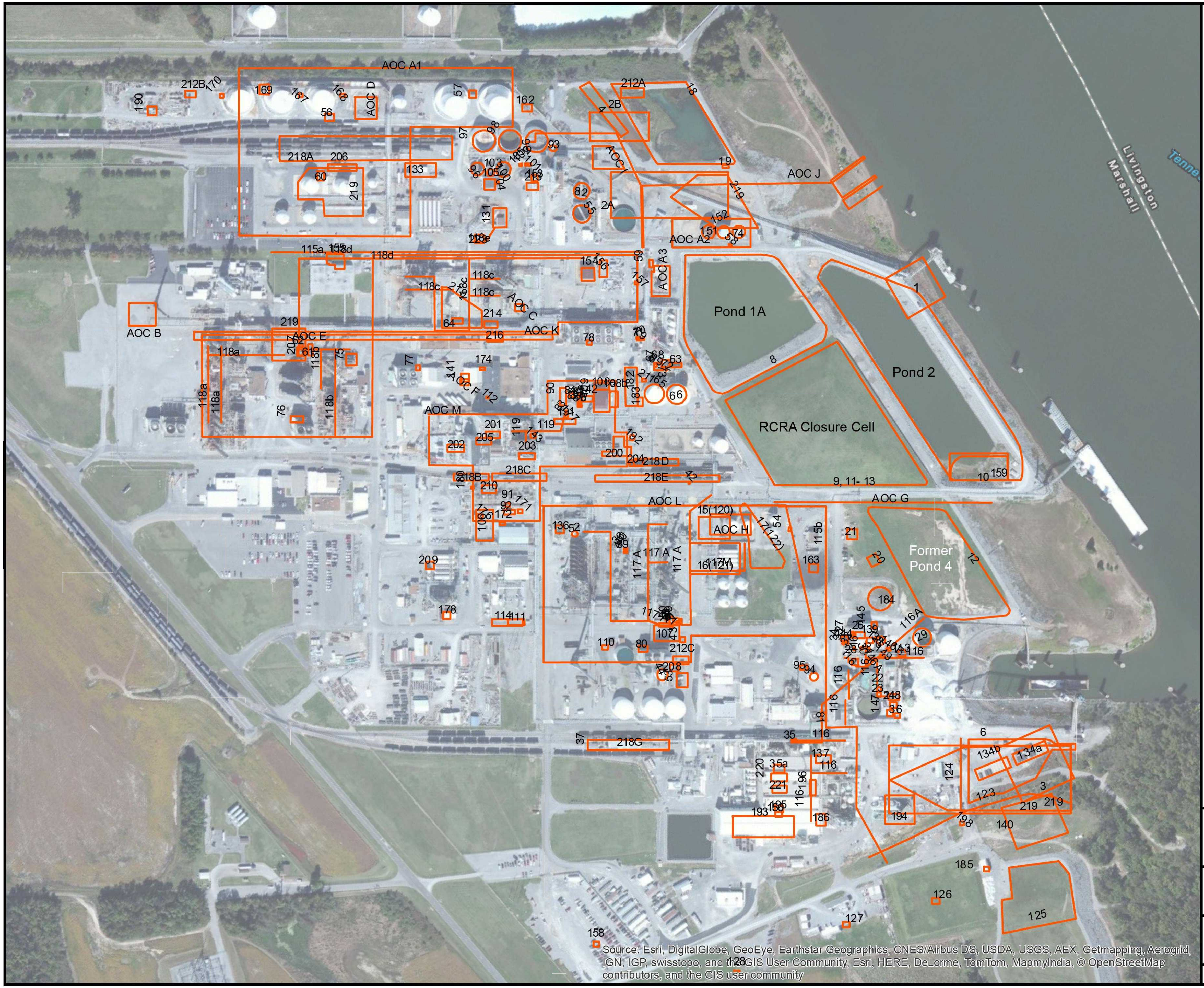
Current Ownership of Industrial Properties

FIGURE
1-4

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 10/13/2014 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\Fig1-04_Current_Ownership_SP.mxd



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Explanation

— Solid Waste Management Units and Areas of Concern

Note: SWMU and AOC Descriptions listed in Table 1-1.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

Source: URS Site Plan with SWMUs by Category 10-27-09, Job No., 14948453

Scale in Feet
0 250 500

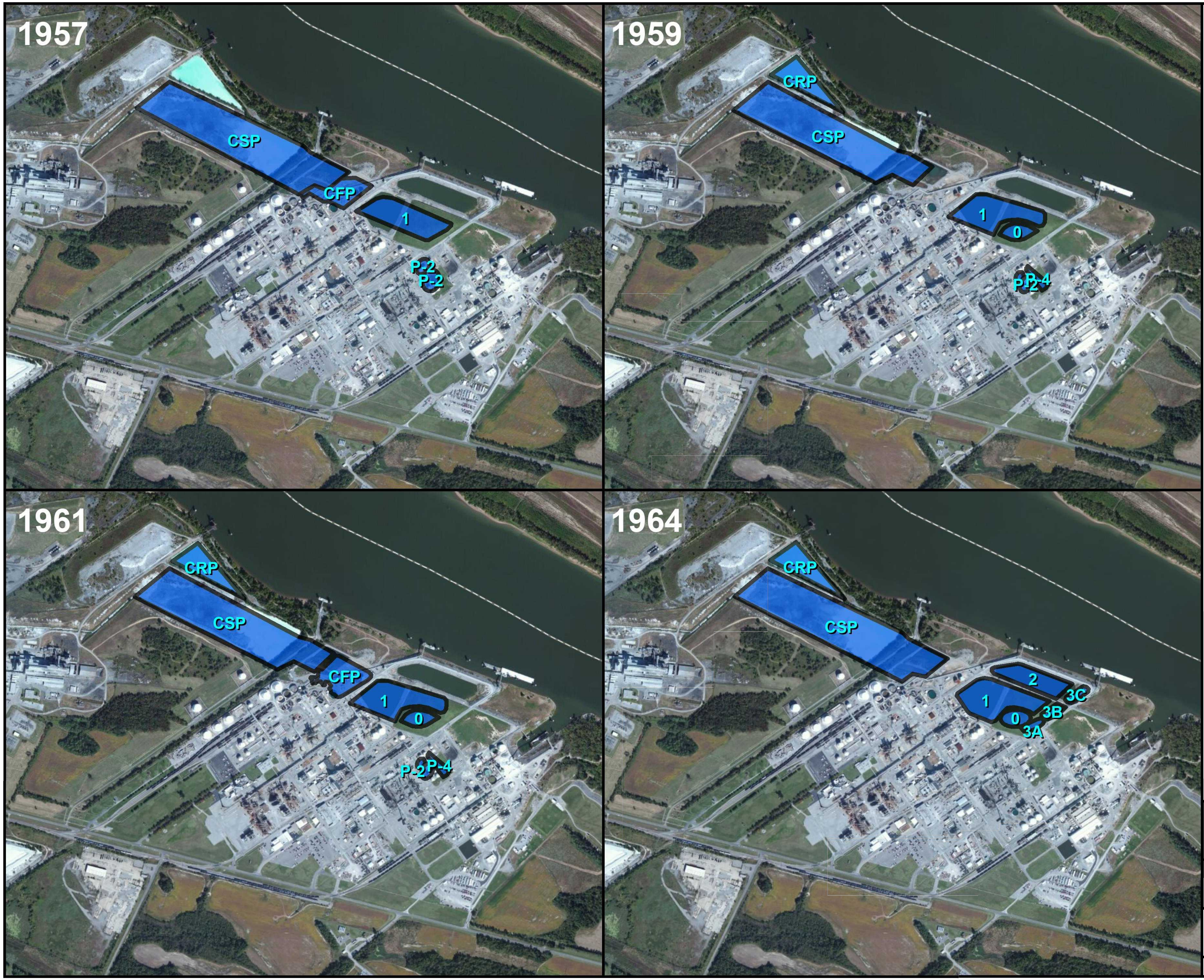
Battelle
The Business of Innovation

Site Plan with RCRA SWMUs and AOCs

FIGURE
1-5

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

1-5_SWMUs-AOCs.mxd 6/25/2015



Explanation

🟦 Pond Location with ID

CRP	Carbide Recycle Pond
CSP	Carbide Settling Pond
CFP	Coal Fines Pond

Source of ortho base map on four panels: ESRI, 2015.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet
0 500 1000 1500 2000

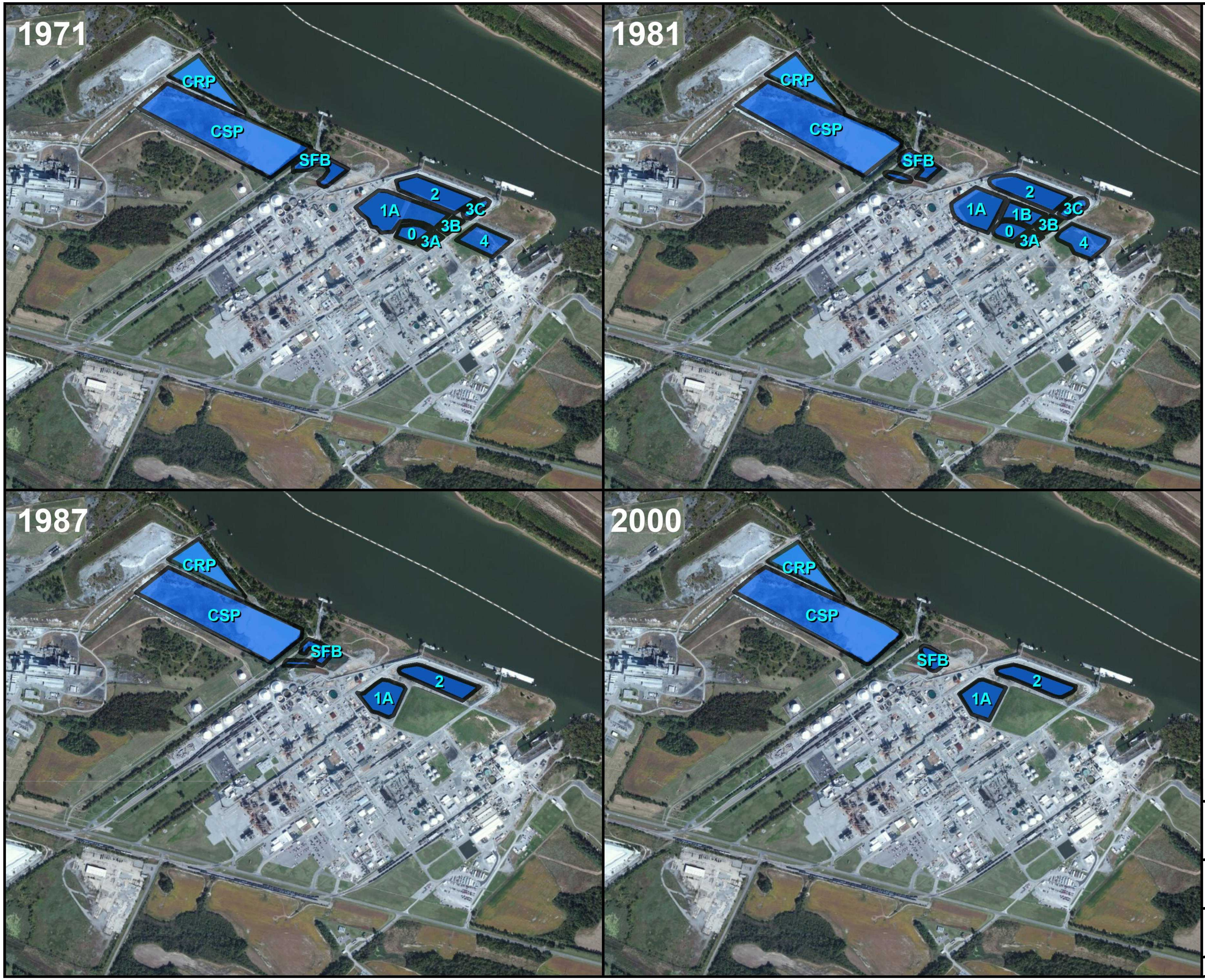
Battelle
The Business of Innovation

Pond Locations (1957-1964)

FIGURE
1-6

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

1-6_1957-1964_pond locations.mxd 5/7/2015



Explanation

🟦 Pond Location with ID

CRP	Carbide Recycle Pond
CSP	Carbide Settling Pond
CFP	Coal Fines Pond
SFB	Sand Filter Backwash Pond

Source of ortho base map on four panels: ESRI, 2015.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet
0 500 1000 1500 2000

Battelle
The Business of Innovation

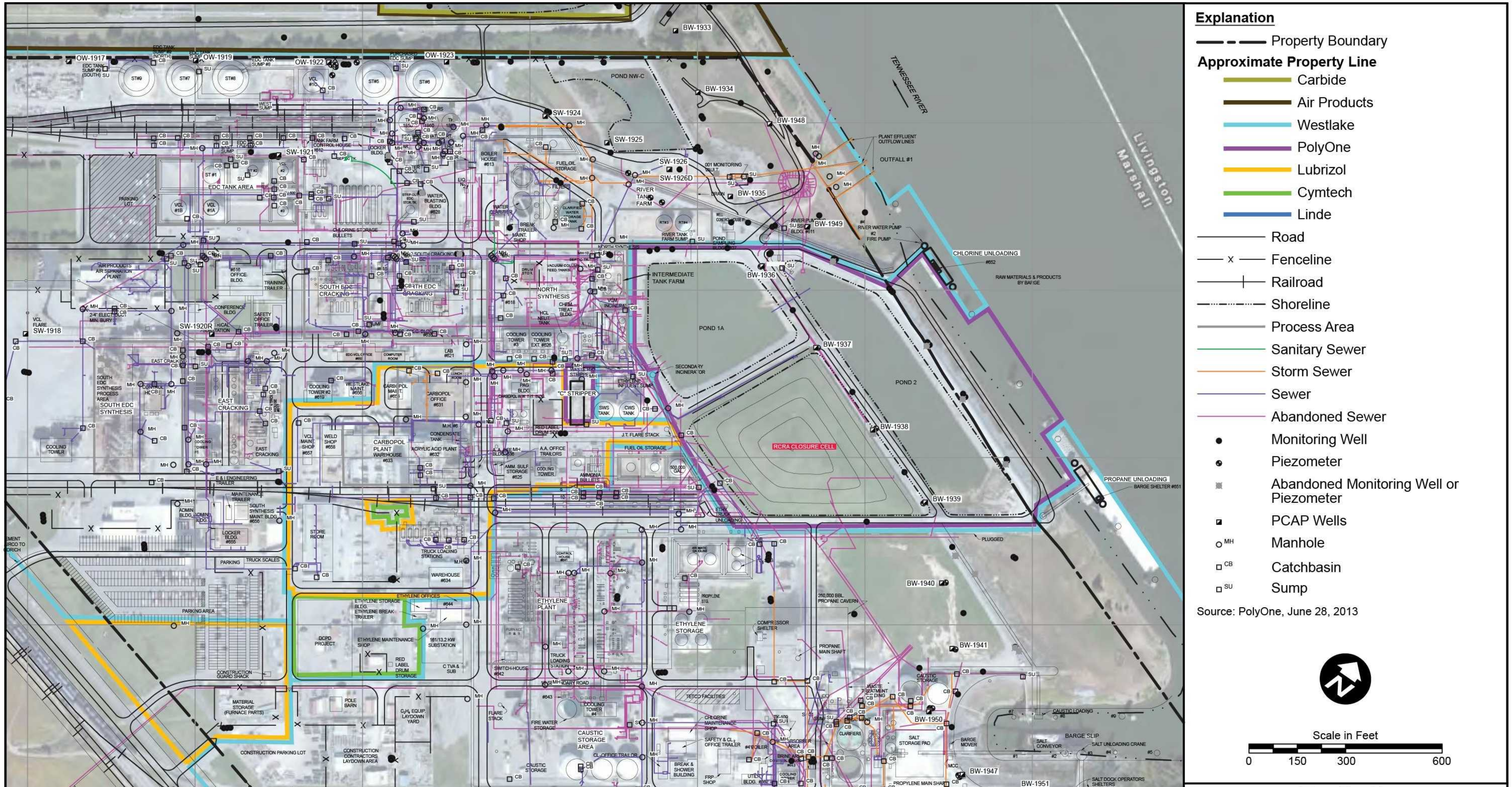
Pond Locations (1971-2000)

FIGURE
1-7

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

1-7_1971-2000_pond locations.mxd 5/7/2015

Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



Battelle

The Business of Innovation

Known Active and Abandoned Underground Piping, Westlake, Lubrizol, Cymtech, and PolyOne Properties

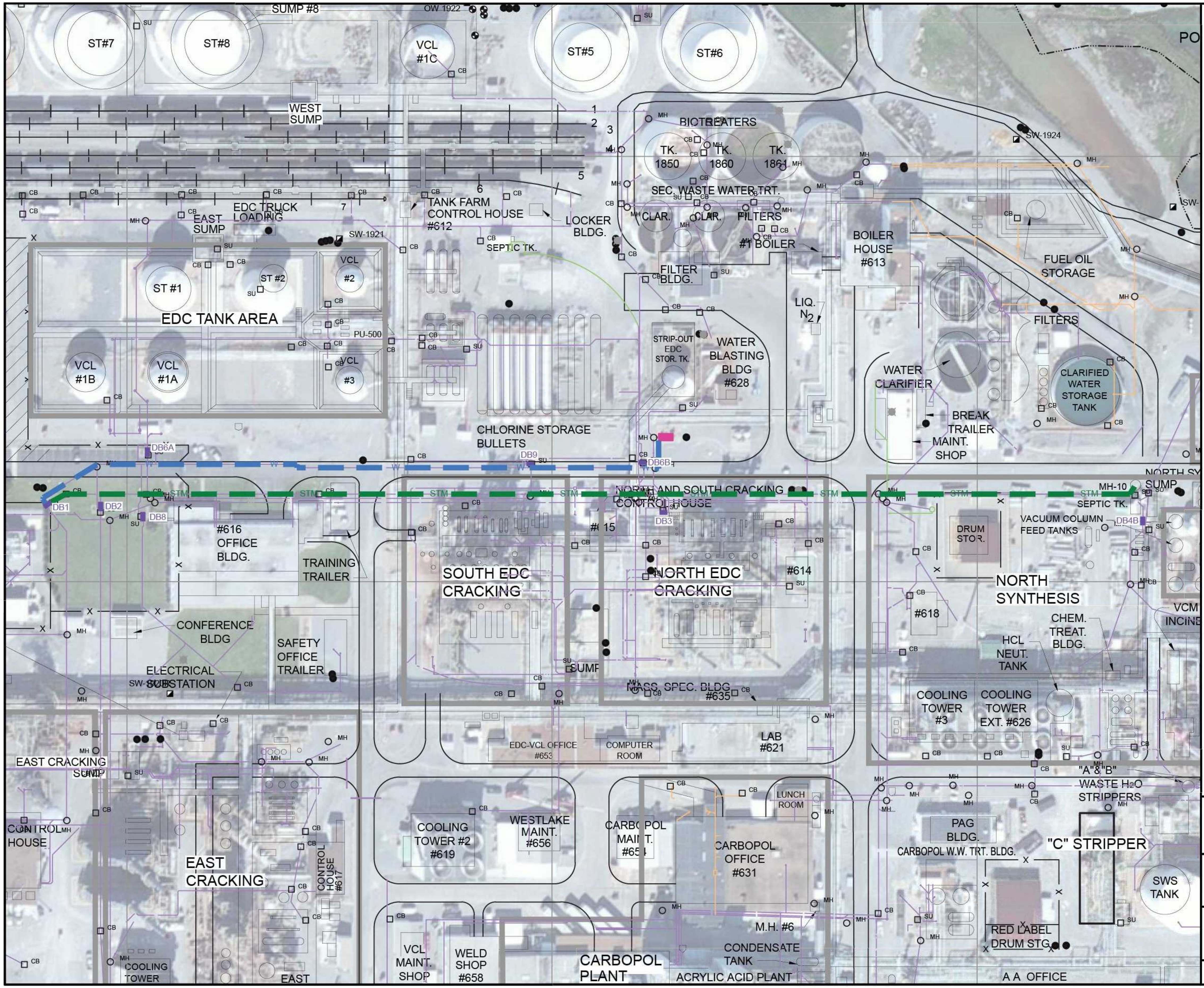
FIGURE

1-8

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

1-8 UNDERGROUND PIPING.CDR

10/14



Explanation

- Property Boundary
- Road
- Fenceline
- Railroad
- Shoreline
- Process Area
- Sanitary Sewer
- Storm Sewer
- Sewer
- Storm Sewer Main
- Contaminated Water Sewer Main
- ● Monitoring Well
- Piezometer
- Abandoned Monitoring Well or Piezometer
- PCAP Wells
- ○ MH Manhole
- ☐ CB Catchbasin
- ☐ SU Sump
- DB2 Diversion Box
- Contaminated Water Lift Station

Source: PolyOne, June 28, 2013

Projected Coordinate System:
Web Mercator, UTM Zone 16N WGS84

Scale in Feet
0 50 100

Battelle
The Business of Innovation

EDC/VCM Plant Stormwater and Contaminated Water System

FIGURE
1-9

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

1-9 STORMWATER.CDR
10/14

Explanation

⭕ 35 Tank Identified in Table*

🟢 61 Former Tank Location

42? Tank in Table with Uncertain Location*

* Refer to Table 2-1 for tank information

Source:
PolyOne, Draft RI report (June 28, 2013)

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet
0 250 500

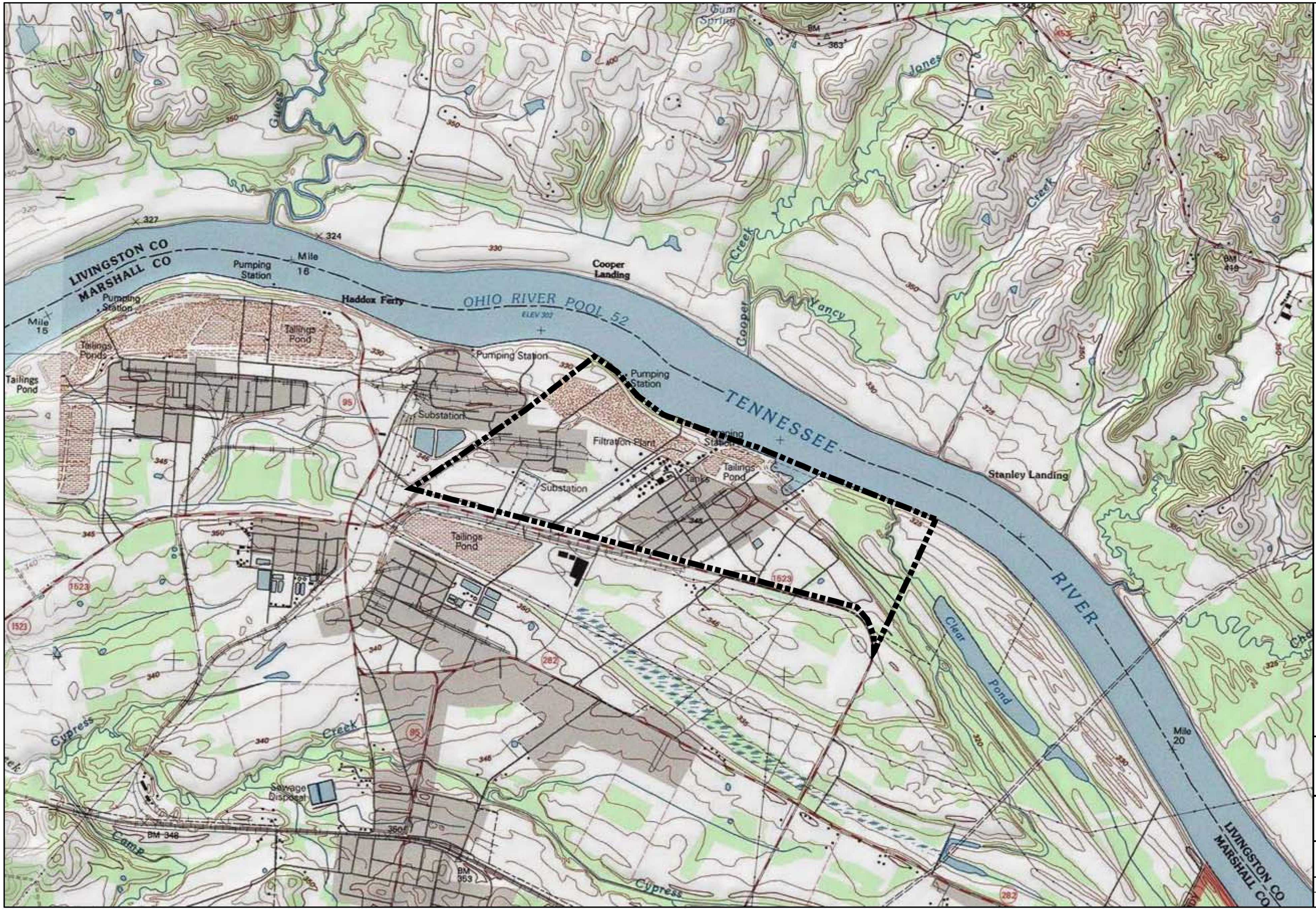
Battelle
The Business of Innovation

Location of Current and Former Tanks

FIGURE
1-10

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

1-10_tanks.mxd
5/7/2015



Legend

▚ Approximate Site Location

Sources:
ESRI USA Topographic Map (2014)

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 1,000 2,000

Battelle
The Business of Innovation

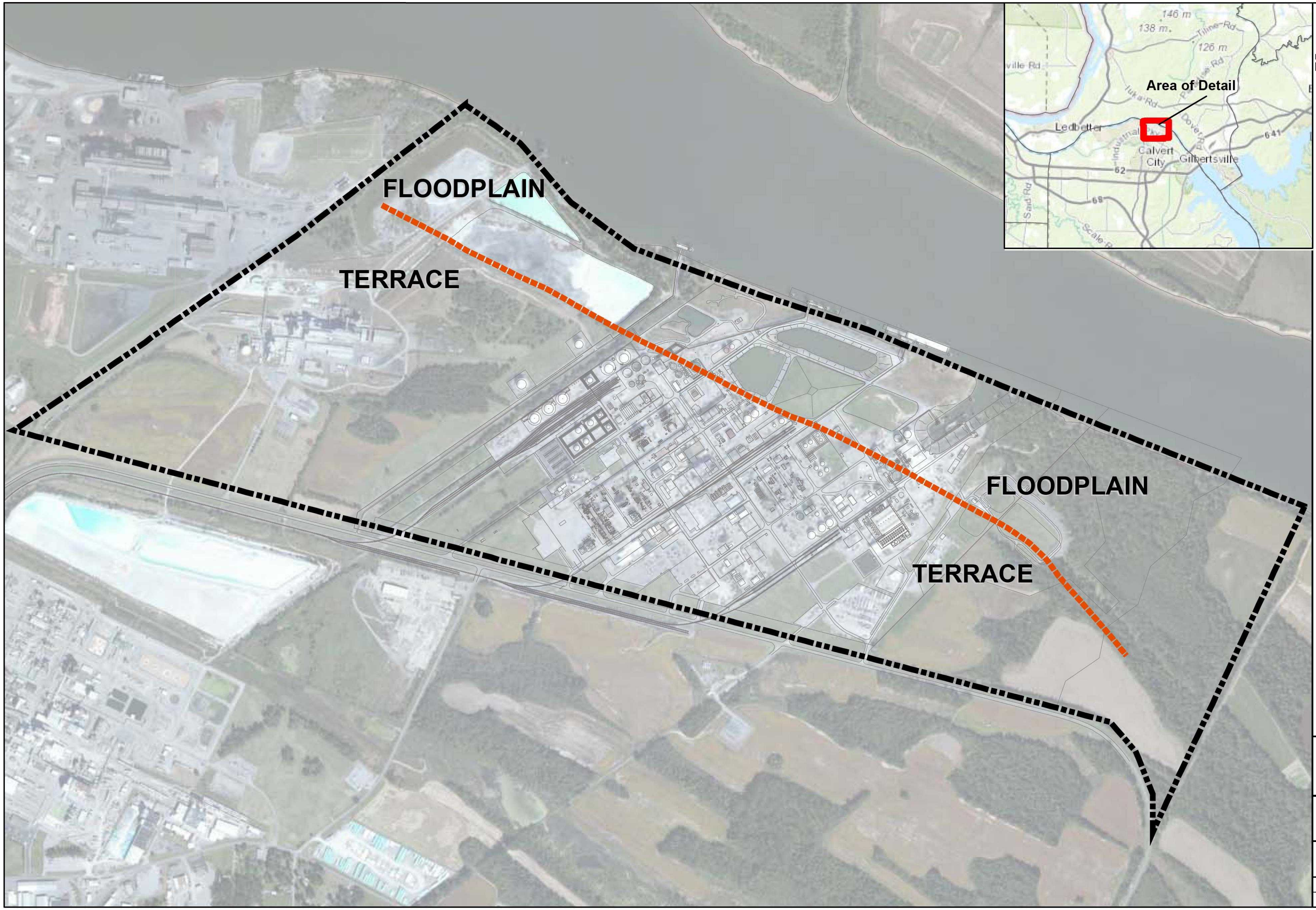
Regional Topographic Map

FIGURE
1-14

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 10/13/2014 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\Fig1-14_Regional_Topographic_Quad.mxd



Legend

▬ Floodplain Terrace Contact

▭ Site Location

Sources:
PolyOne, Draft RI report (June 2013)

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 500 1,000

Battelle
The Business of Innovation

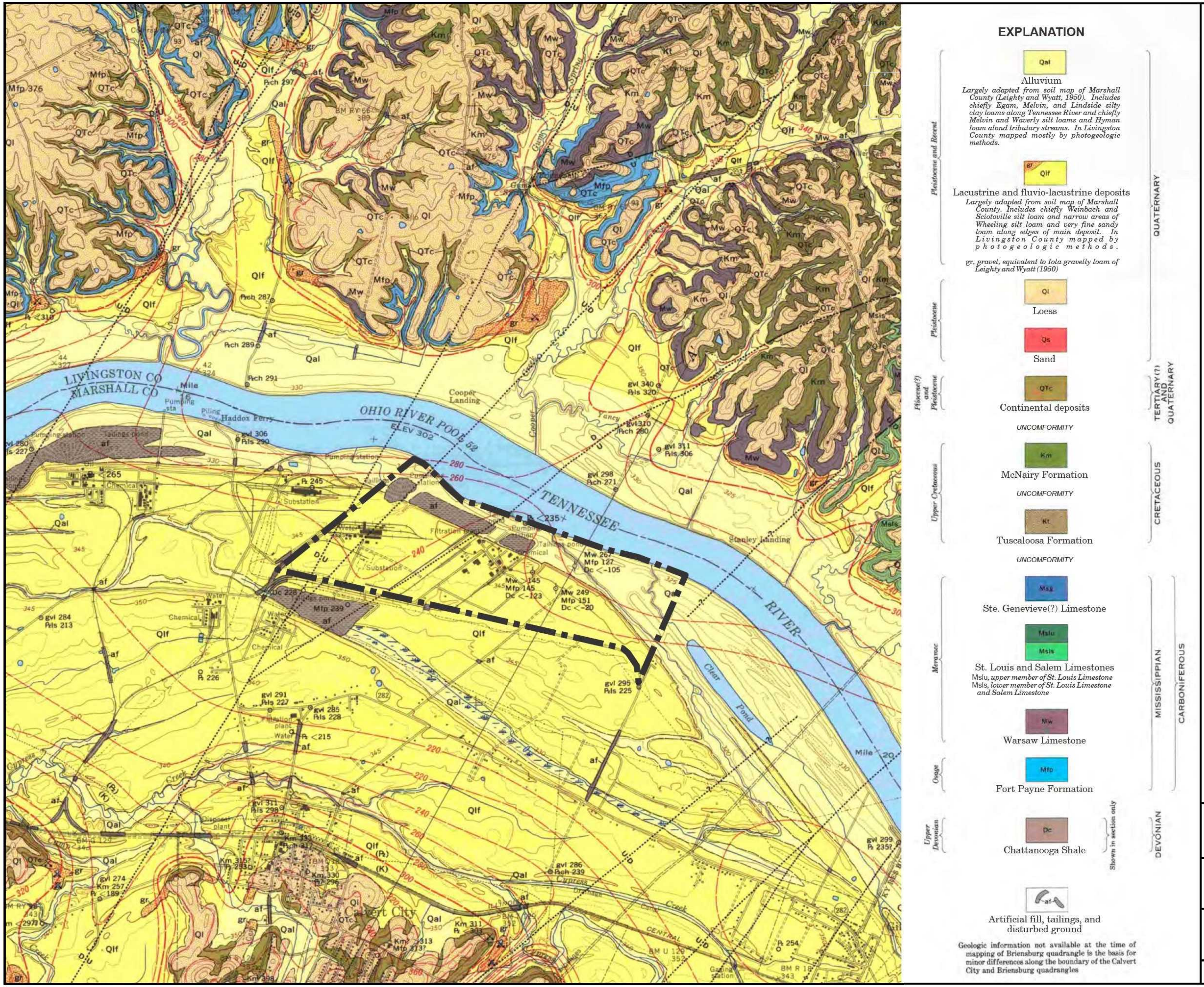
Approximate Floodplain Terrace Contact

FIGURE
1-15

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/10/2015 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\G\SBF_Goodrich\Maps\Fig1-15_Floodplain_Terrace_Contact_Range_extended.mxd



EXPLANATION

Qal
Alluvium
Largely adapted from soil map of Marshall County (Leighty and Wyatt, 1950). Includes chiefly Egam, Melvin, and Lindside silty clay loams along Tennessee River and chiefly Melvin and Waverly silt loams and Hyman loam alond tributary streams. In Livingston County mapped mostly by photogeologic methods.

gr Qlf
Lacustrine and fluvio-lacustrine deposits
Largely adapted from soil map of Marshall County. Includes chiefly Weinbach and Sciotoville silt loam and narrow areas of Wheeling silt loam and very fine sandy loam along edges of main deposit. In Livingston County mapped by photogeologic methods.

gr, *gravel, equivalent to Iola gravelly loam of Leighty and Wyatt (1950)*

Pleistocene and Recent

Ql
Loess

Qs
Sand

Pleistocene

QUATERNARY

QTc
Continental deposits

Pliocene(?) and Pleistocene

TERTIARY(?) AND QUATERNARY

UNCOMFORMITY

Km
McNairy Formation

UNCOMFORMITY

Kt
Tuscaloosa Formation

Upper Cretaceous

CRETACEOUS

UNCOMFORMITY

Msg
Ste. Genevieve(?) Limestone

Mslu
Msls
St. Louis and Salem Limestones
Mslu, *upper member of St. Louis Limestone*
Msls, *lower member of St. Louis Limestone and Salem Limestone*

Mw
Warsaw Limestone

Meramec

Mfp
Fort Payne Formation

Osage

MISSISSIPPIAN

CARBONIFEROUS

Dc
Chattanooga Shale

Upper Devonian

Shown in section only

DEVONIAN

af
Artificial fill, tailings, and disturbed ground

Geologic information not available at the time of mapping of Brienburg quadrangle is the basis for minor differences along the boundary of the Calvert City and Briensburg quadrangles

Explanation

Approximate Site Location

Source: Kentucky Geological Survey, University of Kentucky.

N

Scale in Feet
0 50 100

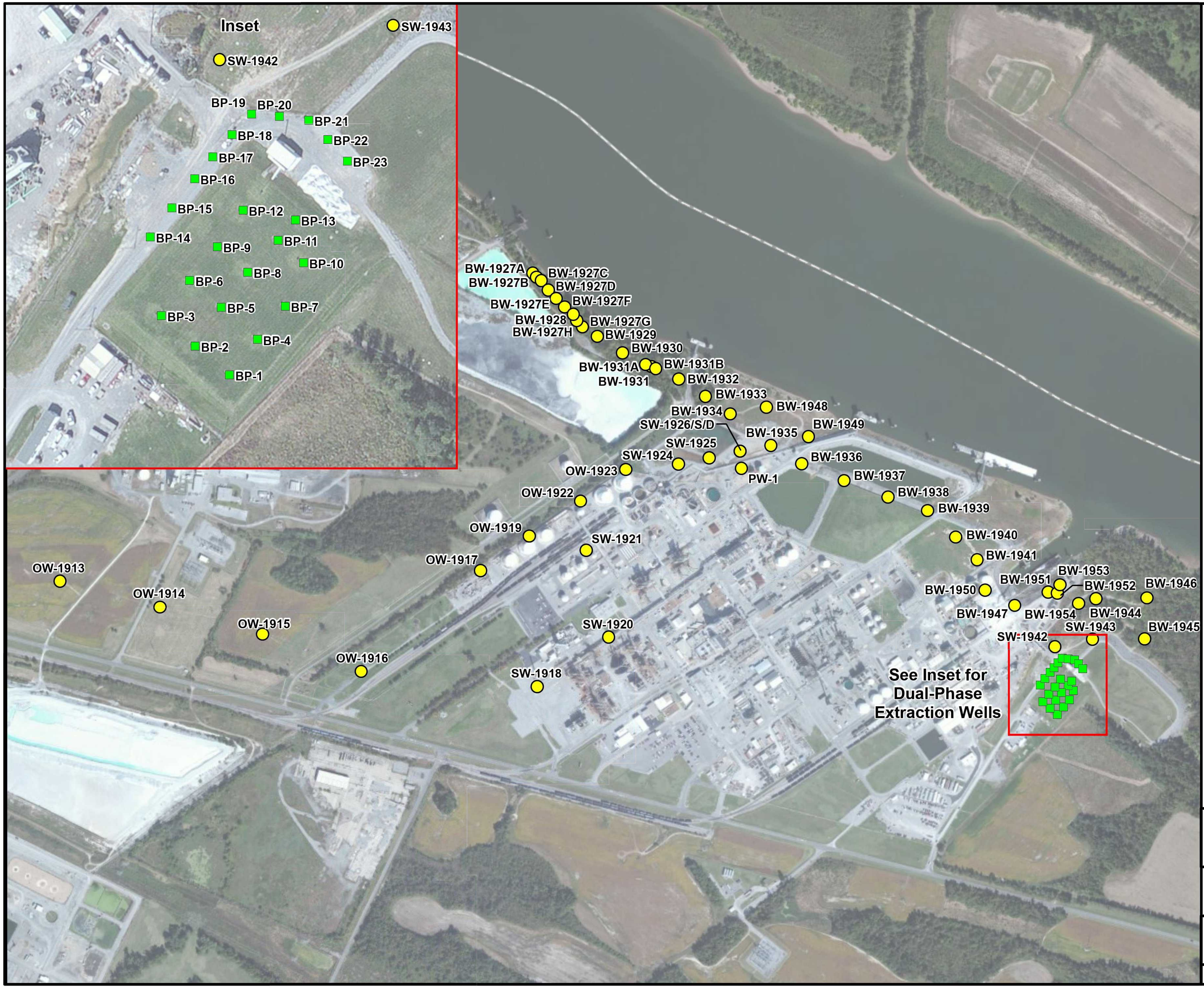
Battelle
The Business *of* Innovation

Regional Geology Map

FIGURE
1-17

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

1-17 REGIONAL GEOLOGY.CDR | 10/14



Explanation

● Extraction Well

🟩 Dual-Phase Extraction Well

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

Scale in Feet
0 500 1000

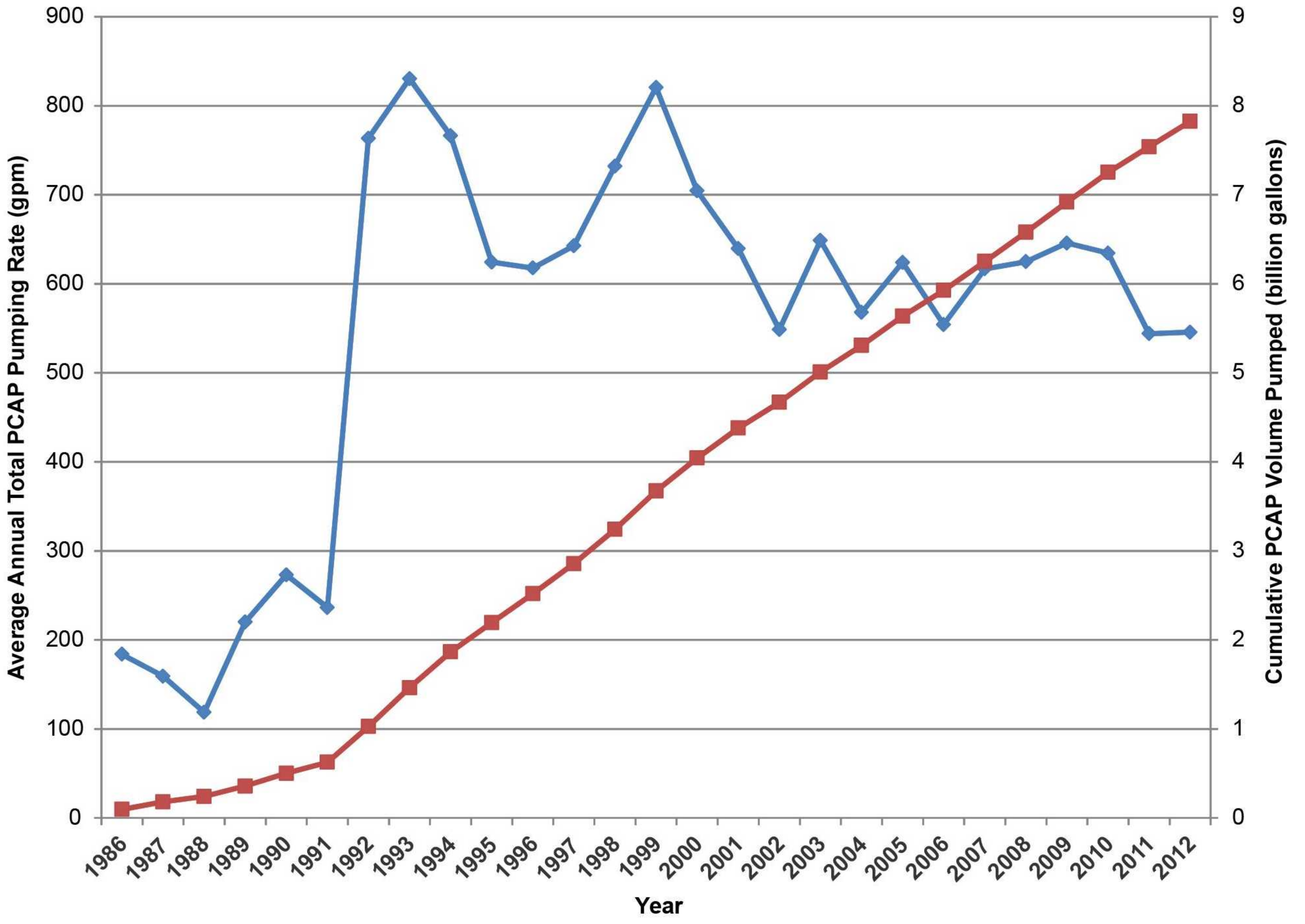
Battelle
The Business of Innovation

PCAP Extraction Wells

FIGURE
2-1

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

2-1_PCAP_extraction_wells.mxd 10/16/2014



Battelle

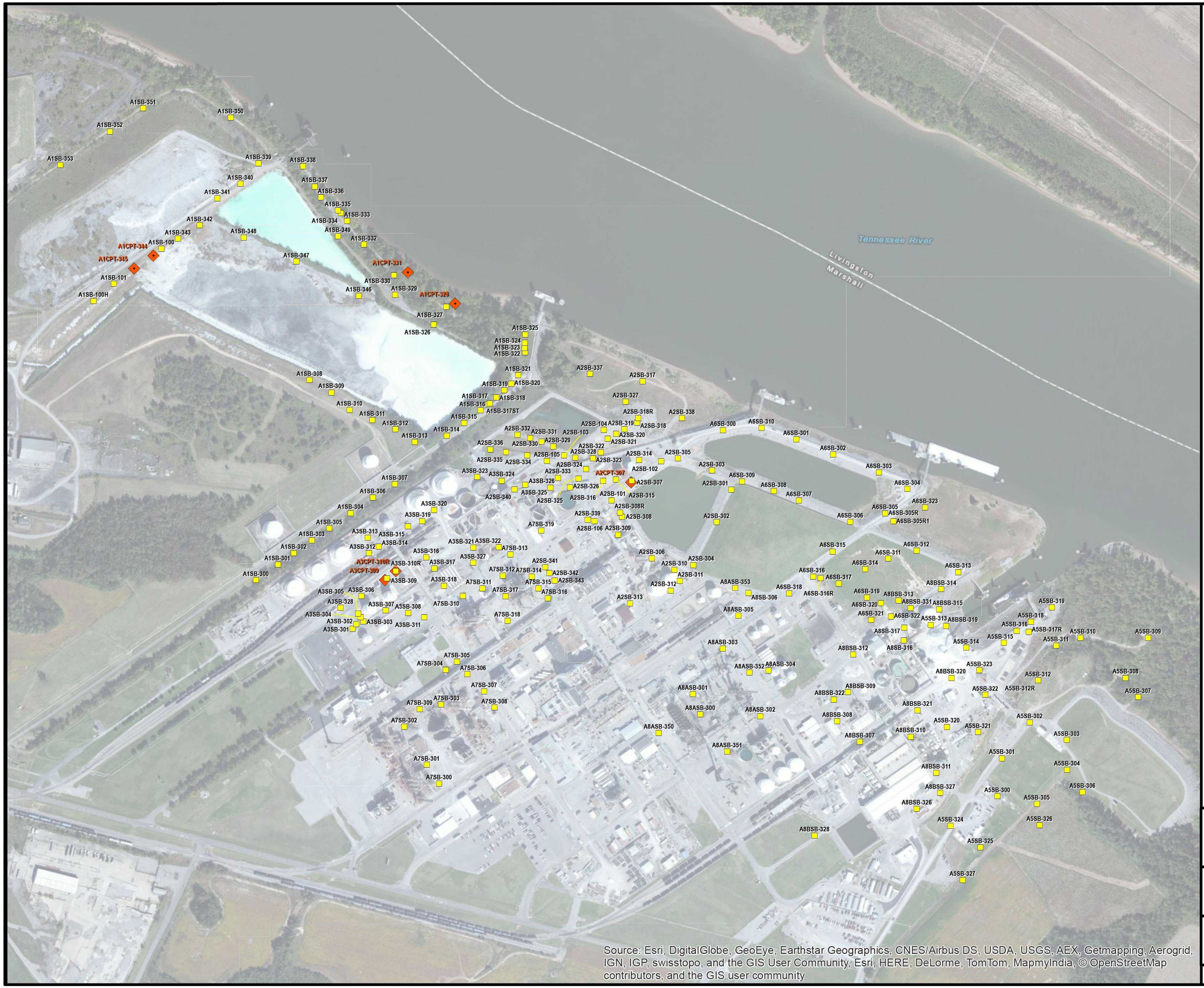
The Business *of* Innovation

Average Annual Total PCAP Pumping Rate and Cumulative Volume

FIGURE
2-2

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

2-2 PCAP PUMPING HISTORY.CDR
10/14



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Explanation

🟨 Soil Boring Location

◆ CPT-MIP Location

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

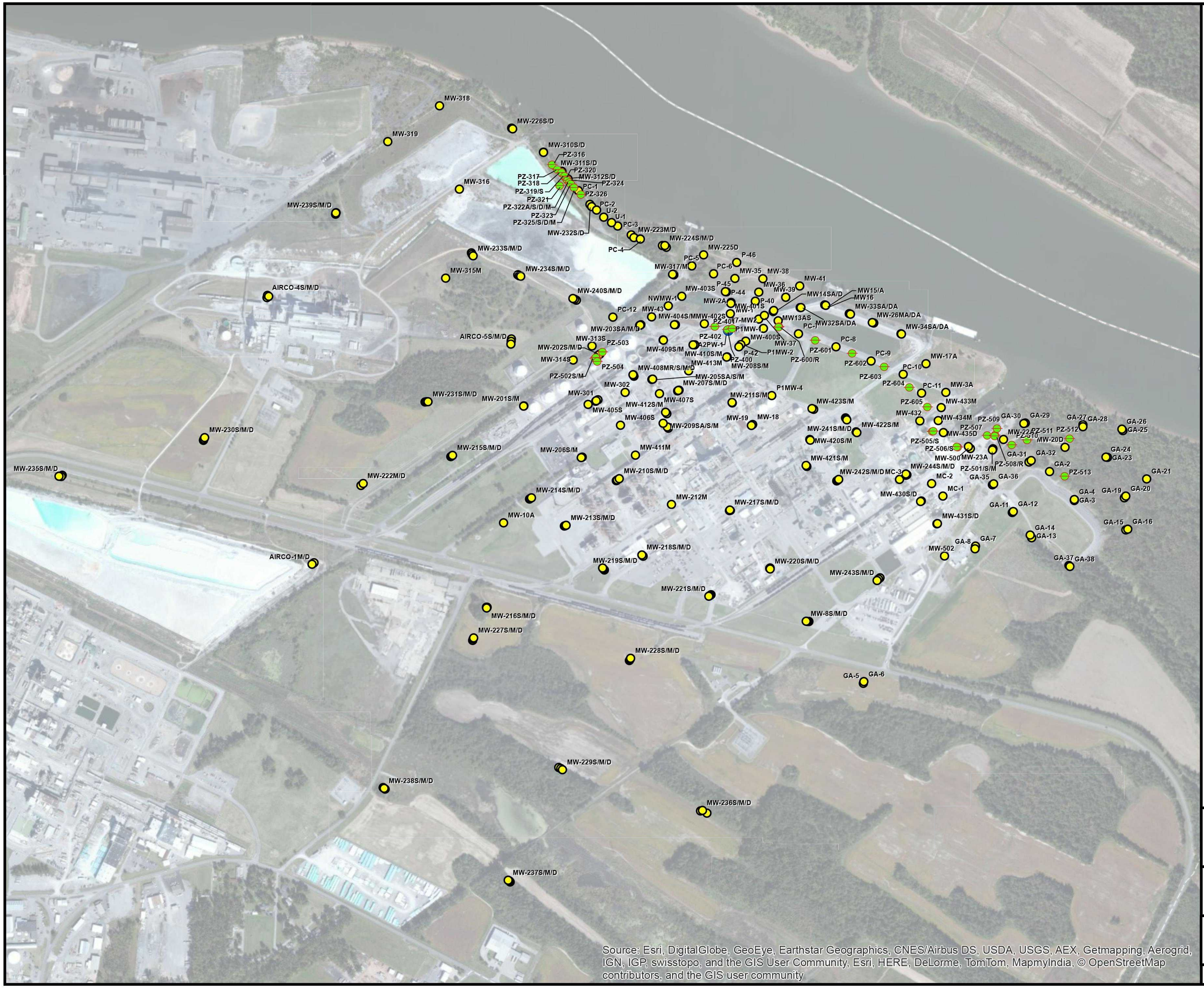
N

Scale in Feet
0 500 1000

Battelle
The Business of Innovation

RI Soil Boring Locations

FIGURE 3-4	REMEDIAL INVESTIGATION B.F. GOODRICH SUPERFUND SITE CALVERT CITY, KENTUCKY
3-4_RI_soil_boring_locations.mxd	6/25/2015



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Explanation

- ▲ Temporary NAPL Extraction Well
- ● Monitoring Well
- ● Piezometer

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

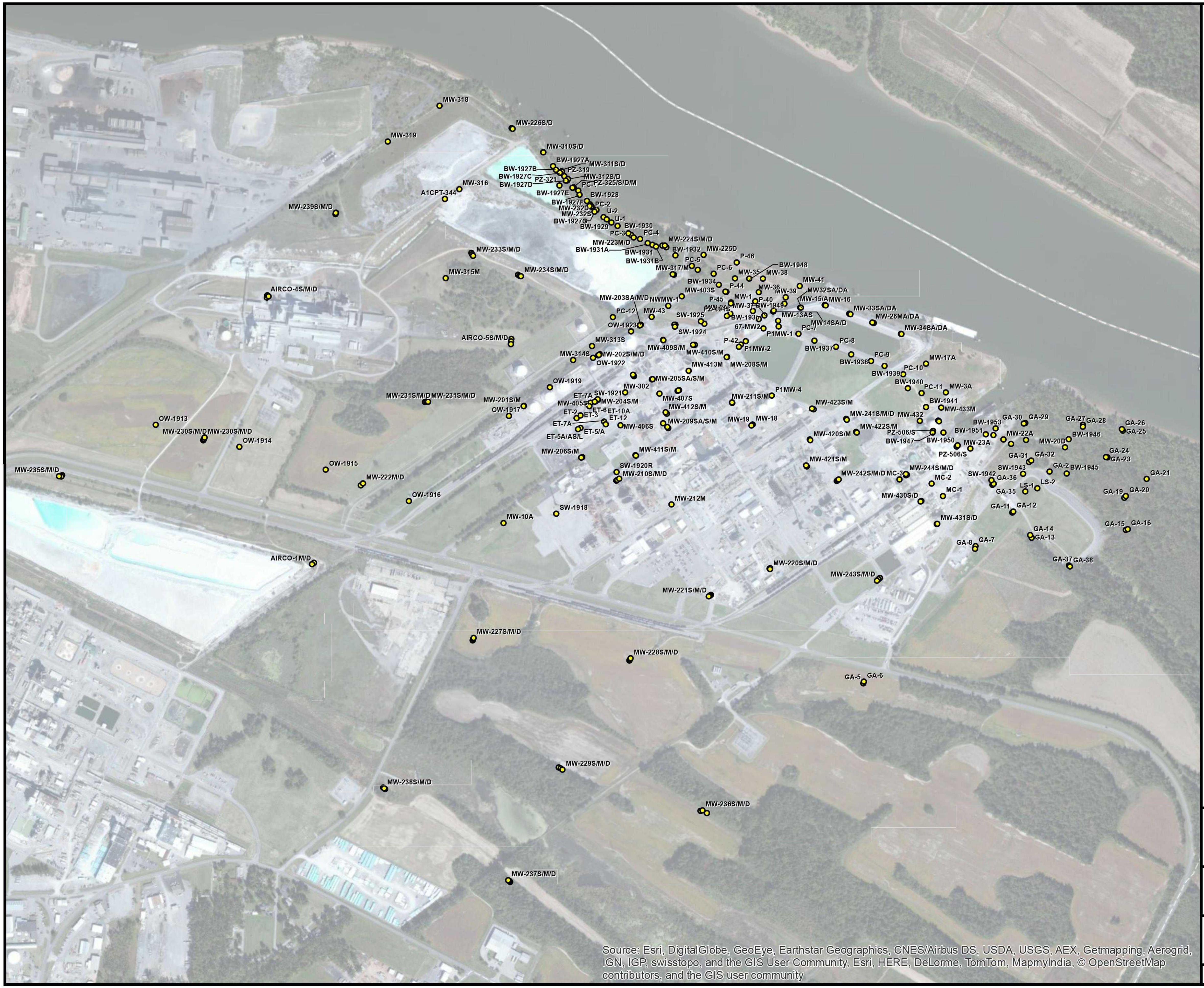
N

Scale in Feet
0 600 1200

Battelle
The Business of Innovation

RI Monitoring Wells, Piezometers, and Temporary NAPL Extraction Well Locations

FIGURE	REMEDIAL INVESTIGATION B.F. GOODRICH SUPERFUND SITE CALVERT CITY, KENTUCKY
3-5	
3-5_RI_MW_PZ_tempNAPL_locations.mxd	6/25/2015



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Explanation

● Groundwater Sampling Locations

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

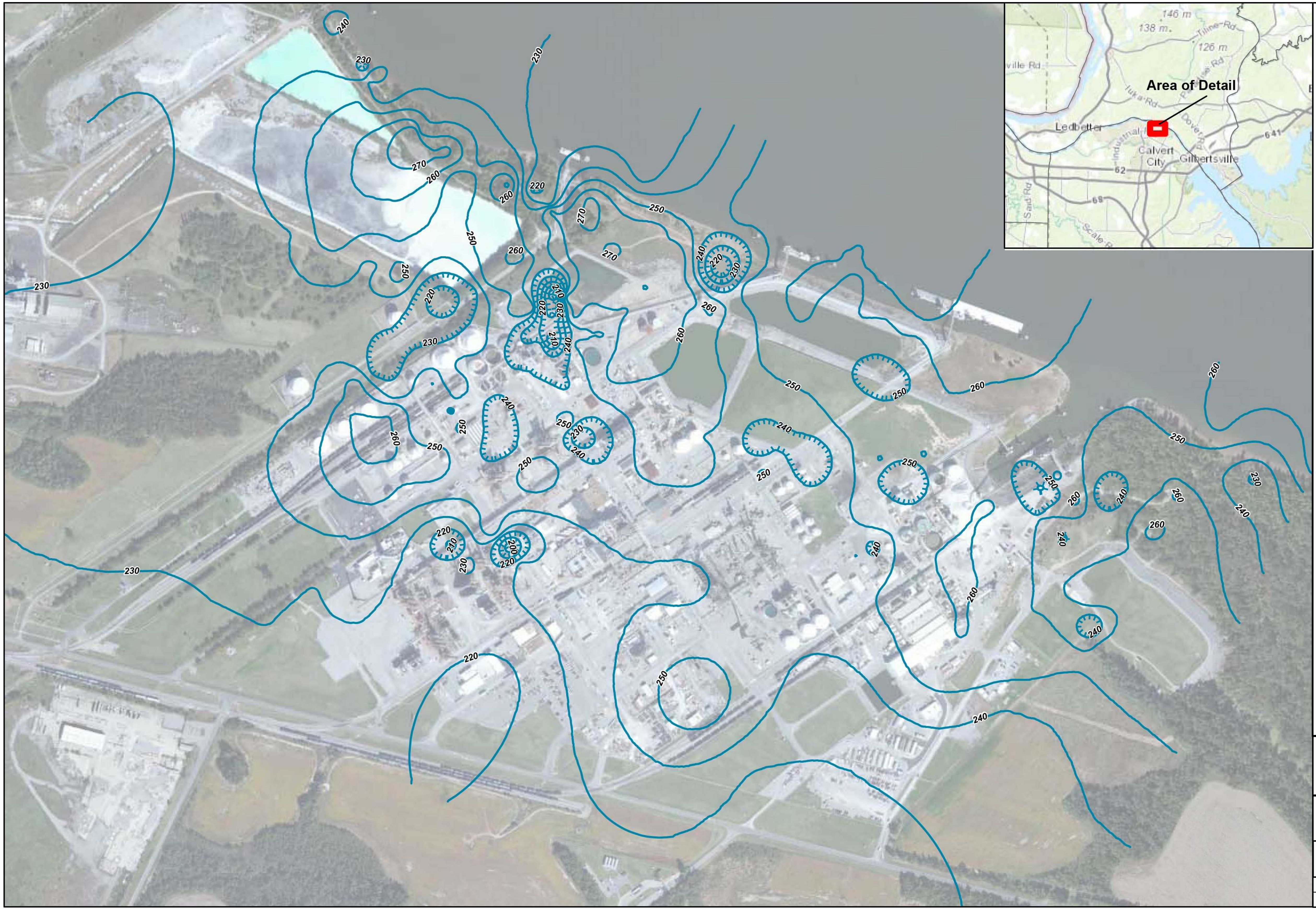
Scale in Feet

0 600 1200

Battelle
The Business of Innovation

Groundwater Sampling Locations

FIGURE	REMEDIAL INVESTIGATION
3-6	B.F. GOODRICH SUPERFUND SITE CALVERT CITY, KENTUCKY
3-6_GW_locations.mxd	6/25/2015



Legend

Bedrock Elevation (10' c.i.)

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

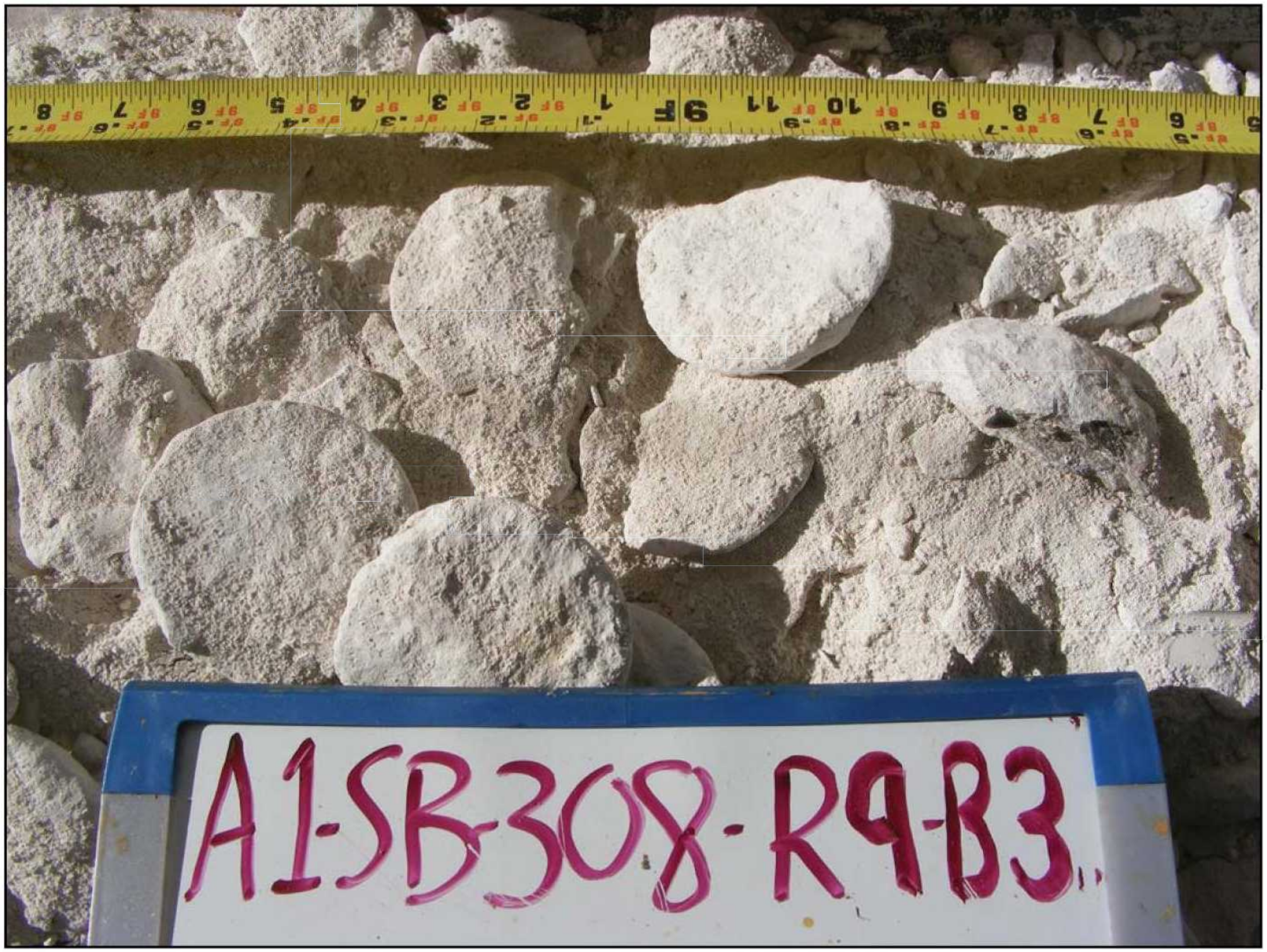
Top of Bedrock Contour Map

FIGURE
4-1

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015
ANALYST: HICKSJ
REV. 0
APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\Fig4-01_Topography_Warsaw_LS.mxd



EXAMPLE OF BEDROCK (B) HYDROCODE
CORE PHOTOGRAPH FROM BORING A1 SB-308

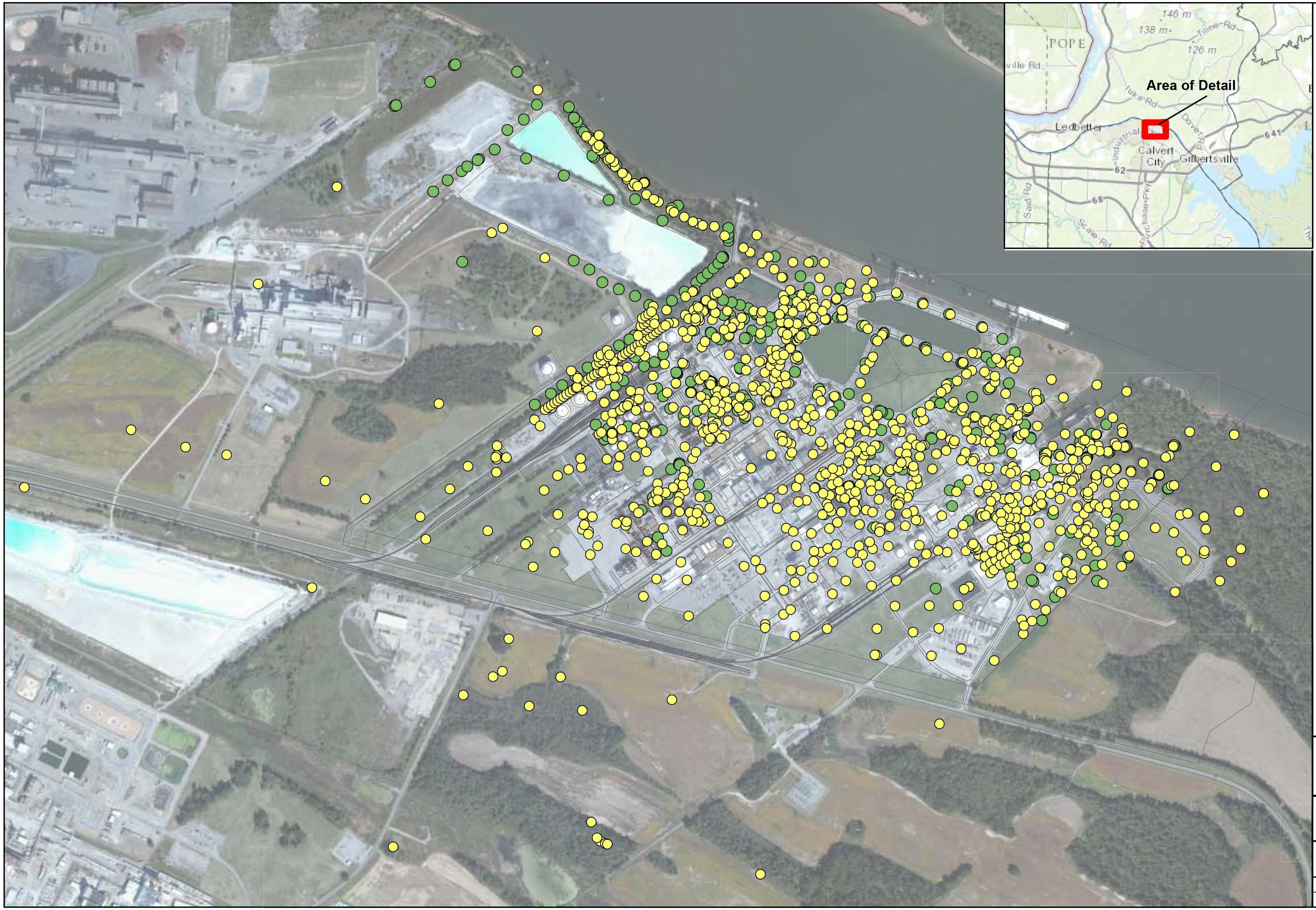
NOTE:
THE ROTOSONIC DRILLING METHOD CAN SHATTER THE LIMESTONE CORE INTO THIN DISKS AND PULVERIZE THE LIMESTONE INTO ROCK FLOUR.

Source: Field Photograph

Battelle
The **Business** *of* **Innovation**

Example of Bedrock (B) Hydrocode

FIGURE **4-2**	REMEDIAL INVESTIGATION B.F. GOODRICH SUPERFUND SITE CALVERT CITY, KENTUCKY
4-2_EXAMPLE_BEDROCK.CDR	10/14



Legend

Lithologic Data Location

🟡 pre-RIFS

🟢 RIFS

Sources:
PolyOne, Draft RI report (June 2013)

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

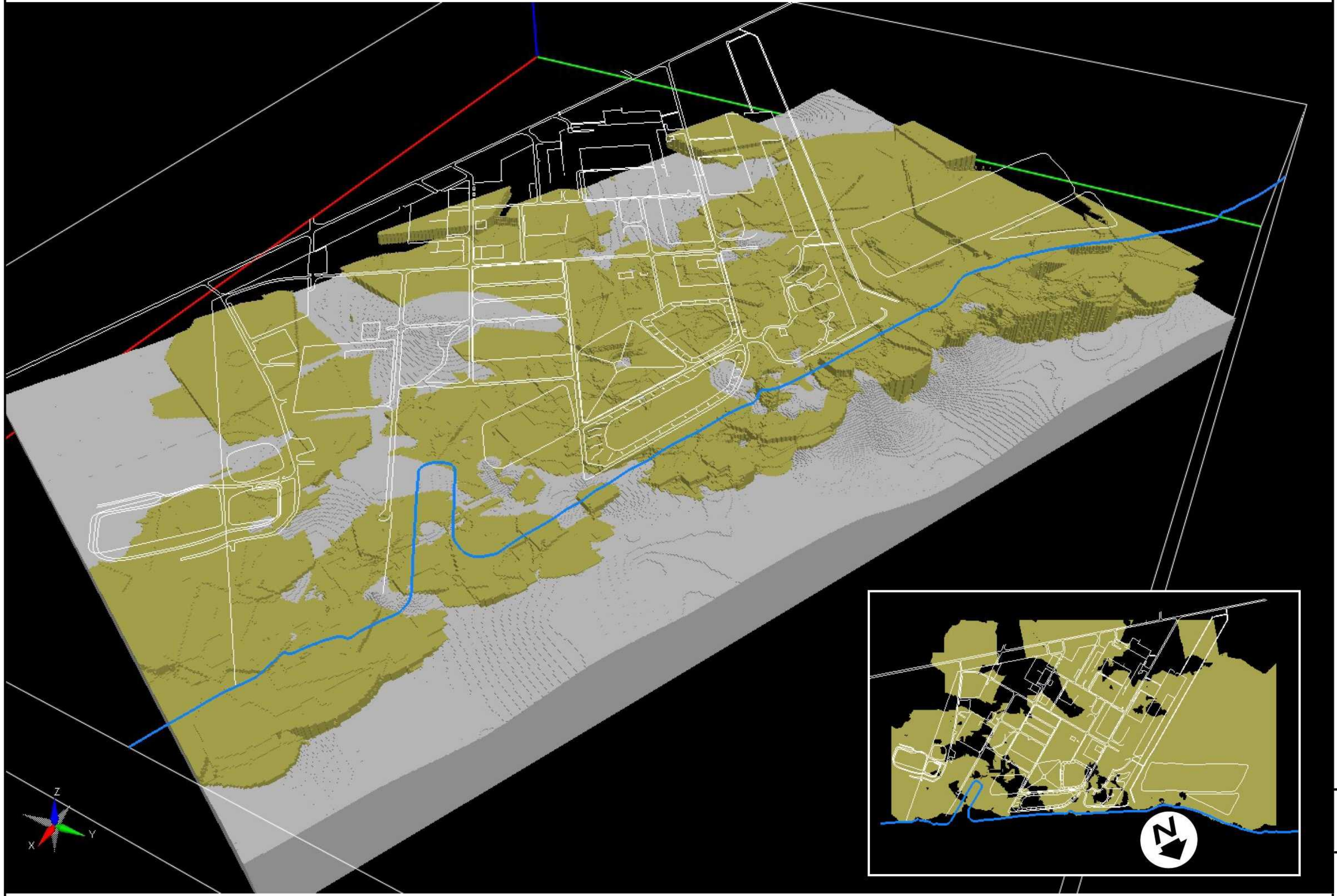
Feet
0 290 580

Battelle
The Business of Innovation

Lithologic Data Locations

FIGURE 4-3	B.F. Goodrich Superfund Site Calvert City, Kentucky
DATE: 10/20/2014	*ANALYST: hicksj*
REV. 0	*APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\Fig4-03_Lithologic_Data.mxd



Explanation

▨ Clay-Rich Heterolithics

▨ Bedrock

— Shoreline

Battelle
The Business of Innovation

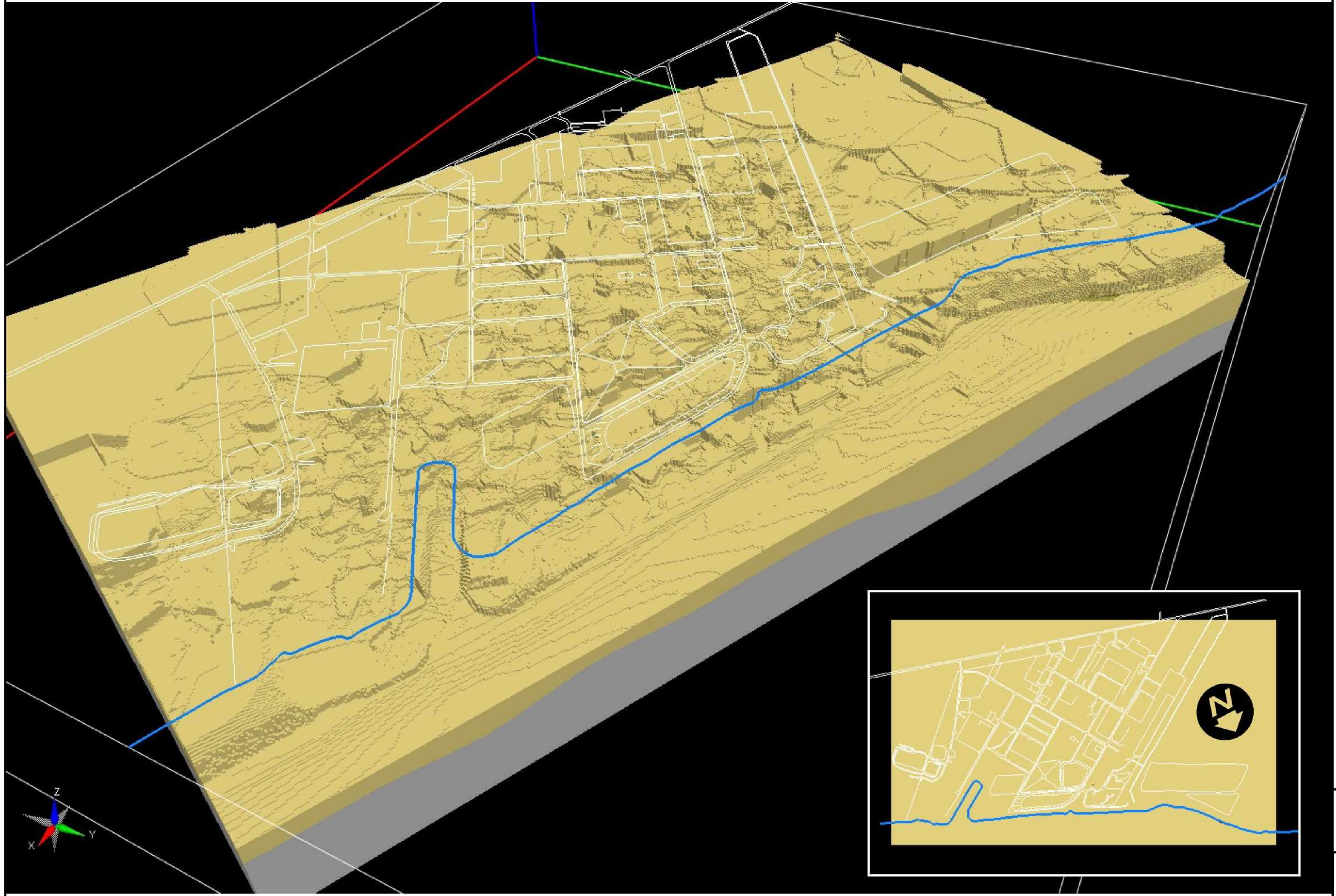
Extent of Clay-Rich Heterolithic (CRH) Hydrocode

FIGURE
4-5

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

4-5_EXTENT_CLAY-RICH-HETEROLITHIC.CDR

10/14



Explanation

🟨 Sand and Gravel

▨ Bedrock

— Shoreline

Battelle
The Business of Innovation

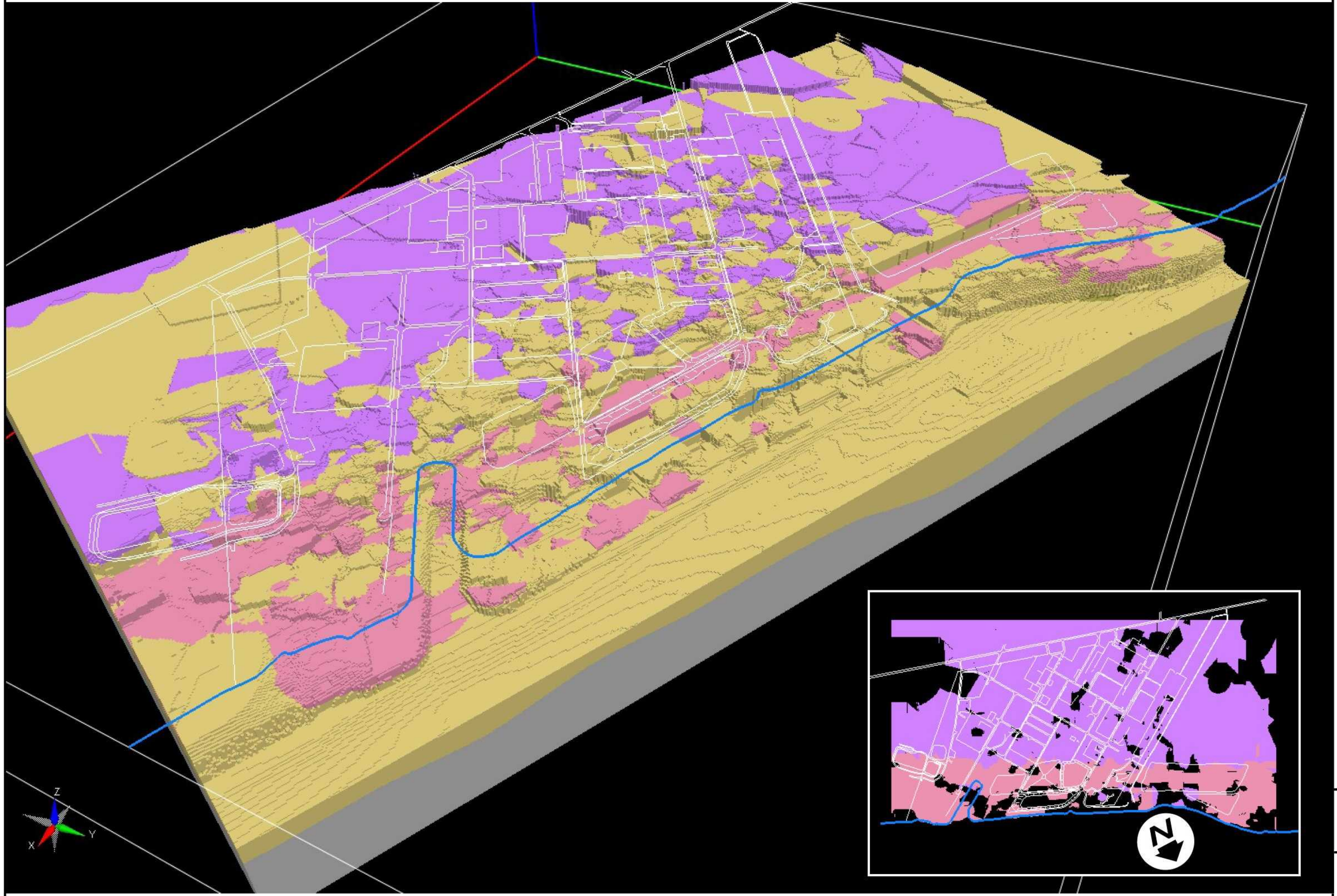
Extent of Sand and Gravel (FS, CS, and G) Hydrocodes

FIGURE
4-7

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

4-7_EXTENT_SAND_GRAVEL.CDR

10/14



Explanation

🟪 Interbeds

🟥 Interbeds on Floodplain

🟨 Sand and Gravel

⬛ Bedrock

〜 Shoreline

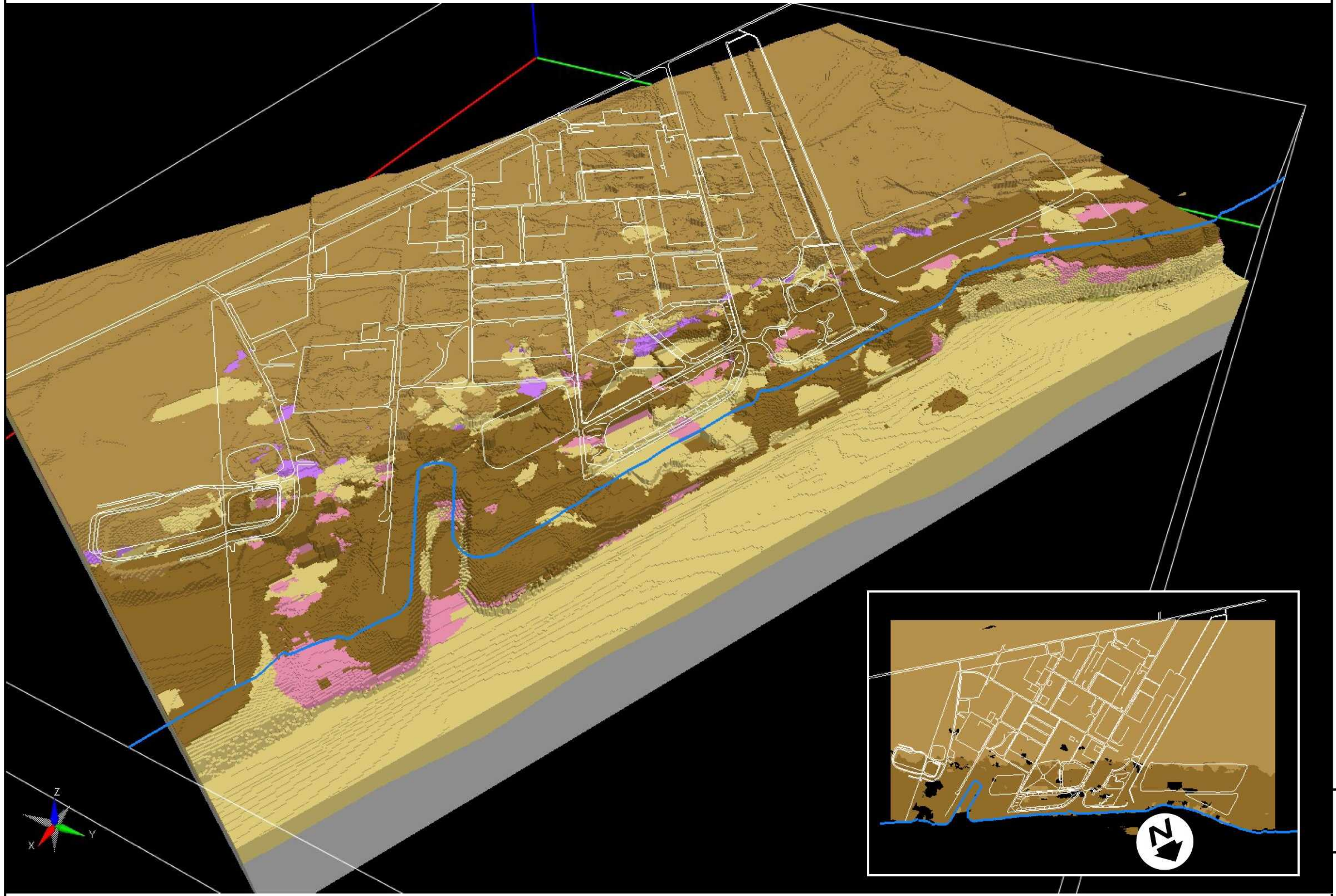
Battelle
The Business *of* Innovation

Extent of Interbeds (I) Hydrocode

FIGURE
4-11

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

4-11_EXTENT_INTERBEDS.CDR 10/14



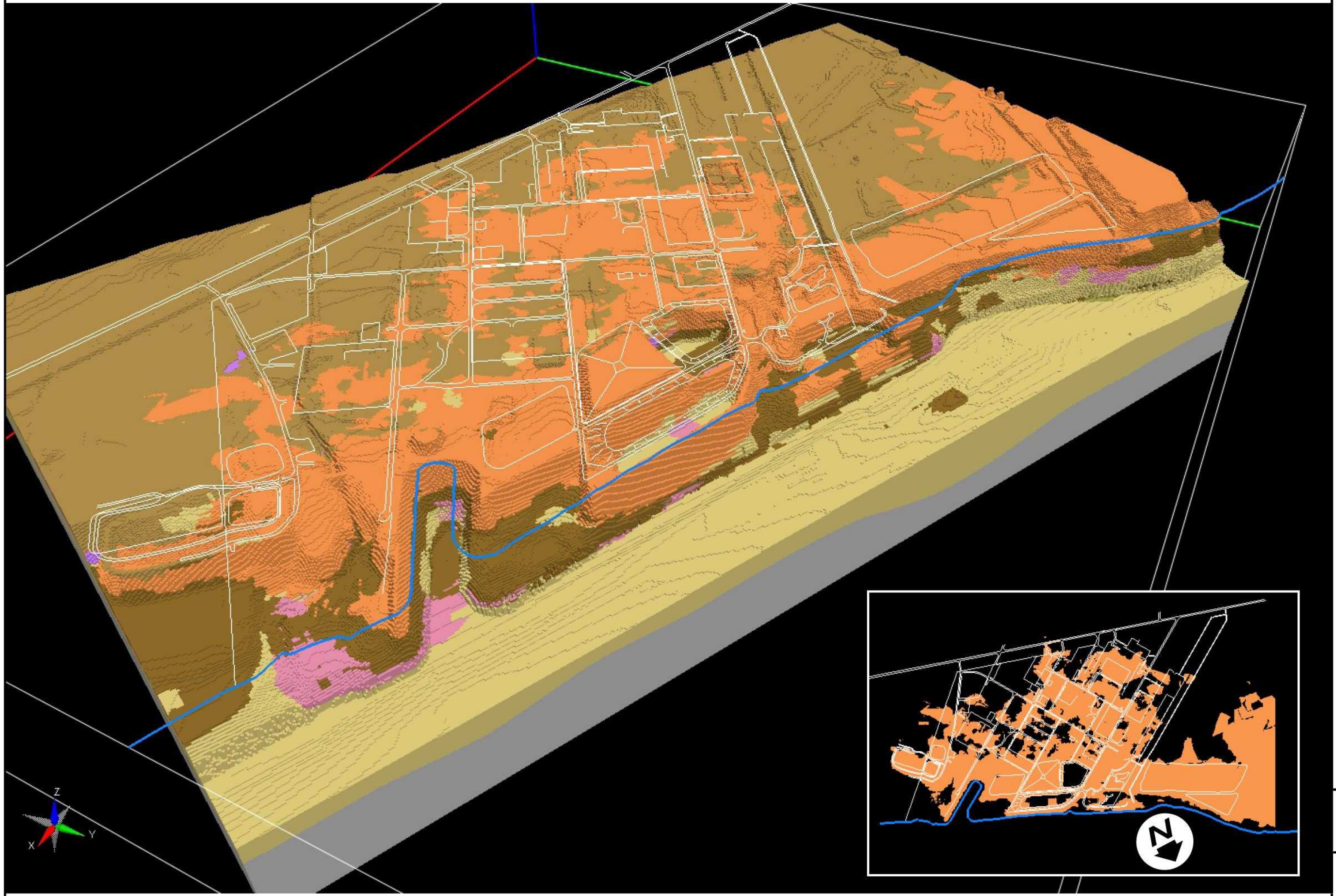
Explanation

- 🟫 Clay and Silt
- 🟫 Clay and Silt on Floodplain
- 🟪 Interbeds
- 🟥 Interbeds on Floodplain
- 🟨 Sand and Gravel
- ⬜ Bedrock
- ━ Shoreline

Battelle
The Business of Innovation

Extent of Clay/Silt (C) Hydrocode

FIGURE **4-13**	REMEDIAL INVESTIGATION B.F. GOODRICH SUPERFUND SITE CALVERT CITY, KENTUCKY
4-13_EXTENT_CLAY-SILT.CDR	10/14



Explanation

- 🟧 Fill
- 🟫 Clay and Silt
- 🟫 Clay and Silt on Floodplain
- 🟪 Interbeds
- 🟪 Interbeds on Floodplain
- 🟨 Sand and Gravel
- ⬜ Bedrock
- 〰 Shoreline

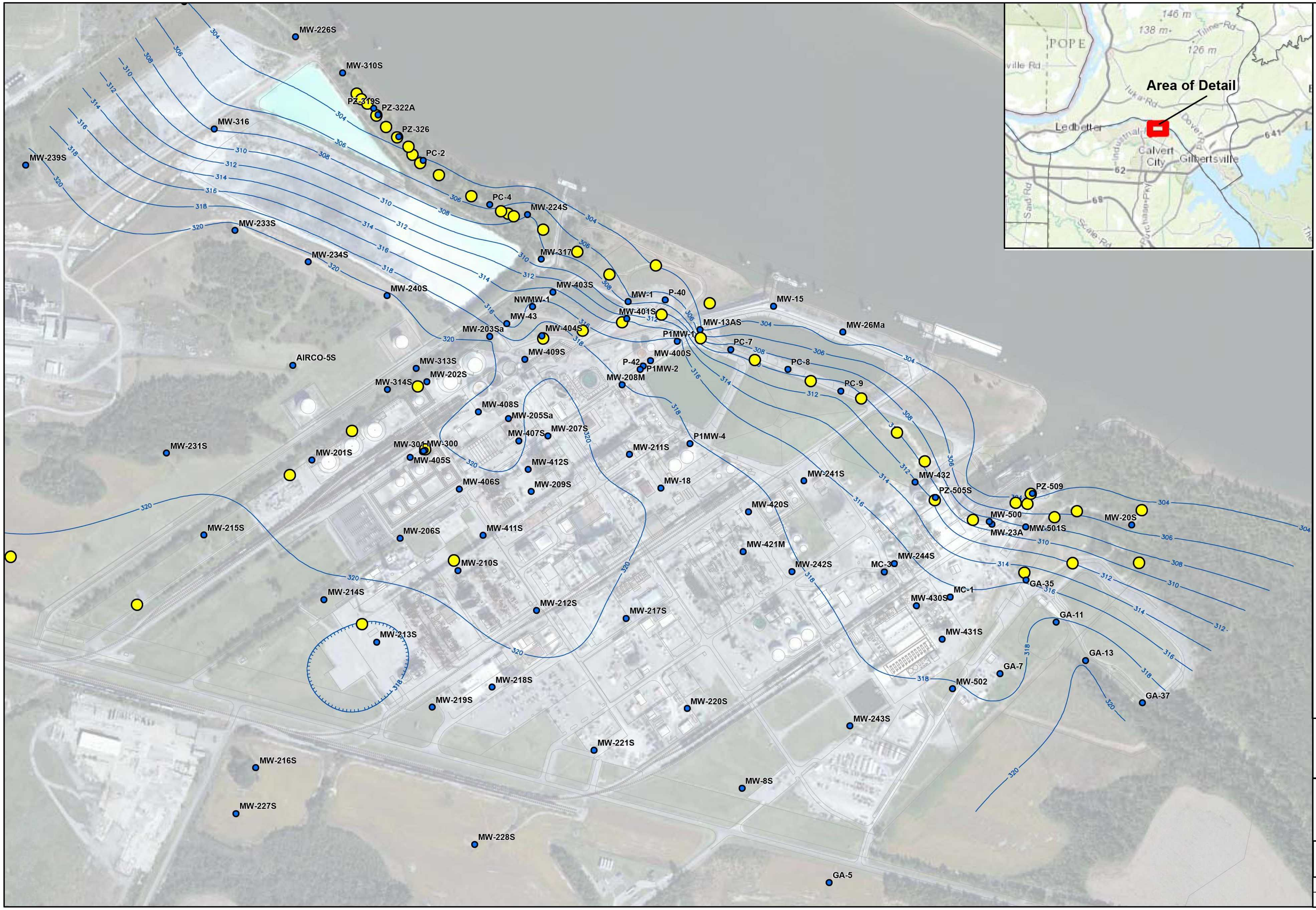
Battelle
The Business of Innovation

Extent of Fill
(FF and FC) Hydrocodes

FIGURE
4-16

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

4-16_EXTENT_FILL.CDR
10/14



Legend

● Monitoring Location

○ PCAP Wells

Notes:

- For well clusters, data from the shallower screen was used for contouring.

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

Groundwater Elevation Contours, Upper Aquifer (November 2011)

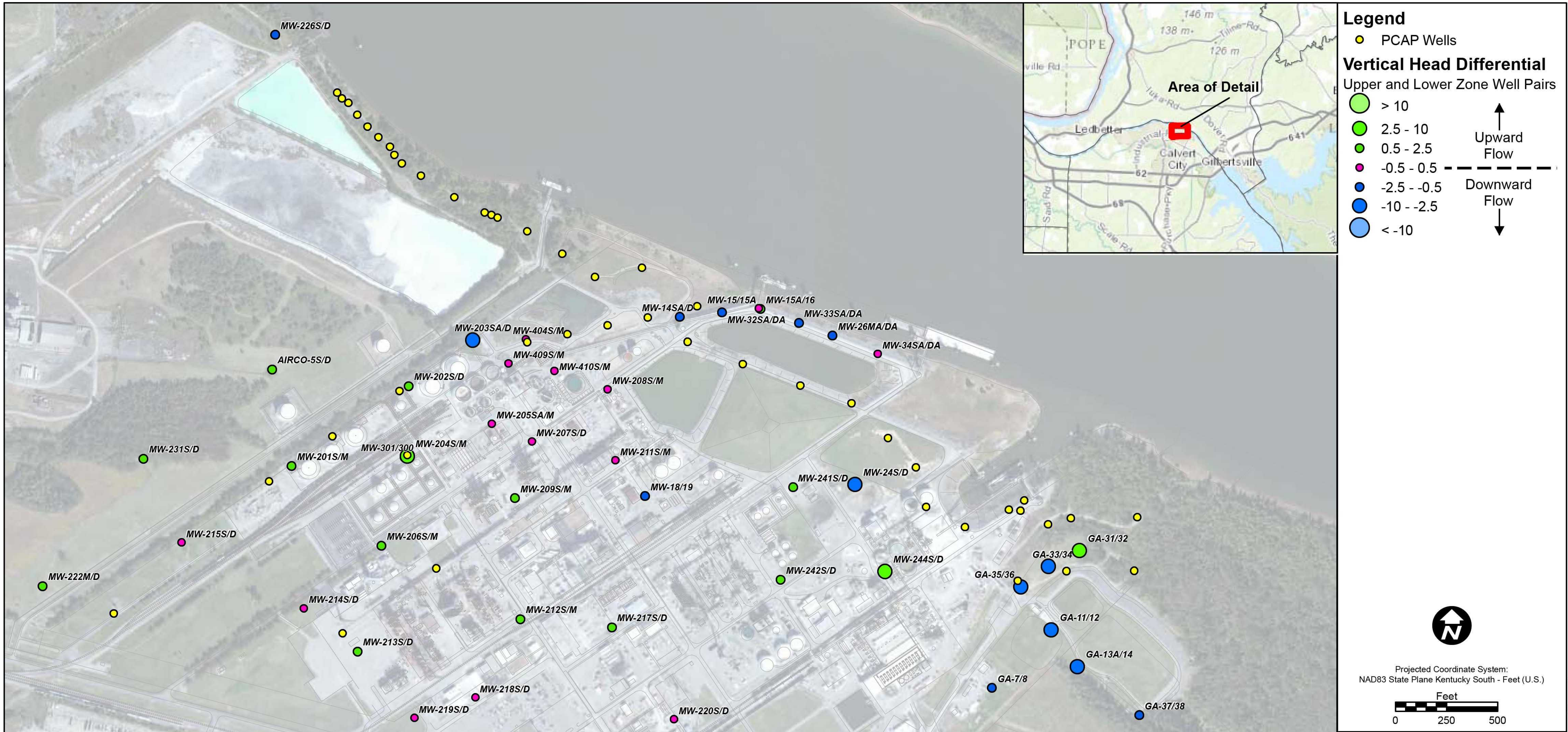
FIGURE
4-29

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 10/21/2014 ANALYST: hicksj

REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\GWL_11Nov_Upper.mxd



Battelle

The Business of Innovation

Vertical Hydraulic Head Differentials (March 2011)

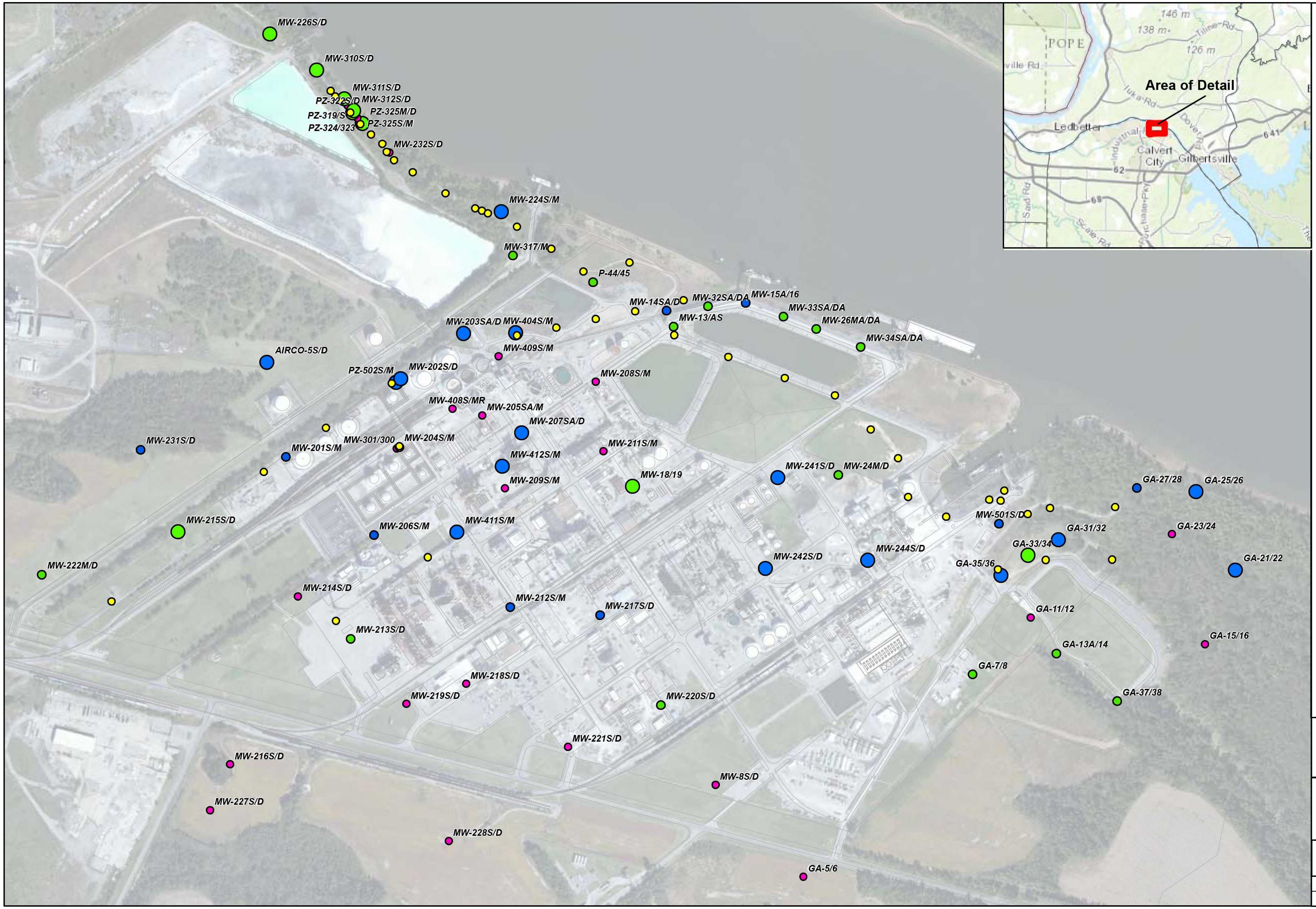
FIGURE
4-33

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 10/22/2014 ANALYST: HICKSJ

REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\GW_vertical_flow_11Mar.mxd



Legend

● PCAP Wells

Vertical Head Differential

Upper and Lower Zone Well Pairs

● > 10
● 2.5 - 10
● 0.5 - 2.5
● -0.5 - 0.5
● -2.5 - -0.5
● -10 - -2.5
● < -10

↑ Upward Flow

Downward Flow ↓

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

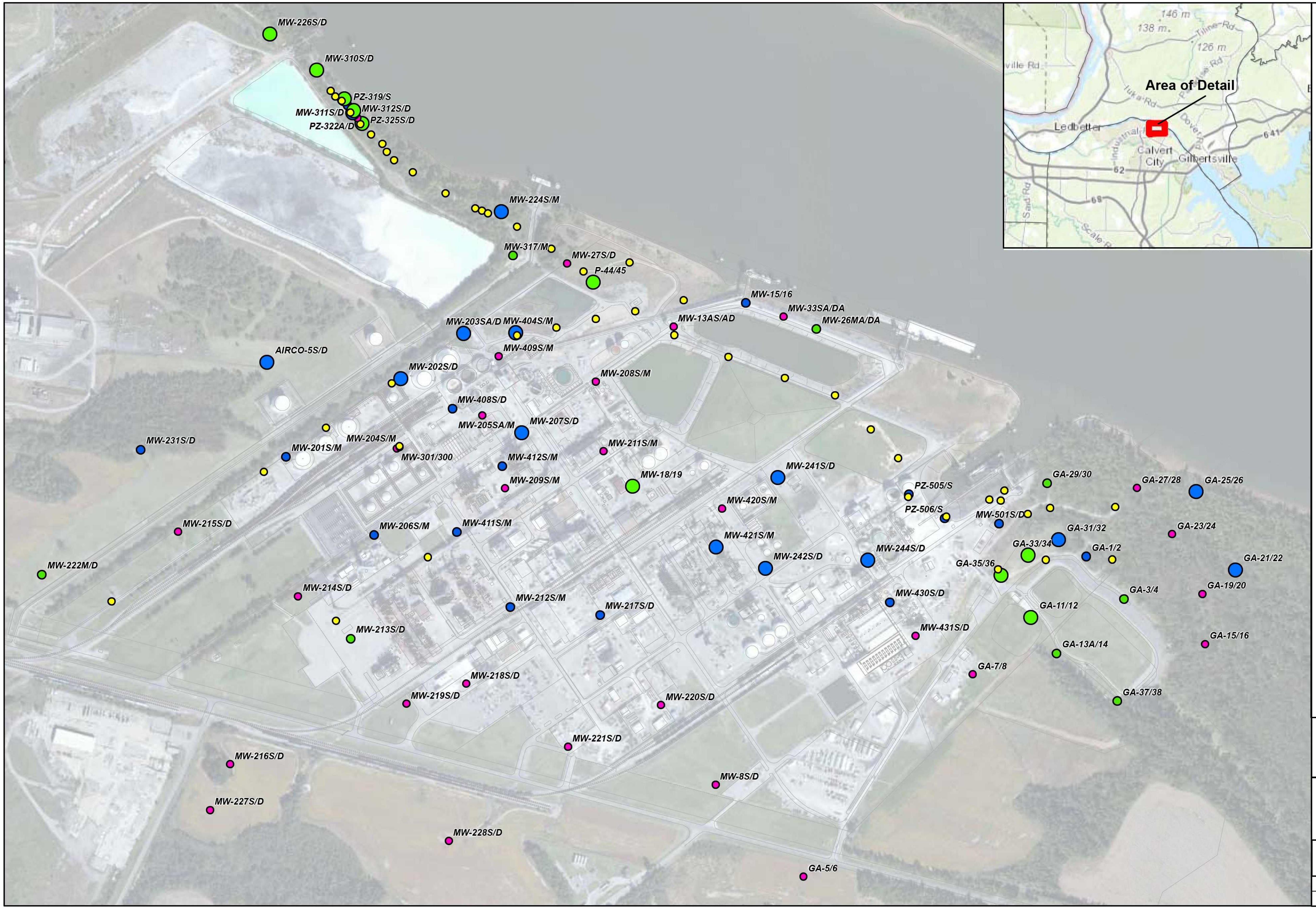
Vertical Hydraulic Head Differentials (August 2011)

FIGURE **4-34**

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 10/22/2014	ANALYST: HICKSJ
REV. 0	APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\GWL_vertical_flow_11Aug.mxd



Legend

● PCAP Wells

Vertical Head Differential

Upper and Lower Zone Well Pairs

- ● > 10
- ● 2.5 - 10
- ● 0.5 - 2.5
- ● -0.5 - 0.5
- ● -2.5 - -0.5
- ● -10 - -2.5
- ● < -10

↑ Upward Flow

Downward Flow ↓

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

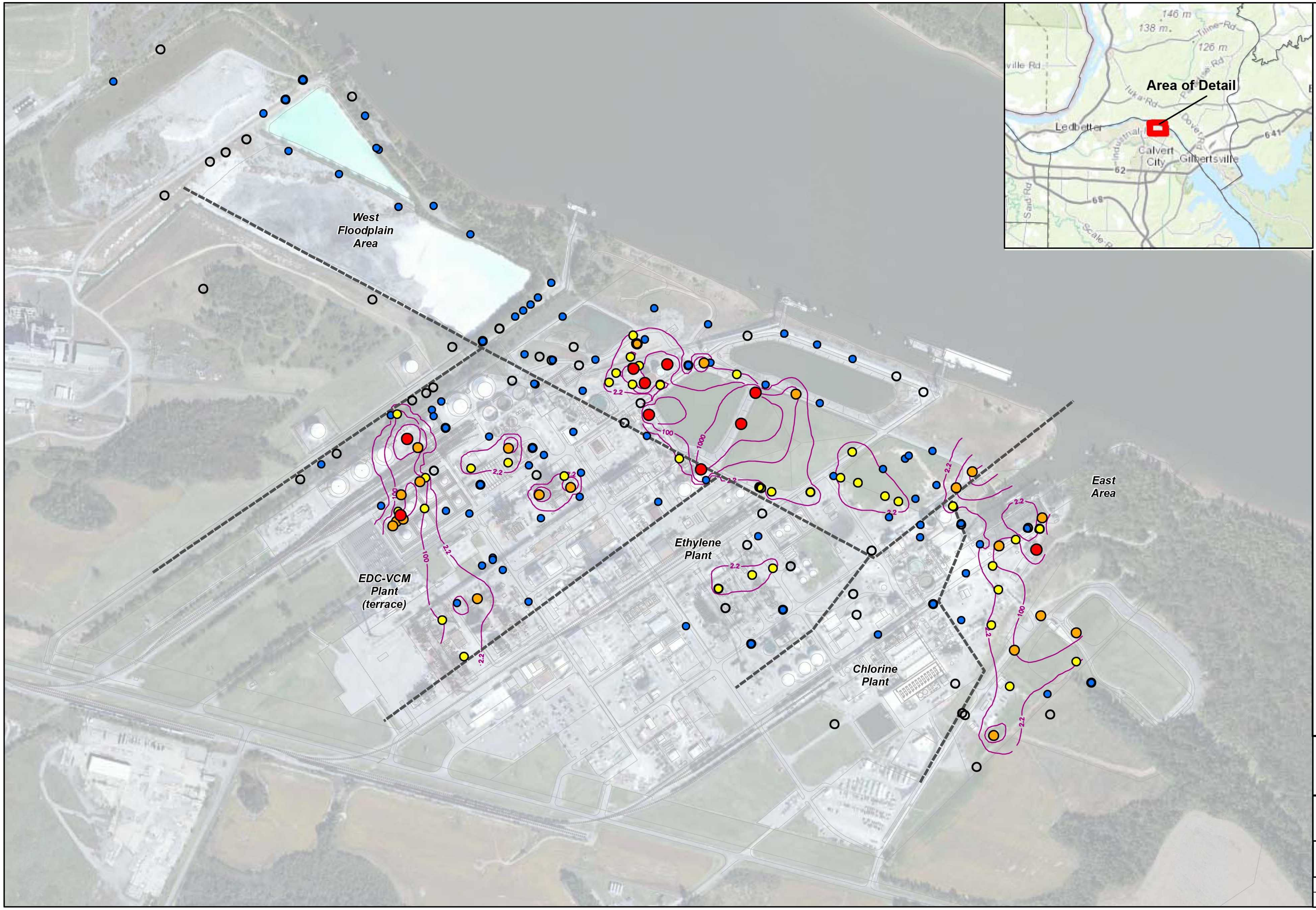
Feet
0 250 500

Battelle
The Business of Innovation

Vertical Hydraulic Head Differentials (November 2011)

FIGURE 4-35	B.F. Goodrich Superfund Site Calvert City, Kentucky
DATE: 6/26/2015	ANALYST: HICKSJ
REV. 0	APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\GWL_vertical_flow_11Nov.mxd



Legend

- ● > 1,000 mg/kg
- ● 100 - 1,000 mg/kg
- ● 2.2 - 100 mg/kg
- ● < 2.2 mg/kg (RSL)
- ○ Not Detected Above Reporting Limit
- — 1,2-DCA Contour (mg/kg)
- - - Regions

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

EDC in Soil (10 feet BGS to WT)

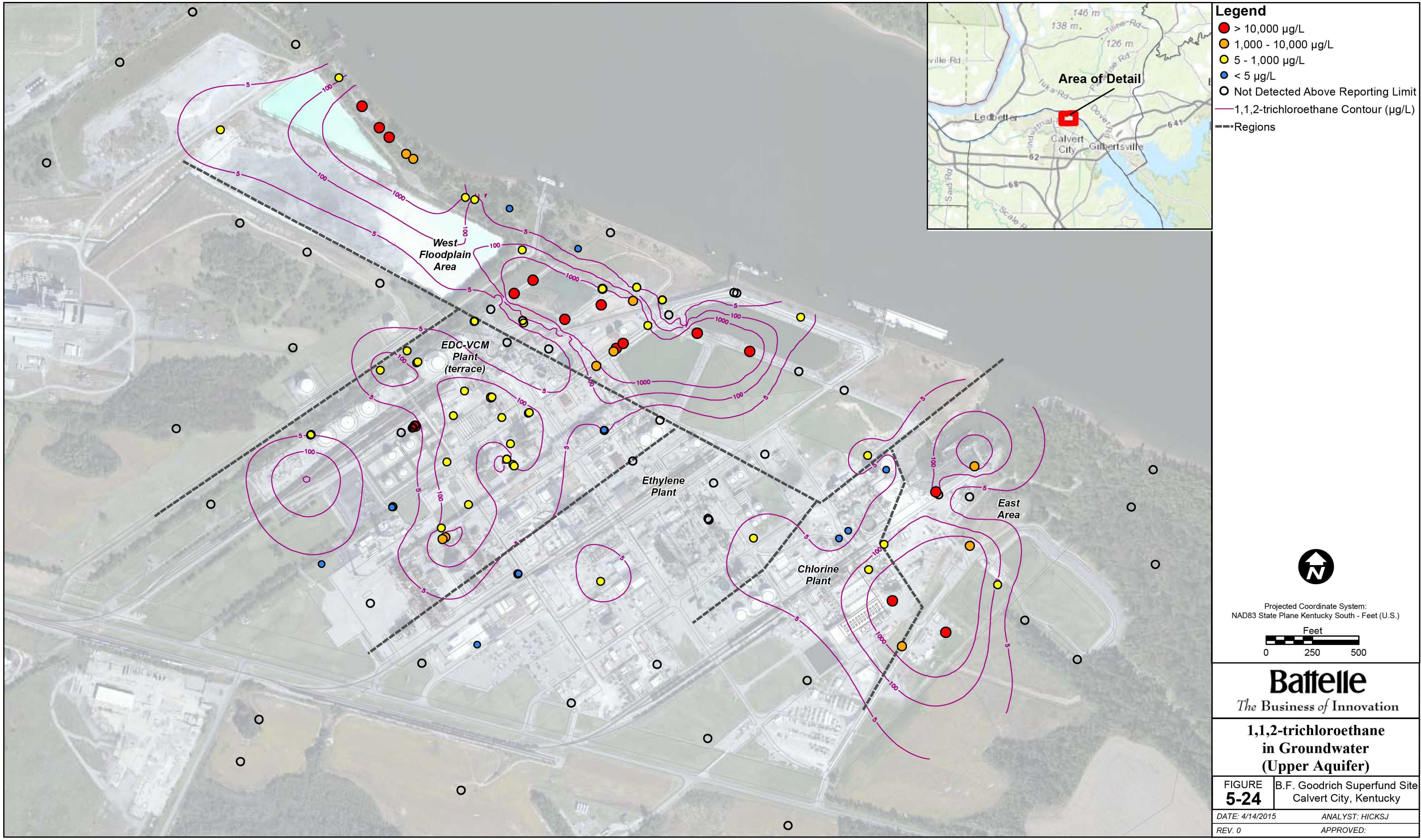
FIGURE 5-7

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/13/2015 ANALYST: HICKSJ

REV. 0 APPROVED:

FILE: C:\G\S\BF_Goodrich\Maps\12DCA_10toGWL_mg_kg.mxd



Legend
- ● > 10,000 µg/L
- ● 1,000 - 10,000 µg/L
- ● 5 - 1,000 µg/L
- ● < 5 µg/L
- ○ Not Detected Above Reporting Limit
- — 1,1,2-trichloroethane Contour (µg/L)
- ╌ Regions

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Battelle
The Business of Innovation

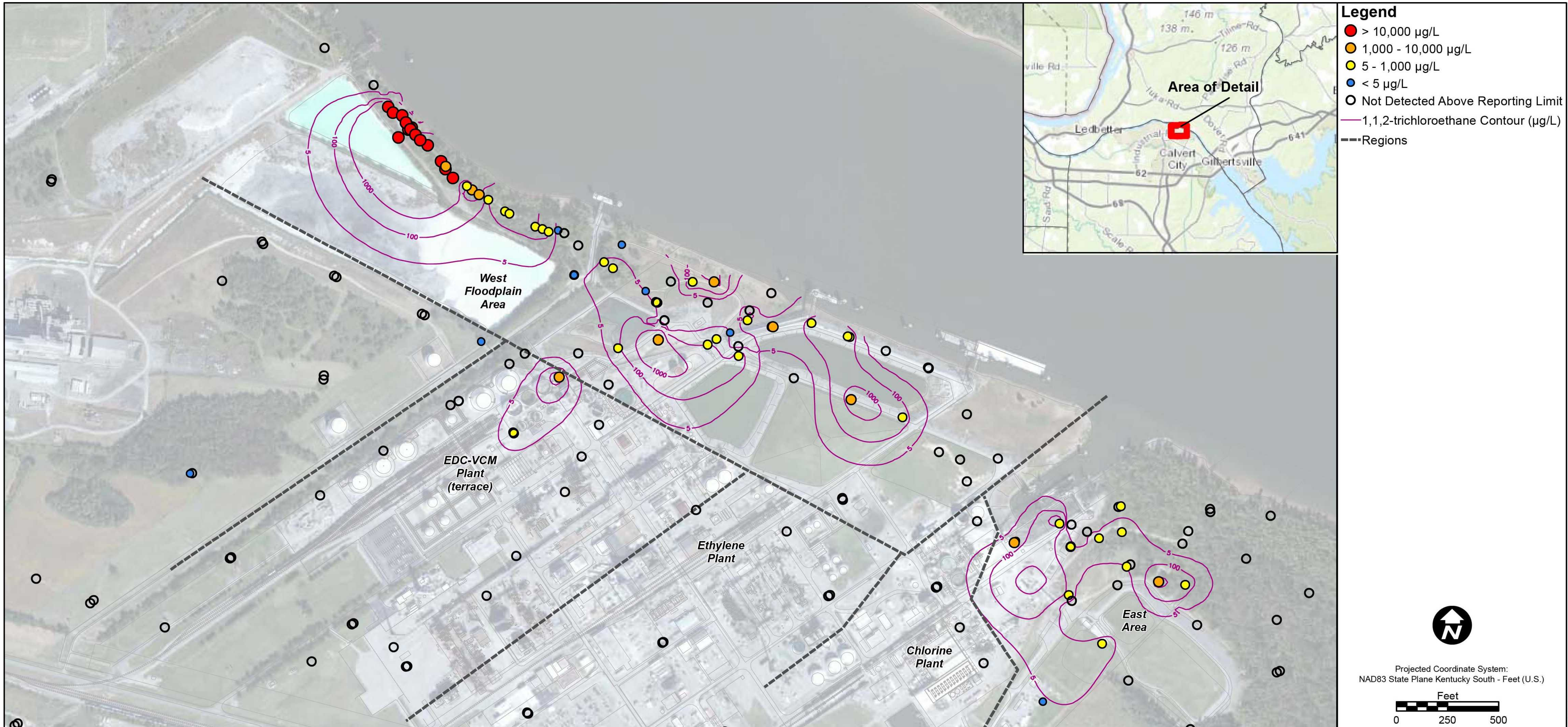
1,1,2-trichloroethane in Groundwater (Upper Aquifer)

FIGURE
5-24

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015
ANALYST: HICKSJ
REV. 0
APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\112TCA_Upper_ND0.mxd



Battelle
The Business of Innovation

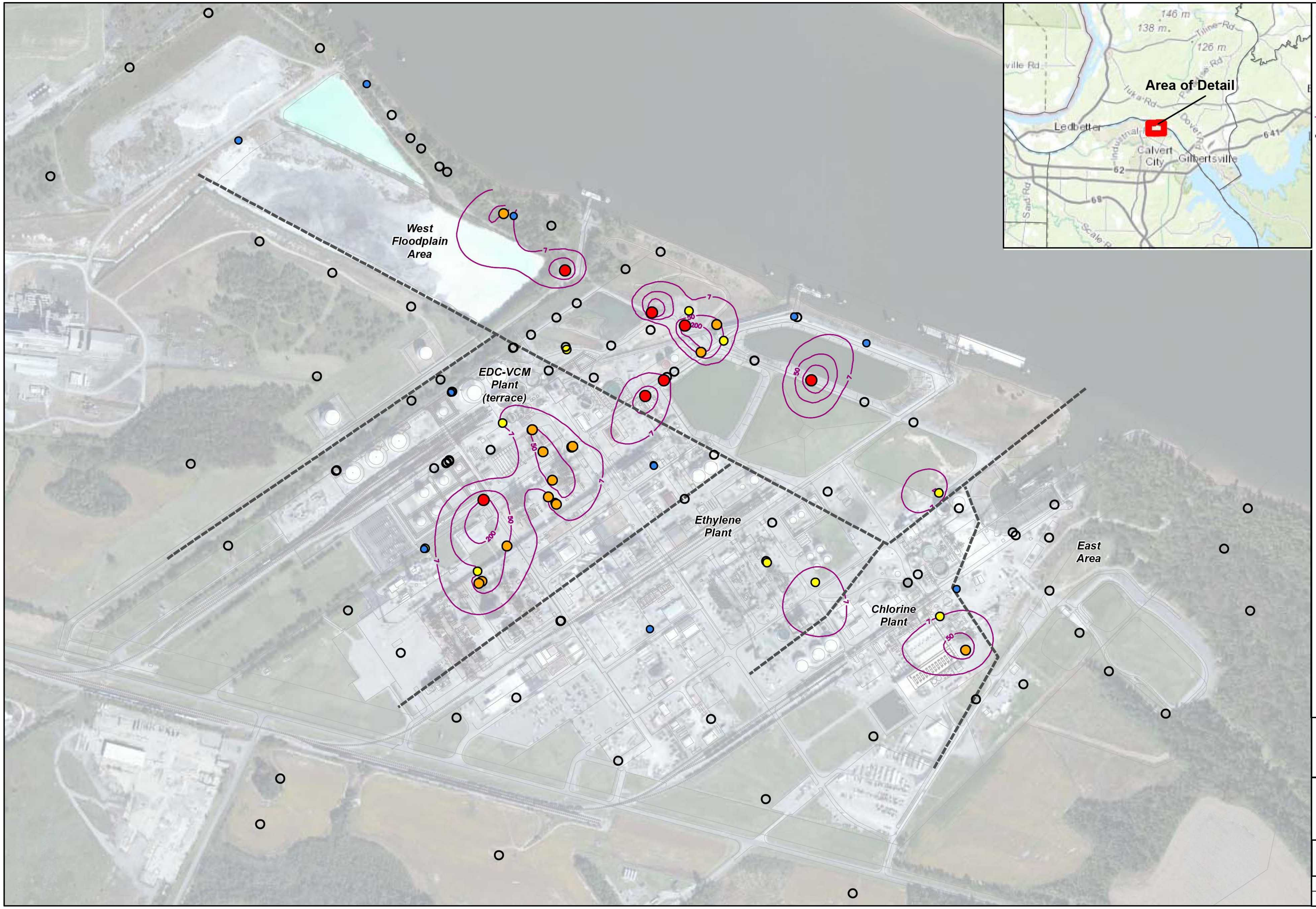
1,1,2-trichloroethane in Groundwater (Lower Aquifer)

FIGURE
5-25

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\112TCA_Lower_ND0.mxd



Legend

- 🔴 > 200 µg/L
- 🟠 50 - 200 µg/L
- 🟡 7 - 50 µg/L
- 🔵 < 7 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- — 1,1-dichloroethene Contour (µg/L)
- - - Regions

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

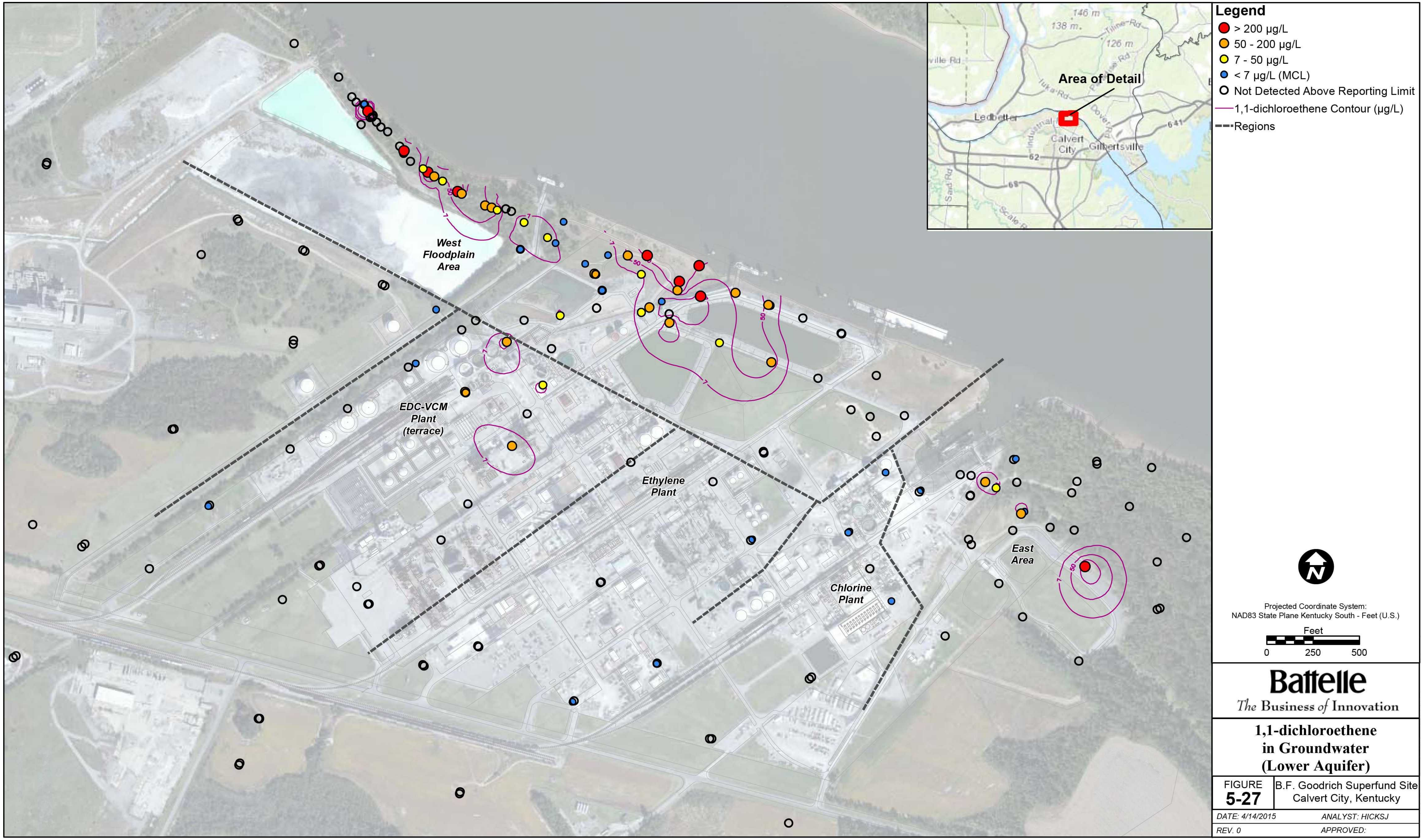
1,1-dichloroethene in Groundwater (Upper Aquifer)

FIGURE
5-26

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\11DCE_Upper_ND0.mxd



Battelle
The Business of Innovation

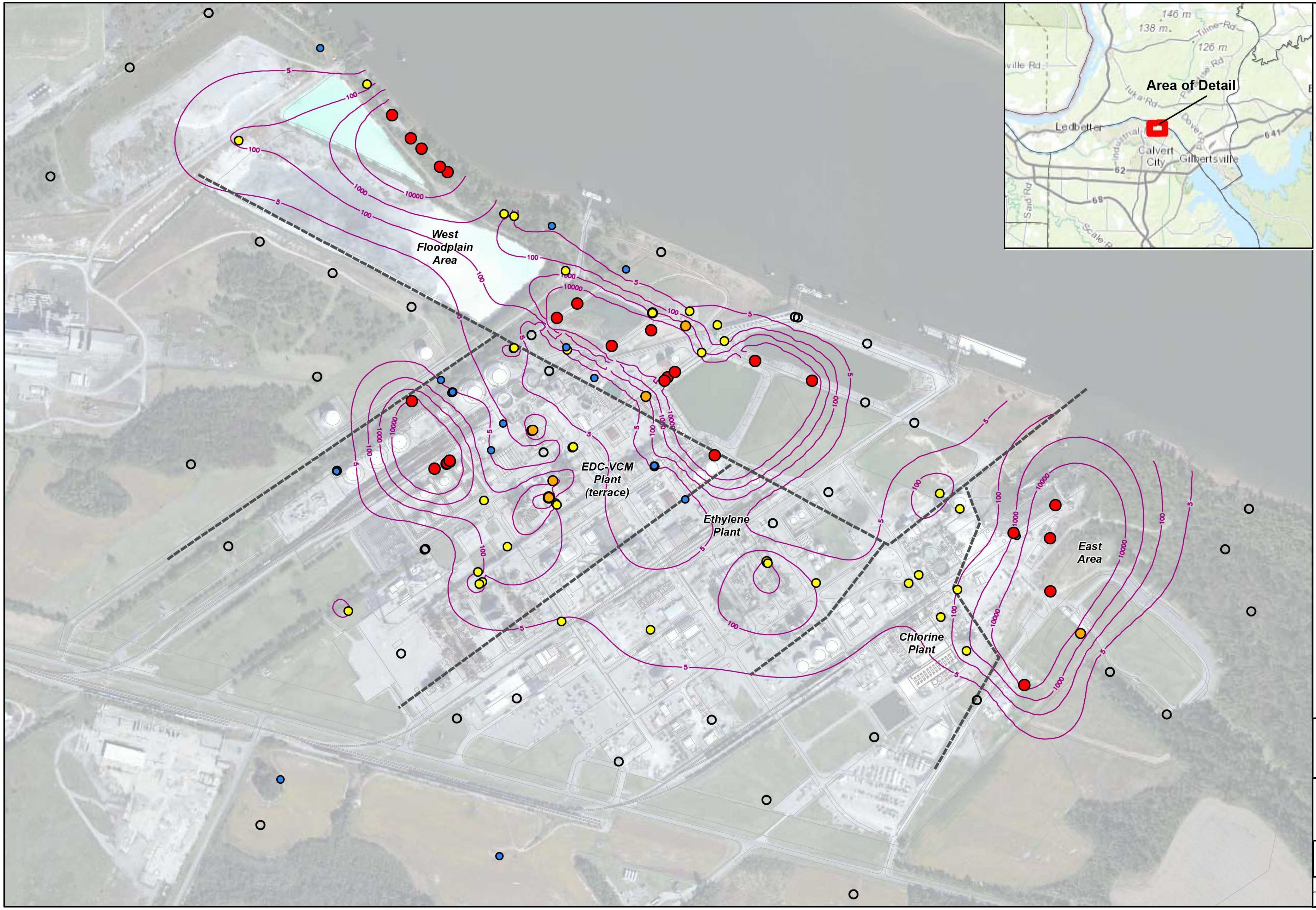
1,1-dichloroethene in Groundwater (Lower Aquifer)

FIGURE 5-27

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\11DCE_Lower_ND0.mxd



Battelle
The Business of Innovation

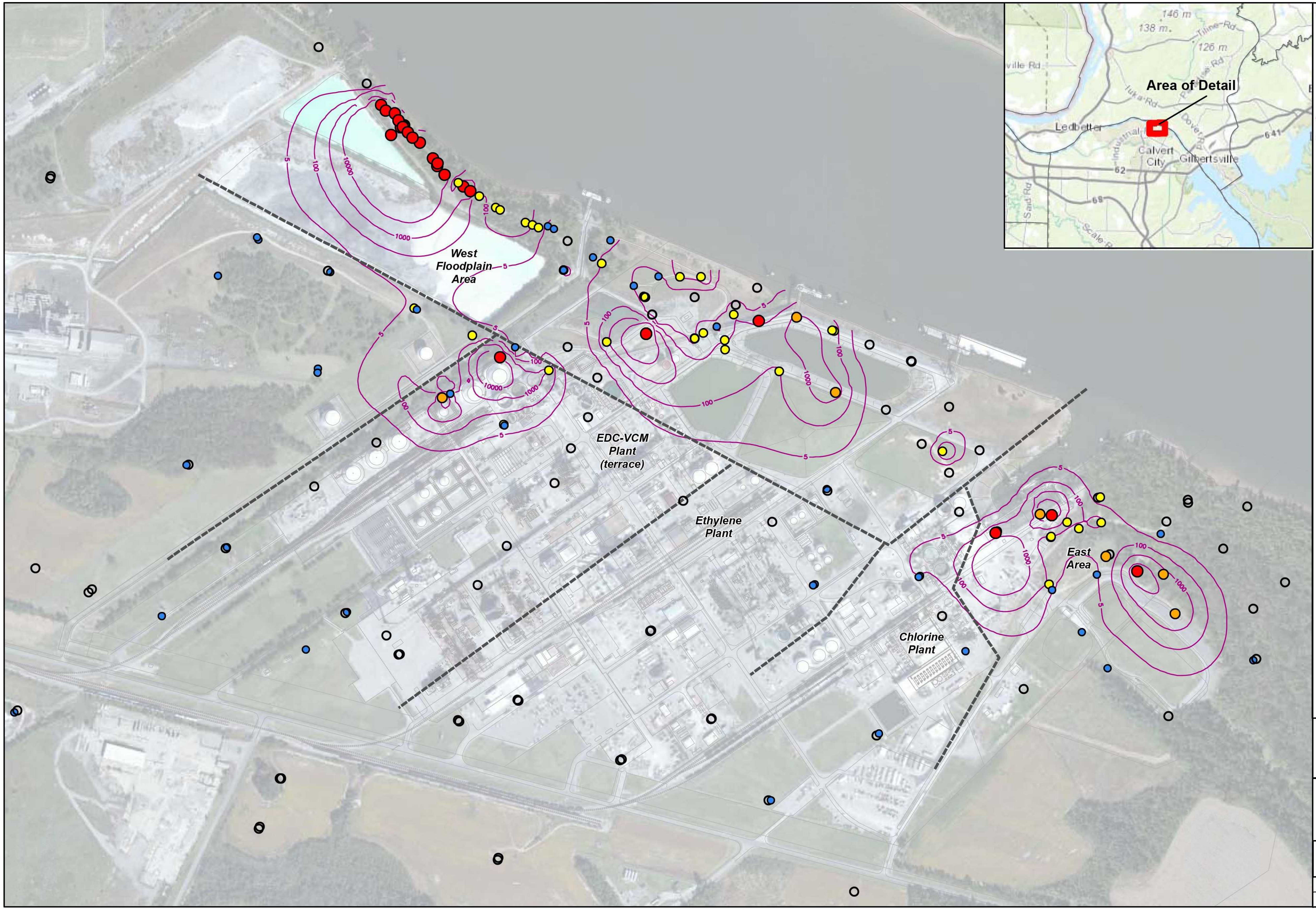
EDC in Groundwater (Upper Aquifer)

FIGURE 5-28

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015
ANALYST: HICKSJ
REV. 0
APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\12DCA_Upper_ND0.mxd



Legend

- 🔴 > 10,000 µg/L
- 🟠 1,000 - 10,000 µg/L
- 🟡 5 - 1,000 µg/L
- 🔵 < 5 µg/L
- ○ Not Detected Above Reporting Limit
- — 1,2-dichloroethane Contour (µg/L)
- - - Regions

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

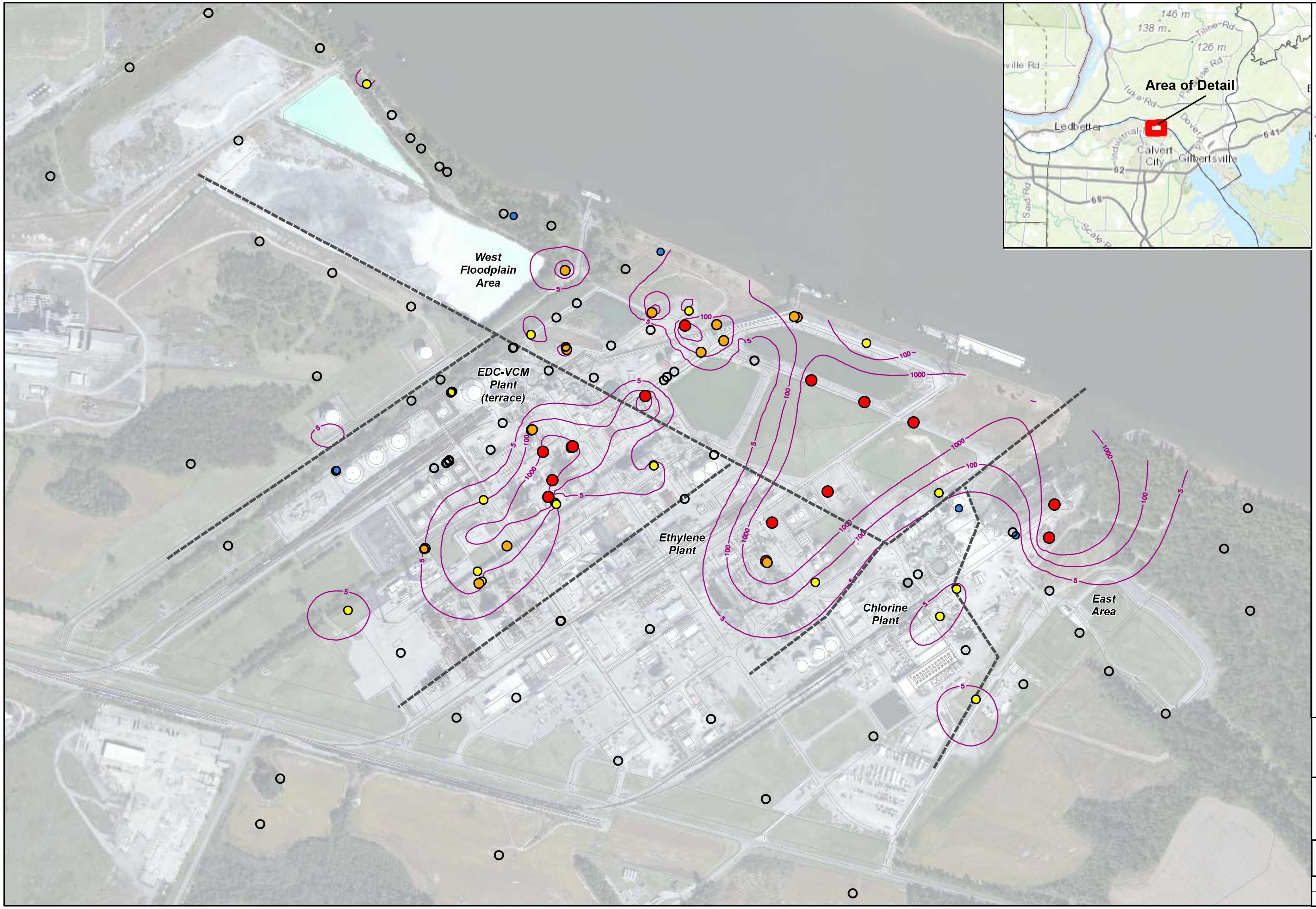
EDC in Groundwater (Lower Aquifer)

FIGURE
5-29

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015
ANALYST: HICKSJ
REV. 0
APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\12DCA_Lower_ND0.mxd



Legend

- 🔴 >1,000 µg/L
- 🟠 100 - 1,000 µg/L
- 🟡 5 - 100 µg/L
- 🔵 < 5 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- — Benzene Contour (µg/L)
- - - Regions

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

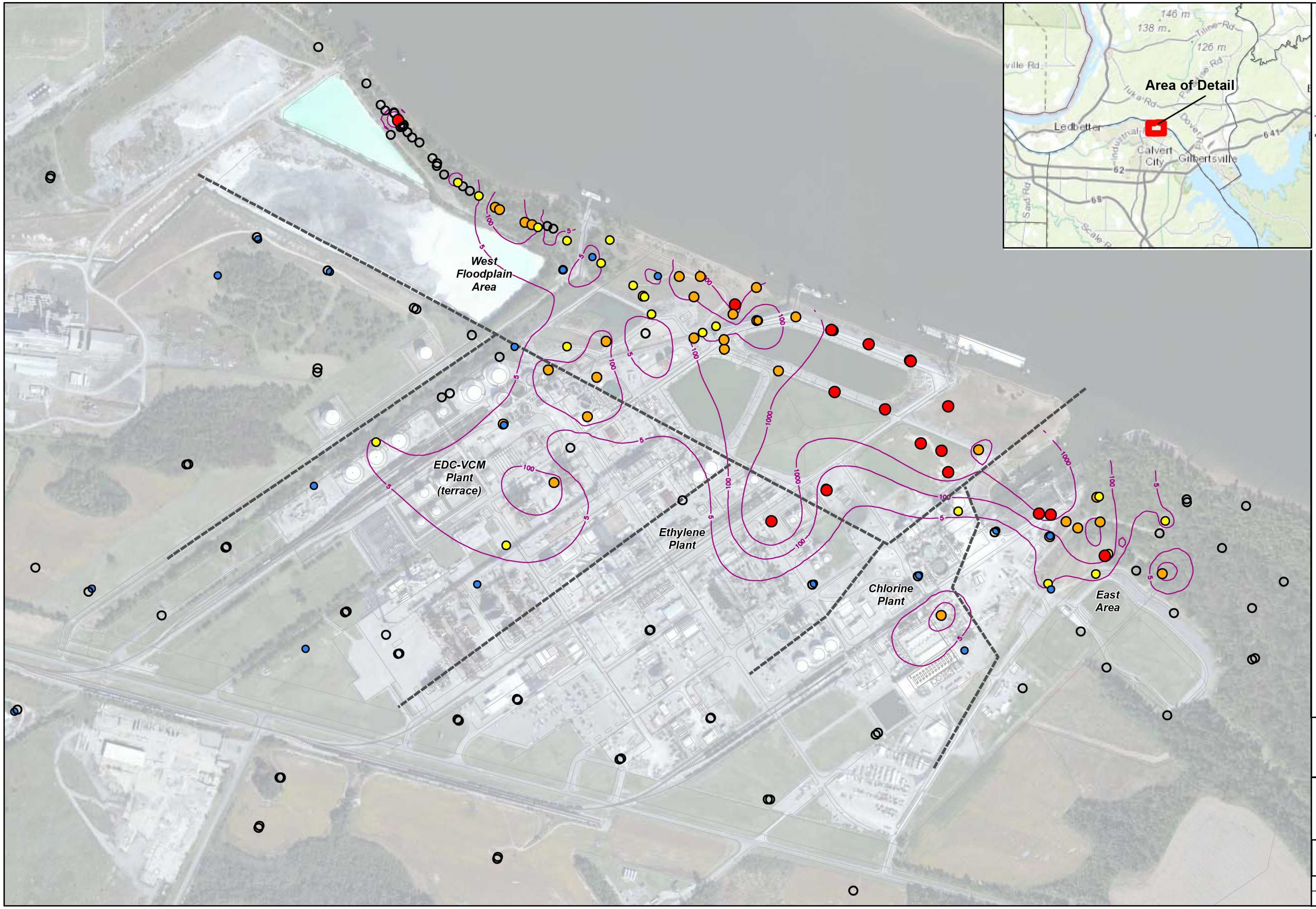
Feet
0 250 500

Battelle
The Business of Innovation

**Benzene
in Groundwater
(Upper Aquifer)**

FIGURE 5-30	B.F. Goodrich Superfund Site Calvert City, Kentucky
DATE: 4/14/2015	ANALYST: HICKSJ
REV. 0	APPROVED:

FILE: C:\G\SBF_Goodrich\Maps\Benzene_Upper_ND0.mxd



Legend

- ● >1,000 µg/L
- ● 100 - 1,000 µg/L
- ● 5 - 100 µg/L
- ● < 5 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- — Benzene Contour (µg/L)
- - - Regions

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

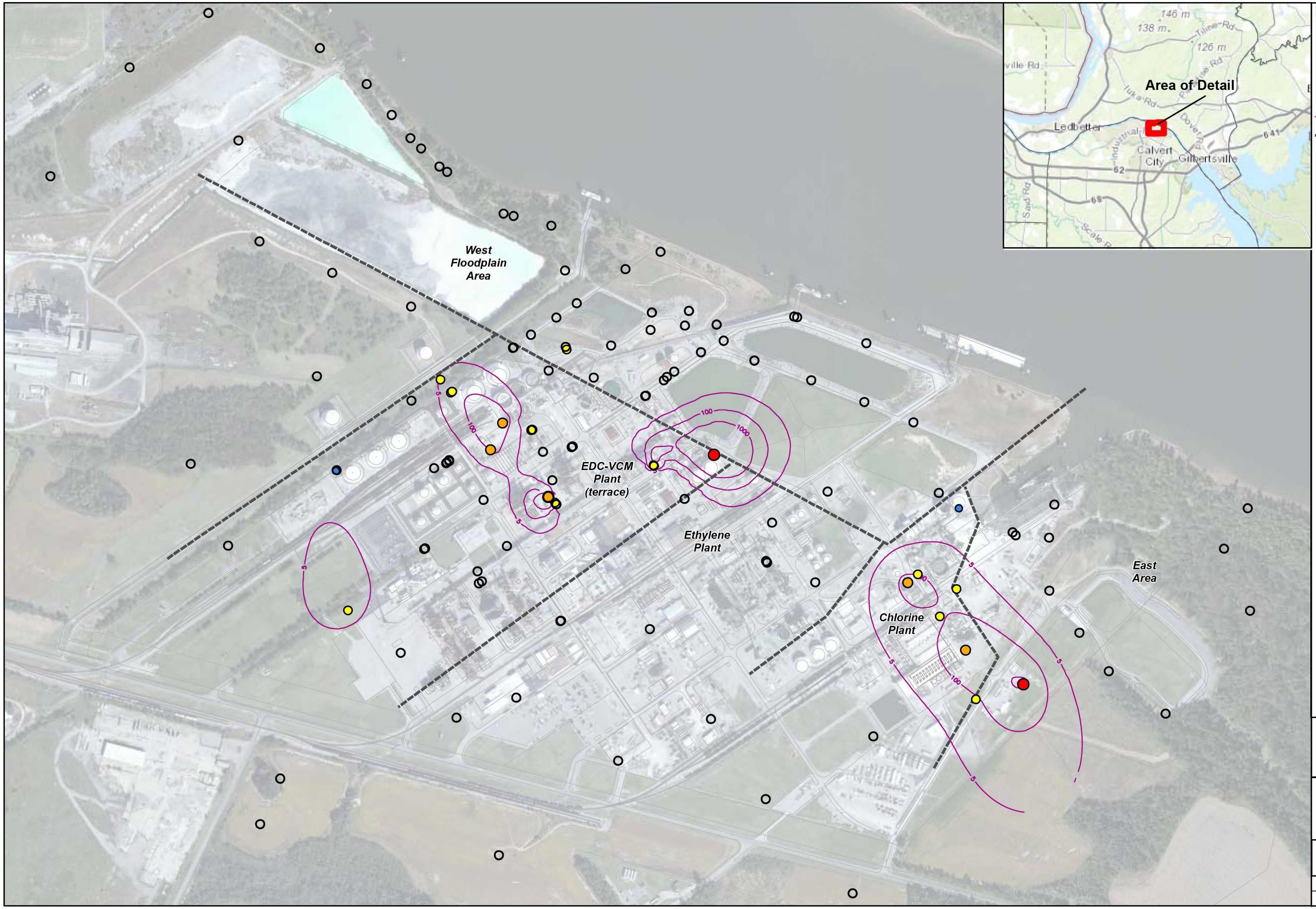
Benzene in Groundwater (Lower Aquifer)

FIGURE
5-31

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 6/26/2015 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\Benzene_Lower_ND0.mxd



Legend

- ● >1,000 µg/L
- ● 100 - 1,000 µg/L
- ● 5 - 100 µg/L
- ● < 5 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- — Carbon Tetrachloride Contour (µg/L)
- - - Regions

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

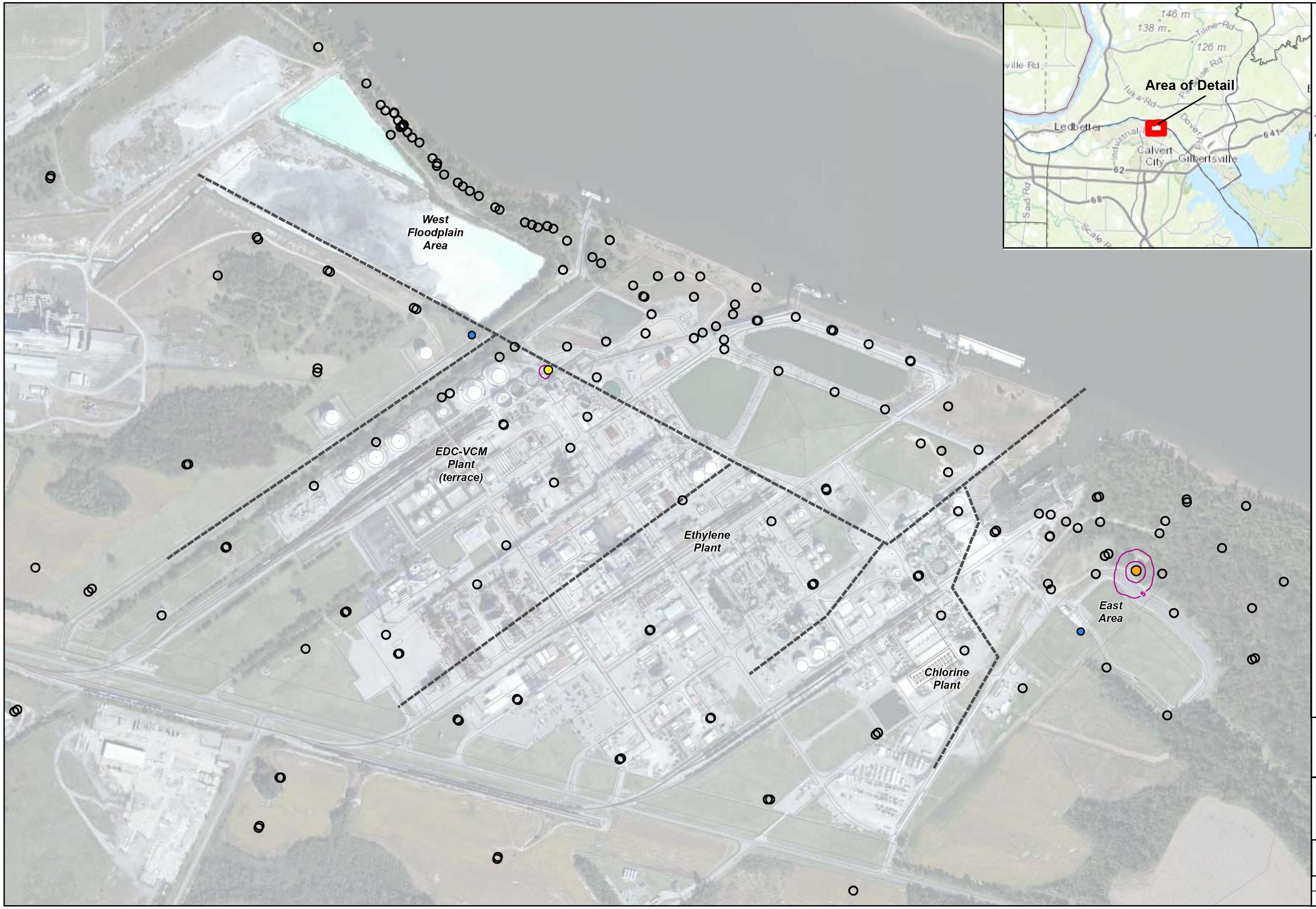
Carbon Tetrachloride in Groundwater (Upper Aquifer)

FIGURE
5-32

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\CTet_Upper_ND0.mxd



Legend

- ● >1,000 µg/L
- ● 100 - 1,000 µg/L
- ● 5 - 100 µg/L
- ● < 5 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- — Carbon Tetrachloride Contour (µg/L)
- - - Regions

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

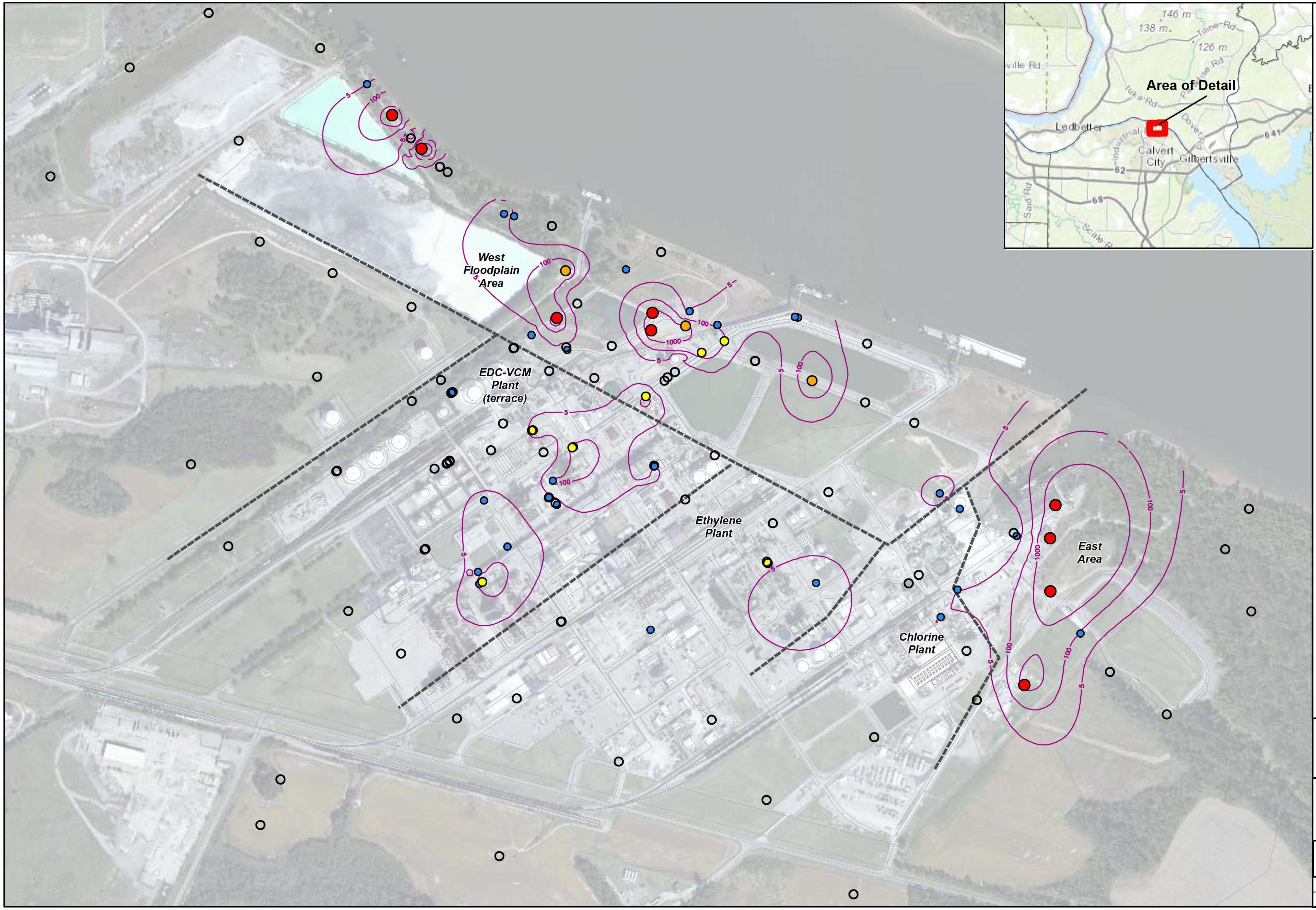
Carbon Tetrachloride in Groundwater (Lower Aquifer)

FIGURE
5-33

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\CTet_Lower_ND0.mxd



Legend

- 🔴 > 1,000 µg/L
- 🟠 500 - 1,000 µg/L
- 🟡 100 - 500 µg/L
- 🔵 < 100 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- — Chlorobenzene Contour (µg/L)
- - - Regions

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

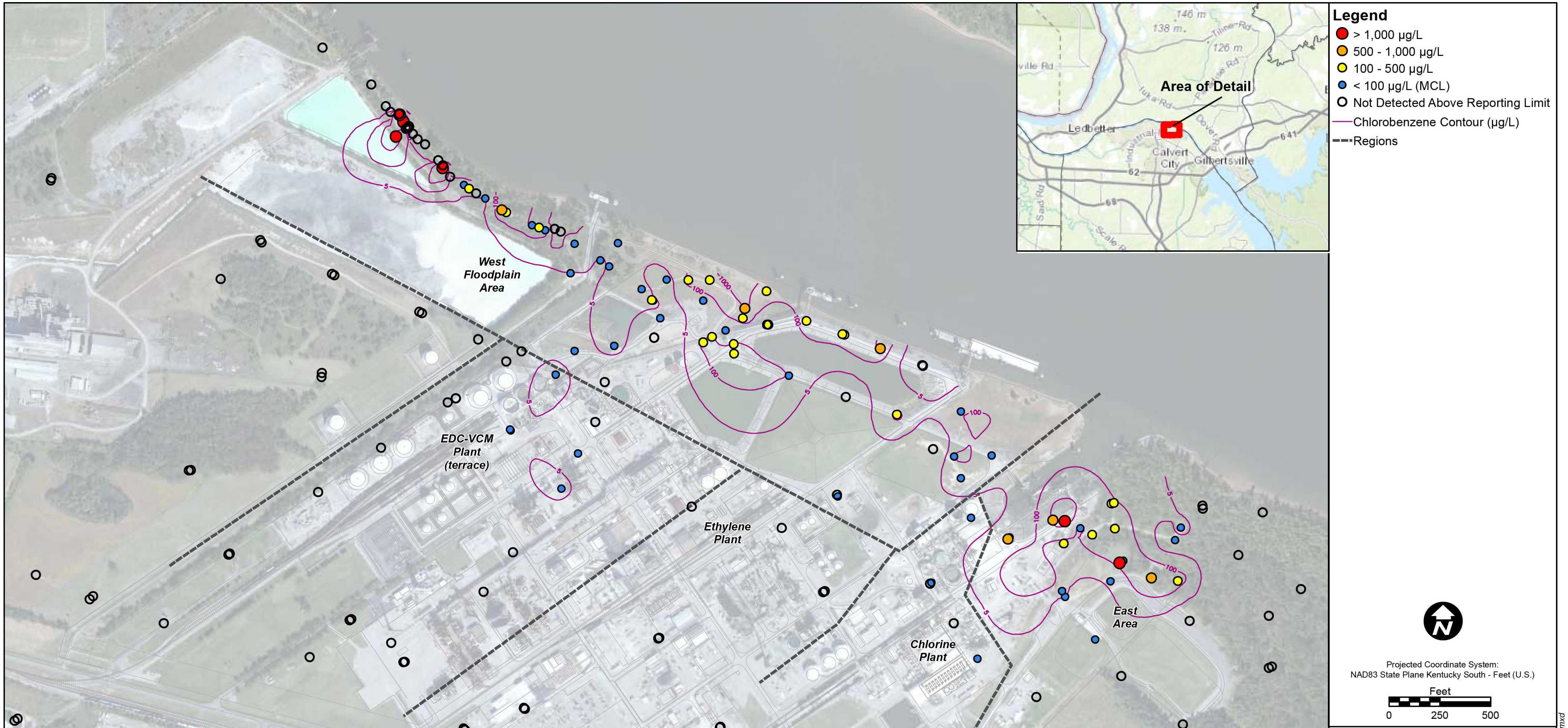
Chlorobenzene in Groundwater (Upper Aquifer)

FIGURE
5-34

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\CB_Upper_ND0.mxd

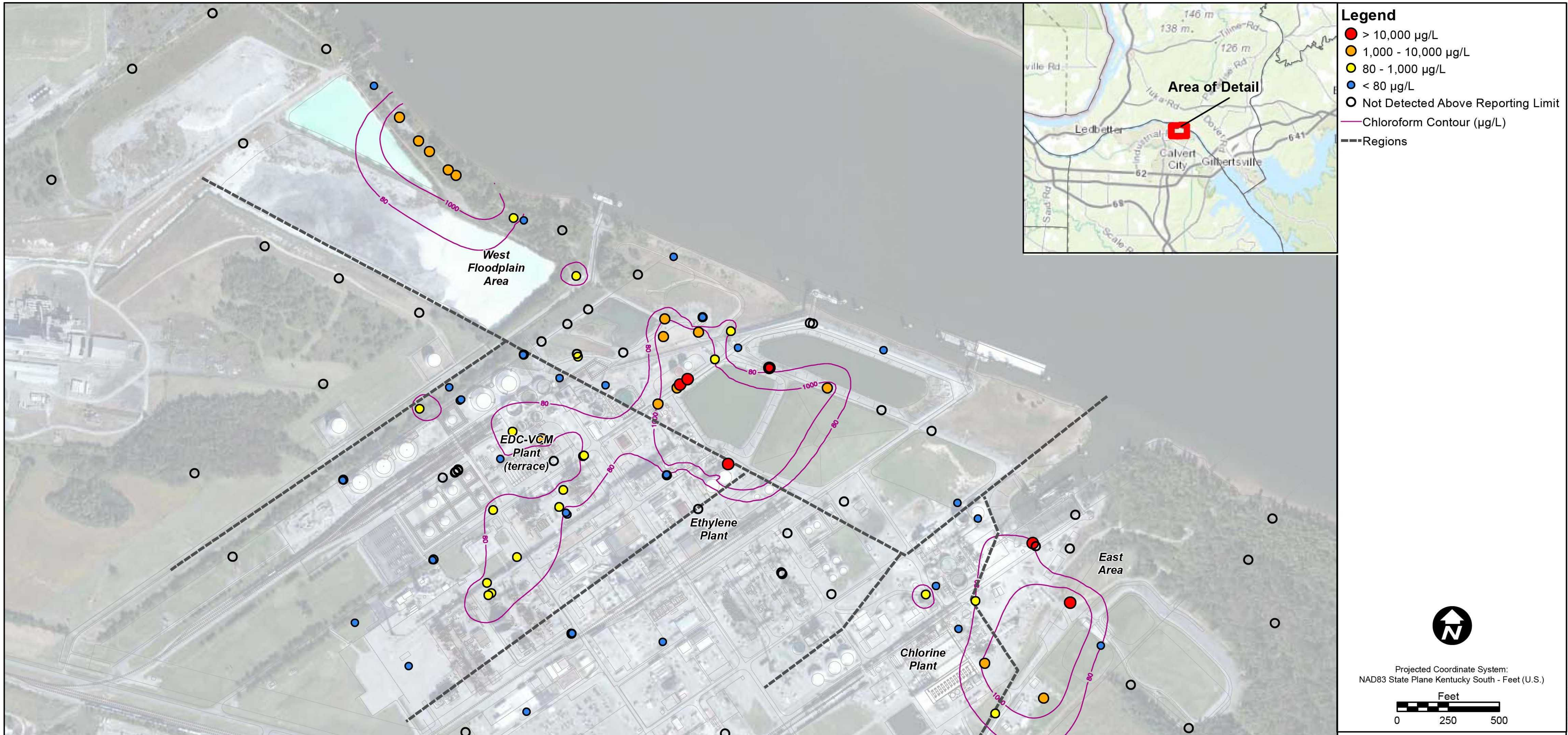


Battelle
The Business of Innovation

Chlorobenzene in Groundwater (Lower Aquifer)

FIGURE 5-35	B.F. Goodrich Superfund Site Calvert City, Kentucky
DATE: 4/14/2015	ANALYST: HICKSJ
REV. 0	APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\CB_Lower_ND0.mxd



Battelle
The Business of Innovation

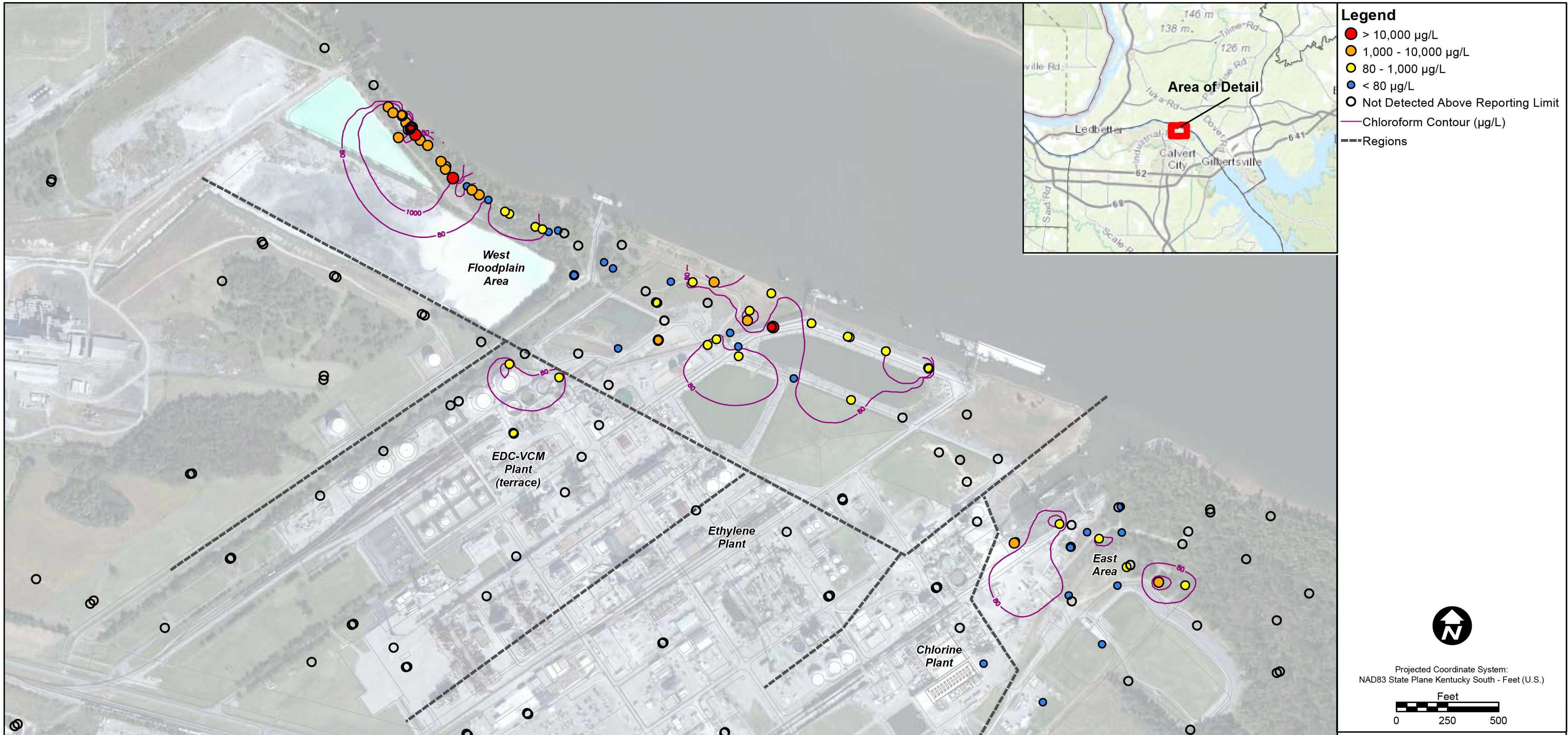
Chloroform in Groundwater (Upper Aquifer)

FIGURE
5-36

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\Chloroform_Upper_ND0.mxd



Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

The Business of Innovation

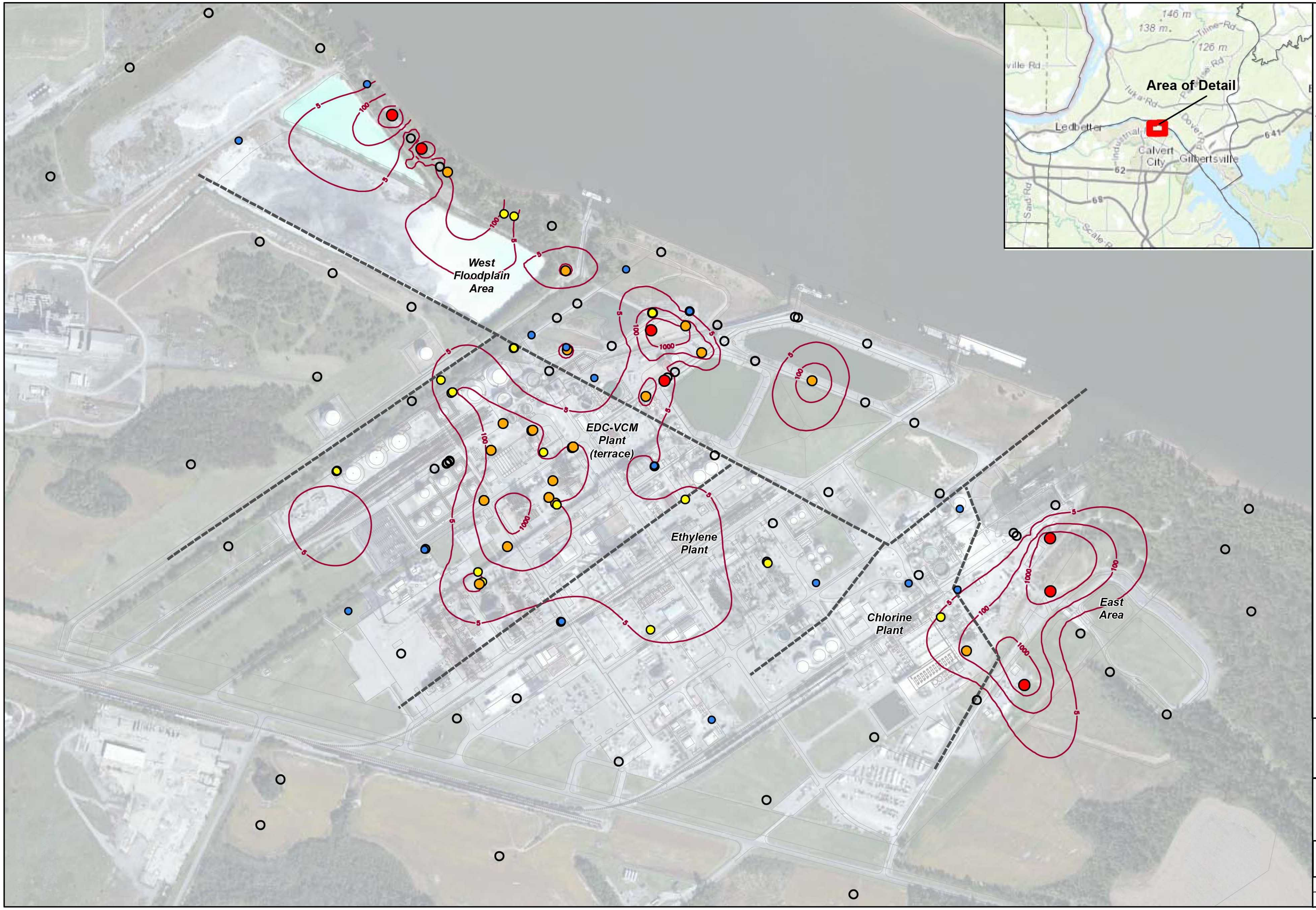
Chloroform in Groundwater (Lower Aquifer)

FIGURE 5-37

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015
ANALYST: HICKSJ
REV. 0
APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\Chloroform_Lower_ND0.mxd



Legend

- 🔴 >1,000 µg/L
- 🟠 100 - 1,000 µg/L
- 🟡 5 - 100 µg/L
- 🔵 < 5 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- ― Tetrachloroethene Contour (µg/L)
- - - Regions

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

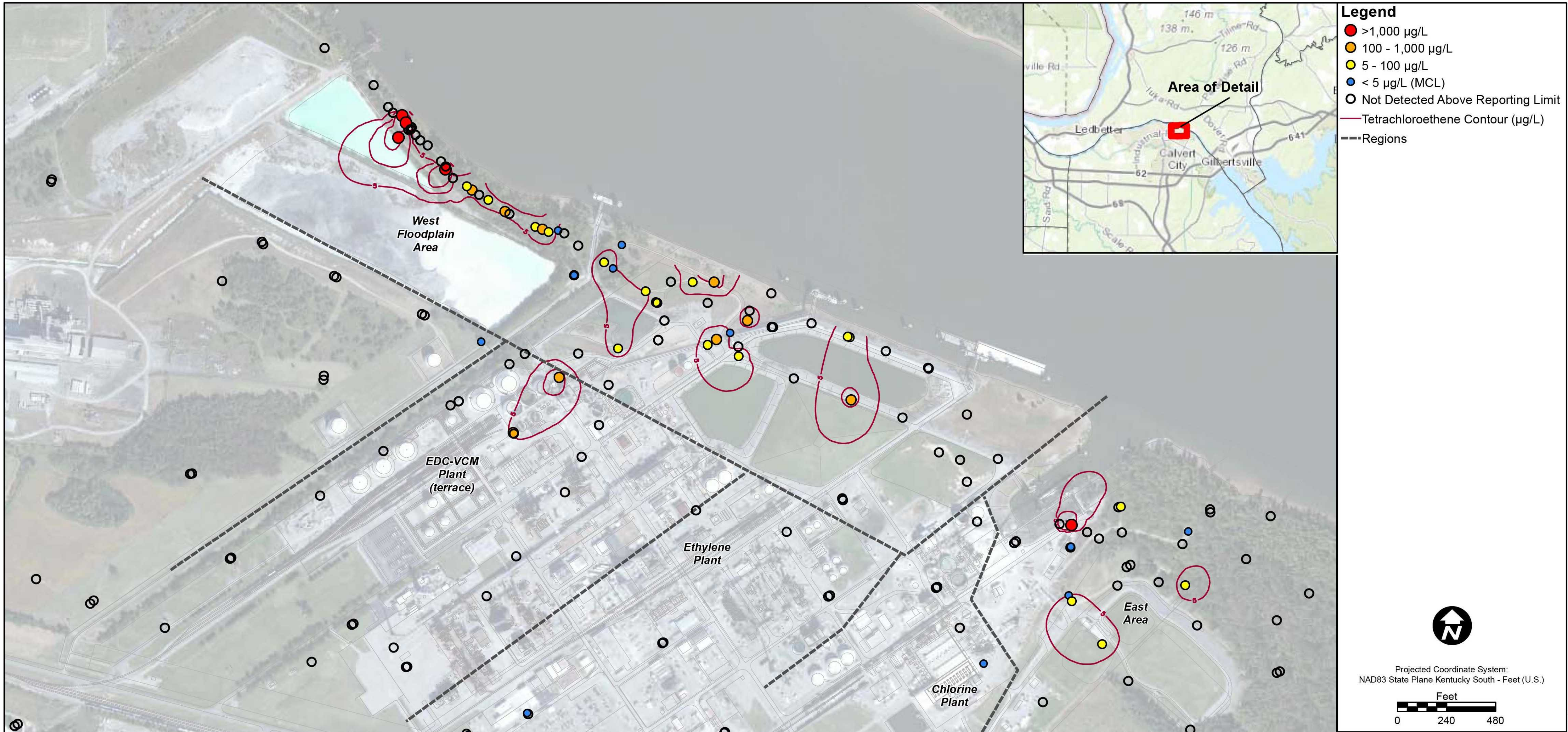
Tetrachloroethene in Groundwater (Upper Aquifer)

FIGURE
5-38

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\PCE_Upper_ND0.mxd



Battelle

The Business of Innovation

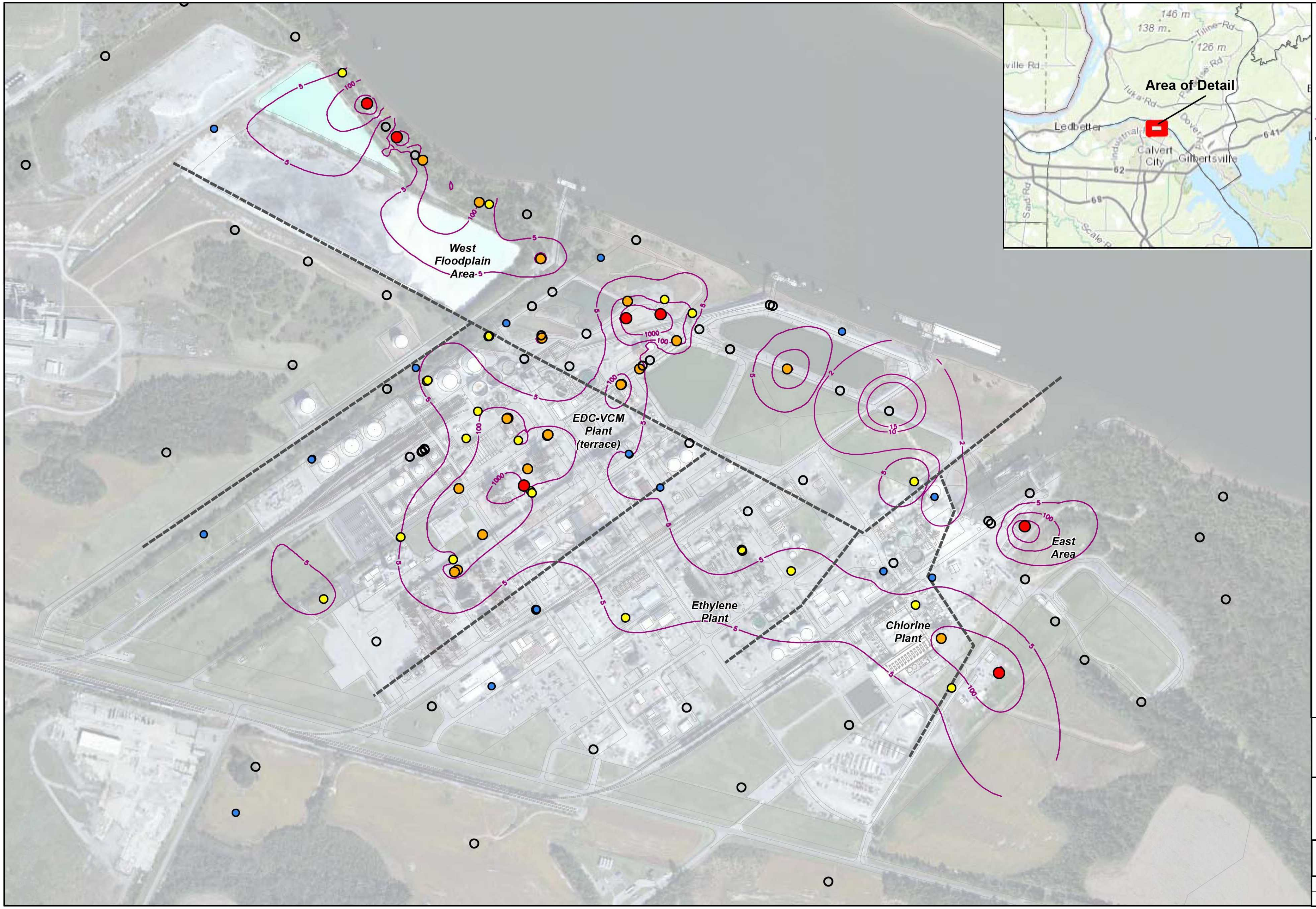
Tetrachloroethene in Groundwater (Lower Aquifer)

FIGURE
5-39

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015
ANALYST: HICKSJ
REV. 0
APPROVED:

FILE: C:\GIS\BF_Goodrich\Maps\PCE_Lower_ND0.mxd



Battelle
The Business of Innovation

Trichloroethene in Groundwater (Upper Aquifer)

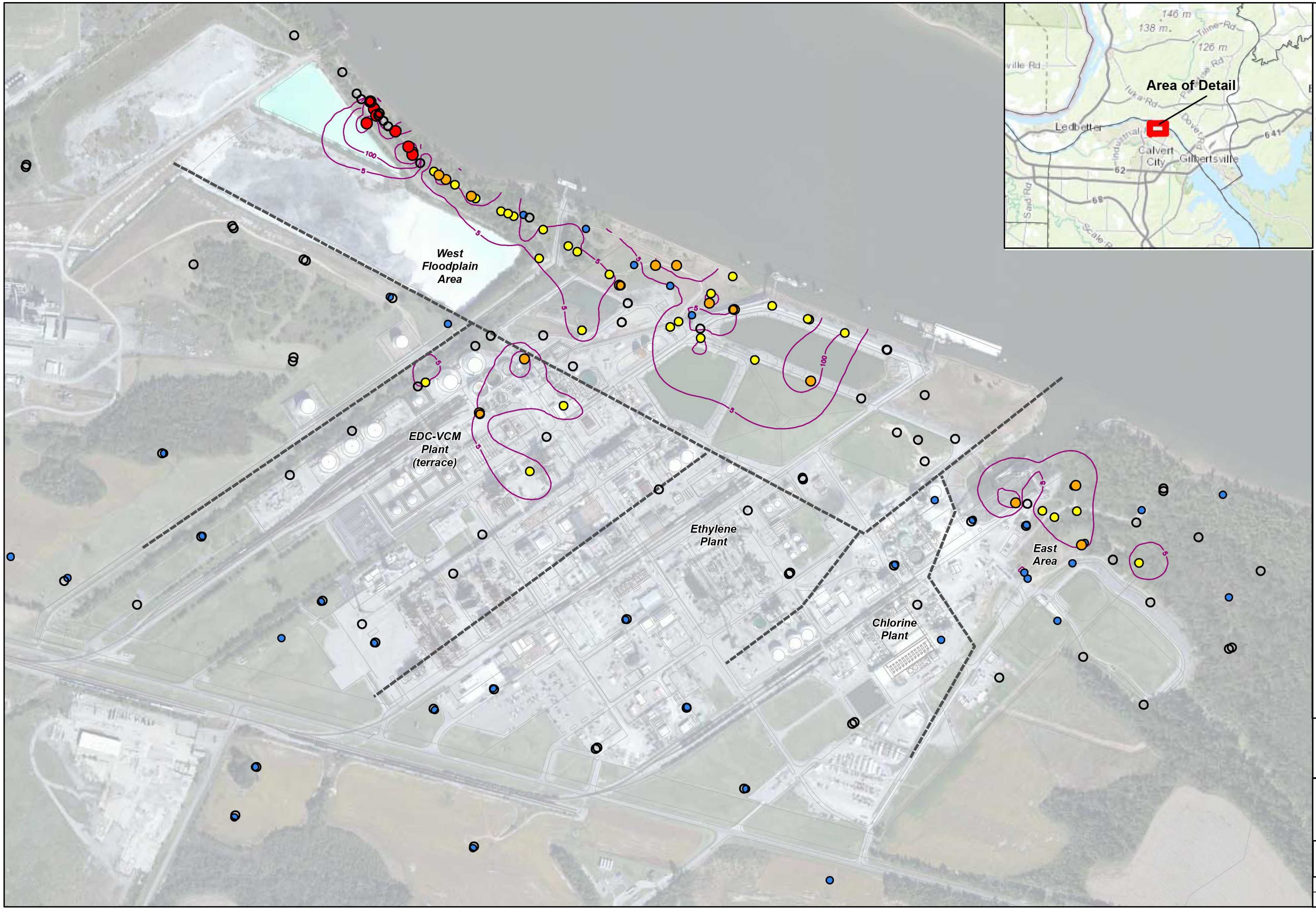
FIGURE
5-40

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*

REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\TCE_Upper_ND0.mxd



Legend

- 🔴 > 1,000 µg/L
- 🟠 100 - 1,000 µg/L
- 🟡 5 - 100 µg/L
- 🔵 < 5 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- — TCE Contour (µg/L)
- - - Regions

N

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

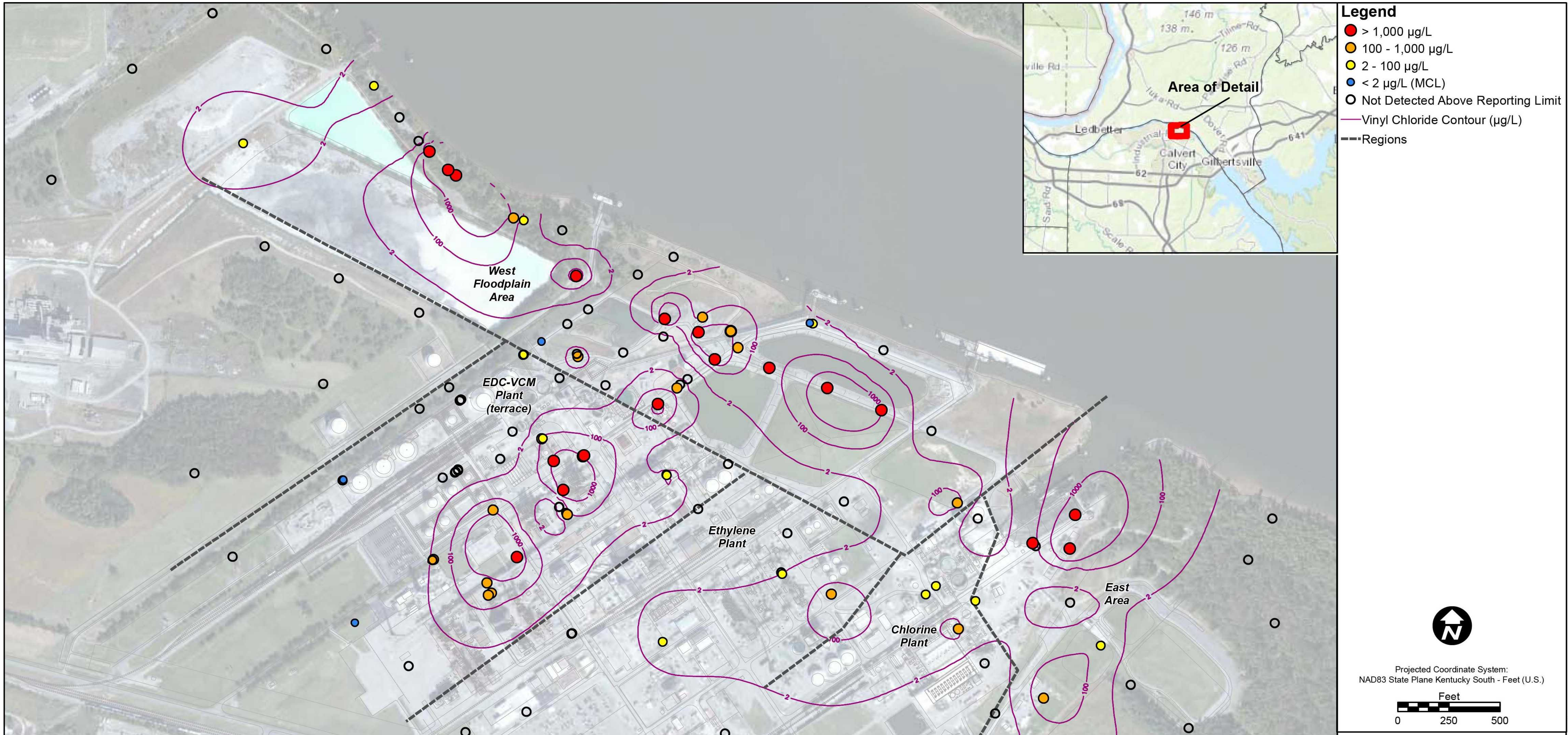
Trichloroethene in Groundwater (Lower Aquifer)

FIGURE **5-41**

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\TCE_Lower_ND0.mxd



Battelle
The Business of Innovation

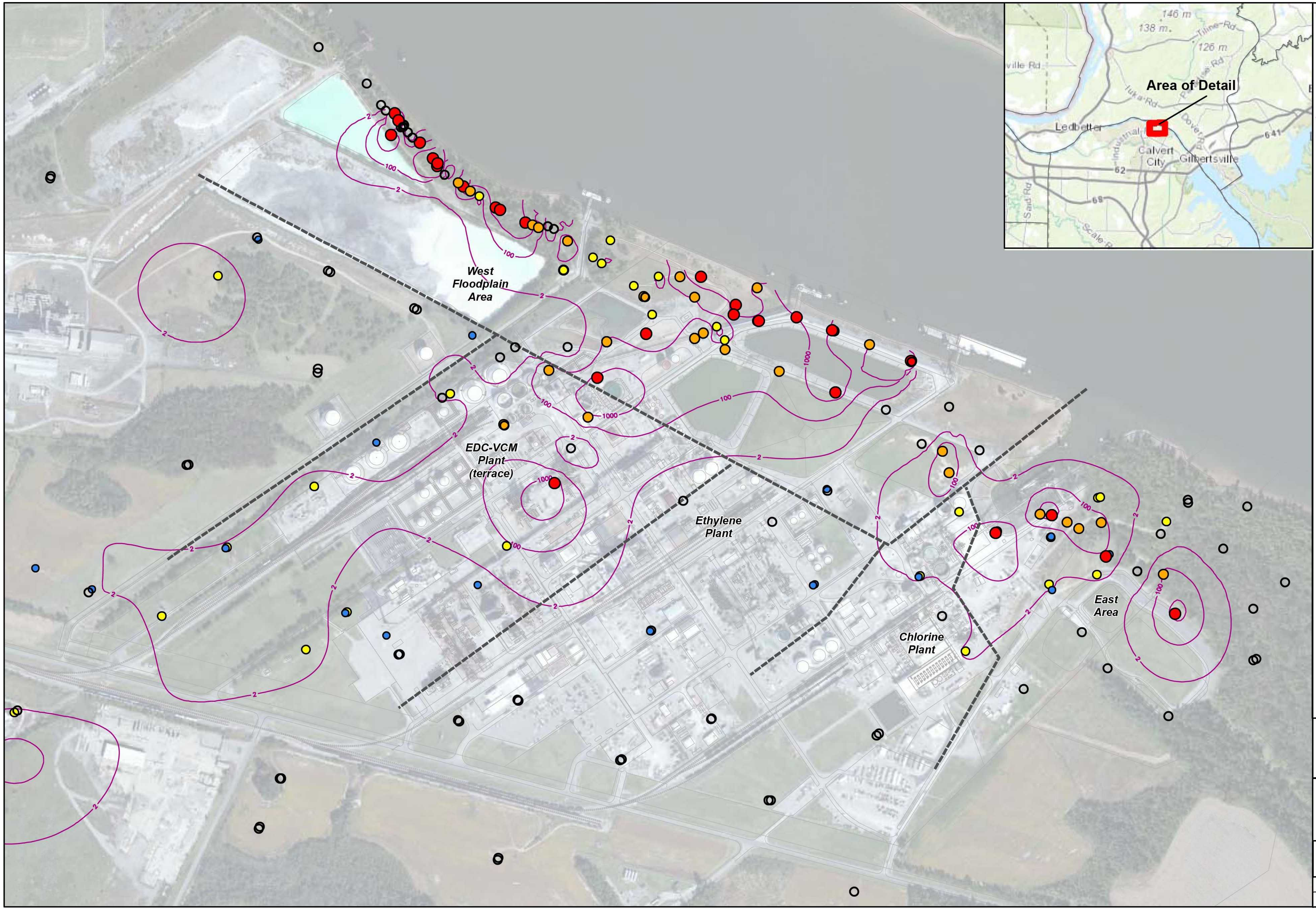
Vinyl Chloride in Groundwater (Upper Aquifer)

FIGURE **5-42**

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 ANALYST: HICKSJ
REV. 0 APPROVED:

FILE: C:\G\S\BF_Goodrich\Maps\VC_Upper_ND0.mxd



Legend

- 🔴 > 1,000 µg/L
- 🟠 100 - 1,000 µg/L
- 🟡 2 - 100 µg/L
- 🔵 < 2 µg/L (MCL)
- ○ Not Detected Above Reporting Limit
- — Vinyl Chloride Contour (µg/L)
- - - Regions

Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Feet
0 250 500

Battelle
The Business of Innovation

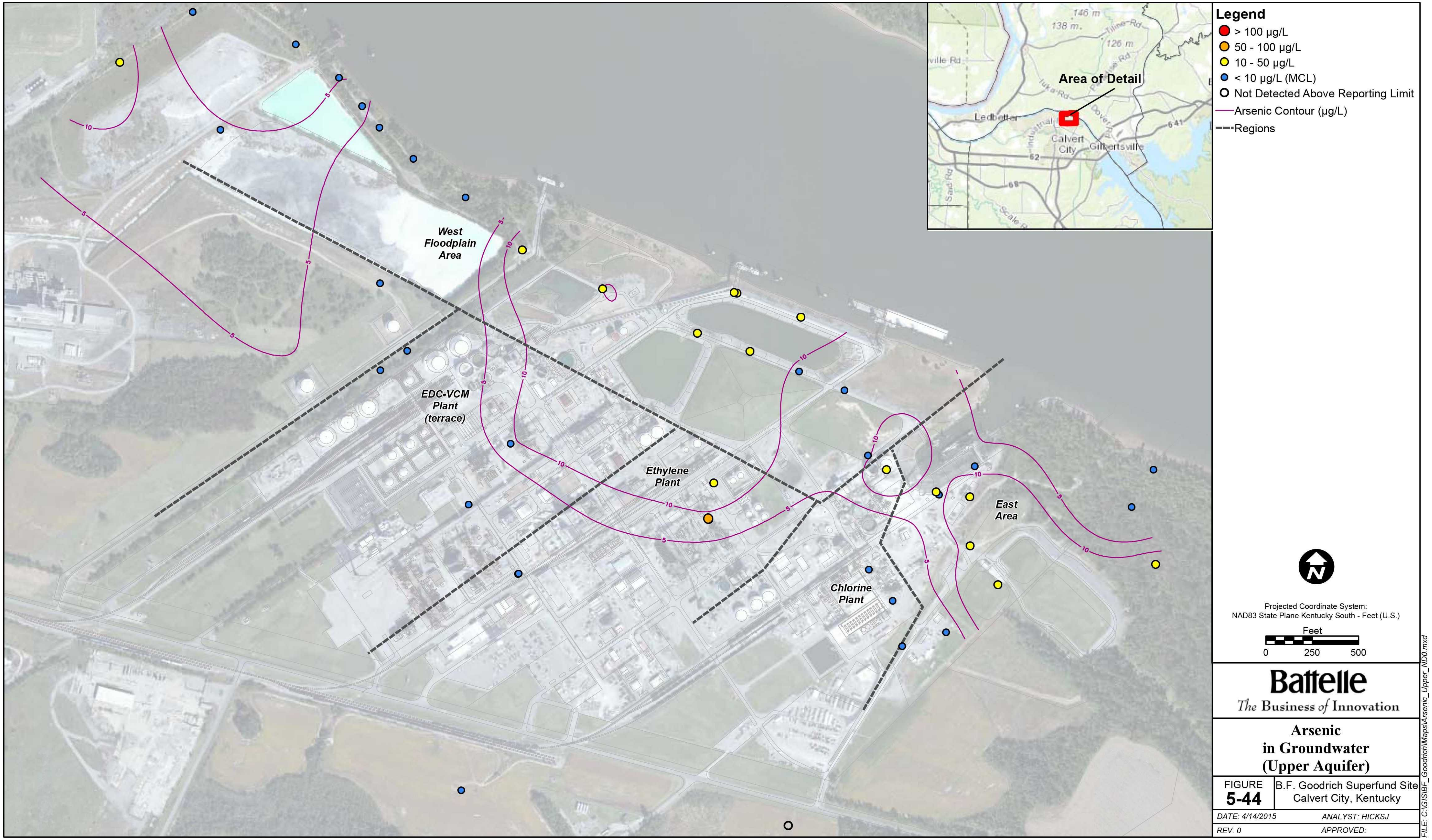
Vinyl Chloride in Groundwater (Lower Aquifer)

FIGURE
5-43

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\VC_Lower_ND0.mxd



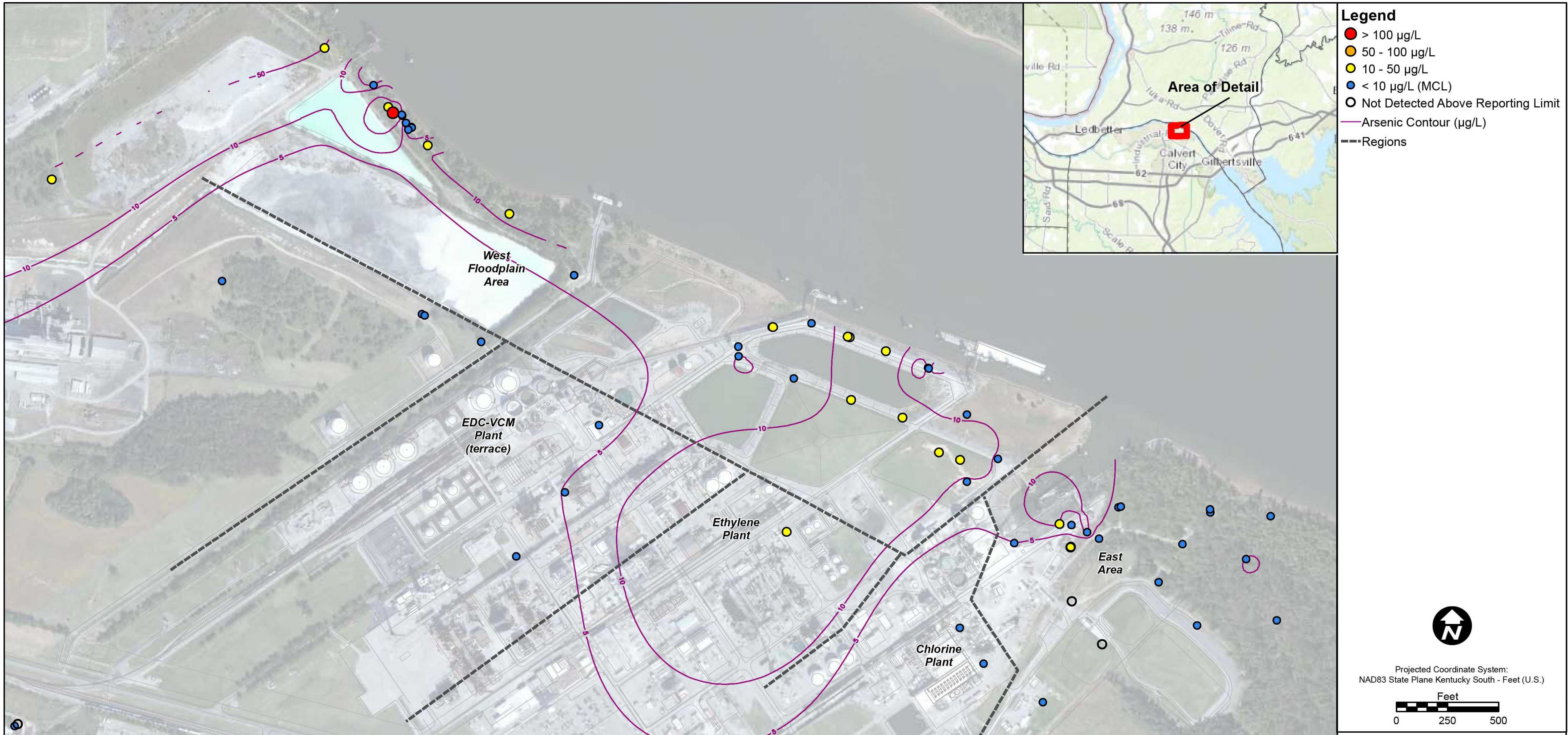
Battelle
The Business of Innovation

Arsenic in Groundwater (Upper Aquifer)

FIGURE 5-44

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015
ANALYST: HICKSJ
REV. 0
APPROVED:



Arsenic in Groundwater (Lower Aquifer)

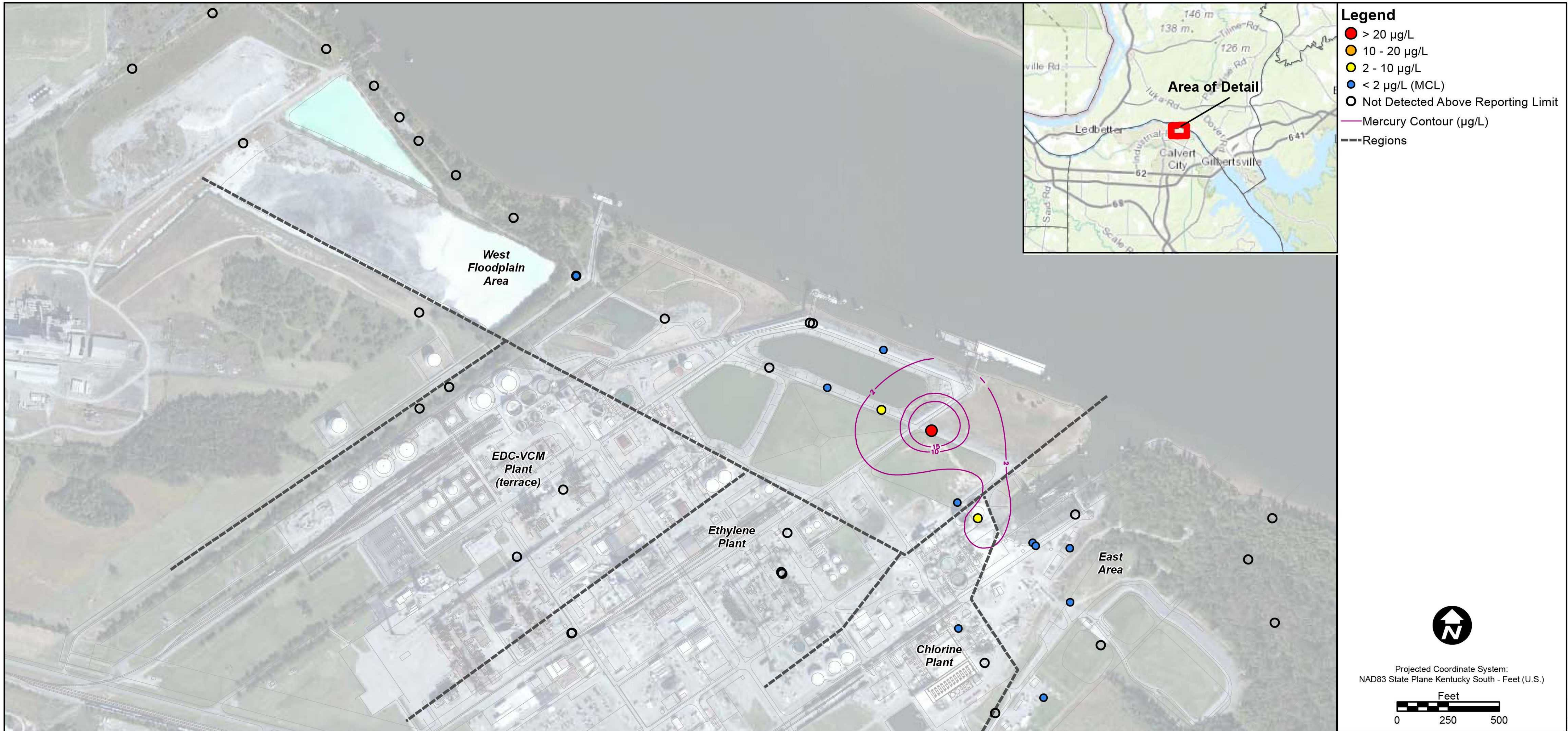
FIGURE **5-45**

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*

REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\Arsenic_Lower_ND0.mxd



Battelle
The Business of Innovation

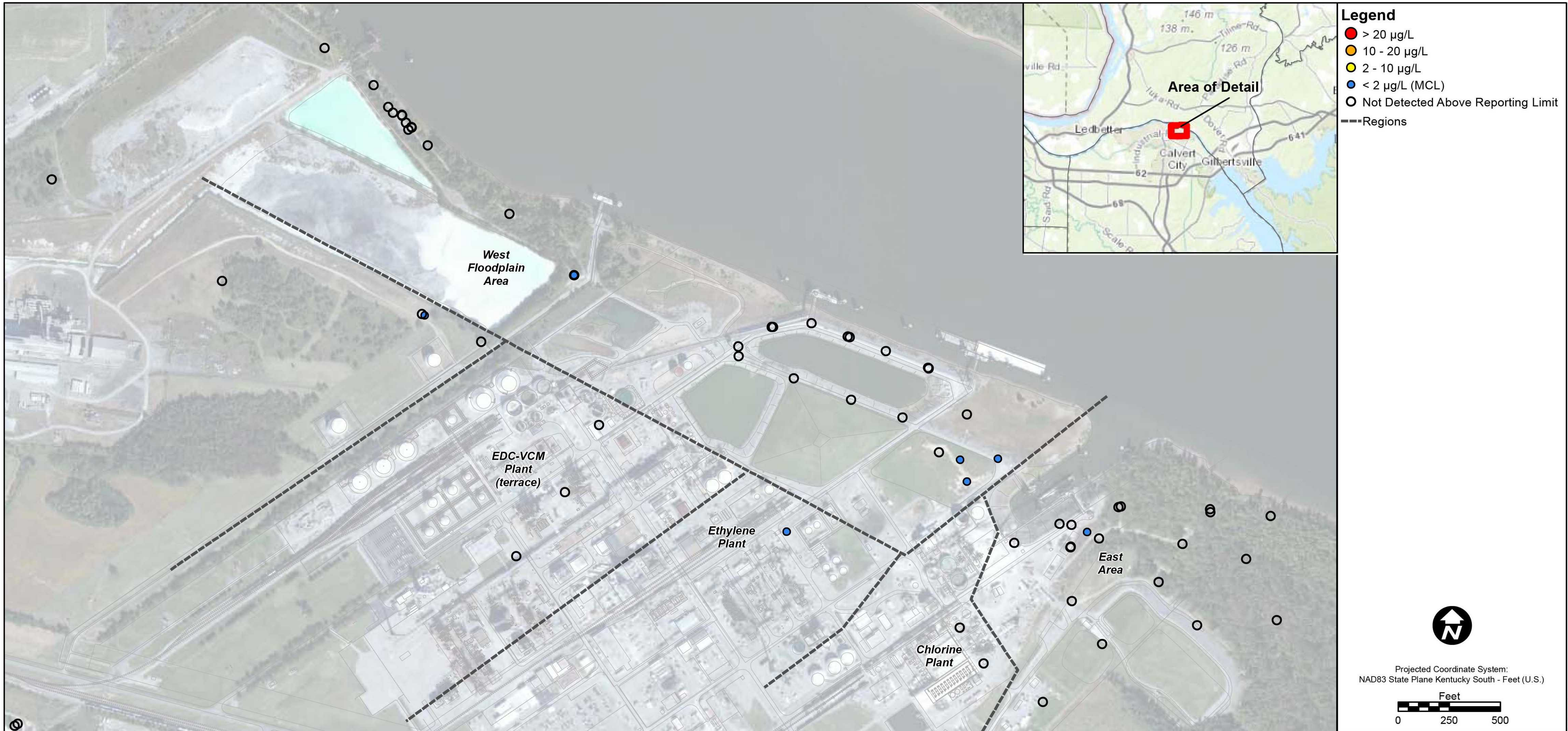
Mercury in Groundwater (Upper Aquifer)

FIGURE **5-46**

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\Mercury_Upper_ND0.mxd



Projected Coordinate System:
NAD83 State Plane Kentucky South - Feet (U.S.)

Battelle
The Business of Innovation

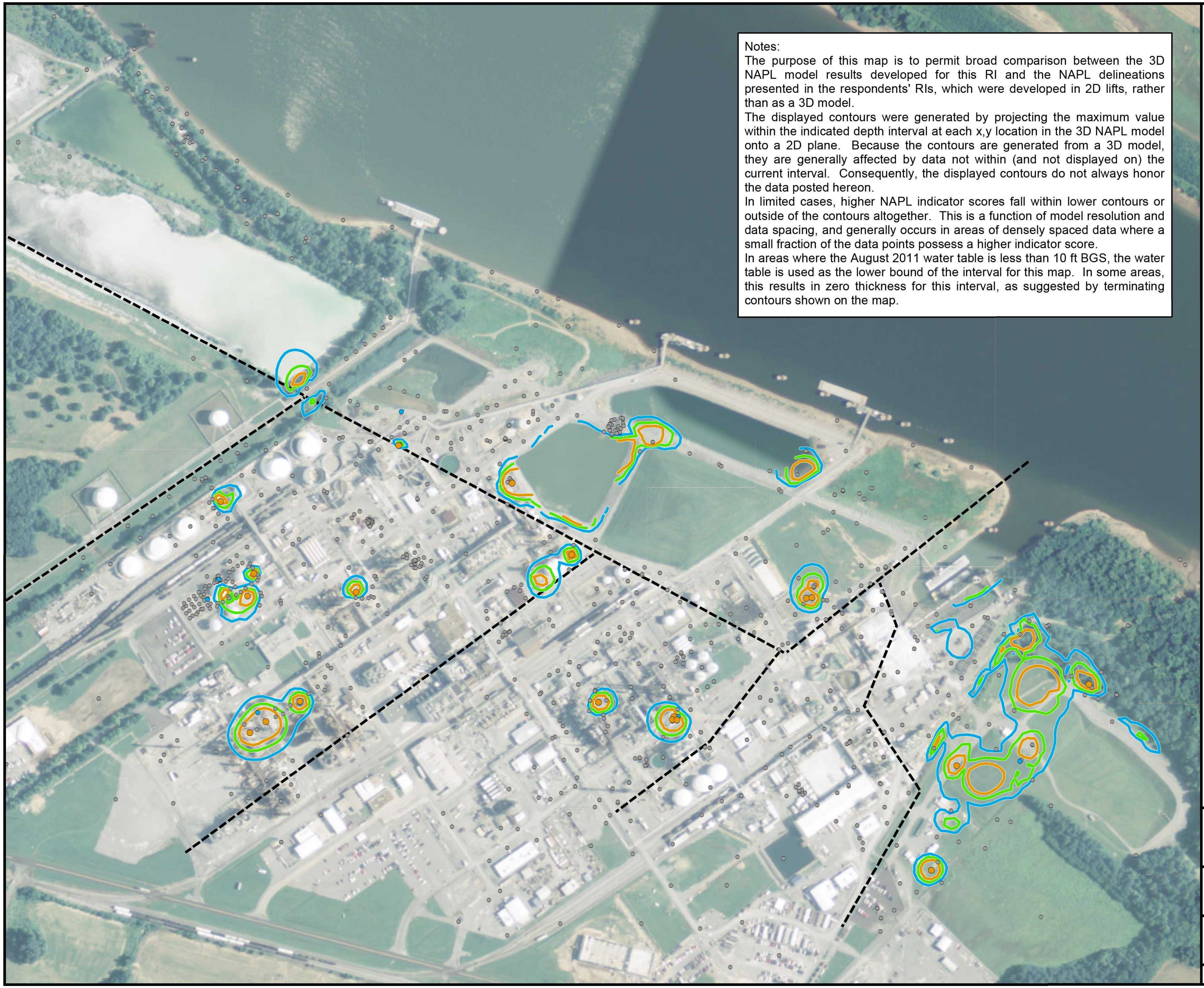
Mercury in Groundwater (Lower Aquifer)

FIGURE
5-47

B.F. Goodrich Superfund Site
Calvert City, Kentucky

DATE: 4/14/2015 *ANALYST: HICKSJ*
REV. 0 *APPROVED:*

FILE: C:\GIS\BF_Goodrich\Maps\Mercury_Lower_ND0.mxd



Notes:
The purpose of this map is to permit broad comparison between the 3D NAPL model results developed for this RI and the NAPL delineations presented in the respondents' RIs, which were developed in 2D lifts, rather than as a 3D model.
The displayed contours were generated by projecting the maximum value within the indicated depth interval at each x,y location in the 3D NAPL model onto a 2D plane. Because the contours are generated from a 3D model, they are generally affected by data not within (and not displayed on) the current interval. Consequently, the displayed contours do not always honor the data posted hereon.
In limited cases, higher NAPL indicator scores fall within lower contours or outside of the contours altogether. This is a function of model resolution and data spacing, and generally occurs in areas of densely spaced data where a small fraction of the data points possess a higher indicator score.
In areas where the August 2011 water table is less than 10 ft BGS, the water table is used as the lower bound of the interval for this map. In some areas, this results in zero thickness for this interval, as suggested by terminating contours shown on the map.

Explanation

NAPL Indicator Data

Potential Indicator (PI) Values

- ● >=70
- ● 50 and 60
- ● 30 and 40
- ● <=20

Estimated NAPL Extent

Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)
- - - - Site Region Boundary

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet
0 400 800

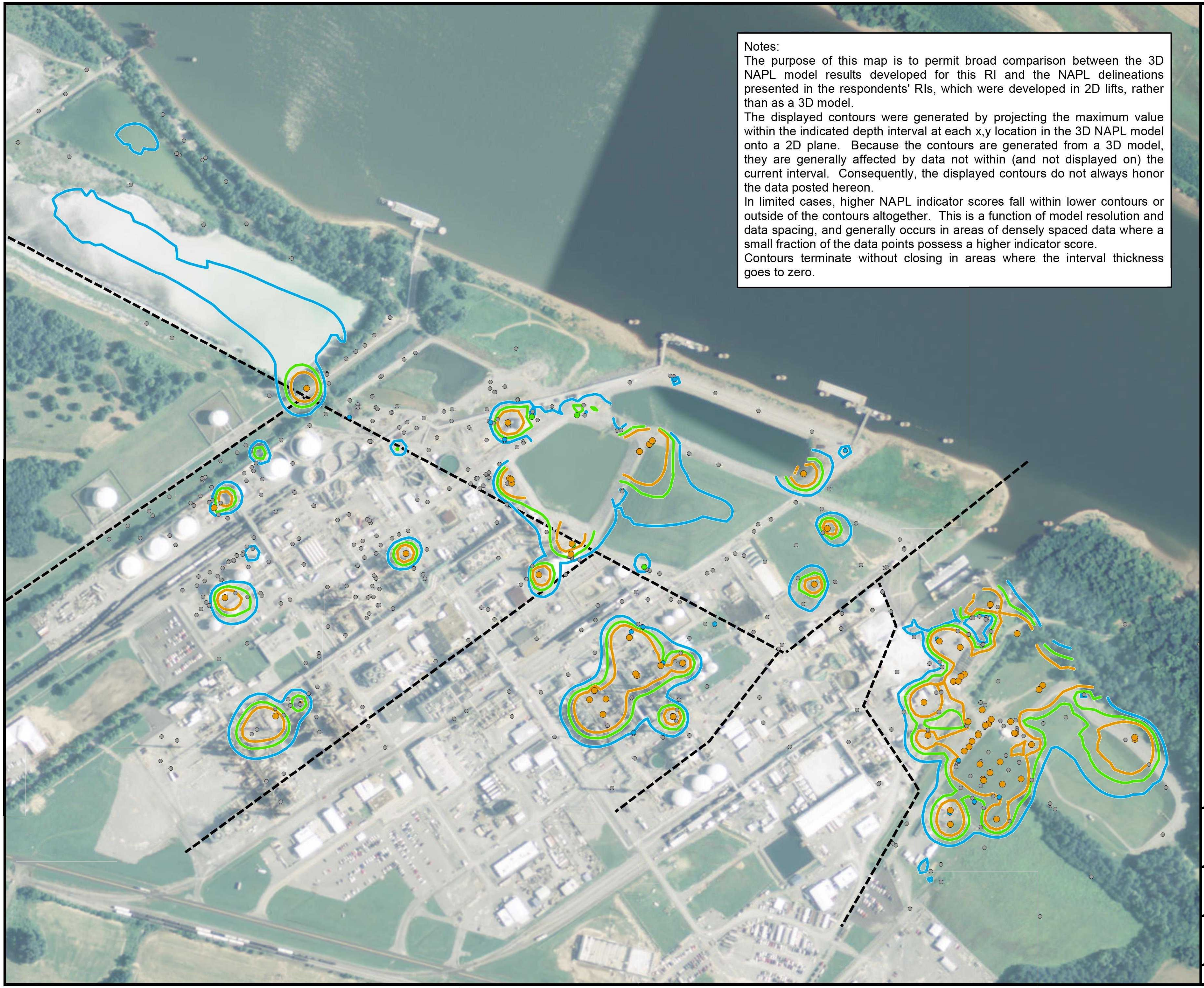
Battelle
The Business of Innovation

NAPL Delineation
Horizon 1 (0 -10 ft bgs)

FIGURE
5-64

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

NAPLimpactedSoil_0to10ftBGS.mxd 8/10/2015



Notes:
The purpose of this map is to permit broad comparison between the 3D NAPL model results developed for this RI and the NAPL delineations presented in the respondents' RIs, which were developed in 2D lifts, rather than as a 3D model.
The displayed contours were generated by projecting the maximum value within the indicated depth interval at each x,y location in the 3D NAPL model onto a 2D plane. Because the contours are generated from a 3D model, they are generally affected by data not within (and not displayed on) the current interval. Consequently, the displayed contours do not always honor the data posted hereon.
In limited cases, higher NAPL indicator scores fall within lower contours or outside of the contours altogether. This is a function of model resolution and data spacing, and generally occurs in areas of densely spaced data where a small fraction of the data points possess a higher indicator score.
Contours terminate without closing in areas where the interval thickness goes to zero.

Explanation

NAPL Indicator Data

Potential Indicator (PI) Values

- ● >=70
- ● 50 and 60
- ● 30 and 40
- ● <=20

Estimated NAPL Extent

Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)
- - - Site Region Boundary

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

Scale in Feet
0 400 800

Battelle
The Business of Innovation

NAPL Delineation
Horizon 2 (10 ft bgs to water table)

FIGURE
5-65

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

NAPLimpactedSoil_10ftBGStoWaterTable.mxd | 8/10/2015

Notes:
The purpose of this map is to permit broad comparison between the 3D NAPL model results developed for this RI and the NAPL delineations presented in the respondents' RIs, which were developed in 2D lifts, rather than as a 3D model.
The displayed contours were generated by projecting the maximum value within the indicated depth interval at each x,y location in the 3D NAPL model onto a 2D plane. Because the contours are generated from a 3D model, they are generally affected by data not within (and not displayed on) the current interval. Consequently, the displayed contours do not always honor the data posted hereon.
In limited cases, higher NAPL indicator scores fall within lower contours or outside of the contours altogether. This is a function of model resolution and data spacing, and generally occurs in areas of densely spaced data where a small fraction of the data points possess a higher indicator score.

Explanation

NAPL Indicator Data

Potential Indicator (PI) Values

- ● >=70
- ● 50 and 60
- ● 30 and 40
- ● <=20

Estimated NAPL Extent

Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)
- - - Site Region Boundary

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet
0 400 800

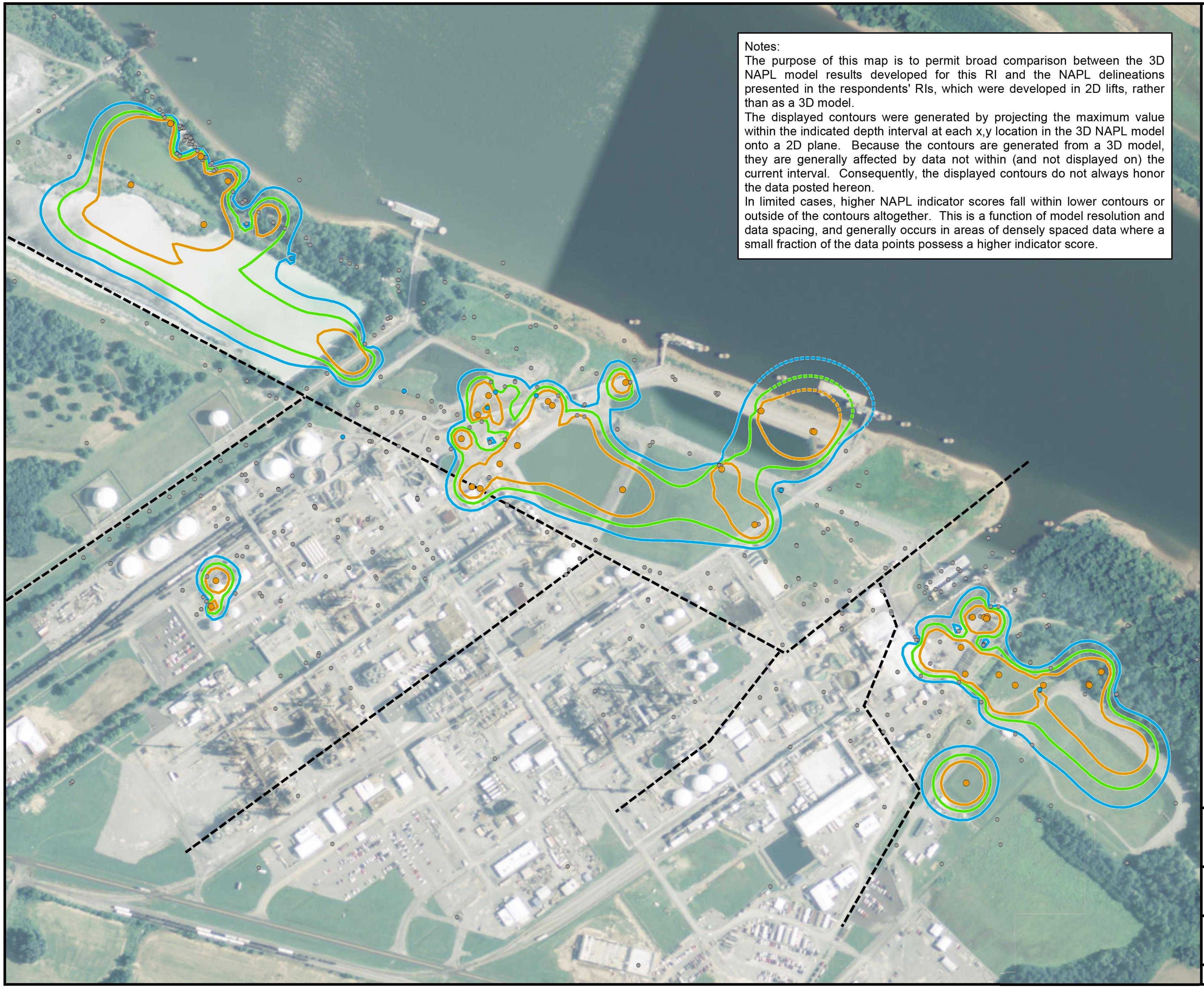
Battelle
The Business of Innovation

NAPL Delineation
Horizon 3 (water table to 295 ft amsl)

FIGURE
5-66

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

NAPLimpactedSoil_WaterTableTo295ft.mxd | 8/10/2015



Notes:
The purpose of this map is to permit broad comparison between the 3D NAPL model results developed for this RI and the NAPL delineations presented in the respondents' RIs, which were developed in 2D lifts, rather than as a 3D model.
The displayed contours were generated by projecting the maximum value within the indicated depth interval at each x,y location in the 3D NAPL model onto a 2D plane. Because the contours are generated from a 3D model, they are generally affected by data not within (and not displayed on) the current interval. Consequently, the displayed contours do not always honor the data posted hereon.
In limited cases, higher NAPL indicator scores fall within lower contours or outside of the contours altogether. This is a function of model resolution and data spacing, and generally occurs in areas of densely spaced data where a small fraction of the data points possess a higher indicator score.

Explanation

NAPL Indicator Data

Potential Indicator (PI) Values

- ● >=70
- ● 50 and 60
- ● 30 and 40
- ● <=20

Estimated NAPL Extent

Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)
- - - Site Region Boundary

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet
0 400 800

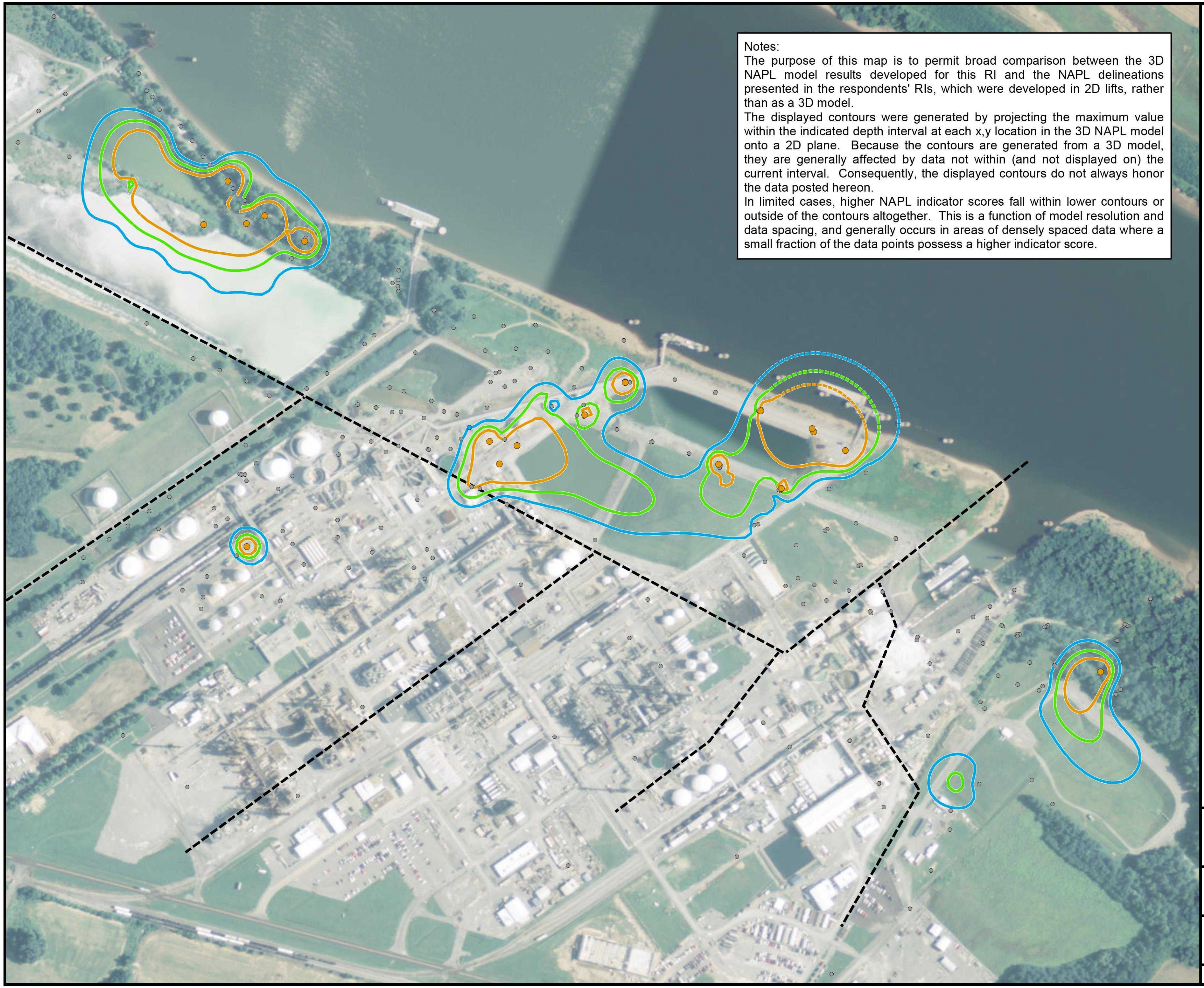
Battelle
The Business of Innovation

NAPL Delineation
Horizon 4 (295 to 280 ft amsl)

FIGURE
5-67

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

NAPLimpactedSoil_295ftTo280ft.mxd 8/10/2015



Notes:
The purpose of this map is to permit broad comparison between the 3D NAPL model results developed for this RI and the NAPL delineations presented in the respondents' RIs, which were developed in 2D lifts, rather than as a 3D model.
The displayed contours were generated by projecting the maximum value within the indicated depth interval at each x,y location in the 3D NAPL model onto a 2D plane. Because the contours are generated from a 3D model, they are generally affected by data not within (and not displayed on) the current interval. Consequently, the displayed contours do not always honor the data posted hereon.
In limited cases, higher NAPL indicator scores fall within lower contours or outside of the contours altogether. This is a function of model resolution and data spacing, and generally occurs in areas of densely spaced data where a small fraction of the data points possess a higher indicator score.

Explanation

NAPL Indicator Data

Potential Indicator (PI) Values

- ● >=70
- ● 50 and 60
- ● 30 and 40
- ● <=20

Estimated NAPL Extent

Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)
- - - - Site Region Boundary

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

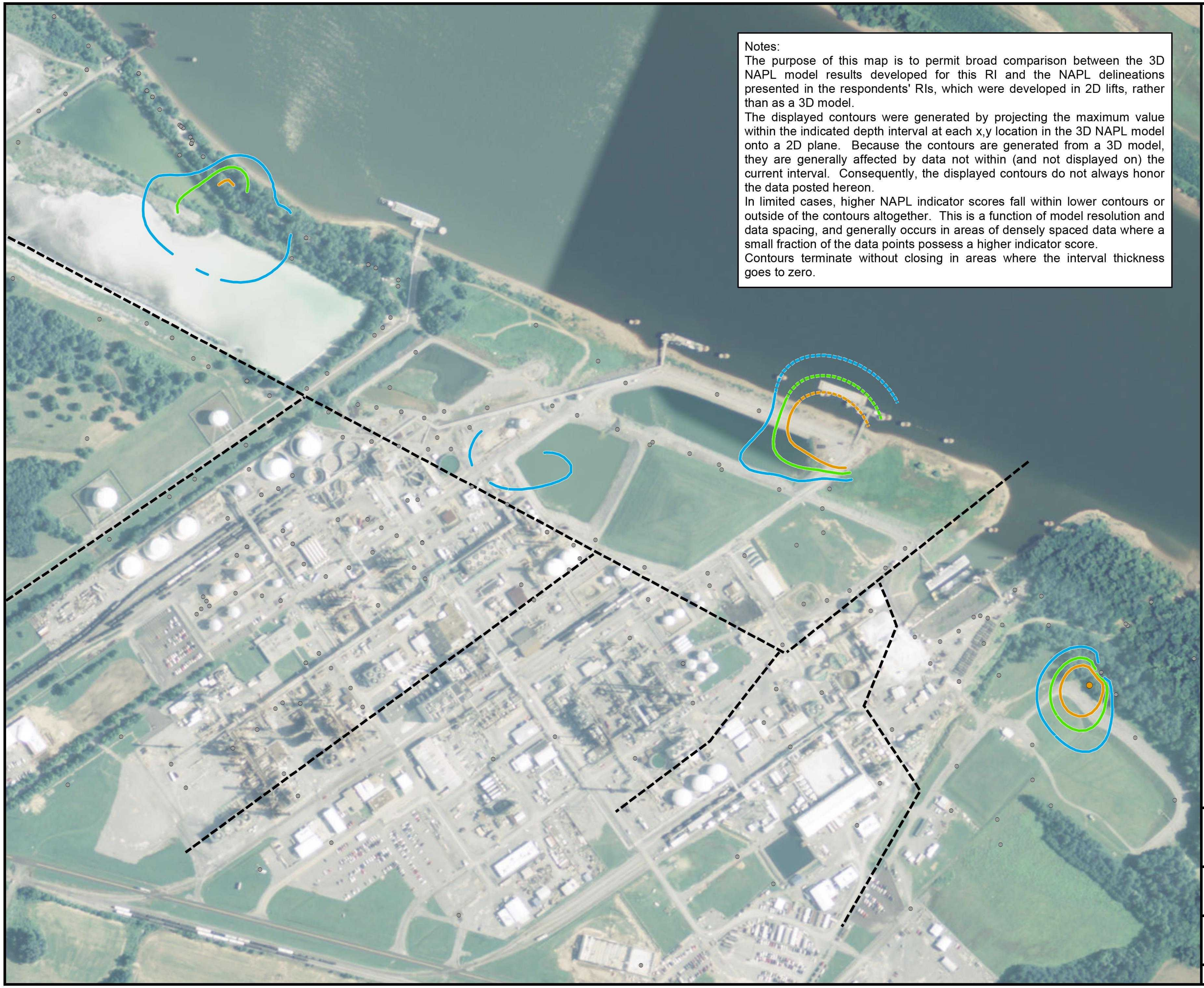
Battelle
The Business of Innovation

NAPL Delineation
Horizon 5 (280 to 265 ft amsl)

FIGURE
5-68

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

NAPLimpactedSoil_280ftTo265ft.mxd
8/10/2015



Notes:
The purpose of this map is to permit broad comparison between the 3D NAPL model results developed for this RI and the NAPL delineations presented in the respondents' RIs, which were developed in 2D lifts, rather than as a 3D model.
The displayed contours were generated by projecting the maximum value within the indicated depth interval at each x,y location in the 3D NAPL model onto a 2D plane. Because the contours are generated from a 3D model, they are generally affected by data not within (and not displayed on) the current interval. Consequently, the displayed contours do not always honor the data posted hereon.
In limited cases, higher NAPL indicator scores fall within lower contours or outside of the contours altogether. This is a function of model resolution and data spacing, and generally occurs in areas of densely spaced data where a small fraction of the data points possess a higher indicator score.
Contours terminate without closing in areas where the interval thickness goes to zero.

Explanation

NAPL Indicator Data

Potential Indicator (PI) Values

- ● >=70
- ● 50 and 60
- ● 30 and 40
- ● <=20

Estimated NAPL Extent

Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)
- - - - Site Region Boundary

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

Scale in Feet
0 400 800

Battelle
The Business of Innovation

NAPL Delineation
Horizon 6 (265 ft amsl to bedrock)

FIGURE
5-69

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

NAPLimpactedSoil_265ftToBedrock.mxd 8/10/2015

Notes:
The displayed contours represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. The contours were generated by projecting the maximum value within the depth column from ground surface to top of bedrock at each x,y location in the 3D NAPL model onto a 2D plane.
All NAPL indicator data throughout the entire depth interval are posted on the figure. Consequently, data with lower NAPL indicator scores often fall within higher contours.
In limited cases, higher NAPL indicator scores fall within lower contours or outside of the contours altogether. This is a function of model resolution and data spacing, and generally occurs in areas of densely spaced data where a small fraction of the data points possess a higher indicator score.

Explanation

NAPL Indicator Data

Potential Indicator (PI) Values

- ● >=70
- ● 50 and 60
- ● 30 and 40
- ● <=20

Estimated NAPL Extent

Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)
- - - Site Region Boundary

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet
0 400 800

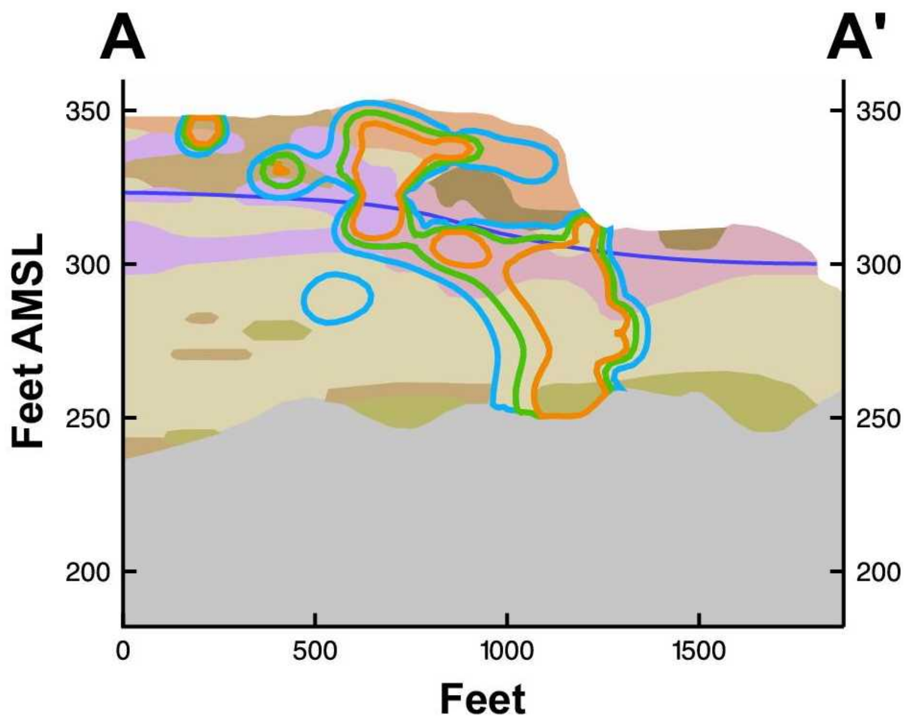
Battelle
The Business of Innovation

NAPL Delineation
Horizons 1 to 6

FIGURE
5-70

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

NAPLimpactedSoil_GStoBedrock.mxd | 8/10/2015



PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Note:
The displayed contours on the map view at right represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. The contours were generated by projecting the maximum value within the depth column from ground surface to top of bedrock at each x,y location in the 3D NAPL model onto a 2D plane.

Explanation

- Fill
- Clay and Silt on Floodplain
- Clay and Silt
- Interbeds on Floodplain
- Interbeds
- Sand and Gravel
- Clay-Rich Heterolithics
- Bedrock
- Groundwater Level

Estimated NAPL Extent
Modeled PI Values

- 70 (Lower Bound Confirmed)
- 50 (Upper Bound Confirmed)
- 30 (Potential)

Vertical Exaggeration = 8X

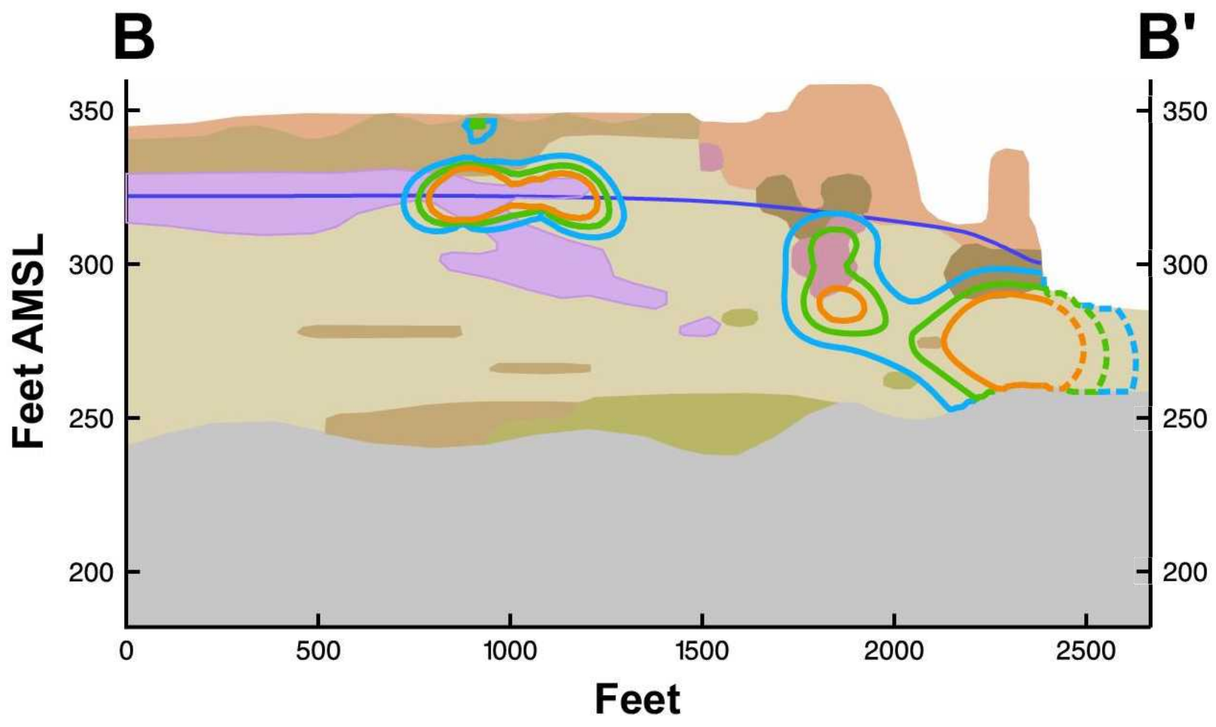
Battelle
The Business of Innovation

Geologic Cross-Section A-A' Showing NAPL Distribution

FIGURE
5-71

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

5-71_GEOLOGIC_XS_A-A'_NAPL.CDR
05/15



Explanation

- 🟧 Fill
- 🟫 Clay and Silt on Floodplain
- 🟫 Clay and Silt
- 🟪 Interbeds on Floodplain
- 🟪 Interbeds
- ⬜ Sand and Gravel
- 🟩 Clay-Rich Heterolithics
- ⬜ Bedrock
- — Groundwater Level

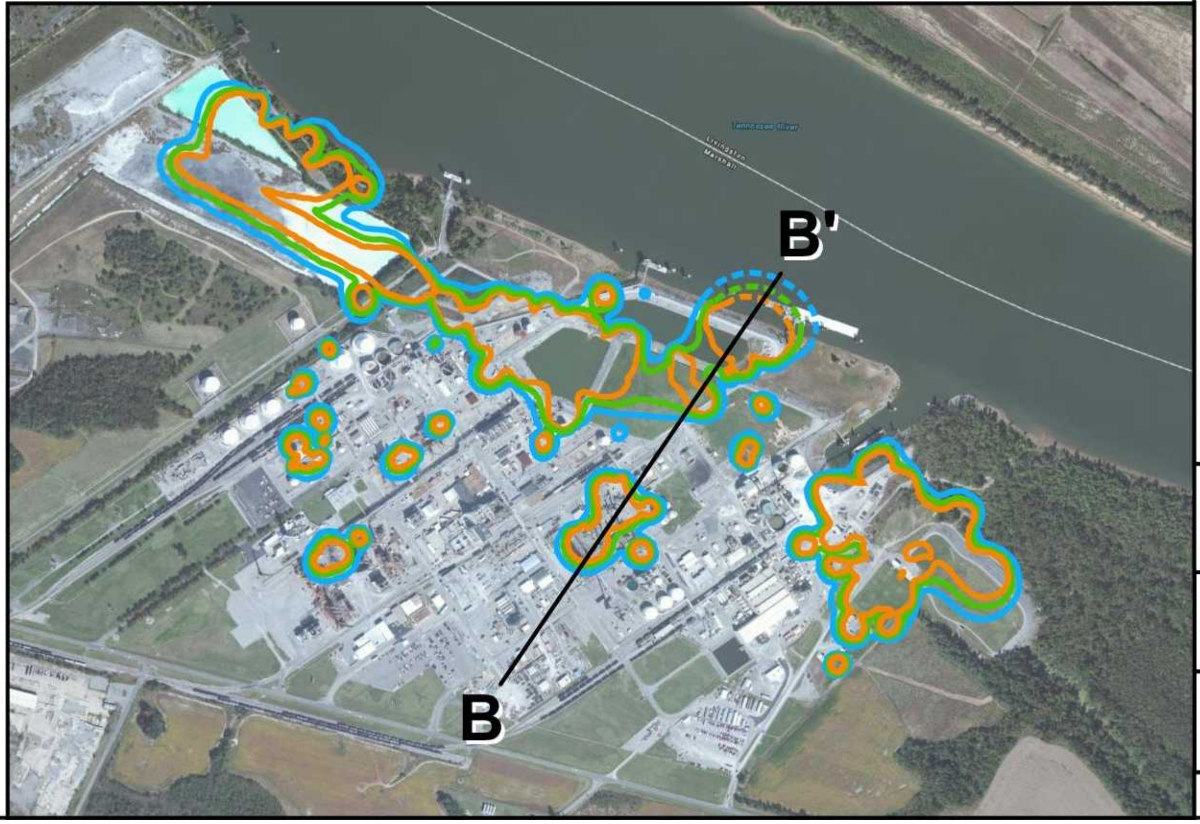
Estimated NAPL Extent
Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)

Vertical Exaggeration = 8X

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Note:
The displayed contours on the map view at right represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. The contours were generated by projecting the maximum value within the depth column from ground surface to top of bedrock at each x,y location in the 3D NAPL model onto a 2D plane.



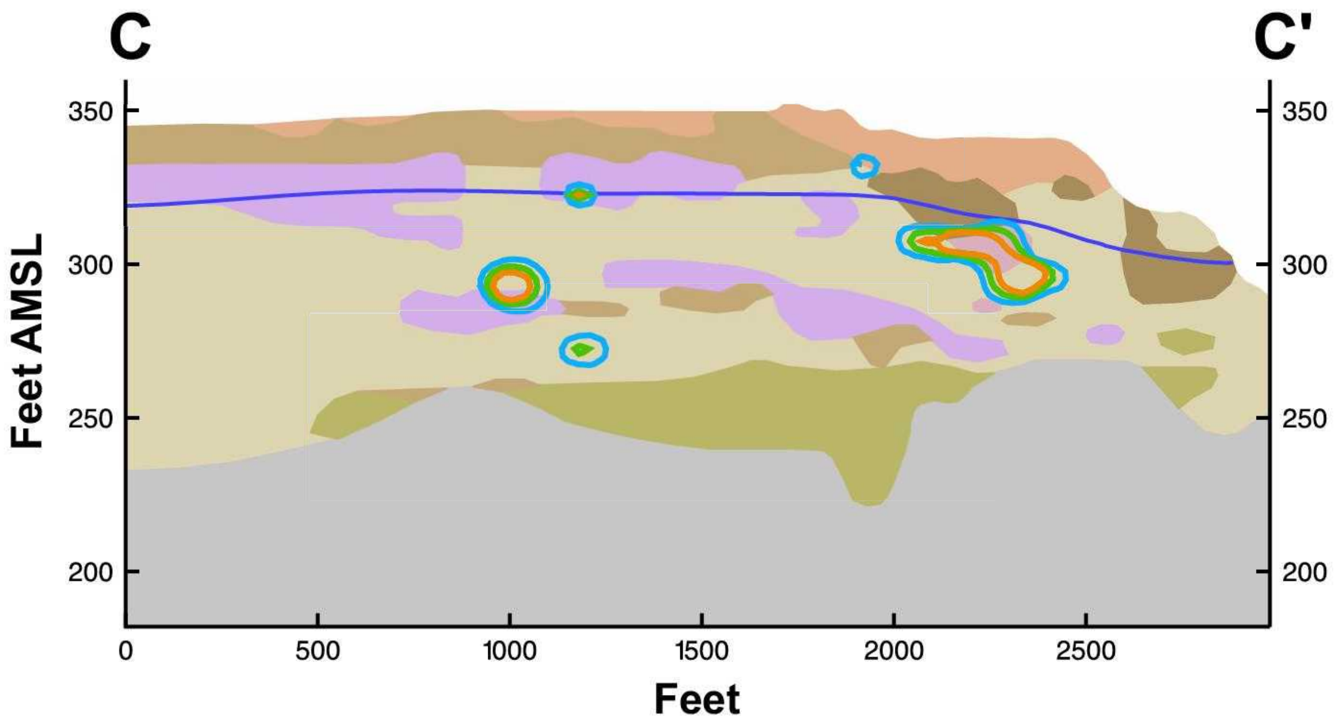
Battelle
The Business of Innovation

Geologic Cross-Section B-B' Showing NAPL Distribution

FIGURE
5-72

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

5-72_GEOLOGIC_XS_B-B'_NAPL.CDR
05/15



Explanation

🟧 Fill

🟫 Clay and Silt on Floodplain

🟫 Clay and Silt

▨ Interbeds on Floodplain

🟪 Interbeds

▨ Sand and Gravel

🟩 Clay-Rich Heterolithics

⬜ Bedrock

— Groundwater Level

Estimated NAPL Extent
Modeled PI Values

— 70 (Lower Bound Confirmed)

— 50 (Upper Bound Confirmed)

— 30 (Potential)

Vertical Exaggeration = 8X

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Note:
The displayed contours on the map view at right represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. The contours were generated by projecting the maximum value within the depth column from ground surface to top of bedrock at each x,y location in the 3D NAPL model onto a 2D plane.

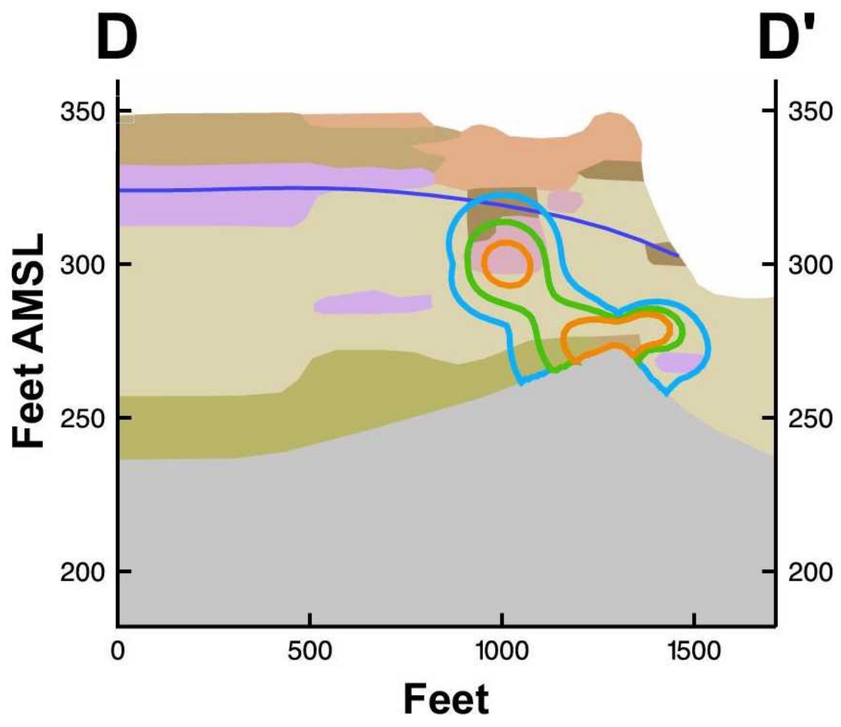
Battelle
The Business of Innovation

Geologic Cross-Section C-C' Showing NAPL Distribution

FIGURE
5-73

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

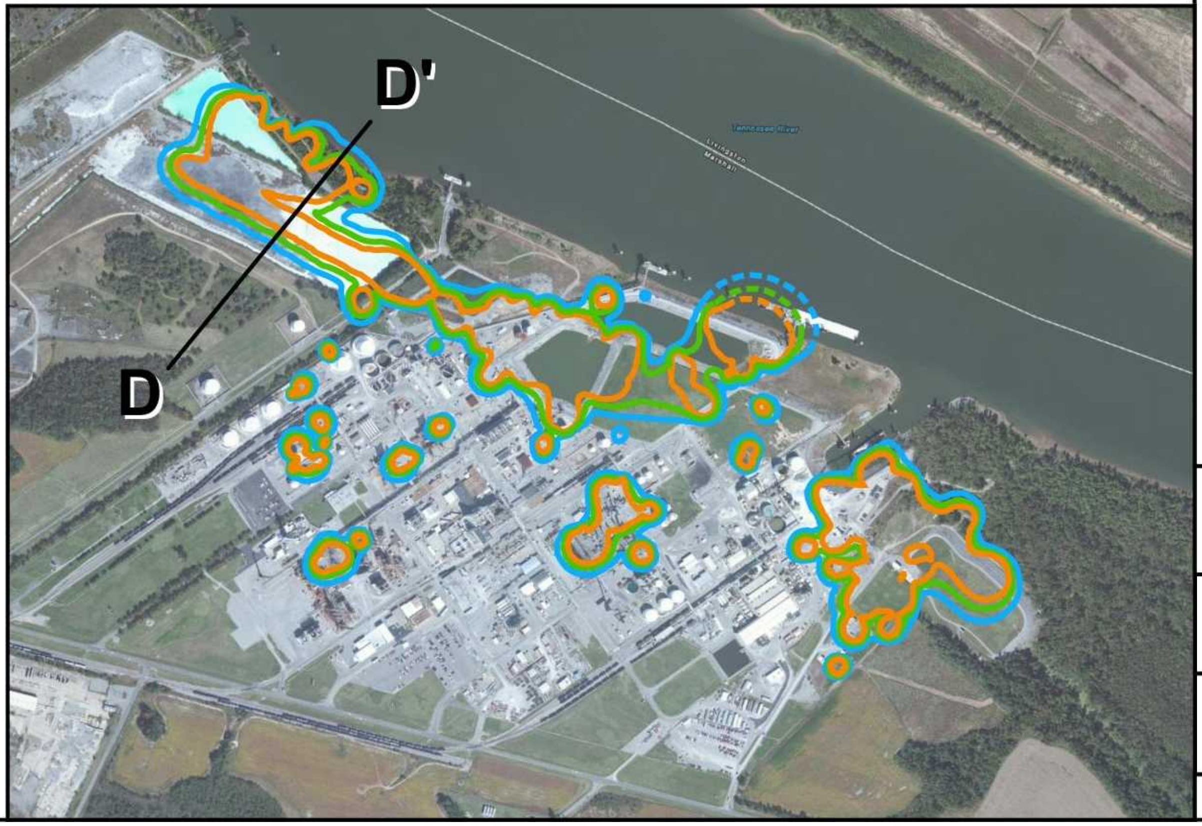
5-73_GEOLOGIC_XS_C-C'_NAPL.CDR | 05/15



PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Note:

The displayed contours on the map view at right represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. The contours were generated by projecting the maximum value within the depth column from ground surface to top of bedrock at each x,y location in the 3D NAPL model onto a 2D plane.



Explanation

- ■ Fill
- ■ Clay and Silt on Floodplain
- ■ Clay and Silt
- ■ Interbeds on Floodplain
- ■ Interbeds
- ■ Sand and Gravel
- ■ Clay-Rich Heterolithics
- ■ Bedrock
- — Groundwater Level

Estimated NAPL Extent
Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)

Vertical Exaggeration = 8X

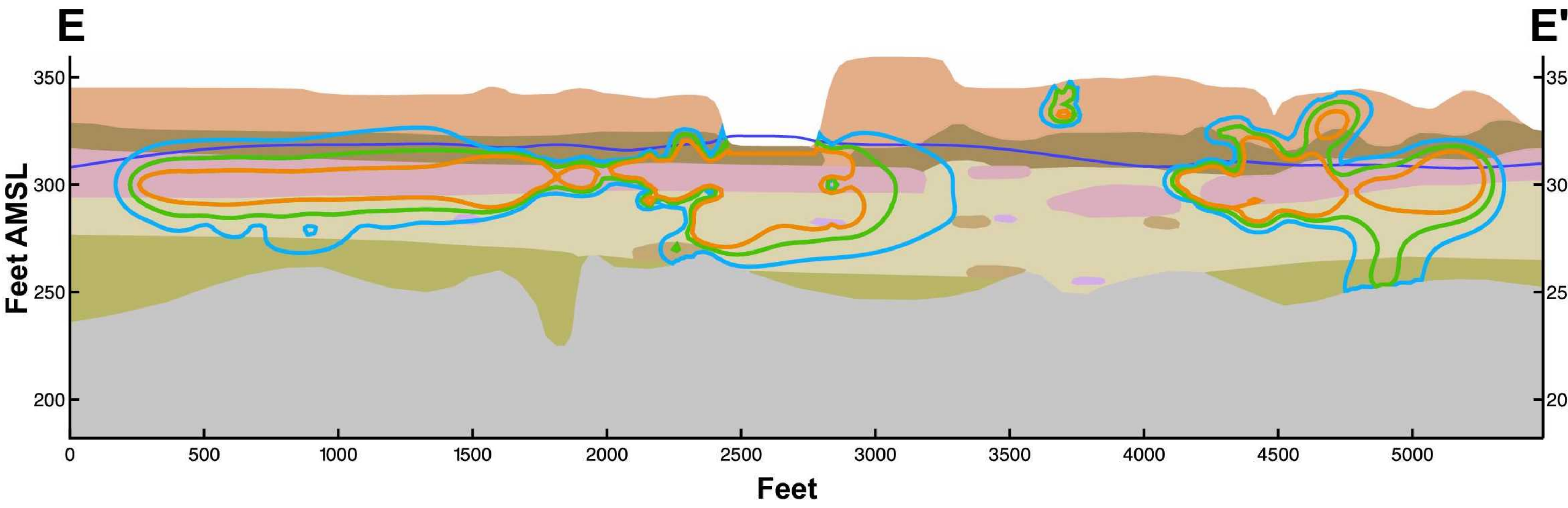
Battelle
The Business of Innovation

Geologic Cross-Section D-D' Showing NAPL Distribution

FIGURE
5-74

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

5-74_GEOLOGIC_XS_D-D'_NAPL.CDR 05/15



Explanation

- ▨ Fill
- ▨ Clay and Silt on Floodplain
- ▨ Clay and Silt
- ▨ Interbeds on Floodplain
- ▨ Sand and Gravel
- ▨ Clay-Rich Heterolithics
- ▨ Bedrock
- — Groundwater Level

Estimated NAPL Extent
Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)

Vertical Exaggeration = 8X

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Note:
The displayed contours on the map view at right represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. The contours were generated by projecting the maximum value within the depth column from ground surface to top of bedrock at each x,y location in the 3D NAPL model onto a 2D plane.

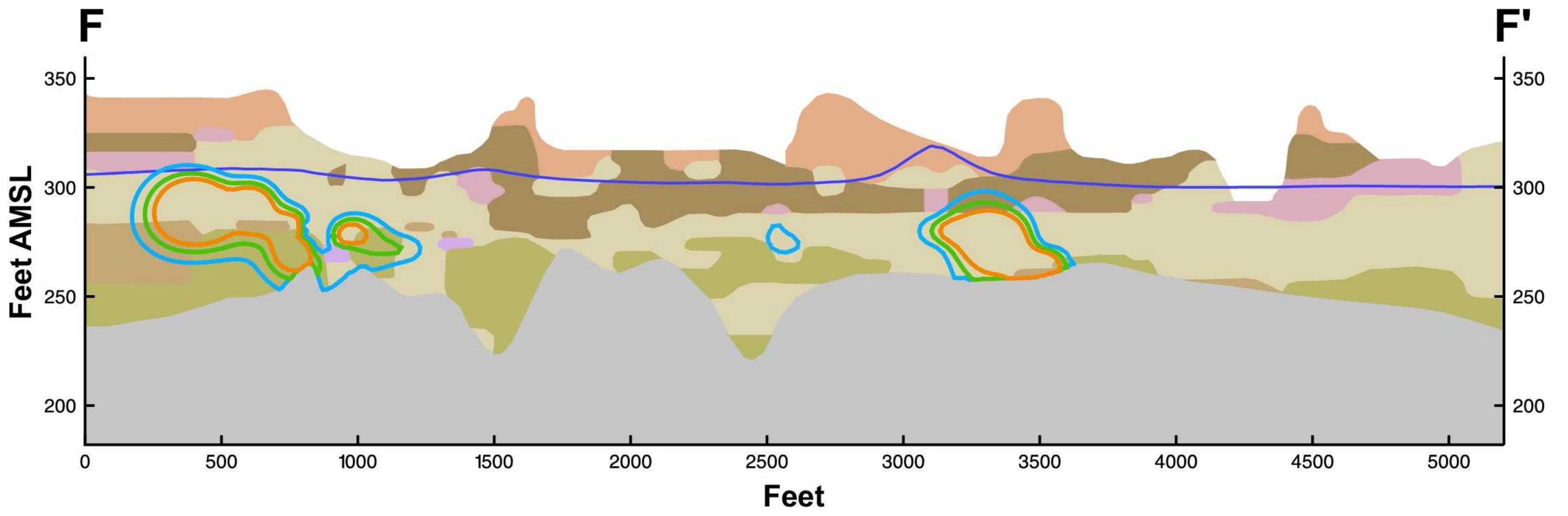
Battelle
The Business of Innovation

Geologic Cross-Section E-E' Showing NAPL Distribution

FIGURE
5-75

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

5-75_GEOLOGIC_XS_E-E'_NAPL.CDR 05/15



PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

Note:

The displayed contours on the map view at right represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. The contours were generated by projecting the maximum value within the depth column from ground surface to top of bedrock at each x,y location in the 3D NAPL model onto a 2D plane.

Explanation

- 🟧 Fill
- 🟫 Clay and Silt on Floodplain
- ▨ Clay and Silt
- ▨ Interbeds on Floodplain
- 🟪 Interbeds
- ▨ Sand and Gravel
- 🟩 Clay-Rich Heterolithics
- ⬜ Bedrock
- — Groundwater Level

Estimated NAPL Extent
Modeled PI Values

- — 70 (Lower Bound Confirmed)
- — 50 (Upper Bound Confirmed)
- — 30 (Potential)

Vertical Exaggeration = 8X

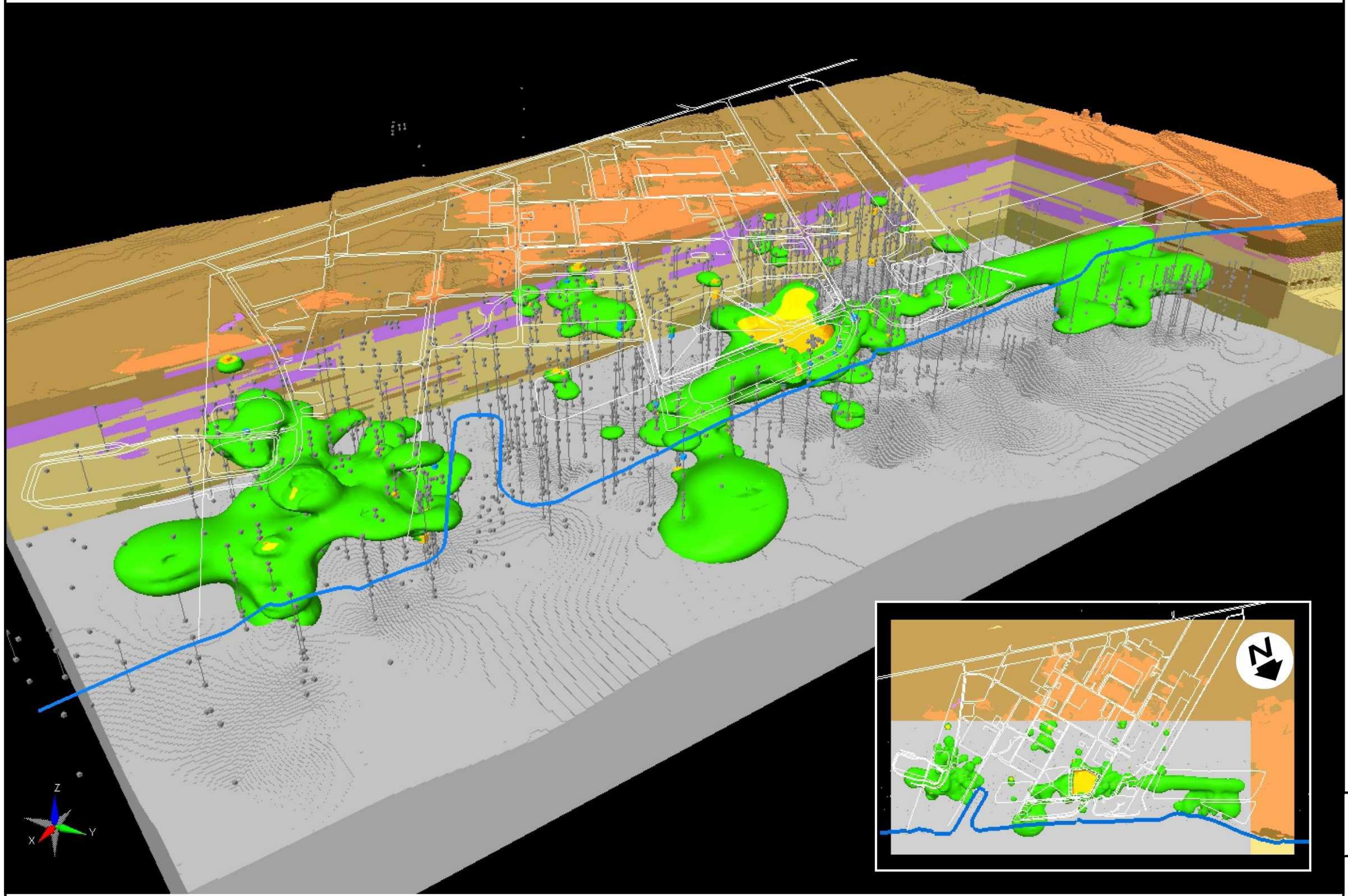
Battelle
The Business of Innovation

Geologic Cross-Section F-F' Showing NAPL Distribution

FIGURE
5-76

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

5-76_GEOLOGIC_XS_F-F'_NAPL.CDR 05/15



Explanation

🟧 Fill

🟫 Clay and Silt

🟫 Clay and Silt on Floodplain

🟪 Interbeds

🟪 Interbeds on Floodplain

🟨 Sand and Gravel

⬛ Bedrock

～ Shoreline

NAPL Indicator Data
Potential Indicator (PI) Values

🟨 >=70

🟩 50 and 60

🟦 30 and 40

■ <=20

Modeled PI Value

70
50
30

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

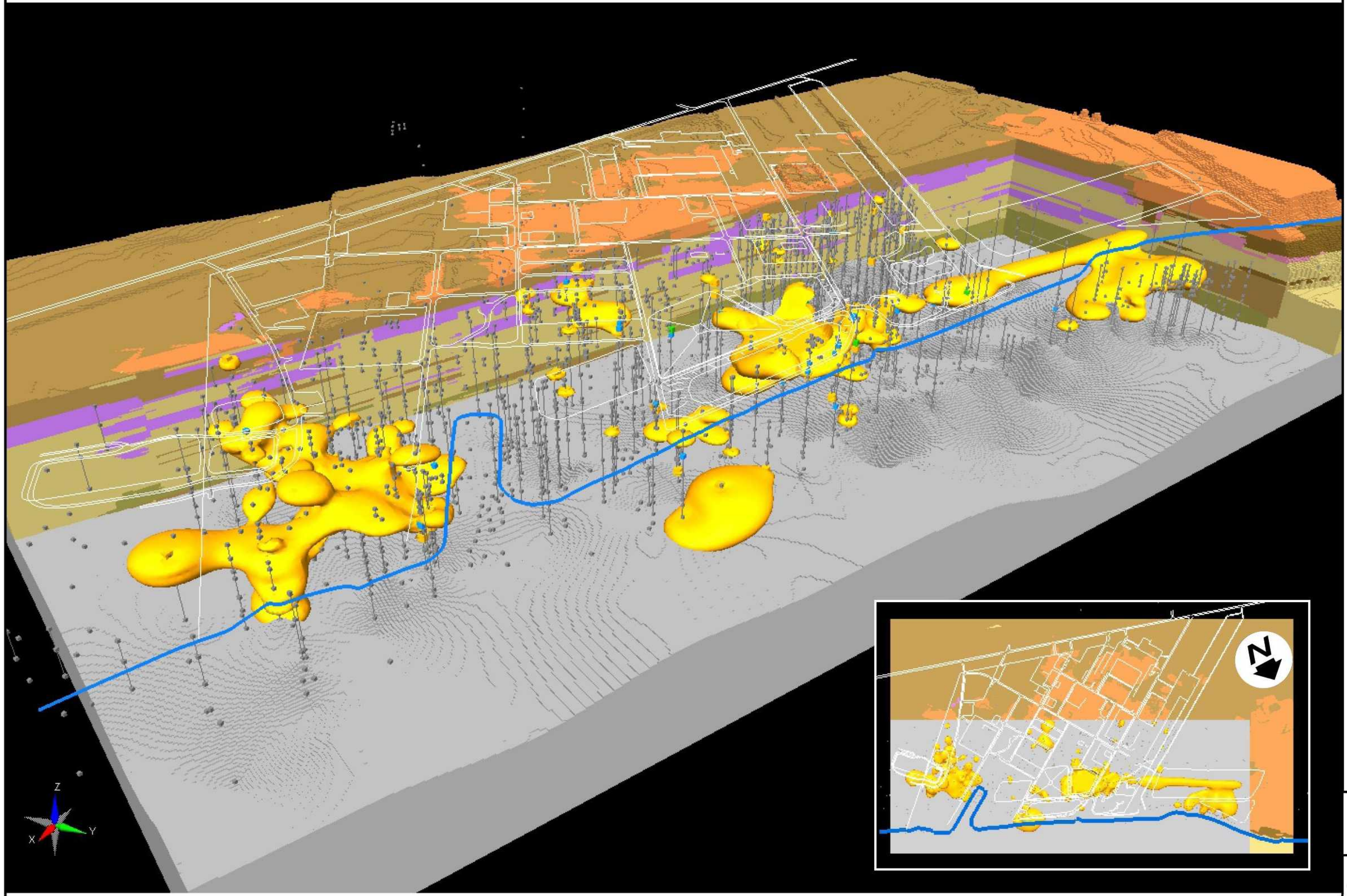
Battelle
The Business of Innovation

3-D NAPL Delineation Showing Upper Bound Confirmed (PI Value ≥ 50)

FIGURE
5-78

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

5-78_3-D_NAPL_DELINEATION_UPPER_BOUND.CDR | 05/15



Explanation

🟧 Fill

🟫 Clay and Silt

🟫 Clay and Silt on Floodplain

🟪 Interbeds

▨ Interbeds on Floodplain

🟨 Sand and Gravel

⬛ Bedrock

— Shoreline

NAPL Indicator Data
Potential Indicator (PI) Values

🟨 >=70

🟩 50 and 60

🟦 30 and 40

■ <=20

Modeled PI Value

70

50

30

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

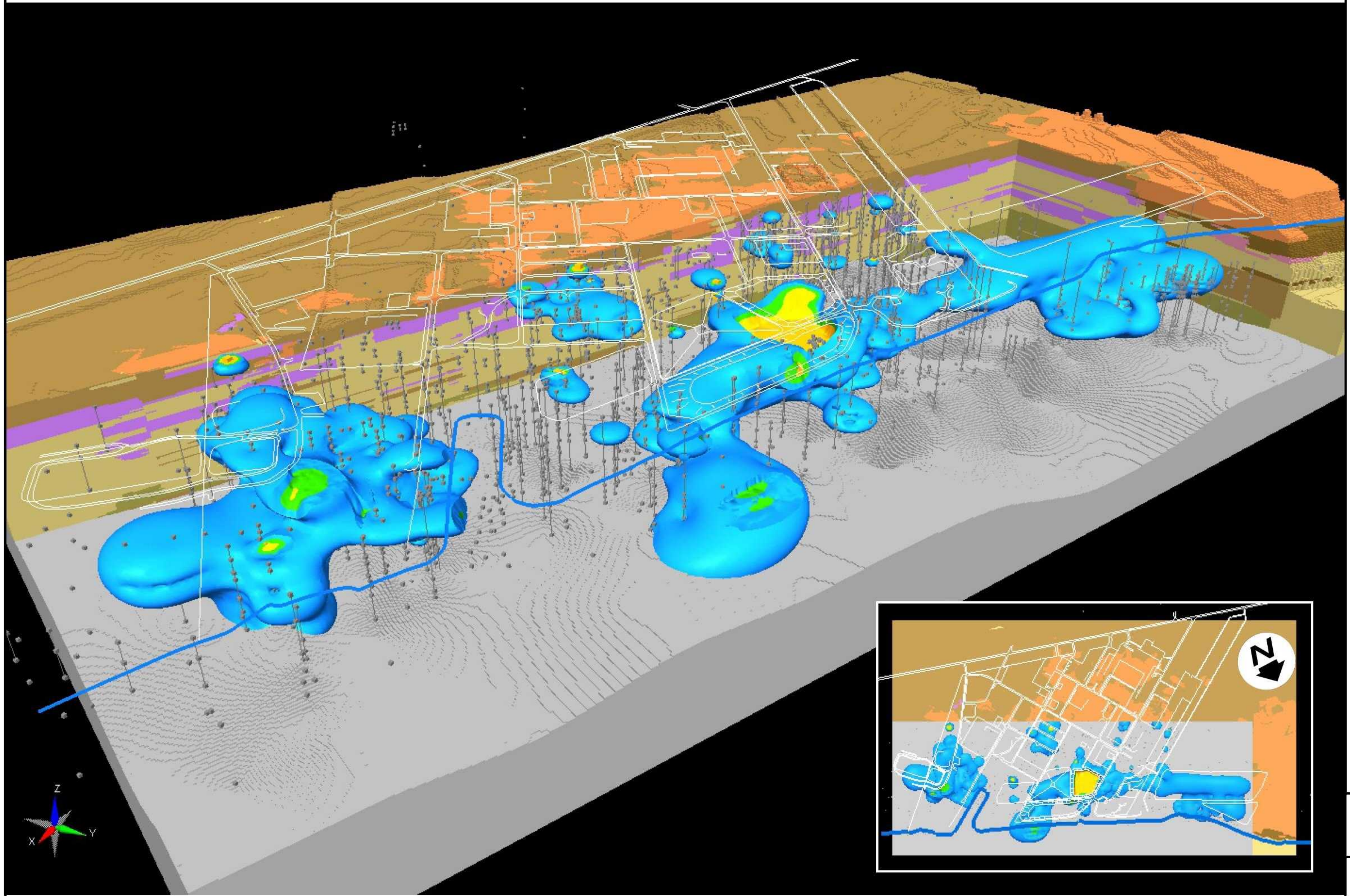
Battelle
The Business of Innovation

3-D NAPL Delineation Showing Lower Bound Confirmed (PI Value ≥ 70)

FIGURE
5-79

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

5-79_3-D_NAPL_DELINEATION_LOWER_BOUND.CDR | 05/15



Explanation

- 🟧 Fill
- 🟫 Clay and Silt
- 🟫 Clay and Silt on Floodplain
- 🟪 Interbeds
- 🟥 Interbeds on Floodplain
- 🟨 Sand and Gravel
- ⬛ Bedrock
- ― Shoreline

NAPL Indicator Data
Potential Indicator (PI) Values

- 🟨 >=70
- 🟩 50 and 60
- 🟦 30 and 40
- ■ <=20

Modeled PI Value

70
50
30

PI Value – An additive score based on the co-occurrence of potential NAPL indicators with confirmed NAPL indicators, the PI Value designates the probability that a location contains NAPL. The higher the PI value, the greater the likelihood that NAPL is present at that location. See Section 5.11.1 through 5.11.3 for a detailed description of the NAPL evaluation process.

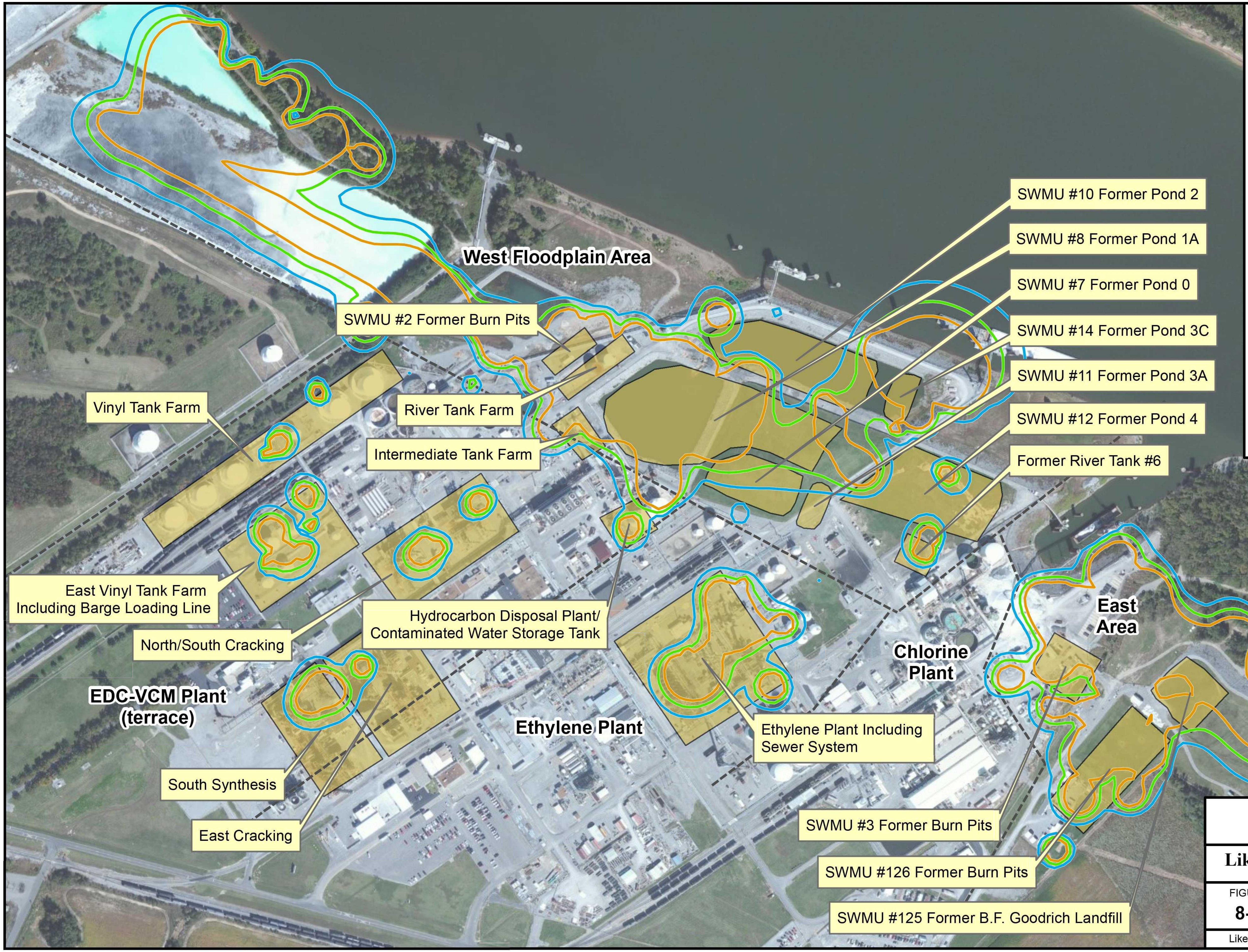
Battelle
The Business of Innovation

3-D NAPL Delineation Showing Potential NAPL (PI Value ≥ 30)

FIGURE
5-80

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

5-80_3-D_NAPL_DELINEATION_POTENTIAL.CDR
05/15



Explanation

Likely Organic NAPL Source Area

▨

Estimated NAPL Extent

Modeled PI Values

- 70 (Lower Bound Confirmed)
- 50 (Upper Bound Confirmed)
- 30 (Potential)
- Site Region Boundary

Note: The displayed contours represent the estimated maximum lateral NAPL extent, considering the interval from ground surface to top of bedrock as a whole. See Figure 5-70 for a complete explanation of contours.

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet

0 350 700

Battelle
The Business of Innovation

Likely Organic NAPL Sources

FIGURE
8-1

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

LikelyOrganicNAPLsources.mxd 4/14/2015

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Battelle
The Business of Innovation

Likely Mercury NAPL Sources

FIGURE
8-2

REMEDIAL INVESTIGATION
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

LikelyMercuryNAPLsources.mxd
6/25/2015

Table 1-1. SWMUs and AOCs

SWMU Number	SWMU Name
1	Landfill L-1 (First Plant Trash Burning Pile)
2A	Landfill L-2 (Boiler Fly Ash Disposal Area) (South)
2B	Landfill L-2 (Boiler Fly Ash Disposal Area) (North)
3	Landfill L-3 (Second Plant Trash Burning Pile)
4	Landfill L-8 (Brine Sludge Disposal Area)
5	Landfill L-9
6	Landfill L-10 (Inert Material Landfill Salt Dock)
7	Pond O (P-3 Surface Impoundment)
8	Pond 1A (P-5 Surface Impoundment)
9	Pond 1B (P-12 Surface Impoundment)
10	Pond 2 (P-9 Surface Impoundment)
11	Pond 3A (P-6 Surface Impoundment)
12	Pond 4 (P-10 Surface Impoundment)
13	Pond 3B (P-7 Surface Impoundment)
14	Pond 3C (P-8 Surface Impoundment)
15	Pond P-1, Acrylonitrile and Acrylic Acid
16	Pond P-2 (2), Acrylonitrile and Acrylic Acid
17	Pond P-4, Acrylonitrile and Acrylic Acid
18	Surface Impoundment P-11, River Water Solids
19	Surface Impoundment P-11 Diversion Box
20	Waste Pile 0-1, Brine Sludge
21	Waste Pile 0-4, Brine Sludge
22	Decanter Blowdown Tank, Brine Sludge
23	Thickening Tank, Brine Sludge
24	Salt Saturator Blowdown Sump
25	#1 Chlorine pH Adjustment Tank
26	Chlorine Filter Building
26A	Hypo Adjustment Tank
26B	Eimco Filter Press
26C	Vacuum Filter Dumpster
26D	Receiver Tanks (2)
26E	Caustic Scrubber
26F	Filtrate Receiver and Vacuum Pump
26G	Precoat Filter Tanks (2)
26H	Filter Blowdown Tank
26I	Sulfide Filter Press
26J	K106 Box
27	Chlorine Filter Building Trench
28	Chlorine Influent Sump
29	Chlorine Stormwater Storage Tank
30	#2 Chlorine pH Adjustment Tank
31	Sulfide Adjustment Tank
32	Final pH Adjustment Tank
33	Carbon Bed Tank #1
34	Carbon Bed Tank #2
35	Cell Room Sump
36	Hazardous Waste Storage Dumpster, Carbon Waste
37	Railcar Cleaning Area, Caustic
38	Ethylene Neutralization Tank
39	Ethylene Neutralization Tank
40	Ethylene Oil/Water Separator Tank A
41	Ethylene Oil/Water Separator Tank B
42	Ethylene Tank Farm Stormwater Sump
43	Ethylene Influent Sump
44	Ethylene Stormwater Surge Tank

Table 1-1. SWMUs and AOCs

SWMU Number	SWMU Name
45	API Sump
46	Incline Plate Separator (PIPS) Tank
47	Light Oil Storage Tank
48	Heavy Oil Storage Tank
49	Induced Air Flotation (IAF) Tank
50	Coalescar Tank
51	Ethylene Effluent Sump
52	Hazardous Waste Oil Tank
53	Ethylene Equipment Cleaning Area
54	Stormwater/Oil Separator
55	Ethylene Stormwater Storage Tank
56	West EDC Tank Farm Sump
57	Purchased EDC Tank Farm Sump
58	River EDC Tank Farm Sump
59	North Synthesis Sump
60	East EDC Tank Farm Sump
61	East Synthesis Sump
62	East Sump Tank
63	Process Sump Tank, WW Stripper
64	North-South Cracking Sump Tank
65	Contaminated Stormwater Storage Tank
66	Contaminated Water Storage Tank
67	EDC Waste Water Stripper
68	EDC Waste Water Stripper
69	EDC pH Adjustment Tank
70	EDC Waste Water Stripper Bottoms Cooler
71	EDC Waste Water Stripper Bottoms Cooler
72	EDC Stripper Heat Interchanger
73	EDC Stripper Heat Interchanger
74	No. 5 River Tank, Less Than 90 Days
75	VCM Batch Caustic Scrubber Blowdown Stripper
76	Cooling Tower Blowdown Sump 1
77	Cooling Tower Blowdown Sump 2
78	Cooling Tower Blowdown Sump 3
79	Cooling Tower Blowdown Sump 3A
80	Cooling Tower Blowdown Sump 4
81	Cooling Tower Blowdown Sump 5
82	Carbopol Stormwater Surge Tank
83	Process Building Sump
84	Carbopol Mix Tank
85	Batch Stripper Holding Tank
86	Carbopol Stripper
87	Still Condenser
88	Carbopol Decanter
89	Vent Condenser
90	Waste Organic Truck Loading Area
91	Carbopol Hazardous Waste Storage Tank, Less Than 90 Days
92	Ignitable Waste Loading Area
93	Neutralization Softener Tank
94	DM Neutralization Tank
95	Wash Sump, Caustic Car
96	Primary Clarifier
97	Biotreater Feed Equalization Tank
98	Biotreater Tank (#1)
99	Biotreater Tank (#2)

Table 1-1. SWMUs and AOCs

SWMU Number	SWMU Name
100	Secondary Clarifier
101	Effluent Sand Filter #1
102	Effluent Sand Filter #2
103	Thickener/Digester
104	Filter Building Sump
105	Filter Press Building
106	Drum Storage 0-2, Old AA Less Than 90 Day
107	Storage 0-3, Pre-Ethylene Construction Drum
108A	EDC/VCM Outdoor Drum Storage Area A
108B	EDC/VCM Outdoor Drum Storage Area B
109	EDC/VCM Shelter Drum Storage Area
110	Ethylene Drum Storage Area
111	Empty Drum Storage, Returnable Drum Area
112	Lab Waste Drum Storage Area
113	Former Sulfide Treatment System
114	Scrap Pile, Bone Yard
115	Stormwater Sewers
115A	EDC/VCM Stormwater Sewer
115B	Ethylene Stormwater Sewer
116	Chlorine Plant Process Sewer
117	Ethylene Plant Process Sewer
118	EDC/VCM Plant Process Sewer
119	Carbopol Plant Process Sewer
120	REMOVED
121	REMOVED
122	REMOVED
123	Drainage Route From Area of SWMU 6
124	Drainage Route From Area of SWMU 6
125	BFGoodrich Landfill (Landfill L-7)
126	Burn Pit Area (Landfill L-6)
127	Brine Sludge Burial Area Next to Burn Pit Area (Landfill L-5)
128	Landfill Ethylene Plant Oily Sludge (Landfill L-4)
129	RESERVED
130	RESERVED
131	EDC/VCM Equipment Cleaning (Water Blasting) Pad
132	Boiler House Drain Tank
133	E&E Roll-Off Boxes Accumulation Area, Boiler House
134	E&E Roll-Off Boxes Accumulation Pad, Chlorine
135	E&E Wastewater Treatment Sand Filter
136	Ethylene Wastewater Pretreatment
137	Mercury Retort
138	Chlorine Plant Mercury Wastewater Treatment Tank
139	Chlorine Plant Mercury Wastewater Treatment Tank
140	Inert Material Landfill Beside CERCLA Site (L-7)
141	Carbopol Plant Cardboard Storage Area
142	Carbopol Plant Equipment Cleaning Area
143	Carbopol Plant Wastewater Stripper
144	Chlorine Plant Brine Sludge Roll-Off Box Storage Area (South)
145	Chlorine Plant Brine Sludge Roll-Off Box Storage Area (West)
146	Chlorine Plant Brine Sludge Roll-Off Box Storage Area (East)
147	Chlorine Plant Salt Sludge Roll-Off Box Storage Area
148	Chlorine Plant Salt Sludge Pile Storage Area
149	Chlorine Plant Brine Sludge Portable Treatment Area
150	Chlorine Plant Equipment Cleaning Area
151	EDC/VCM Plant Stormwater Storage Tank

Table 1-1. SWMUs and AOCs

SWMU Number	SWMU Name
152	EDC/VCM Plant Stormwater Storage Tank
153	RESERVED
154	Westlake Less Than 90 Day Drum Storage Area
155	EDC/VCM Plant Solid Waste Roll-Off Box
156	Empty Drum Storage Area
157	RESERVED
158	EDC/VCM Construction Inert Soil
159	Construction Inert Soil
160	RESERVED
161	RESERVED
162	West Equipment Sand Blasting and Paint Area
163	East Equipment Sand Blasting and Paint Area
164	RESERVED
165	RESERVED
166	RESERVED
167	EDC Tank Sump No. 7
168	EDC Tank Sump No. 8
169	EDC Tank Sump No. 9 (North)
170	EDC Tank Sump No. 9 (South)
171	Carbopol Tank Farm Sump
172	Carbopol Empty Drum Storage Area
173	RESERVED
174	Carbopol Waste Storage Cabinet
175	RESERVED
176	Carbopol Waste Storage Area (Off-Specification Product)
177	Carbopol Wash Tank (TK-1W)
178	Telene Drummed Waste Storage Area
179	RESERVED
180	Telene Railcar Unloading Sump
181	RESERVED
182	Ground Water Stripper "C" Stripper System
183	"C" Stripper Sump Tank
184	Crude EDC Storage Tank No. 6 Foundation (No. 6 River Tank)
185	Superfund Site Leachate Transfer Tank
186	Former Chlorine Less Than 90 Day Drum Storage Area
187	RESERVED
188	RESERVED
189	RESERVED
190	Used Battery Storage Area
191	Flare Header Drain, Ethyl Acetate
192	Wastewater Contingency Tank
193	Mercury Release East Side Cell Room
194	Mercury Contaminated Dirt Storage Area
195	Mercury Waste Roll-Off Box Storage Area
196	Mercury Release North Side Cell Room
197	Outdoor Mercury Cell Building Sump
198	Stormwater Run-on Cut-off
199	Historical Location of Acrylonitrile Plant
200	Carbopol Equipment Lay-down Area
201	Transfer Tank 29F
202	Carbopol Non-Hazardous Storage Areas
203	Co-Solvent Wastewater Tank (Tank 35B)
204	Former Acrylonitrile Plant Loading/Unloading Area
205	Carbopol Vacuum Cleaning Systems
206	Former EDC Truck Loading Area

Table 1-1. SWMUs and AOCs

SWMU Number	SWMU Name
207	Historical Wastewater Sump
208	Ethylene Equipment Cleaning Area Sump
209	Telene Stormwater Sump
210	Telene Railcar Load Out Area
211	C Stripper Filter Media Hazardous Waste Accumulation Area
212A	Westlake Lay-down Area A
212B	Westlake Lay-down Area B
212C	Westlake Lay-down Area C
213	Carbon Beds (4)
214	Carbopol Less Than 90 Day Drum Storage Area
215	Aerobic Digester Tank
216	Laboratory Satellite Accumulation Areas
217	Dumpsters (Solid Waste Accumulation Areas)
218	Railcar Loading/Unloading Areas
219	Soil Vapor Extraction/Air Sparging (SVE/AS) System
220	RESERVED
221	RESERVED
222	RESERVED
223	Lift Station Sump for EDC/VCM Contaminated Storm Water

AOC	AOC Name
A	EDC/VCM Tank Farm
B	EDC/VCM Flare Area
C	Old Dowtherm Pump Pad
D	No. 4 EDC Shore Tank Area
E	North-South EDC/VCM Pipe Rack Area
F	Diesel Fuel Tank Release
G	Aromatic Gasoline Pipeline Leak
H	Aromatic Gasoline Storage Tanks Dike Soil Contamination
I	Former Fuel Oil Storage Tank Dike Oil Spill
J	KPDES Outfall 001
K	EDC/VCM Plant Area
L	Ethylene Plant and East Synthesis Area
M	Carbopol Plant Area
N	Ethylene Used Equipment Lay-down Area
O	EDC/VCM Used Equipment Lay-down Area
P	Boiler House Used Equipment Lay-down Area
Q	Westlake Equipment Lay-down Area at Eastern Property Fence

Source: RCRA Permit Table IV-1

Table 1 2. Summary of Former and Current Liquid Storage Capacity

Key ID'	Tank Name and Identifiers	Plant Area	Materials Stored	Years Operated	Dimensions	Volume Each (gallons)
1	Former Shore Tank 1	Vinyl Tank Farm	Crude EDC	1962-1980	46 ft dia x 50 ft h	600,000
1	Former Shore Tank 1	Vinyl Tank Farm	Crude EDC	1980 - 2005	46.5 ft dia x 50 ft h	600,000
1	Shore Tank 1 (TK-906-1)	Vinyl Tank Farm	EDC and Catoxid® Feed chlorinated byproduct	2005 - present	46.5 ft dia x 50 ft h	600,000
2	Former Shore Tank 2	Vinyl Tank Farm	Product EDC, crude EDC	1959 - 1980	35 ft dia x 45 ft h	300,000
2	Former Shore Tank 2 (TK-1E-1)	Vinyl Tank Farm	Product EDC, Catoxid® Feed chlorinated byproduct	1980 - 2004	46.5 ft dia x 50 ft h	600,000
2	Shore Tank 2 (TK-1E-1)	Vinyl Tank Farm	Product EDC, Catoxid® Feed chlorinated byproduct	2004 - present	46.5 ft dia x 48 ft h	
3	Former Shore Tank 3	Vinyl Tank Farm	Product EDC	est. 1959 - est. 1979	approx. 35 ft dia x 45 ft h	300,000
4	Former Shore Tank 4 (TK-701B)	Vinyl Tank Farm	Crude EDC, Purchased EDC	1967 - 1992	60 ft dia x 40 ft h	1,000,000
5	Shore Tank 5 (TK-702B)	Vinyl Tank Farm	Purchased EDC	1980 - present	75 ft dia x 48 ft h	1,400,000
6	Shore Tank 6 (TK-703B)	Vinyl Tank Farm	Purchased EDC	1980 - present	75 ft dia x 48 ft h	1,400,000
7	Shore Tank 7 (TK-704-89)	Vinyl Tank Farm	Catoxid® Feed chlorinated byproduct	1990 - present	75 ft dia x 40 ft h	1,300,000
8	Shore Tank 8 (TK-705)	Vinyl Tank Farm	Crude EDC, oxychlorination	1990 - present	75 ft dia x 40 ft h	1,300,000
9	Shore Tank 9 (TK-706)	Vinyl Tank Farm	Crude EDC, Catoxid® Feed chlorinated byproduct	1992 - present	75 ft dia x 40 ft h	1,300,000
10	Stop-out EDC Storage Tank (TK-30-B2)	Vinyl Tank Farm	EDC, trace vinyl chloride	1978 - present	24 ft dia x 43 ft h	
10A	Vacuum Column Feed Tank (former Stop-out EDC Storage Tank TK-30-B2)	Vinyl Tank Farm	EDC & CMHC (mix of vacuum column feed/bottoms)			17,500
11	1A Vinyl Sphere	Vinyl Tank Farm	vinyl chloride	1963 - present	43.5 ft high	322,450
12	1B Vinyl Sphere	Vinyl Tank Farm	vinyl chloride	1969 - present	43.25 ft high	323,173
13	1C Vinyl Sphere	Vinyl Tank Farm	vinyl chloride	1972 - present	43.5 ft high	322,631
14	#2 Vinyl Sphere	Vinyl Tank Farm	off-spec vinyl chloride	1954 - present	22.5 ft high	128,045
15	#3 Vinyl Sphere	Vinyl Tank Farm	off-spec vinyl chloride	1954 - present	22.5 ft high	128,045
16	No. 1 Vinyl Vapor Recovery Tank (TK-4B)	Vinyl Tank Farm	vinyl chloride			
17	No. 2 Vinyl Vapor Recovery Tank (TK-5B)	Vinyl Tank Farm	vinyl chloride			
18	No. 3 Vinyl Vapor Recovery Tank (TK-6B)	Vinyl Tank Farm	vinyl chloride			
19	No. 1 Chlorine Storage Tank (TK-911A)	Vinyl Tank Farm	liquid chlorine			
20	No. 2 Chlorine Storage Tank (TK-911B)	Vinyl Tank Farm	liquid chlorine			
21	No. 3 Chlorine Storage Tank (TK-911C)	Vinyl Tank Farm	liquid chlorine			
22	No. 4 Chlorine Storage Tank (TK-911D)	Vinyl Tank Farm	liquid chlorine			
23	No. 5 Chlorine Storage Tank (TK-911E)	Vinyl Tank Farm	liquid chlorine			
24	No. 6 Chlorine Storage Tank (TK-911F)	Vinyl Tank Farm	liquid chlorine			
25	No. 7 Chlorine Storage Tank (TK-1881)	Vinyl Tank Farm	liquid chlorine			
26	No. 8 Chlorine Storage Tank (TK-2881)	Vinyl Tank Farm	liquid chlorine			
27	Primary Clarifier (SWMU 96)	Utility Area	wastewater	1965 - post 2002		165,000
28	Biotreater Feed Equalization Tank (SWMU 97)	Utility Area	wastewater	1965 - post 2002		1,500,000
29	Biotreater Tanks (SWMU 98, 99)	Utility Area	wastewater	1965 - post 2002		900,000
30	Secondary Clarifier (SWMU 100)	Utility Area	wastewater	1965 - post 2002		190,000
31	Thickener Digester (SWMU 105)	Utility Area	wastewater	1966 - post 2002		60,000
32	Neutralization Softener Tank (SWMU 95)	Utility Area	softener water, caustic, sulfuric acid	1965 - post 2002	12 ft dia x 12 ft high	
33	Boiler House Drain Tank (SWMU 102)	Utility Area	oily liquid	1994 - post 2002		25,000
33A	Diesel Tank (AOC 1)	Utility Area				3,000
34	Water Clarifier (2)	Utility Area	clarified river water		80 ft dia x 16 ft high	
35	Clarified Water Storage Tank	Utility Area	clarified river water		90 ft dia x 16 ft high	
35	Ethylene Storm Water Storage Tank (SWMU 55)	Utility Area	initially clarified river water, then stormwater from Ethylene Plant, then backwash for carbon filter / wastewater treatment	1965 - post 2002		245,000
36	West Vacuum Column Feed Tank (TK-711-B; No. 1 West)	Intermediate Tank Farm	vacuum column feed/bottoms	pre 1966 - 2006	18.5 ft dia x 25.5 ft high	45,000
37	East Vacuum Column Feed Tank (TK-711-A; No. 2 East)	Intermediate Tank Farm	vacuum column feed/bottoms	pre 1966 - 2006	18.5 ft dia x 25.5 ft high	45,000
38	West Solvesso Tank (No. 1; MTK-539HA)	Intermediate Tank Farm	Aromatic 150 (petroleum hydrocarbon and naphthalene)			5,640
39	East Solvesso Tank (No. 2; MTK-540HA)	Intermediate Tank Farm	Aromatic 150 (petroleum hydrocarbon and naphthalene)			5,640
40	Caustic Tank	Intermediate Tank Farm	20% Caustic Soda solution			
41	HCl Neutralization Tank (TK-1670)	North Synthesis	Caustic Solution			
42	Weak Acid Storage Tank (TK-1G1)	North Synthesis	HCl (weak)			
43	Weak Acid Storage Tank (TK-2G1)	North Synthesis	HCl (weak)			
44	Strong Acid Storage Tank (TK-11G1)	North Synthesis	HCl acid (strong)			
45	Strong Acid Storage Tank (TK-12G1)	North Synthesis	HCl acid (strong)			
45A	Storage Tank ID 4	EDC/VCM Plant	Gasoline			1,000
45B	Storage Tank ID 5	EDC/VCM Plant	Diesel			1,000
46	Storm Water Storage Tank (SWMU 65)	EDC/VCM Plant	stormwater from EDC/VCM Plant, wastewater	1962 - post 2002		1,200,000
47	Contaminated Water Storage Tank (SWMU 66)	EDC/VCM Plant	process wastewater from EDC/VCM Plant	1962 - post 2002		1,200,000
48	East Sump Tank (SWMU 62)	EDC/VCM Plant	pad drainage and process blowdown with caustic	1962 - post 2002	15 ft x 40 ft x 16 ft deep	
49	Process Sump Tank (SWMU 63)	EDC/VCM Plant	pad drainage and process blowdown	1962 - post 2002	15 ft x 40 ft x 15 ft deep	
50	North South Cracking Sump Tank (SWMU 64)	EDC/VCM Plant	pad drainage and process blowdown	1967 - post 2002	15 ft x 40 ft x 15 ft deep	
51	EDC pH Adjustment Tank (SWMU 69)	EDC/VCM Plant	wastewater and 20% caustic	1962 - post 2002	8 ft dia x 30 ft high	
52	Former River Tank 1	River Tank Farm	Catoxid® Feed chlorinated byproduct Oxy crude EDC	pre 1966 - 1974		800,000
52	Former River Tank 1	River Tank Farm	intermediate	1975 - 1991	52 ft dia x 48 ft h	750,000
53	Former River Tank 2	River Tank Farm	Catoxid® Feed chlorinated byproduct Oxy crude EDC	pre 1966 - 1985		500,000
54	River Tank 3 (TK-3B-1)	River Tank Farm	byproduct, Oxychlorination crude EDC, wastewater	pre 1966 - 1974		500,000
54	River Tank 3	River Tank Farm	byproduct (to 1996), crude EDC	1974 - 1996	45 ft dia x 42 ft h	500,000
54	River Tank 3 (SWMU 151)	River Tank Farm	stormwater and/or wastewater	1996 - post 2002		500,000

Table 1-2. Summary of Former and Current Liquid Storage Capacity

Key ID[1]	Tank Name and Identifiers	Plant Area	Materials Stored	Years Operated	Dimensions	Volume Each (gallons)
55	River Tank 4	River Tank Farm	Oxychlorination crude EDC, wastewater	pre 1966 - 1977		500,000
55	River Tank 4	River Tank Farm	crude EDC to 1997 crude EDC	1977 - 1997	45 ft dia x 42 ft h	500,000
55	River Tank 4 (SWMU 152)	River Tank Farm	stormwater and/or wastewater	1997 - post 2002		500,000
56	Former River Tank 5	River Tank Farm	Catoxid® Feed chlorinated byproduct, Oxy crude EDC	pre 1966 - late 1970	45 ft dia x 42 ft h long	500,000
56	Former River Tank 5 (SWMU 74)	River Tank Farm	EDC product	late 1970 - 1980		200,000
57	Former River Tank 6	River Tank Farm	byproduct - Catoxid® Feed chlorinated byproduct	pre 1966 - 1995	80 ft dia x 40 ft high	1,500,000
58	Aromatic Gasoline Tank (2)	Ethylene Plant	aromatic gasoline		24 ft dia x 32 ft high	
59	C4 Storage Tank (2)	Ethylene Plant	butane and butene			
60	Ethylene Storage	Ethylene Plant	Ethylene			
61	Fuel Oil Storage Tank No. 3	Ethylene Plant	Fuel Oil		20 ft dia x 24 ft high	
62	Fuel Oil Storage Tank No. 2	Ethylene Plant	Fuel Oil		20 ft dia x 24 ft high	
63	Ethylene Neutralization Tank (SWMU 38, 39)	Ethylene Plant	wastewater	1965 - 1992	3 ft dia x 5 ft high	
64	Ethylene Oil/Water Separator Tank (SWMU 40, 41)	Ethylene Plant	oil and water	1965 - 1992	5 ft dia x 5 and 7 ft high	
65	Ethylene Storm Water Surge Tank (SWMU 44)	Ethylene Plant	storm water	1965 - 1992		365,000
66	Incline Plate Separator Tank (SWMU 46)	Ethylene Plant	wastewater and oil	1965 - 1992	8 ft x 3 ft x 10 ft	
67	Light Oil Storage Tank (SWMU 47)	Ethylene Plant	oil from wastewater	1965 - 1992	5 ft dia x 12 ft high	
68	Heavy Oil Storage Tank (SWMU 48)	Ethylene Plant	oil from incline plate	1965 - 1992	4 ft dia x 10 ft long	
69	Induced Air Flotation Tank (SWMU 49)	Ethylene Plant	waste water and oil	1965 - 1992	3 ft dia x 20 ft long	
70	Coalescer Tank (SWMU 50)	Ethylene Plant	wastewater and oil	1965 - 1992	5 ft dia x 6 ft long	
71	Hazardous Waste Oil Tank (SWMU 52)	Ethylene Plant	oil from Ethylene prep	1965 - 1992	5 ft dia x 8 ft long	
72	Storm Water Oil Separator Tank (SWMU 54)	Ethylene Plant	stormwater and oil	1965 - post 2002	4 ft x 10 ft x 10 ft	
73	Ethylene Quench Tank	Ethylene Plant	ethylene, steam from furnace		10 ft dia x 50 ft long	
74	Ethylene Plant Wastewater Treatment Tank	Ethylene Plant	waste water			
75	Wastewater Contingency Tank (SWMU 192)	Ethylene Plant	fuel oil storage	unknown - 2001		40,000
75	Wastewater Contingency Tank (SWMU 192)	Ethylene Plant	wastewater	2001 - post 2002		40,000
76	Former Oil/Water Separator Tank	Ethylene Plant	waste water		30 ft dia x 24 ft high	
76A	Storage Tank ID 14	Ethylene Plant	gasoline			4,500
76B	Storage Tank ID 15	Ethylene Plant	Polytree 595			1,000
76C	Storage Tank ID 16	Ethylene Plant	Betz 20x55			1,000
76D	Storage Tank ID 17	Ethylene Plant	Injection oil			7,050
76E	Propylene Storage Tank	Ethylene Plant	Propylene			
77	Carbopol Stormwater Surge Tank (SWMU 62)	Carbopol Plant	stormwater from Carbopol plant	prior to 1965 - post 2002		245,000
78	Carbopol Mix Tank (SWMU 64)	Carbopol Plant	reactor wash and lime	1965 to post 2002		15,000
79	Batch Stripper Holding Tank (65)	Carbopol Plant	wastewater from Carbopol	1965 to post 2002		20,000
80	Carbopol Batch Stripper Hold Tank (SWMU 66)	Carbopol Plant	stripper bottom	1965 - 1999		20,000
80	Carbopol Batch Stripper Hold Tank (SWMU 66)	Carbopol Plant	stripper bottom	1999 - post 2002		5,500
81	Carbopol Hazardous Waste Storage Tank (SWMU 91)	Carbopol Plant	ignitable waste (hexane and benzene)	1965 - post 2002		2,770
82	Carbopol Wash Tank (TK-1W) (SWMU 177)	Carbopol Plant	wastewater	1968 - post 2002		1,500
83	Saturator (2)	Chlorine Plant	salt brine solution, mercury sludge		20 ft dia x 40 ft high	
84	Clarifier (2)	Chlorine Plant	brine solution, mercury sludge		80 ft dia x 12 ft high	
85	Clarifier Overflow Tank	Chlorine Plant	clarifier sludge, mercury sludge		30 ft x 30 ft x 30 ft high	
86	Sludge Storage Pit (2)	Chlorine Plant	clarifier sludge, mercury sludge		20 ft x 8 ft x 8 ft high	
87	Depleted Brine Tank (2)	Chlorine Plant	brine solution		12 ft dia x 10 ft high	
88	Dechlorination Brine Tank	Chlorine Plant	brine solution		12 ft dia x 10 ft high	
89	Filtered Brine Storage Tank	Chlorine Plant	brine solution		25 ft dia x 32 ft high	
90	Hypochlorite Storage Tank	Chlorine Plant	hypochlorite		12 ft dia x 8 ft high	
91	Caustic Storage Tank (4)	Chlorine Plant	caustic		75 ft dia x 32 ft high	
92	Wastewater Storage Tank	Chlorine Plant	chlorine plant waste water		25 ft dia x 32 ft high	
93	Sulfide Treatment Tank (multiple)	Chlorine Plant	filtrate and filter cake			
94	Fire Water Storage Tank	Chlorine Plant	river water		50 ft dia x 16 ft high	
95	Chlorine Adjustment Tank (SWMU 25)	Chlorine Plant	brine wastewater	1965 - post 2002		100,000
96	Chlorine Stormwater Storage Tank (SWMU 29)	Chlorine Plant	stormwater from chlorine plant	1965 - post 2002		700,000
97	Chlorine pH Adjustment Tank (SWMU 30)	Chlorine Plant	waste water	1965 - post 2002	12 ft dia x 20 ft high	
100	Sulfide Adjustment Tank (SWMU 31)	Chlorine Plant	waste water	1965 - post 2002	8 ft dia x 15 ft high	
101	Final pH Adjustment Tank (SWMU 32)	Chlorine Plant	waste water and caustic	1965 - post 2002	10 ft dia x 20 ft high	
102	Carbon Bed Tank (SWMU 33, 34)	Chlorine Plant	waste water and carbon	1965 - post 2002	5 ft dia x 12 ft high	
103	DM Neutralization Tank (SWMU 94)	Chlorine Plant	dilute caustic, acid and wastewater	1965 - post 2002	20 ft dia x 12 ft high	
104	Former Sulfide Treatment System (SWMU 113)	Chlorine Plant	wastewater from chlorine plant	1970 - 1985		1,000
105	Storage Tank ID 13	Chlorine Plant	diesel			1,000
106	Storage Tank ID 9	Chlorine Plant	diesel			1,000
107	Wacker Tank North	Wacker	vinyl acetate monomer	1970		1,000,000
108	Wacker Tank South	Wacker	vinyl acetate monomer	1970		1,500,000
	Pond P-1 (SWMU 15)	Floodplain	VCM and Carbopol wastewater	1954-1963	78,800 cubic yards, 5.44 Acre	15,900,000
	Pond P-2 (SWMU 16)	Floodplain	ammonium sulfate	1957-1962	2.4 Acre	
	Pond P-4 (SWMU 17)	Floodplain	ammonium sulfate	1959-1962	2.4 Acre	
	Pond P0 (SWMU 7)	Floodplain	settling waste from EDC/VCM	1958-1974	213 ft x 150 ft, 1.3 Acre	
	Pond 1 (SWMU 10)	Floodplain		1963-1981	62,000 cubic yard	12,500,000
	Pond 1A (SWMU 8)	Floodplain	wastewater and stormwater EDC/VCM, Ethylene production and settling of acrylic and polymer wastewater	1963-1985	segment of Pond 1 above, 275 ft x 325 ft, 2.1 Acre	
	Pond 1B (SWMU 9)	Floodplain	equalization for surface water prior to discharge	1963-1985	segment of Pond 1 above, 250 ft x 150 ft x 16 ft deep (8 ft freeboard), 0.86 Acre	
	Pond 2	Floodplain	final stabilization basin prior to discharge	1963-1985	200 ft x 475 ft x 25 feet deep (13 ft freeboard), 2.2 Acres, 50,000 cubic yard	10,200,000
	Pond 3A (SWMU 11)	Floodplain	firm basin for process and storm water from ethylene plant	1963-1985	160 ft x 75 ft, 0.3 Acre, 7,500 cubic yard	1,500,000
	Pond 3B (SWMU 13)	Floodplain	iron and copper hydroxide sludge	1963-1985	75 ft x 190 ft, 0.33 Acre, 5,900 cubic yard	1,200,000
	Pond 3C (SWMU 14)	Floodplain	acrylic and polymer sludge and wastewater from ethylene plant, dredge spoil from barge slip	1963-1985	200 ft x 80 ft, 0.4 Acre, 9,900 cubic yard	2,000,000
	Pond 4 (SWMU 12)	Floodplain	storm diversion and treatment and settling for brine material and wastewater from chlor-alkali plant	1965-1988	290 ft x 190 ft, 1.3 Acre, 69,000 cubic yard	14,000,000

Note: [1] See Figure 1.9

Table 5-2. Summary of Groundwater Sample Analytical Results

Parameter	Unit	MCL	No. of Samples	No. of Detections	% Detections	Minimum Detected Result	Maximum Detected Result	Average Detected Result	No. Exceeding MCL	% Samples Exceeding MCL	COPC
Gas											
Carbon Dioxide	ug/L		171	163	95.32	8400	1100000	167510.43		0	No
Ethane	ug/L		171	106	61.99	0.28	2300	162.12		0	No
Ethene	ug/L		171	118	69.01	0.31	81000	10101.51		0	No
Methane	ug/L		171	167	97.66	0.11	12000	609.28		0	No
Metals											
Aluminum	ug/L		171	102	59.65	105	90000	3812.32		0	No
Antimony	ug/L	6	148	49	33.11	0.13	450	9.65	1	0.68	No
Arsenic	ug/L	10	148	141	95.27	0.41	1800	23.31	36	24.32	Yes
Barium	ug/L	2000	148	75	50.68	15.5	3200	318.37	3	2.03	No
Beryllium	ug/L	4	148	44	29.73	0.2	51	2.49	5	3.38	No
Cadmium	ug/L	5	148	64	43.24	0.13	49	2.92	9	6.08	No
Chromium	ug/L	100	180	78	43.33	2.2	7300	117.39	7	3.89	No
Cobalt	ug/L		148	138	93.24	0.091	580	42.25		0	No
Copper	ug/L	1300	148	39	26.35	0.29	220	22.12		0	No
Cyanide	ug/L	200	86	27	31.40	5.3	160	25.85		0	No
Iron	ug/L		342	323	94.44	110	750000	44598.11		0	No
Lead	ug/L	15	148	68	45.95	0.18	380	8.56	3	2.03	No
Magnesium	ug/L		178	166	93.26	1700	260000	19626.57		0	No
Manganese	ug/L		342	337	98.54	16	54000	5226.71		0	No
Mercury	ug/L	2	153	33	21.57	0.12	35	3.70	9	5.88	Yes
Nickel	ug/L		148	100	67.57	3.2	1250	60.11		0	No
Potassium	ug/L		171	54	31.58	2500	45000	12077.04		0	No
Selenium	ug/L	50	148	62	41.89	0.62	1800	31.58	1	0.68	No
Silver	ug/L		148	6	4.05	0.096	46	7.84		0	No
Sodium	ug/L		171	171	100.00	4600	10000000	445941.23		0	No
Vanadium	ug/L		148	55	37.16	0.45	440	17.77		0	No
Zinc	ug/L		148	51	34.46	5.4	3000	305.97		0	No
PCBs											
Aroclor 1016	ug/L	0.5	30	2	6.67	20	58	39.00	2	6.67	No
TEPH											
TPH - C12-C24 (DRO)	ug/L		22	10	45.45	240	2800	944.00		0	No
TPH - C24 - C40 (ORO)	ug/L		22	1	4.55	290	290	290.00		0	No

Table 5-2. Summary of Groundwater Sample Analytical Results

Parameter	Unit	MCL	No. of Samples	No. of Detections	% Detections	Minimum Detected Result	Maximum Detected Result	Average Detected Result	No. Exceeding MCL	% Samples Exceeding MCL	COPC
SVOCs											
1,2,3,4-Tetrachlorobenzene	ug/L		160	3	1.88	2.7	15	8.83		0	No
1,2,3-Trichlorobenzene	ug/L		160	2	1.25	0.4	0.82	0.61		0	No
1,2,3,5-Tetrachlorobenzene	ug/L		160		0.00					0	No
1,2,4,5-Tetrachlorobenzene	ug/L		160	4	2.50	1.1	41	14.98		0	No
1,2,4-Trichlorobenzene	ug/L	70	160	27	16.88	0.46	7.6	2.28		0	No
1,3,5-Trichlorobenzene	ug/L		160	1	0.63	0.67	0.67	0.67		0	No
2,4-Dimethylphenol	ug/L		160	2	1.25	0.54	13	6.77		0	No
2-Chloronaphthalene	ug/L		160	10	6.25	0.33	7	2.77		0	No
2-Methylnaphthalene	ug/L		160	79	49.38	0.14	1300	72.30		0	No
3&4 Methylphenol	ug/L		160	8	5.00	0.91	39	13.81		0	No
4-Nitrophenol	ug/L		160		0.00					0	No
Acenaphthene	ug/L		160	60	37.50	0.14	240	13.40		0	No
Acenaphthylene	ug/L		160	61	38.13	0.12	1000	37.88		0	No
Acetophenone	ug/L		160	60	37.50	0.34	9800	474.40		0	No
Anthracene	ug/L		160	13	8.13	0.3	130	14.39		0	No
Benzo[A]Anthracene	ug/L		160	2	1.25	2.6	24	13.30		0	No
Benzo[A]Pyrene	ug/L	0.2	160	2	1.25	1.2	11	6.10	2	1.25	No
Benzo[B]Fluoranthene	ug/L		160	1	0.63	1	1	1.00		0	No
Benzo[G,H,I]Perylene	ug/L		160		0.00					0	No
Benzo[K]Fluoranthene	ug/L		160		0.00					0	No
Bis(2-Chloroethyl) Ether	ug/L		160	92	57.50	0.18	1000	73.25		0	No
Bis(2-Ethylhexyl) Phthalate (Dehp)	ug/L	6	160	19	11.88	0.82	3.8	1.37		0	No
Chrysene	ug/L		160	2	1.25	2.4	22	12.20		0	No
Dibenzo[A,H]Anthracene	ug/L		160		0.00					0	No
Di-N-Butyl Phthalate (Dbp)	ug/L		160		0.00					0	No
Fluoranthene	ug/L		160	10	6.25	0.21	72	9.10		0	No
Fluorene	ug/L		160	64	40.00	0.14	480	20.10		0	No
Hexachlorobenzene	ug/L	1	160	3	1.88	0.49	4.3	1.76	1	0.63	No
Hexachloroethane	ug/L		160	1	0.63	1.4	1.4	1.40		0	No
Indeno[1,2,3-Cd]Pyrene	ug/L		160		0.00					0	No
O-Cresol	ug/L		160	2	1.25	0.19	32	16.10		0	No
Pentachlorobenzene	ug/L		160	3	1.88	5	11	7.27		0	No
Pentachloroethane	ug/L		160	3	1.88	1.3	48	17.13		0	No
Phenanthrene	ug/L		160	28	17.50	0.064	550	32.67		0	No
Phenol	ug/L		160	51	31.88	0.67	440	58.04		0	No
Pyrene	ug/L		160	9	5.63	0.66	130	17.61		0	No

Table 5-2. Summary of Groundwater Sample Analytical Results

Parameter	Unit	MCL	No. of Samples	No. of Detections	% Detections	Minimum Detected Result	Maximum Detected Result	Average Detected Result	No. Exceeding MCL	% Samples Exceeding MCL	COPC
VOCs											
1,1,1,2-Tetrachloroethane	ug/L		389		0.00					0	No
1,1,1-Trichloroethane	ug/L	200	389	1	0.26	0.33	0.33	0.33		0	No
1,1,2,2-Tetrachloroethane	ug/L		389	21	5.40	0.45	3800	252.13		0	No
1,1,2-Trichloroethane	ug/L	5	389	179	46.02	0.28	270000	8370.77	155	39.85	Yes
1,1-Dichloroethane	ug/L		389	215	55.27	0.15	85000	1533.95		0	No
1,1-Dichloroethene	ug/L	7	389	134	34.45	0.2	1000	99.68	93	23.91	Yes
1,2,3-Trichloropropane	ug/L		389		0.00					0	No
1,2-Dichlorobenzene	ug/L	600	389	86	22.11	0.22	2500	263.01	12	3.08	No
1,2-Dichloroethane	ug/L	5	389	235	60.41	0.22	6200000	175098.69	176	45.24	Yes
1,2-Dichloroethene, Total	ug/L		389	168	43.19	0.34	3200	238.48		0	No
1,2-Dichloropropane	ug/L	5	389	5	1.29	1.5	5.1	2.80	1	0.26	No
1,3-Dichlorobenzene	ug/L		389	3	0.77	0.41	40	17.47		0	No
1,3-Dichloropropane	ug/L		389	31	7.97	0.21	3000	208.62		0	No
1,4-Dichlorobenzene	ug/L	75	389	12	3.08	0.2	39	11.10		0	No
2-Hexanone	ug/L		389		0.00					0	No
Benzene	ug/L	5	389	170	43.70	0.15	300000	5193.69	143	36.76	Yes
Carbon Tetrachloride	ug/L	5	389	29	7.46	0.17	90000	3296.41	24	6.17	Yes
Chlorobenzene	ug/L	100	389	157	40.36	0.17	17000	632.75	69	17.74	Yes
Chloroethane	ug/L		389	28	7.20	0.32	2900	281.16		0	No
Chloroform (Trichloromethane)	ug/L	80	389	169	43.44	0.17	280000	4000.17	112	28.79	Yes
Dichlorofluoromethane	ug/L		389	1	0.26	3.6	3.6	3.60		0	
Ethylbenzene	ug/L	700	389	51	13.11	0.17	7400	907.70	13	3.34	No
Methyl Methacrylate	ug/L		389		0.00					0	No
Methylene Chloride	ug/L	5	389	18	4.63	2.4	2500	286.48	16	4.11	No
Naphthalene	ug/L		389	67	17.22	0.4	56000	2231.68		0	No
Styrene	ug/L	100	389	34	8.74	2.3	10000	1083.61	14	3.60	No
Tetrachloroethene	ug/L	5	389	136	34.96	0.32	7000	518.94	99	25.45	Yes
Toluene	ug/L	1000	389	119	30.59	0.16	72000	1416.15	14	3.60	No
Trichloroethene	ug/L	5	389	194	49.87	0.18	7900	397.29	128	32.90	Yes
Vinyl Chloride	ug/L	2	389	193	49.61	0.22	29000	1405.59	169	43.44	Yes
Xylenes, Total	ug/L	10000	389	38	9.77	0.67	4000	354.54		0	No

Table 5-2. Summary of Groundwater Sample Analytical Results

Parameter	Unit	MCL	No. of Samples	No. of Detections	% Detections	Minimum Detected Result	Maximum Detected Result	Average Detected Result	No. Exceeding MCL	% Samples Exceeding MCL	COPC
Water Quality											
Alkalinity, Bicarbonate (Hco3)	mg/L		171	156	91.23	2.8	860	129.52		0	No
Alkalinity, Carbonate (Co3)	mg/L		171	5	2.92	18	1100	422.40		0	No
Calcium	ug/L		171	167	97.66	6300	470000	81523.95		0	No
Chloride	mg/L		192	192	100.00	2.2	19000	777.54		0	No
Dissolved Organic Carbon (Doc)	mg/L		171	151	88.30	0.8	150	9.41		0	No
Nitrate (As N)	mg/L	10	171	53	30.99	0.036	7.9	1.27		0	No
Nitrite (As N)	mg/L	1	171	8	4.68	0.019	0.63	0.23		0	No
Sulfate	mg/L		171	165	96.49	0.17	3800	188.13		0	No
Total Dissolved Solids	mg/L		15	15	100.00	220	20000	4351.33		0	No

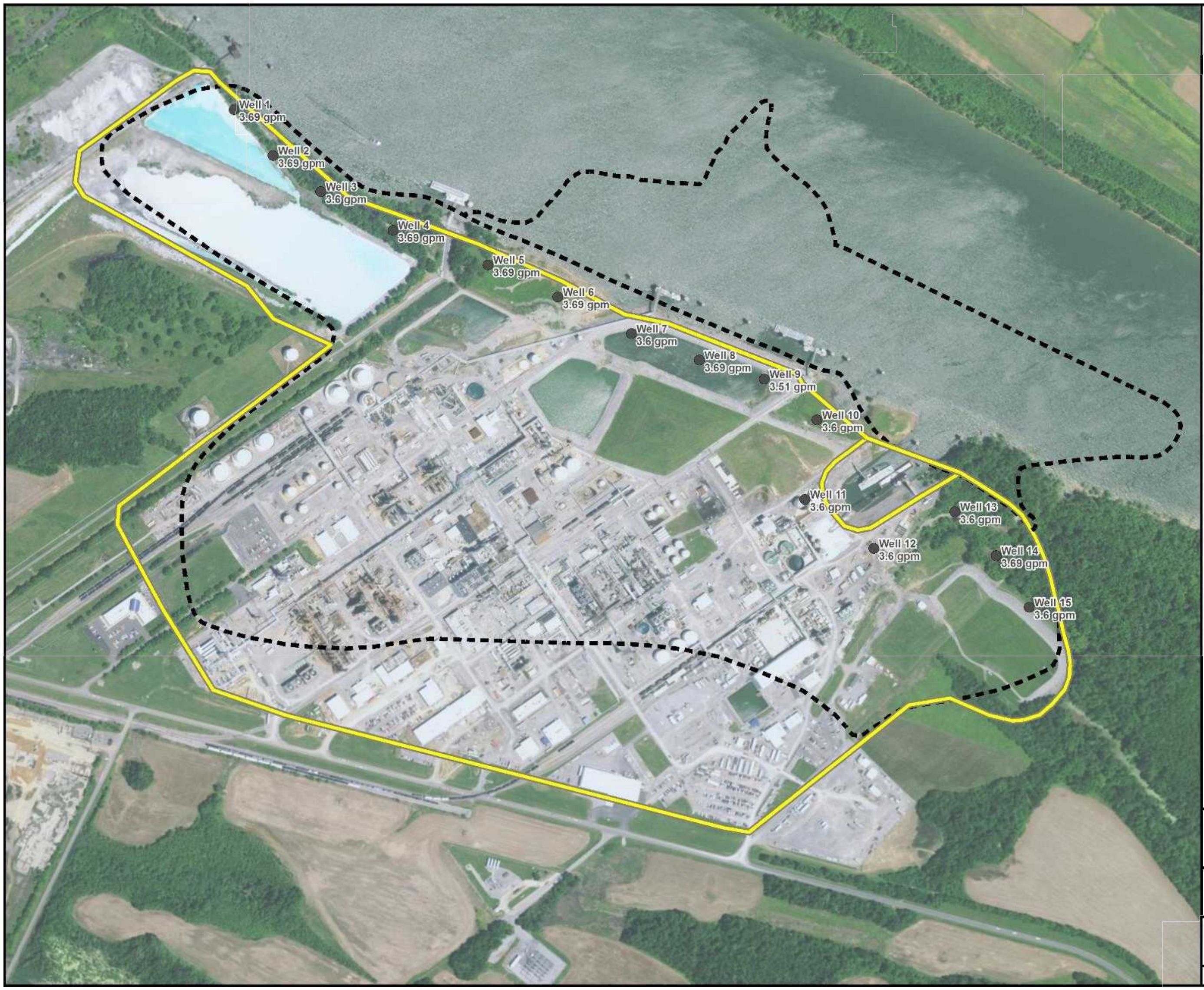
Table 5-11. Horizon-Specific NAPL-Impacted Soil Volume Estimates (yd^3)

Horizon	Threshold	Chlorine Plant	East Area	EDC-VCM Plant	Ethylene Plant	West Floodplain Area	Site-Wide Total
1 (0 to 10 ft bgs)	Lower Bound Confirmed NAPL (PI>70)	0	11,000	3,500	1,800	5,900	22,000
	Upper Bound Confirmed NAPL (PI>50)	0	28,000	8,900	4,000	14,000	55,000
	Upper Bound Confirmed plus Potential NAPL (PI>30	0	68,000	23,000	9,500	30,000	130,000
2 (10 ft bgs - WT)	Lower Bound Confirmed NAPL (PI>70)	0	100,000	7,000	19,000	21,000	150,000
	Upper Bound Confirmed NAPL (PI>50)	0	170,000	16,000	32,000	39,000	260,000
	Upper Bound Confirmed plus Potential NAPL (PI>30	0	280,000	42,000	62,000	130,000	510,000
3 (WT to 295 ft amsl)	Lower Bound Confirmed NAPL (PI>70)	0	140,000	7,000	16,000	290,000	460,000
	Upper Bound Confirmed NAPL (PI>50)	0	210,000	16,000	30,000	530,000	780,000
	Upper Bound Confirmed plus Potential NAPL (PI>30	430	310,000	38,000	57,000	840,000	1,200,000
4 (295 to 280 ft amsl)	Lower Bound Confirmed NAPL (PI>70)	0	66,000	2,200	0	210,000	280,000
	Upper Bound Confirmed NAPL (PI>50)	0	130,000	5,200	0	400,000	530,000
	Upper Bound Confirmed plus Potential NAPL (PI>30	0	220,000	13,000	0	650,000	870,000
5 (280 to 265 ft amsl)	Lower Bound Confirmed NAPL (PI>70)	0	12,000	650	0	140,000	150,000
	Upper Bound Confirmed NAPL (PI>50)	0	31,000	2,100	0	270,000	300,000
	Upper Bound Confirmed plus Potential NAPL (PI>30	0	73,000	7,400	0	530,000	610,000
6 (265 ft amsl to bedrock)	Lower Bound Confirmed NAPL (PI>70)	0	12,000	0	0	14,000	26,000
	Upper Bound Confirmed NAPL (PI>50)	0	23000	0	0	32000	56000
	Upper Bound Confirmed plus Potential NAPL (PI>30	0	45,000	0	0	90,000	130,000
1-6 (Total)	Lower Bound Confirmed NAPL (PI>70)	0	340,000	20,000	36,000	680,000	1,100,000
	Upper Bound Confirmed NAPL (PI>50)	0	600,000	48,000	66,000	1,300,000	2,000,000
	Upper Bound Confirmed plus Potential NAPL (PI>30	430	990,000	120,000	130,000	2,300,000	3,500,000

Appendix B

Figures from the 2017 Feasibility Study

Former B. F. Goodrich Site



Explanation

● Perimeter Wall Extraction Well

— Perimeter Wall

⬚ Remedial Footprint

Projected Coordinate System:
NAD83 State Plane Kentucky South
FIPS 1602 Feet

N

Scale in Feet
0 500 1000

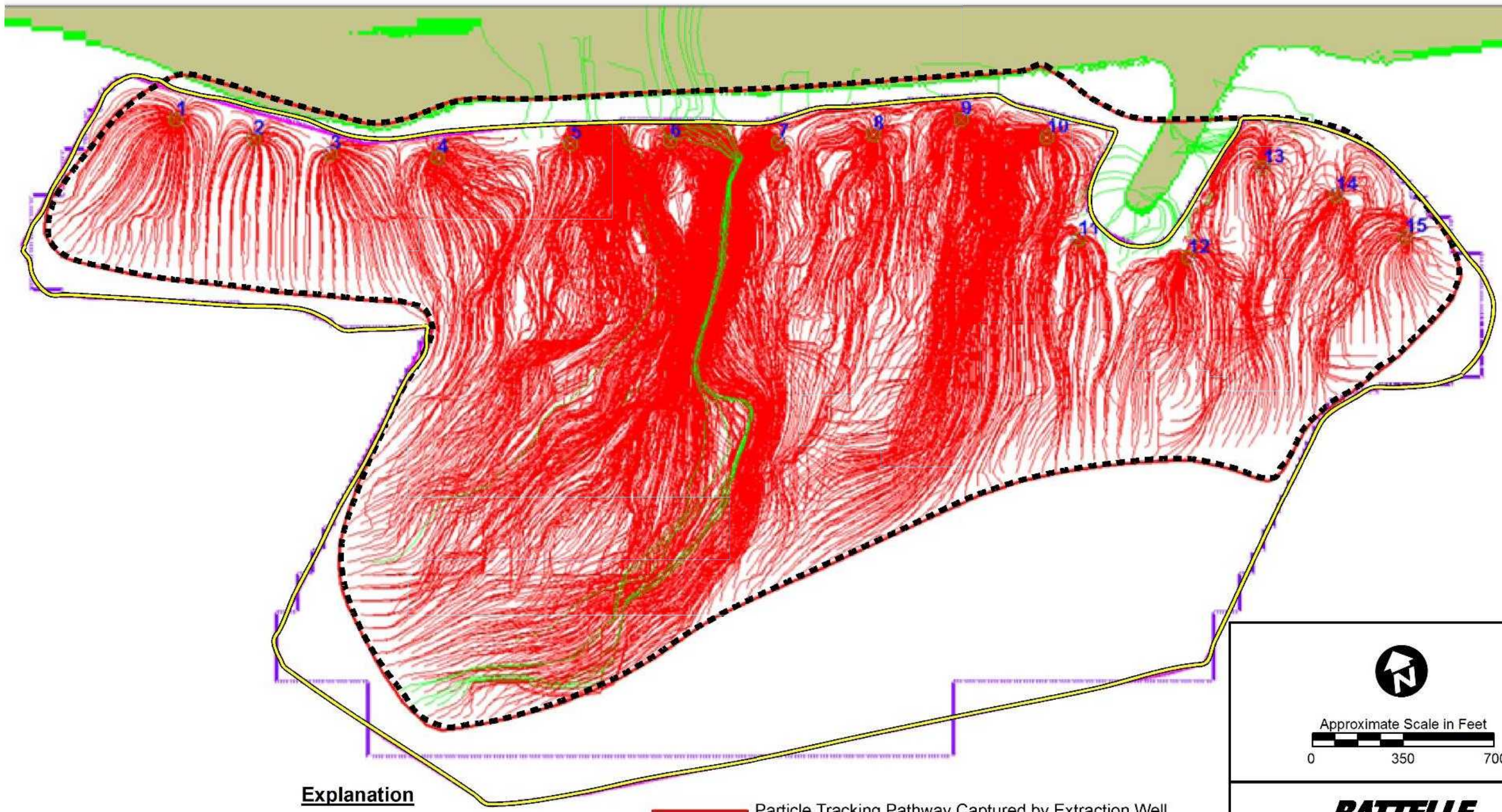
BATTELLE

**Remedial Alternative SC3a:
Complete Barrier Wall**

FIGURE
5-6

FEASIBILITY STUDY
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

PerimeterWall.mxd 10/4/2017



Explanation

On-Site Remedial Footprint

⊗15 Extraction Well and ID

Tennessee River

Particle Tracking Pathway Captured by Extraction Well

Particle Tracking Pathway Not Captured by Extraction Well

Proposed Barrier Wall Location

Groundwater Model Simulated Barrier Wall Location

Approximate Scale in Feet

0 350 700

BATTELLE

Remedial Alternative SC3a: Particle Tracking Results in Model Layer 17"

FIGURE
5-7

FEASIBILITY STUDY
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

remedial_alt_model_SC3a_layer17.mxd

10/6/2017

APPENDIX C

RESPONSIVENESS SUMMARY

TABLE OF CONTENTS

1.0 INTRODUCTION

Pursuant to the Superfund Amendments and Reauthorization Act §113 and §117(b) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) §300.430(f)(3)(i)(F), this Responsiveness Summary provides a summary of comments received during two public comment periods for the BF Goodrich (BFG) Superfund Site located in Calvert City, Marshall, County, Kentucky. The first comment period was for the November 2017, Proposed Plan and a second comment period was held for the June 2018, Proposed Plan Amendment. The Responsiveness Summary includes a summary of the comments received along with the Environmental Protection Agency's (EPA's) response to the comments. Public meetings were also held for both proposed plans.

The complete comments are included in the Administrative Record (AR), which is available at the local repository. The comments are also available for review on the EPA web page for the BFG Site at: https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0401930 .

2.0 SUMMARY OF COMMUNITY RELATIONS ACTIVITIES

EPA has pursued a communications strategy designed to actively engage the community at the BFG Site since the start of the remedial investigation (RI) in 2010. EPA has held community meetings, issued factsheets, briefed the Calvert City, City Council on multiple occasions, and attended local community advisory board meetings to provide information and encourage participation in the Superfund process.

In general, there has been comparatively little participation by area residents in the process. However, briefings to the City Council and advisory board indicates general support of the work being conducted by EPA, Kentucky Department of Environmental Protection (KDEP), and the Potentially Responsible Parties (PRPs).

The two major events that resulted in significant interest in the Site and submittal of written comments were the release of EPA's Proposed Plan and the Amended Plan for the cleanup of the BFG Site. The Proposed Plan was released to the public on November 30, 2017. A public meeting was held on December 7, 2017. The comment period was scheduled to expire on December 30, 2017, but multiple requests for an extension during the comment period resulted in an extension until February 13, 2018.

Comments on the Proposed Plan conveyed a general concern for EPA's proposed approach to address the non-aqueous phase liquids (NAPL) that migrated from the Site beneath the Tennessee River. The comments included additional technical information and other proposals to address the NAPL contamination beneath the River. After consideration of the comments, and consultation with KDEP, EPA decided to revise the strategy for addressing the NAPL beneath the River and issue an Amendment to the Proposed Plan.

The Amended Plan was issued on June 20, 2018, with a 30-day comment period that expired on July 20, 2018. A public meeting was held on July 12, 2018. Most of the comments were submitted by the PRPs for the Site. Comments were generally supportive of the revised strategy.

3.0 SUMMARY OF COMMENTS AND RESPONSES

3.1 November 2017 – Proposed Plan Comments and Responses

Most of the comments were received in written form during the comment period for the Proposed Plan. Written comments were primarily received from the PRPs and the American Chemistry Council. Additional written comments were received from KDEP, US Fish and Wildlife Service, and the City of Paducah Water Authority. The December 7, 2017 public meeting was not well attended and no formal comments were received during the public meeting.

3.1.1 NAPL Classification

Comment: Two of the commenters addressed the terminology used by EPA to describe NAPL at the Site. The commenters explained that there is a hierarchy of different states of NAPL that were observed at the Site. The commenters believe that the majority of the NAPL is in a residual state. This NAPL is at a lower concentration and is bound within the soil matrix. Some of the NAPL is believed to be more concentrated and pooled on some of the lower permeability geologic units. The commenters disagree with the use of the term "mobile NAPL" because that implies that there is a large enough quantity of NAPL to exert hydraulic pressures, overcoming the interstitial surface tensions within the soil and allowing the NAPL to move.

Response: EPA agrees that the RI documented the presence of residual NAPL. However, there were boreholes and monitoring wells where NAPL was observed at such quantities that it may be recoverable. EPA revised the terminology used in the Record of Decision (ROD) and avoided the use of residual, pooled, or mobile NAPL, instead, referring to it as recoverable. A figure was developed for the Selected Remedy Section of the ROD that identifies the location of monitoring wells and borehole locations where NAPL was observed during the RI. This figure will be used as an indicator of where NAPL may be recoverable, although other areas may also be encountered during the remedial design/remedial action (RD/RA).

3.1.2 Principal Threat Waste Classification

Comment: Two of the commenters challenged EPA's conclusion in the Proposed Plan that NAPL is considered principal threat waste (PTW). The commenters quote EPA's guidance that defines PTW as, "*source material considered to be highly toxic or highly mobile and that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.*" The commenters further cite portions of the Feasibility Study (FS) report that conclude that the alternatives developed can reliably contain the NAPL and that the NAPL is present at such depths below the land surface that exposures would not be expected to occur.

Response: EPA appreciates the different interpretation presented by the commenters and the observation of the different assessments from the FS and Proposed Plan. However, it is EPA's position that NAPL in any of its forms generally would constitute a PTW. EPA thinks that the barrier wall in conjunction with maintaining hydraulic controls and removing the recoverable NAPL, including the mercury NAPL to the extent practicable, will be effective in containing the NAPL.

3.1.3 Appropriateness of River-NAPL Alternative (RN2)

Among the topics covered in the public comments, Alternative RN2 was one of the most extensively addressed subjects. Thirteen (13) categories of objections were raised regarding the proposed selection of Alternative RN2 to address the NAPL located beneath the Tennessee River. The comments received from six different commenters are summarized below.

Comments:

- The scope of the response (i.e., NAPL excavation) is not supported by the documented risk. NAPL was observed over 7 ft below the River bottom. The River morphology for this area is such that sediments are deposited over time, further increasing the distance between potential receptors and the NAPL source. Furthermore, the River bottom data collected by EPA indicates that contaminants are attenuated prior to reaching the benthic receptors or receptors in the water column.
- Short-term risk posed by the excavation of NAPL from beneath the River was underestimated. The excavation would require the short-term destruction of critical habitat of endangered mussels. It would also require the construction of a massive cofferdam (i.e., concentric 100-ft diameter cells). Although a health and safety plan would be developed, conducting this work of this magnitude in a marine environment greatly increases the potential for worker accidents. Lastly, excavation and exposure of NAPL-contaminated material increases the potential of contact with construction workers or release of contaminants to the River.
- Excavation of the NAPL from beneath the River bottom poses significant implementation issues. First, the Propane Dock and associated infrastructure would have to be relocated. Second, the excavation would also require stabilization/shoring of the Pond 2 dike. Failure of the dike could result in ruptures to pipelines containing hazardous and flammable chemicals. Lastly, the excavation would be too large and too deep to be completed in one low-pool cycle for the River. Should the excavation not be completed within 6 to 9 months, the River could flood the excavation or cause the cofferdam to fail. The excavation would need to be conducted in phases, greatly complicating the engineering issues and length of construction.
- The River-NAPL excavation remedy is not cost-effective. According to the NCP, a remedy is cost-effective if the costs are proportional to its overall effectiveness. EPA evaluated a containment remedy Alternative RN3 that would be highly effective in isolating the NAPL and contaminated soil from the environment, preventing the potential for exposure. The cost of the containment remedy is 22 times higher than an equally protective remedy (assuming there were documented risks).
- Excavation of the River-NAPL would be unnecessarily disruptive to the current plant operations at the Propane Dock and along the Pond 2 dike. The Propane Dock is in the optimal location to support the Ethylene Plant. The only available area would be downstream of the current location, near an existing Kentucky Pollutant Discharge Elimination System outfall, which would increase the distance from the Ethylene Plant and require the relocation of the outfall. In addition, several large-diameter (e.g., 20-ft) mooring dolphins would have to be relocated along with the stabilization/shoring of the Pond 2 dike. After remediation, the dock and outfall would need to be moved back to their optimal locations. The containment of the NAPL source through Alternative RN3 would not require any infrastructure relocation.
- The River-NAPL area is in a depositional portion of the River, where sediment thickness is increasing, which is evident by the need to regularly dredge this area to maintain adequate depth for barge traffic. The accumulation of sediments in this area naturally increases the thickness of the soil and sediments between potential River receptors, and the NAPL and contaminated soil beneath the River.

- EPA used as justification of the selection of the excavation alternative (RN2) vs the containment alternative (RN3), that "there is less certainty that the NAPL beneath the River can be contained, and if released, could pose significant environmental risk." This is inconsistent with the FS and Proposed Plan findings regarding the on-shore containment remedy. EPA concludes that the on-shore NAPL, NAPL-contaminated soil, and contaminated groundwater can be reliably contained. The off-shore NAPL is just an extension of the on-shore NAPL and located in the same geologic units. Therefore, off-shore containment should be just as effective as on-shore containment.

- EPA surprisingly changed its FS assessment of the River-NAPL containment option as the best alternative. Although EPA had taken over the lead in preparing the FS, it continued to work collaboratively with the PRPs because of the enforcement agreement to conduct the RI/FS. Based on the comparative analysis of the FS alternatives, one would conclude that containment of the River-NAPL source would provide the best balance of trade-offs among the nine NCP evaluation criteria and would be carried forward as the Preferred Alternative in the Proposed Plan. The analysis in the Proposed Plan did not carry forward the same comparative analysis as the FS.

- The cost of the River-NAPL exaction is underestimated. EPA likely underestimated the cost of the disposal, construction of the cofferdam, and relocation of facility infrastructure. Further analysis of the cost indicates that EPA's $144M cost estimate for RN2 could be underestimated by $220M to $340M. Correspondingly, the time to achieve Remedial Action Objectives (RAOs) is likely underestimated as well.

- The selection of Alternative RN2 (excavation) would be arbitrary and capricious, and otherwise not in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the NCP. EPA's FS comparative analysis shows that Alternative RN2 would be equally protective and Applicable or Relevant and Appropriate Requirements (ARAR) compliant; be equally effective and permanent; pose the least short-term risks; be the most implementable; and be the most cost-effective among the alternatives evaluated. Alternative RN3 would not achieve the same degree of reduction in toxicity, mobility, or volume through treatment, but this balancing criterion alone would not be enough to warrant selection of alternatives that are not cost-effective, pose greater short-term risks, or are less-implementable. Selection of Alternative RN3 (excavation) is not supported by the FS or Proposed Plan comparative analysis.

- Although excavation of River bottom sediments has been used at other Superfund sites, it is conducted under markedly different River conditions. Typically, River sediment excavations are conducted at shallower depths and lower River velocity. In the case of the BFG Site, the excavation is not of sediment occurring along the River bottom, but soils 7 to 25 ft below the River bottom. Moreover, the water depth at normal pool is about 14 ft, flowing at a velocity of about 15,000 cubic feet per second (cfs). However, during flood stage, the water depth could increase to about 34 ft, with a velocity approaching 100,000 cfs. Engineering and constructing a cofferdam to withstand these excavation depths and River extremes poses significant challenges, increases cost and risks to workers, and increases the likelihood of contaminant release to the environment.

- Principals of administrative law require that an agency engage in "reasonable decision-making." An agency must consider all the relevant facts and make a rationale connection between the facts and resulting decision. Selection of Alternative RN2 (excavation) is not supported by the facts. The lack of risk to human or ecological receptors to the contamination below the River bottom compels a more reasonable, less complex remedy selection.

- The Proposed Plan states that the upper 5 ft of the River bottom is not contaminated and could likely be segregated and re-used. Segregation of the upper 5 ft (which some estimates indicate 7 ft), would likely not be feasible or cost-effective. The additional cost of disposal and backfill needs to be included in the cost estimate for Alternative RN2.

Response: The above comments generally address EPA's more conservative comparative analysis of the River-NAPL alternatives in the Proposed Plan than was presented in the FS, which was largely due to EPA's expectation to return groundwater to beneficial use and ensure the long-term protection of the Tennessee River. Nevertheless, the commenters raised important considerations regarding potential issues associated with the excavation remedy.

In consideration of the public comment regarding the proposed River-NAPL excavation (Alternative RN2) (as well as alternative approaches discussed below), EPA issued a Proposed Plan Amendment on June 20, 2018, with an alternative strategy for addressing the NAPL below the River. A public comment period was conducted from June 20 through July 20, 2018, along with a public meeting on July 12, 2018. The same commenters that objected to EPA's Preferred Alternative for the River-NAPL submitted comments that were supportive of interim River-NAPL strategy presented in the Proposed Plan Amendment.

Because EPA issued a new strategy to address the contamination below the River and the public comment favorable toward the new strategy, EPA considers the above comments to have been effectively addressed by the Amended Plan and favorable comments. As a result, a point-by-point response to the comments opposing the NAPL excavation alternative is not provided.

3.1.4 Recommended Modified River-NAPL Alternative (RN2)

In conjunction with comments submitted regarding the selection of Alternative RN2 to address the NAPL contamination below the River bottom (see Section 3.1.3), several of the commenters proposed an alternative approach to address the NAPL below the River. The commenters proposed the following alternative approach:

- Removal of pooled NAPL to the extent practicable to remove (or render immobile) the NAPL,
- Installation of a barrier wall around the NAPL source zone to contain residual NAPL,
- Long-term monitoring, and
- Institutional controls to prohibit deep dredging.

The commenters supported their proposal with conceptual designs that addressed many design considerations. Also included in the comments was a comparative analysis of the new approach to the RN2 excavation alternative using the NCP nine-criteria. Relative to the comparison between the new alternative and Alternative RN2, the commenters concluded the following:

- Equally protective and ARAR compliant as Alternative RN2,
- More implementable than Alternative RN2,
- Comparable reduction in toxicity, mobility, and volume through treatment as Alternative RN2,
- Less short-term risks than Alternative RN2, and
- More cost-effective than Alternative RN2.

Response: It was evident from the comments that the commenters not only had important concerns with Alternative RN2 but were committed to supporting EPA in identifying an alternative approach that was protective and achieved the cleanup levels and RAOs for this portion of the Site, among other things.

Based on a review of the conceptual design and comparative analysis of the new approach (as well as the comments that opposed Alternative RN2), EPA developed a revised strategy to address the NAPL and NAPL-contaminated soil beneath the River. This revised strategy was presented to the public for comment on June 20, 2018, in an Amended Proposed Plan. Public comment received on the Amended Plan is presented in Section 3.2.

3.1.5 River-Groundwater Alternative (RG3)

Several commenters expressed concern regarding the implementation, cost, and comparability with Alternative RG2 (monitored natural attenuation). A summary of the comments and responses is provided below.

3.1.5.1 Implementation

Comment: A commenter expressed concern that the criteria for implementing the pumping and treating portion of Alternative RN3 was too vague.

Response: The intent of the remedy is not to unnecessarily require the pumping and treating of groundwater, but to have in place the mechanism to do so, if warranted. Section 12.2.2.3 of the ROD explains that pumping and treating of the groundwater would not be implemented until after the first Five-Year Review, to evaluate the effectiveness of the on-shore and off-shore NAPL source actions and whether active pumping and treating of the groundwater beneath the River is necessary to restore the groundwater to drinking water standards.

3.1.5.2 Cost

Comment: Commenters expressed concern that EPA underestimated the cost for pumping and treating the groundwater beneath the River. They argued that EPA did not account for the strong vertical gradient. The current well spacing may not be effective in the collection of groundwater, but rather a large percentage of the water collected could be from the River. A tighter well spacing would be needed to overcome the River influences.

Response: EPA appreciates the commenters' analysis of the hydraulic influences the River could have on the horizontal pumping wells. However, EPA believes that the cost associated with additional well spacing would still be within the cost range of +50 to -30%. Moreover, the significant cost difference between Alternative RG2 Monitored Natural Attenuation (MNA) and Alternative RG3 (MNA with pumping and treating) is evident and would not change because of additional pumping wells.

3.1.5.3 Comparability with Alternative RG2

Comment: Commenters argued that given the lack of risk to human health or the environment posed by the groundwater plume beneath the River, selection of Alternative RG3 (MNA with pumping and treating) is not support by an NCP nine-criteria evaluation. The commenters argued that the primary objective of the off-shore groundwater remedy is restoration of the groundwater, not the reduction in risk to current human or ecological receptors. Further, Alternative RG2 (MNA) is more readily implemented; poses fewer short-term risk; is equally effective and permanent; reduces toxicity, mobility, and volume of contaminants; and is more cost-effective than Alternative RG3. As a result, selection of Alternative RG2 (MNA) is more appropriate.

Response: EPA agrees with the commenters that River-Groundwater Alternative RN2 (MNA) should be an effective alternative. EPA believes that once the flux of contaminants from the on-shore and the off-shore NAPL sources is stopped, the groundwater plume beneath the River should attenuate naturally. However, in the event that MNA is not as effective as anticipated, or should exposure assumptions change, the remedy can be readily adapted to the improve the MNA by further reducing the contaminant mass through pumping and treating.

CERCLA Section 121(d)(2)(A)(ii) states, "such remedial action shall require a level or standard of control which at least attains Maximum Contaminant Level Goals [MCLGs] established under the Safe Drinking Water Act and water quality criteria [WQC] established under section 304 or 303 of the Clean Water Act…" Therefore, cleanup levels in the groundwater and the surface water are to achieve MCLs, non-zero MCLGs, and WQC, except where a waiver is justified.

3.1.6 On-shore Source Control Alternative (SC3a)

Several commenters submitted numerous comments related to the on-shore source control Alternative SC3a. The comments supported the selection of Alternative SC3a for the containment of on-shore NAPL, NAPL-contaminated soil, groundwater, and sediment. Some comments were related to NAPL recovery and others related to barrier wall design. Some of the comments recommended changes to the Proposed Plan. Below is a summary of the comments and responses.

3.1.6.1 Alternative SC3a Support

Comment: Several commenters expressed general support for the selection of Alternative SC3a as the appropriate remedy for on-shore source control.

Response: The commenters' support is noted.

3.1.6.2 NAPL Recovery

Comment: A significant number of comments were submitted regarding the recovery of NAPL. The commenters noted differences between the FS and Proposed Plan as to how NAPL recovery was addressed. The comments noted that the recovery approach in the Proposed Plan was generally more stringent than in the FS. For example, the FS referred to NAPL recovery in the context that it would be removed during construction, while the Proposed Plan included NAPL recovery beyond the construction phase, citing recovery to the "extent practicable" and to the "maximum extent practicable." Lastly, comments addressed the characterization of NAPL with regard to its mobility and potential to be recovered.

Response: As noted by the commenters, there has been some evolution between the FS and the Proposed Plan, and now the ROD, as to characterization and response to the NAPL. First, in the ROD, EPA chose to use the term "recoverable" instead of "mobile" or "pooled." EPA recognizes that there are varying geologic conditions; NAPL volume; and chemical composition that can affect the recoverability of the NAPL. Based on the comments, EPA also recognizes that the terms "mobile" and "pooled" are indented to have specific meanings that are based on potentially subjective field observations. Therefore, EPA will use "recoverable" to characterize NAPL that may be removed for treatment and disposal. Figure 32 of the ROD shows the location where NAPL has been observed in monitoring wells or was observed in borehole logs at such volume that it “seeped” from the cores. These locations will be used as an indicator as to where NAPL may be recoverable. The term recoverable also allows for the ability to use additional data collected during the design or remedy implementation to remove NAPL (organic and mercury) if it is found at such volume (and is accessible) such that it may be recovered.

In addition, EPA clarified in the ROD the circumstances where NAPL would be recovered and the degree of recovery. Although the FS focused on the recovery of on-shore NAPL during the remedy design and construction phase, EPA expanded the NAPL recovery concept in the Proposed Plan. EPA concluded that NAPL may be encountered during the long-term implementation of the remedy and that the remedy should include the added flexibility of NAPL recovery throughout the duration of the remedy.

Lastly, the ROD also clarifies the degree for which NAPL is recovered. “Extent practicable” is now used to describe the degree of effort for the recovery of on-shore NAPL. NAPL recovery will generally be limited to those areas where NAPL is accessible and at such volume that it will accumulate in wells for removal. Figure 32 of the ROD shows locations where NAPL may be recoverable. However, as noted in the Proposed Plan Amendment, the strategy for the on-shore NAPL has been revised to an interim-based approach.

The interim phase focuses on NAPL recovery followed by a final remedy with a goal of groundwater restoration. As such, the standard for recovery of the off-shore NAPL will be to the maximum extent practicable, which implies that efforts will be made through additional data collection to locate and remove the NAPL. Chemical additives may be used to enhance the mobility and recoverability of the NAPL. The potential for in-situ treatment of NAPL would be addressed in an ROD for restoration of groundwater in the off-shore NAPL source zone area.

3.1.6.3 Barrier Wall Location

Comment: A commenter noted a difference between the FS and Proposed Plan relative to the barrier wall location. The FS used an elevation-based wall alignment, while the Proposed Plan used a broader description based on the presence of contamination.

Response: The alignment of the barrier wall will be established during the RD. It will consider factors such as land elevation, contaminant location, infrastructure, additional data, and other relevant factors.

3.1.6.4 Barrier Wall Design

Comment: A commenter addressed the Proposed Plan description of the construction materials planned for the barrier wall.

Response: The barrier wall construction material and methods will be determined during the RD, which is explained in the Barrier Wall Section (12.2.1.3) of the ROD.

3.1.6.5 Hydraulic Control

Comment: A commenter questioned the Proposed Plan description of the placement of the groundwater pumping wells located inside the barrier wall. The commenter was concerned that the description was too prescriptive.

Response: The location of the hydraulic control wells will be determined during the RD, which is explained in the Hydraulic Control Section (12.2.1.4) of the ROD.

3.1.7 Administrative/Editorial

Comment: Two of the commenters submitted numerous comments on the Proposed Plan that are administrative or editorial in nature. The comments are related to text that describes things such as the history or characterization of the Site, or other non-remedy or technical specific issue.

Response: First, these comments are administrative and editorial comments. They did not affect the evaluation of alternatives or development of the Preferred Alternative. The Proposed Plan will not be revised and re-issued in response to these comments. However, where appropriate, Proposed Plan text used in the ROD has been revised.

3.1.8 Contaminant Release and Migration

Comment: Two of the commenters submitted numerous comments on the Proposed Plan that are related to contaminant releases and migration. The commenters are a current owner and a current owner/operator in litigation over various Site-related issues. As a result, some of the comments present different views.

Response: As noted in Section 3.1.7, these comments do not affect the evaluation of alternatives or development of the Preferred Alternative. The Proposed Plan will not be revised and re-issued in response to these comments. Moreover, it is beyond the scope of this ROD to arbitrate issues among parties with contested litigation issues. Where appropriate, Proposed Plan text used in the ROD has been revised.

3.1.9 Site Risks

Two commenters submitted comments related to EPA's characterization of potential risks posed by the Site. The following is a summary of the comments and EPA's responses.

3.1.9.1 Risk Observed in River

Comment: A comment addressed EPA's description of the risks posed to ecological receptors in the Tennessee River. The commenter noted that the Introduction Section of the Proposed Plan states that contaminated groundwater discharging to the River poses a significant risk to human health and the environment.

Response: The statement in the Proposed Plan was part of a discussion of the importance of the interception of contaminated groundwater discharging to the River. The Plant-Wide Corrective Action (PCAP) pumping wells capture about 60% of the contaminated water that migrates from beneath the chemical plants within the BFG Site. Data from the RI suggested that significant levels of contaminants are entering the River that could pose a threat to ecological receptors or human receptors consuming aquatic life.

However, post-RI collection of data from the River show that the contaminants are being attenuated prior to entering the water column. It is unclear whether the contaminants are being attenuated biologically or simply by dilution from the massive River volume. This discussion will be revised as appropriate in the ROD.

3.1.9.2 Ambient Air Risks

Comment: A commenter requested that EPA's characterization of the hazardous substances at the Site, which included ambient air, be clarified to note that they are not CERCLA-related.

Response: The association of chemicals in the ambient air and potential risk is a difficult issue. Based on the limited ambient air study conducted as part of the RI, sub-slab, indoor air, and outdoor air suggests that there are other sources of the air contaminants such as the point and non-point sources from the operating plants. However, groundwater contaminant levels are such that it could lead to indoor air contamination, thus creating a CERCLA related concern.

EPA addressed the potential for indoor air contamination from the groundwater by requiring the use of vapor resistant building construction methods for buildings that house non-Occupational Safety and Health Administration regulated workers.

3.1.9.3 Future Resident Risk Estimate

Comment: A comment was received that stated that the basis for the risk estimate of a hypothetical future resident at the Site was not included in the supporting documents and should be deleted.

Response: An estimated cancer risk and non-cancer risk was developed for a hypothetical future resident. The basis for this risk estimate is summarized in Tables 3-1, 4-14, 4-15, and 4-16 of the Human Health Risk Assessment. These documents are included in the AR for the Site.

3.1.9.4 Upper Bound Estimate of Risk to River Receptors

Comment: A commenter disagrees with EPA's hypothetical estimation of potential risk to River receptors in the absence of the interception of contaminated groundwater prior to its discharge to the River. The commenter further states that the risk estimates did not follow the same methods used in the Human Health Risk Assessment.

Response: The purpose of this risk analysis was to illustrate the importance of the interception of contaminated groundwater and NAPL prior to entering the River. Groundwater modeling estimates indicate that approximately 60% of the groundwater is intercepted prior to entering the River. Moreover, the PCAP system has recovered approximately 11,000,000 pounds of contaminants prior to its migration to the River. Estimating an upper bound cancer risk of 3×10^{-1} and non-cancer health hazard of 10,085 could be argued as an overly conservative estimate, but there is significant uncertainty as to the effect that the lack of groundwater interception could have on the human and ecological receptors associated with the River. EPA believes that illustrating the potential risk (albeit conservative) is an important part of illustrating the need to prevent the migration of contaminated groundwater (and possibly NAPL) to the River. A more realistic estimate could not be measured because of the ongoing PCAP.

3.1.9.5 Quality of Ecological Habitat along the River

Comment: A commenter disagrees with EPA's characterization of the habitat along the River. The Proposed Plan refers to the River, floodplain, and upland areas along the River as high-quality habitat. The commenter contends that the areas along the River are highly industrialized and not high-quality habitat.

Response: The purpose of this statement was to illustrate the ecological importance, not only the River, but the floodplain and upland area along the Riverbank. It is true that the area is industrialized but is also provides important habitat for receptors along the Riverbank that must also be protected.

3.1.10 Technical Impracticability (TI) Waiver

Two commenters submitted comments related to the technical impracticability determination used to support waiver of the MCLs as ARARs.

3.1.10.1 Adjustment of TI Zone

Comment: Two commenters noted that NAPL was observed outside of the TI Zone, west of the western vinyl tank farm and that the TI Zone may need to be updated based on the results from the RD.

Response: EPA acknowledges that the boundary of the TI Zone may need to be adjusted as new data are collected that show the presence of contaminants or other factors that demonstrate the technical impracticability for the restoration of groundwater for these areas as well.

3.1.10.2 Extension of TI Zone Beneath River

Comment: A commenter noted that EPA provided no basis for distinguishing the difference between the contaminants in the groundwater beneath the on-shore and off-shore portions of the Site. As a result, the commenter believes that the groundwater beneath the Tennessee River should be included in the TI waiver.

Response: EPA agrees that the contaminants in the on-shore and off-shore groundwater, as well as the geologic units in which they occur, are similar. However, the contamination in the on-shore area is located in many areas beneath the operating plant infrastructure. Furthermore, the sheer volume of NAPL located in the on-shore area would prevent restoration of groundwater to its beneficial use within a reasonable timeframe, even if extensive efforts were made to remove as much NAPL as possible. This situation does not exist in the off-shore area; therefore, a TI waiver beneath the River for the groundwater MCL standards cannot be justified at this time.

3.1.11 Non-Selected Remedial Alternative Clarification

Two commenters submitted multiple comments regarding EPA's characterization of the other remedial alternatives evaluated in the Proposed Plan, primarily related to Alternative SC6 (source treatment) and Alternative RN4 (in-situ stabilization of River-NAPL).

3.1.11.1 Alternative SC6 – ISCO Treatment

Comment: With regard to Alternative SC6, a commenter stated that the radius of influence of the in-situ chemical oxidation points is smaller than estimated by EPA, and that many more injection points would be needed for the treatment of the NAPL beneath the Carbide Ponds. As a result, substantial mass would remain in place.

Response: EPA believes that the Proposed Plan provided a reasonable approximation of the scope of the remedy and treatment requirements for a full source treatment alternative such as Alternative SC6. While additional injections points could be needed, the additional cost increase would be negligible given the already high remedy cost of $1.2B. Furthermore, this alternative was not identified as part of the Preferred Alternative in the Proposed Plan or selected in the ROD.

3.1.11.2 Alternative RN4 – Continued Propane Dock Operations

Comment: Several comments were made by two commenters regarding the characterization of Alternative RN4 in the Proposed Plan. The commenters object to EPA's statement that in-situ stabilization could be conducted without disruptions to the Propane Dock operations.

Response: The purpose of this statement was to draw a distinction between the River-NAPL excavation (RN2) and stabilization (RN4) alternatives, relative to the impact they would have on the Propane Dock operations. Based on observations during the multiple River samplings, EPA noted that the Propane Dock was not used on a daily basis and assumed the work schedules for the remedy and Propane Dock could be coordinated to maintain operations. Nevertheless, this alternative was not identified as part of the Preferred Alternative in the Proposed Plan nor selected in the ROD.

3.1.11.3 Alternative RN4 – Additional Treatment Cost

Comment: A commenter noted that the Proposed Plan estimate for Alternative RN4 did not account for the additional treatment cost for material brought to the surface as a result of the in-situ mixing. The commenter estimated that the treatment cost could be 20% higher than estimated.

Response: EPA acknowledges that the treatment cost could be higher, but that the cost estimate used in the Proposed Plan was consistent with the +50 to -30% cost estimate range for the purpose of the FS evaluation of alternatives. The cost estimates developed among the River-NAPL alternatives appropriately demonstrate the relative differences on cost for excavation, containment, and in-situ stabilization. Nevertheless, this alternative was not identified as part of the Preferred Alternative in the Proposed Plan or selected in the ROD.

3.1.11.4 Alternative RN4 – Armoring

Comment: A commenter noted that that the Alternative RN4 discusses the need for armoring of the River bottom after the completion of the in-situ stabilization. In order to achieve an elevation that would not disrupt barge traffic, the surface of the stabilized area would need to be undercut, allowing room for the placement for the riprap.

Response: The observation is noted; however, the additional cost increase would be negligible given the Proposed Plan estimate of $112M. It would still be within the +50% to -30% range the purpose of the FS evaluation of alternatives. Nevertheless, this alternative was not identified as part of the Preferred Alternative in the Proposed Plan or selected in the ROD.

3.1.12 Preferred Alternative

Comment: In the Cost Section of the comparative analysis of the alternatives presented in the Proposed Plan, EPA only provided the range of costs of the alternatives. No comparative analysis of costs was provided. As a result, the commenter does not believe that the Proposed Plan supports the statement that the Preferred Alternative would be cost-effective.

Response: In consideration of the public comment received on the Proposed Plan, EPA issued an amendment to the Plan, proposing a modification to the Preferred Alternative. This change addressed the River-NAPL alternative, decreasing the cost of this portion of the remedy from $144M to $6.3M. As a result, the preferred strategy for addressing the River-NAPL is clearly the most cost-effective among the River-NAPL alternatives.

3.1.13 Evaluation of Alternatives

A commenter submitted several comments regarding EPA's comparative analysis of the alternatives. A summary of these comments and EPA's responses are presented below.

3.1.13.1 Comparative Analysis of Permanence

Comment: A commenter requested that the Proposed Plan be revised to note the relative comparability of permanence among the treatment/excavation alternatives (i.e., SC6, SC5a, and RN4) and the containment alternatives (SC3a and RN3). The commenter argued that the treatment/excavation alternatives would not treat all of the material and that the containment alternatives would provide treatment as part of the hydraulic containment and natural attenuation process.

Response: The observation is noted. However, it did not affect the relative comparison among the alternatives nor the selection of the remedy in the ROD for the source control alternative. Public comment led to the issuance of an Amended Plan for the River-NAPL and a revised comparative analysis for the River-NAPL alternatives.

3.1.13.2 Comparative Analysis of Reduction in Toxicity, Mobility, or Volume

Comment: A commenter noted that while Alternative RG3 (MNA with groundwater extraction) would be expected to provide the highest reduction in toxicity, mobility, or volume, the Proposed Plan should be revised to also note that Alternative RG2 would also reduce toxicity, mobility, or volume though treatment.

Response: The observation is noted. MNA may achieve cleanup levels through natural processes. However, MNA does not generally satisfy the CERCLA preference for treatment because it is not an engineered technology. While contaminated groundwater does not constitute a principal threat, treatment of groundwater may be considered under the "Reduction in Toxicity, Mobility, or Volume" criteria and Alternative RG3 (MNA and Pump and Treat) is discussed under this criterion. Furthermore, the selection of Alternative RG3 versus Alternative RG2 is appropriate because it includes the pumping and treating of groundwater in the event that MNA is not as effective as anticipated. The pumping and treating of the groundwater would not be implement unless after the first Five-Year Review, MNA was shown to be ineffective.

3.1.13.3 Comparative Analysis of Short-term Risks

Comment: A commenter noted that although Alternative RN2 (River-NAPL excavation) and Alternative RN4 (River-NAPL in-situ stabilization) would provide the greatest short-term risk, Alternative RN2 (containment) would also pose short-term risk by working in a marine environment and the transport of construction equipment and materials through the community to the Site. The commenter recommended that the Proposed Plan be revised accordingly.

Response: The observation is noted. However, it does not change the results of the comparative analysis of the River-NAPL alternatives regarding short-term risk. Moreover, the consideration of public comment on the River-NAPL alternatives resulted in an Amendment to the Proposed Plan, whereby the River-NAPL strategy was revised.

3.1.13.4 Remedy Implementation

Comment: A commenter noted that the Proposed Plan included a discussion whereby successful implementation of an extensive source treatment remedy would be highly questionable given the existing plant infrastructure, unless the remedy implementation was delayed until the area is decommissioned. The commenter noted that there are no plans to decommission the chemical plant complexes and delay in remedy implementation could indefinitely delay the cleanup.

Response: Comment noted.

3.1.13.5 Implementability, River-Groundwater Alternatives

Comment: A commenter noted a typo in the comparative analysis of the Implementability of the River-Groundwater alternatives. The last paragraph of the "Implementability" Section of the Proposed Plan incorrectly refers to Alternative RN2 instead of Alternative RG2 when discussing the Implementability of the MNA alternative for the groundwater.

Response: Typographical error was corrected for the ROD.

3.1.14 Common Elements

The common elements section of the ROD included a presentation of remedial elements that would be common to the implementation of all the alternatives. Two commenters submitted multiple comments regarding the common elements. A summary of these comments and EPA's responses are presented in the following sections.

3.1.14.1 Pond Closures – Resource Conservation and Recovery Act (RCRA) Liner and NAPL Recovery

Comment: Two of the commenters noted that the Proposed Plan specified the use of an RCRA liner in the closure of Pond 1A and 2; removal of NAPL from beneath the ponds as part of the closure; and the use of clean fill for the ponds. The commenters disagreed with the need for a RCRA liner or the removal of NAPL from below the ponds as part of the closure. The commenters also noted that non-hazardous excess soil will be generated from the construction of the barrier wall, which could be used to backfill the ponds.

Response: EPA noted that Pond 2 was the only pond that needed filling and modifications to the dike due to stability concerns. It is possible to achieve the necessary reduction in infiltration by lining Pond 1A, rather than filling. Accordingly, the ROD assumed that Pond 1A would be lined and not backfilled, but the final determination will be made during the RD.

These ponds were closed pursuant to a state-led RCRA corrective action in the 1980s. The hazardous substances in these ponds were removed and consolidated in the on-site RCRA closure cell. The landfill is managed pursuant to the KDEP-issued corrective action permit and has an RCRA-compliant cap and liner. Although the goal of the pond closures is simply to reduce infiltration of rainwater, these ponds are listed as regulated units in the RCRA corrective action permit. As a result, RCRA requirements for the capping/lining of the ponds is included as an ARAR in the ROD.

Regarding the use of non-hazardous fill for the pond closures, the ROD allows for the filling of the ponds with soil that does not contain hazardous constituents that present an unacceptable risk to human health or ecology, or the potential for transport of hazardous constituents to surface water or groundwater.

The approach to NAPL recovery has been revised in the ROD, with different objectives for the on-shore and off-shore NAPL. Moreover, NAPL recovery has been removed from the pond closures and incorporated into the overall NAPL recovery approach for the Site. In general, recovery of on-shore NAPL will be conducted to the extent practicable and takes into account the presence of plant infrastructure. The timing for the recovery of the on-shore NAPL will be determined during the RD. (NAPL recovery is also addressed in comment response 3.1.6.2).

3.1.14.2 Off-shore Groundwater Monitoring

Comment: A comment was submitted regarding the monitoring of groundwater contaminant levels beneath the River to evaluate plume reduction and stability. The commenter noted that because the groundwater contamination is expected to naturally attenuate, a more useful monitoring point would be the soil porewater, instead of the dissolved phase plume.

Response: EPA believes that both data points will be useful in monitoring the stability of the groundwater plume beneath the River and the quality of groundwater upwelling into the River. Groundwater sampling will be used to evaluate the progress toward achieving MCLs. The porewater will be monitored to evaluate the progress toward achieving protective levels in sediment and surface water, as well as assessing potential migration of contaminants into the River. Both monitoring requirements are included in the ROD.

3.1.14.3 Seep Monitoring

Comment: A commenter recommended that the monitoring for potential seep occurrence along the shoreline be revised to clarify that it is only for the occurrence of contaminated seeps.

Response: After the installation of the barrier wall along the shoreline, hydrogeologic conditions will change dramatically. The physical barrier to groundwater flow should stop the occurrence of seeps along the River. Therefore, general seep monitoring is included in the ROD because it is important to not only detect contaminated seeps, but to also monitor for leakage through the barrier wall, which could be an indicator of hydraulic control issues.

3.1.14.4 Indoor Air Monitoring

Comment: A comment addressed the requirement for indoor air monitoring for volatile organic compounds and mercury. The commenter noted that mercury is only an issue in the vicinity of the Mercury Cell Building (MCB). Therefore, mercury monitoring should not be required for all buildings, but just those in the vicinity of the MCB.

Response: The requirement has been revised and reflected in the ROD.

3.1.14.5 Vapor Resistant Construction

Comment: Regarding the Institutional Control (IC) requirement for the retrofitting of administrative buildings to include vapor resistant construction, a commenter noted that some of the buildings may have been retrofitted by the time of the implementation of the remedy. As a result, the requirement should be qualified to include “as necessary.”

Response: The requirement has been revised and reflected in the ROD.

3.1.14.6 River Dredging

Comment: A commenter noted that the IC limiting the dredging of the River bottom or installation of structures that could expose contaminated media needs to be clarified.

Response: The requirement has been revised and reflected in the ROD.

3.1.15 RAOs/Preliminary Remediation Goals (PRGs)

Two commenters submitted multiple comments regarding the discussion of RAOs and PRGs in the Proposed Plan. A summary of the comments and responses are provided below.

3.1.15.1 RAO Inconsistency

Comment: The commenter notes that the RAOs presented in the Proposed Plan are different from the RAOs of the FS.

Response: RAOs from the FS were refined for use in the Proposed Plan and ROD.

3.1.15.2 Soil RAOs

Comment: A commenter expressed concern regarding the Proposed Plan explanation of how soils are addressed at the Site. The commenter refers to a statement from the Proposed Plan that states, "because soil is generally within the limits of the active chemical plant complexes, no RAOs are established for soil or air other than land use controls to prevent potential exposures to contaminated media." The commenter requested that this statement be clarified.

Response: This statement was intended to address the difference between the contaminated surface soil within the operating portion of the chemical plant and the NAPL-contaminated subsurface soil. It is not the intent of the CERCLA response to address surface soils within the operating portion of the chemical plant, but rather the deeper contaminated soils.

3.1.15.3 Groundwater Restoration RAO

Comment: A commenter expressed disagreement with the RAO that required restoration of the groundwater beneath the Tennessee River to its beneficial reuse. The commenter contends that the RAO is inappropriate because there is no feasible human use.

Response: CERCLA Section 121(d)(2)(A)(ii) states, "such remedial action shall require a level or standard of control which at least attains Maximum Contaminant Level Goals [MCLGs] established under the Safe Drinking Water Act and water quality criteria [WQC] established under section 304 or 303 of the Clean Water Act…" Therefore, cleanup levels in the groundwater and the surface water are to achieve MCLs, non-zero MCLGs and WQC, except where a waiver is justified. Pursuant to CERCLA and the NCP, there is an expectation that the groundwater beneath the River would also be restored to its beneficial reuse.

Furthermore, KDEP does not distinguish groundwaters of the Commonwealth. Therefore, all groundwater is considered a potential drinking water resource.

3.1.15.4 NAPL Recovery RAO

Comment: A commenter expressed concern for the RAO that required the recovery of pooled or mobile NAPL to the extent practicable. The commenter contends that removal of NAPL will not further reduce risks to human health or result in an appreciable reduction in the NAPL mass. The commenter recommends removal of this RAO.

Response: The matter of NAPL recovery is addressed in comment response 3.1.6.2.

3.1.15.5 NAPL Exposure RAO

Comment: A commenter expressed concern for the wording of an RAO that states "prevent human and ecological receptor exposure to NAPL to protective levels."

Response: Under CERCLA, remedial actions are to protective of human health and the environment, which is reflected in the RAO.

3.1.15.6 Other Media RAO

Comment: A commenter recommended that the reference to "increased" risk be revised to "unacceptable" risk for the Other Media.

Response: The language for this RAO was revised in the ROD.

3.1.15.7 NAPL Extent

Comment: A commenter expressed confusion regarding the description of the basis for characterizing the extent of the area for the NAPL response. The Proposed Plan explains that a "weight-of-evidence approach is being used to establish the NAPL extent as a cleanup decision is selected."

Response: The description of this approach was clarified in the ROD.

3.1.16 Paducah Water Source

Comment: The Paducah Water Authority submitted a comment noting that the Water Authority obtains water from the Ohio River, near the confluence with the Tennessee River. As such, the Water Authority strongly supports the cleanup for the BFG Site that is swift and efficient in order to prevent further migration of ethylene dichloride into the Tennessee River and surrounding waters.

Response: The comment was considered in the development of the selected remedy for the Site.

3.1.17 Tennessee River Critical Habitat

Comment: The US Fish and Wildlife Service (FWS) submitted comments related to the critical habitat for endangered and threatened species in the Tennessee River near the BFG Site. The FWS expressed the importance of the protection of the natural resource and the need for consultations with the Service pursuant to the Endangered Species Act. The FWS also stated that it fully supports EPA's intent to clean up the BFG Site.

Response: The comment was considered in the development of the selected remedy for the Site.

3.2 June 20, 2018 Amended Proposed Plan

Based on consideration of public comments received on the Proposed Plan, EPA issued an amendment that proposed a modification of the Preferred Alternative. The Proposed Plan Amendment was issued for public comment on June 20, 2018, and the comment period expired on July 20, 2018. Significantly fewer comments were received on the Amended Proposed Plan. Written comments were received from a local citizen, the Paducah Water Authority, the American Chemistry Council, and PRPs. While attendance was greater for the July 12 public meeting for the Amended Proposed Plan than for the previous Proposed Plan, only one formal comment was received at the public meeting. In general, there was support for the Amended Proposed Plan. One commenter provided additional comments regarding the practicability of restoration of the groundwater in the NAPL source zone beneath the River. These comments are included in the AR. A summary of the comments and responses are provided below.

3.2.1 General Support

Comment: All of the commenters expressed support through written correspondence in support of the interim NAPL recovery proposal in the July 2018, Proposed Plan Amendment instead of the excavation alternative (RN2) in the Proposed Plan.

Response: The support for the interim River-NAPL strategy was considered in developing the selected remedy for the Site.

3.2.2 River-Groundwater Alternative

Comment: A local resident relayed a formal comment at the public meeting, along with the submittal of the comment in writing. The resident explained that he owns property across the River from the BFG Site and plans to install a high-capacity (e.g., 250 gpm) groundwater pumping well. The resident is concerned that the groundwater may be contaminated and that the well could produce contaminated water. In the event that it is not yet contaminated, he is concerned that pumping the high-capacity well could cause the plume to spread to his well. The resident recommended that EPA select the pump and treat alternative (RG3) for the groundwater beneath the River instead of just MNA.

Response: Given the current location of the groundwater plume beneath the River and distance of the property from the plume, EPA does not think the pumping would likely spread the groundwater plume. As part of the Site-remedy, monitoring of the groundwater plume will continue. Should the owner activate a high-capacity pumping well, monitoring efforts could be expanded (e.g., sentinel wells along the north bank of the River) to detect plume movement. Lastly, the selected River-Groundwater Alternative RG3 provides for the ability to pump and treat the groundwater if MNA is shown to be ineffective.

EPA will continue to communicate with the property owner regarding the status of the well installation and groundwater plume beneath the River.

3.2.3 TI Waiver

Comment: One of the commenters questioned the need for restoration of the groundwater in the vicinity of the NAPL source zone beneath the River. The commenter asserted that the TI waiver should be extended and include groundwater within the NAPL source zone. The commenter reasoned that KDEP has not classified the groundwater beneath the River as drinking water; the off-shore NAPL occurs within the same geologic units as the on-shore NAPL; and the presence of manufacturing structures limits accessibility.

Response: EPA does not agree with the conclusions of the commenter. It is true that the on-shore NAPL is present in the same geologic units as the off-shore NAPL. However, there are factors that make this area markedly different than the on-shore NAPL. Access to the majority of the source zone is not incumbered by infrastructure. On-shore, the NAPL is of such a large volume that even if all the NAPL were removed to the extent practicable, the groundwater would not be restored to its beneficial use in a reasonable timeframe. However, the off-shore area does not pose the same infrastructure issues nor is it of the same volume.

Furthermore, the NAPL is believed to occur along contacts between finer and coarser grain soils, as opposed to the expansive vertical and horizontal occurrence of the on-shore NAPL. The volume of off-shore NAPL-contaminated soil is in the range of 150,000 cubic yards versus 3,500,000 cubic yards for the on-shore NAPL. Lastly, KDEP considers all groundwater within the Commonwealth as a potential drinking water resource.

As a result, EPA does not believe that there is technical support at this time to make a technical determination that restoration of groundwater in the NAPL source zone is impracticable. EPA believes that there are remedial options that could be implemented that could lead to the restoration of the groundwater. Should the actions prove unsuccessful, the actions will have resulted in the removal of contaminant mass and may be used to support the future analysis of technical impracticability.

3.2.4 Interim vs. Final Remedy

Comment: One commenter questioned the need for an interim remedy and proposed modifications to the amendment that could support a final action. The commenter reasoned that coupled with a TI waiver, installation of a barrier wall around the off-shore NAPL source zone would serve as an effective final remedy.

Response: For the reasons described in comment 3.2.3, a TI waiver for the off-shore NAPL source zone is not possible at this time. Therefore, the addition of a barrier wall would not result in a final remedy for the off-shore NAPL source zone. The selected remedy does, however, allow for this installation of a barrier wall around the source zone, if during remedy implementation, is it determined to be necessary.

3.2.5 Use of PCAP System for NAPL Treatment

Comment: A commenter objected to the use of the current PCAP system to treat NAPL recovered from the off-shore NAPL source zone. According to the commenter, the steam stripping system that currently supports the PCAP system is not designed to treat NAPL.

Response: The use of the PCAP treatment system is one of several treatment and disposal options. The range of options include treatment through the PCAP, on-site recycling, on-site treatment, or off-site treatment and disposal. The most appropriate option would be determined during RD.

It is also EPA's understanding that the PCAP system has an oil/water separator that separates the NAPL from the treatment stream. Based on observations by EPA of the NAPL recovered during the River investigation, the NAPL recovered was an emulsion of both water and oil. Based on these observations, the PCAP system may have some application. As noted above, however, this would be determined during the RD.

3.2.6 Surfactant Injection

Comment: A commenter expressed concern over the use of surfactants to enhance the removal of the NAPL. The commenter noted that there is increasing evidence that surfactants may cause more harm than good. The use of surfactants could result in the transfer of the NAPL into the groundwater, potentially increasing the extent of the problem. It also creates the potential for the spread of contamination into non-contaminated areas.

Response: EPA acknowledges that surfactants enhance the mobility of the contaminants, and if not used with the proper precautions could result in contaminant migration. However, because the long-term goal for the NAPL source area beneath the River is restoration of groundwater to MCLs, the use of chemicals to enhance the recovery of NAPL may be useful. The use of chemicals to enhance NAPL recovery will be evaluated and determined during the RD.

3.2.7 Groundwater Pumping in the Off-shore NAPL Source Zone

Comment: A commenter requested clarification regarding the interaction of the remedy for the off-shore NAPL source zone and the River-Groundwater Alternative (RG3). The commenter reasoned that a TI waiver is appropriate for the groundwater within the off-shore NAPL source zone, and as a result, the potential pumping requirements for Alternative RG3 should not include the NAPL source zone area.

Response: Additional detail is provided in the Selected Remedy Section of the ROD to differentiate the implementation of the off-shore interim NAPL response and Alternative RG3. In short, the interim NAPL response will focus on the recovery of NAPL to the maximum extent practicable. Because the long-term goal of this area is restoration of groundwater, after the completion of the off-shore NAPL recovery, a ROD will be issued for this area to address groundwater restoration.

3.2.8 Implementation of Pumping and Treating for Alternative RG3

Comment: A commenter requested clarification on the implementation of the River-Groundwater Alternative RG3. The commenter was unclear from the Proposed Plan description regarding the timing of the pumping and treating of groundwater.

Response: The Selected Remedy Section of the ROD provides a clear description for the implementation of Alternative RG3. The ROD explains that the pumping and treating of groundwater would be delayed until after the first Five-Year Review in order to evaluate the effectiveness of MNA. If there is no evidence of MNA, a pumping and treating would be conducted.

3.3 RI/FS Reports

Numerous technical comments were submitted by the PRPs on the RI/FS Reports and Risk Assessment. In some instances, the RI/FS was revised based on the comments and the final reports will be included in the AR. The final reports will also be posted to the EPA web page for the BFG Site. However, other comments did not result in a direct revision of the report. Because of the number of comments and specialized technical nature, these comment responses are presented in Appendix 1 to this Responsiveness Summary.

APPENDIX 1
SUMMARY OF COMMENT RESOLUTIONS
RI AND FS REPORTS
BF GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

Response to Comments on BF Goodrich RI Report

Comment	Page, Section	Comment	Response
PolyOne, 4-1	v	The RI states that a shallow clay silt unit is "continuously present throughout the entire Site." This is incorrect. Figure 4-1 shows locations in the geology Kriged field where shallow clay silt soils are not present below fill in the top 20 feet and where shallow clay silt soils are thin (1 to 4 feet thick). The RI should be revised to state that shallow clay silt soils are present throughout much of the Site, but are absent or relatively thin (1 to 4 feet thick) in certain areas of the Site.	Agree with comment. Text will be revised accordingly to note that the unit is present throughout much of the Site.
PolyOne, 4-2	v	The RI states that the land slopes from elevation 355 feet amsl to 325 feet amsl, and that the sloped area abuts a bluff that drops to the floodplain of the Tennessee River. This statement is incorrect. As shown on Figures 4-19 and 4-20 of the RI, the ground surface elevation at the south end of the Site is approximately 340 feet amsl and slopes up to approximately 350 feet amsl at the contact point between the terrace and the floodplain. At that point, the ground surface slopes down to the Tennessee River floodplain. The text should be revised to be consistent with the ground surface elevations depicted on Figures 4-19 and 4-20 of the RI.	Agree with comment. Text will be revised to reflect the correct land surface elevations observed at the Site.
PolyOne, 4-3	1-3	The RI states that "[i]n 1963 and 1964, the Ethylene Plant and the North Synthesis Unit ... were constructed to produce ethylene and chlorine." The text should be revised to state that the Ethylene Plant began operating in 1963, and the North Synthesis Unit began operating in 1964. Figure 1-3 should also be revised to include these dates.	Agree with comment. Text will be updated accordingly to reflect the correct dates.
PolyOne, 4-4	1-4	The RI states that a portion of AIRCO's existing landfill has been in use since 1956. This statement is supported by several documentary sources (NUS Corporation, 1983; Luken, 1979). Other sources state that landfill operations in 1959 or that the date landfill operations began is uncertain (Greenstar, 2011; Dames & Moore, 1988). The RI should be revised to note the discrepancies in these references.	Agree with comment. Text will be updated accordingly to reflect the correct dates.
PolyOne, 4-5	1-5	The RI incorrectly states that The Geon Company became the owner of the Ethylene and Chlorine Plants in 1993. As correctly noted on page iv of the Executive Summary, PolyOne (fka The Geon Company) has owned only non-manufacturing areas of the Site since 2007 and has never owned or operated any manufacturing areas at the Site. B.F. Goodrich retained ownership of the Ethylene Plant and Chlorine Plant in 1993 (and, as both pages iv and 1-5 note, subsequently sold those plants in 1997).	Agree with comment. Text will be updated accordingly to reflect the correct ownership history.
PolyOne, 4-6	1-7	The RI states that recovered EDC that could not be directly recycled to the cracking furnaces was historically discharged to the wastewater ponds. In fact, EDC was recovered from the sumps and tanks and directed to the crude EDC tanks for recycling.	Comment noted. No change to report text.
PolyOne, 4-7	1-9, 1.5.1	The RI states that the wastewater treatment ponds were closed in 1984. The wastewater treatment ponds stopped receiving waste in 1984. The pond closure activities took place between November 1985 and March 1988. The Kentucky Department of Environmental Protection (KDEP) issued a certificate of closure for the ponds in February 1989.	Agree with comment. Text will be updated to indicate the correct pond closure activities and dates.
PolyOne, 4-8	1-9, 1-10	The pond surface areas on pages 1-9 and 1-10 of the RI are inconsistent with the surface areas in Table 1-2. The surface areas in Table 1-2 are correct. In addition, pages 1-9 and 1-10 of the RI state that Pond P-1 received wastewater containing acrylic acid and benzene. This statement should be revised to state that Pond P-1 also received wastewater from the acetylene VCM plant.	Agree with comment. The pond surface areas in the report text will be corrected to match those in Table 1-2. Text will be revised to state that Pond P-1 received water from the VCM plant

Comment	Page, Section	Comment	Response
			and the EDC VCM pilot plant. Comment noted.
PolyOne, 4-9	1-11, 1.5.3	The RI incorrectly states that the AIRCO landfill has operated since 1951. As discussed above, the landfill began operating at some time between 1956 and 1959.	Agree with comment. Text will be updated accordingly to reflect the correct dates.
PolyOne, 4-10	1-13	The RI states that process sewers at EDC VCM Plant were constructed in the mid-1970s. This statement is incorrect. Construction of the EDC VCM Plant, including construction of process sewers, began in 1959. In 1969, concrete process pads and open drainage trenches were installed in EDC VCM process areas. Improvements were made to sumps and the liquid hydrocarbon draining system in the mid-1970s, and significant changes were made to the underground sewer system in the early 1980s as part of a Goodrich wastewater improvement project.	Agree with comment. Text will be updated accordingly to reflect the correct sewer construction activities and dates.
PolyOne, 4-11	1-14	The C Stripper does not presently use carbon beds as an emission control. Carbon beds for a Carbon Vapor Adsorption (CVA) treatment process were installed for the C Stripper unit but were rarely used.	Agree with comment. Text will be updated accordingly to correctly describe the process related to the stripper units.
PolyOne, 4-12	1-14	The RI states "[t]he water used in the cleaning of the stripper units is stored in a tank and reprocessed through the stripper units and discharged to the Secondary Wastewater Treatment System." This is incorrect. The A and B Stripper Units employ steam, not water, to remove VOCs from process wastewater. Steam that condenses in the strippers is not stored in a tank; it is sent directly to the secondary wastewater treatment system. In addition, the description of C Stripper operations on page 1-14 is not an accurate description of its current configuration. Carbon beds are not presently used for emission control. Non-condensable gases from C Stripper are sent to Westlake's Oxy or Primary Incinerators for treatment. The RI also states that "wastes from this unit are pumped back into the Groundwater 'C' Stripper System." In fact, steam and chlorinated and non-chlorinated compounds in a gaseous phase exit the top of the stripper and are passed through the overhead condenser. The condenser converts steam and gaseous chlorinated and nonchlorinated compounds into an aqueous phase and an organic liquid phase. The aqueous phase is returned to C Stripper and the organic liquid phase is recycled in the EDC VCM Plant.	Agree with comment. Text will be updated accordingly to correctly describe the process related to the stripper units.
PolyOne, 4-13	Figure 1-2	Figure 1-2 indicates that the chemical manufacturing plant owned by Cymetech is the Telene Plant. However, the text on pages iii and iv of the RI identifies this plant as the Ultrene® Plant. The text is correct. Figure 1-2 should be revised to identify the Cymetech-owned plant as the Ultrene® Plant.	Agree with comment. Text in Figure 1-2 will be updated accordingly.
PolyOne, 4-14	Figure 1-3	Figure 1-3 indicates that Goodrich sold the EDC VCM plant to Westlake Monomers in 1986. The correct year is 1990.	Agree with comment. Text will be revised accordingly.
PolyOne, 4-15	Figure 1-10	Shore Tank 9 is incorrectly labeled as Shore Tank 6 in Figure 1-10. In addition, the legend on Figure 1-10 should refer to Table 1-2.	Agree with comment. Text will be revised accordingly.
PolyOne, 4-16	2-4	The RI states "[a] key source of soil and surface water data was the Soil and Groundwater study." This sentence should refer to groundwater data, not surface water data.	Agree with comment. Text will be revised accordingly.
PolyOne, 4-17	2-10, 2-11	The RI states that only CERCLA data were used for the RI. This statement is incorrect and is also inconsistent with statements elsewhere in the RI (for example, p. 5-1). The RI uses non-	Comment noted. No change to report text.

Comment	Page, Section	Comment	Response
		CERCLA data for NAPL delineation and other purposes. As discussed in Comment 4-25, the RI should identify the data used for NAPL source zone delineation and acknowledge the limitations of and potential biases that result from the use of certain non-RI data such as excavation samples.	
PolyOne, 4-18	3-24	The RI incorrectly states that Respondents were performing dispersion modeling at the Site at the time the RI was prepared. That statement is incorrect and should be deleted. Tables 3-3 and 3-4: Data from bedrock wells are not included in Table 3-3 or Table 3-4. The bedrock wells are discussed in the text of the RI. Accordingly, data from those wells should be included in these tables.	Comment noted. The reference to dispersion modeling will be removed from the report. The report that documents the bedrock well installation will be included as an Appendix to the RI.
PolyOne, 4-19	4-3	The RI also incorrectly states that the "Warsaw Formation is largely absent beneath the Site." Respondents have concluded that the Warsaw Formation is present beneath the Site. (Westlake, 2013, p. 87; PolyOne, 2013, p. 3-25.) Amos and Finch (1968) states that the Warsaw Formation is present beneath the Site. The RI should be revised to indicate the presence of the Warsaw Formation beneath the Site.	Agree with comment. Text will be revised accordingly to note the presence of the Warsaw Formation beneath the site.
PolyOne, 4-20	4-2	The RI incorrectly states that the bedrock investigation revealed that the top of bedrock was "weathered, fractured and porous." This statement is incorrect. The bedrock investigation at the Site found that the bedrock is competent and weathering at the top of the bedrock is limited. Geophysical testing indicated a low density of fractures. The RI should be revised to reflect the results of Respondents' bedrock investigation.	Agree with comment. Text will be revised accordingly to reflect the results of the bedrock investigation in that weathering at the top of bedrock is limited.
PolyOne, 4-21	4-8	The values listed for the Pre-RI laboratory hydraulic conductivity results on page 4-8 of the RI are not correct. The range of hydraulic conductivity values on page 4-8 should be revised to be consistent with Table L.3 of the RI.	Agree with comment. Text will be revised accordingly.
PolyOne, 4-22	4-22	Page 4-14 of the RI refers to seven ponds being depicted on Figure 4-44. However, Figure 4-44 only depicts 6 ponds. The Carbide Slurry Pond, located south of Highway 1523, is not depicted on Figure 4-44.	Agree with comment. Text will be revised accordingly.
PolyOne, 4-23	4-8 to 4-9, Table 5-9	The text of the RI and Table 5-9 lists values for effective porosity that were used in NAPL partitioning calculations, including 0.33, 0.30, and 0.28 for fine sand, coarse sand, and gravel, respectively. Effective porosity for fine sand should be less than that of coarse sand. This is consistent with values for effective porosity listed in Table C.3.2 of Appendix C in EPA (1998). Respondents had previously agreed on an effective porosity value of 0.20 for fine sand based on the mid-range.	Comment noted. No change to report text.
PolyOne, 4-24	5-22 to 5-27	Pages 5-22 to 5-27: The NAPL scoring system used in the RI is inappropriate for use at this Site because the scoring system is too heavily weighted in favor of the presence of visible NAPL. For example, a sampling location that has a positive dye test and exceeds the partitioning threshold for EDC would receive a score of 20 and would not be considered a potential NAPL source zone under the scoring system, despite strong evidence that NAPL is present at that location. This conclusion is both unrealistic and inconsistent with EPA NAPL source zone delineation guidance (EPA, 2009, page 8), which recommends against weighting multiple lines of evidence and notes that assigning weighting factors to separate lines of evidence "negates [the] objectivity" of the source zone delineation.	Comment noted. The NAPL rubric and NAPL model represent an unbiased and consistent evaluation of NAPL distribution at the site. The NAPL model may be updated with additional offshore information collected during the 2016 and 2017 offshore investigations and the offshore NAPL

Comment	**Page, Section**	**Comment**	**Response**
		Under the RI's scoring system, in the vast majority of cases visible NAPL must be observed to classify a location as having confirmed NAPL. This overreliance on observations of visible NAPL is inappropriate because a large amount of NAPL at the Site is clear or light in color and not readily visible. Consequently, the scoring system does not realistically portray the extent of NAPL at the Site. Indeed, 97% of all locations with indirect NAPL indicators fall outside of confirmed NAPL source zones in the RI. Further, 76% of these NAPL indicator locations fall outside of potential NAPL source zones. The scoring system is also inconsistent with EPA's 2009 guidance for NAPL delineation because it ignores the presence of other positive indicators above or below each 5-foot interval of a soil boring, and at nearby borings. EPA's 2009 guidance states that NAPL source zone delineation should consider "various lines of evidence... within the same general spatial area." (page 8) Thus, the source zone boundaries should take into consideration the cumulative weight of multiple positive or negative indicators in the same area. The RI does not take this approach; data at nearby locations are not considered in determining NAPL presence or absence at a specific 5-foot interval of a soil boring. This results in errors, such as the RI's failure to identify a NAPL source zone in shallow soils at the River Tank Farm (see Comment 4-33). shallow soils at the River Tank Farm (see Comment 4-33). EPA should review the methodology that was used to weight NAPL indicators and provide a detailed description of this methodology, the calculations of weighted scores, and the supporting rationale for the decision to use the methodology. EPA should consider changes in the scoring system to ensure that it realistically depicts the extent of NAPL at the Site and does not exclude areas from NAPL source zones where multiple positive non-visual NAPL indicators are present. The RI should also include a statement acknowledging the limits of the NAPL indicator scoring system, particularly in areas of the Site where NAPL may be present but not visible. Alternatively, EPA should eliminate the use of the scoring system.	remedial design investigation. No change to report text.
PolyOne, 4-25	5-23	The RI inappropriately uses low concentrations of volatile organic compounds (VOCs) in excavation samples as indicators of NAPL absence. Excavation samples include pre-RI data that were collected as composite samples and/or at fixed intervals, for the purpose of characterizing soils for disposal. The use of excavation samples systematically underestimates VOC concentrations because (i) volatilization of VOCs occurs when soils are exposed to the atmosphere prior to sampling, and (ii) the practice of collecting excavation samples at fixed intervals without PID screening and/or the use of composite samples often hides the presence of "hot spots" of high VOC concentration that would indicate the presence of NAPL. For these reasons, EPA NAPL source zone delineation guidance (2009) advises against the use of samples that are composite or collected at fixed intervals without screening for delineating NAPL source zones.	See response to PolyOne Comment 4-24.

Comment	Page, Section	Comment	Response
		The use of excavation samples as negative NAPL indicators underestimates the extent of NAPL source zones at the Site. To illustrate, Figure 4-2 shows a cross-section through RI boring A3SB-301 (conducted in 2011) and an adjacent excavation sample collected in 2004. The figure shows that in 2011, the concentration of EDC at boring A3SB-301 at an elevation of approximately 345 feet amsl is 160 mg/kg. This result is 43,000 times higher than the 2004 excavation sample collected at an adjacent location (0.00371 mg/kg at composite sample EK-9). This difference in concentration demonstrates that excavation samples are not representative of current conditions and should not be used as negative NAPL indicators. Another example is shown in Figure 4-3, which illustrates RI NAPL indicators and source zones in Horizon 1 (0 to 10 feet bgs) at the East Vinyl Tank Farm. Figure 4-3 shows that there are two positive NAPL indicators with a Potential Indicator (PI) score of 30 outside the RI potential NAPL source zone. These two positive NAPL indicators are surrounded by excavation samples from shallow soil with EDC concentrations that were significantly lower than nearby RI borings in 2011. The excavation samples were not collected for the purpose of delineating NAPL source zones and are not representative of Site conditions, for the reasons identified in EPA's 2009 guidance. (For comparison, PolyOne's (2014) NAPL source zone is also delineated with a purple line on Figure 4-3; all ten positive NAPL indicators present in this area are within PolyOne's NAPL source zone.)	
PolyOne, 4-26	5-29 to 5-30 and Figures 5-64 to 5-80	Pages 5-29 to 5-30 and Figures 5-64 to 5-80: The NAPL source zones in the RI are based on PI values developed using the NAPL scoring system discussed above. The RI selects "threshold values" for determining whether NAPL is present and then applies a three-dimensional modeling algorithm to generate contours. The use of threshold values and the modeling algorithm is highly subjective. In addition to arbitrarily selecting the threshold value for NAPL presence, the three-dimensional model relies on control points that are set, sometimes incorrectly, to determine NAPL presence or absence at a location. For example, control points are used to indicate that pooled NAPL is present next to the Tennessee River at wells where pooled NAPL has never been observed. In other cases, more control points should have been used to constrain NAPL source zones to more realistically depict their extent. EPA should develop source zones using independent professional judgment, taking into account Site data, as opposed to relying solely on a numerical model. If EPA elects to use a modeling algorithm in a revised RI Report, it should include a statement in the RI acknowledging that the contours produced by the model may be inconsistent with observations of NAPL indicators at the Site and that the contouring process does not take into geologic features at the Site.	See response to PolyOne Comment 4-24.
PolyOne, 4-27	5-31 to 5-35 and Figures	On 10 December 2015, PolyOne submitted a letter to EPA identifying issues in the RI's NAPL source zone delineation (included as Exhibit 4-1). The letter identified several issues in the NAPL source zone delineation in the Carbide Ponds area, as follows:	See response to PolyOne Comment 4-24.

Comment	Page, Section	Comment	Response
	5-64 to 5-80	• the overestimation of horizontal and vertical extent of NAPL source zones below the rectangular Carbide Settling Pond; • the merger of two separate LNAPL and DNAPL source zones near the east side of the rectangular Carbide Settling Pond; and • the incorrect use of NAPL indicator control points to delineate the NAPL source below and adjacent to the triangular Carbide Recycling Pond. EPA should revise NAPL source zones in the Carbide Ponds area to address these deficiencies in the NAPL source zone model. In addition, Figures 5-64 to 5-80 should be revised to show the location of control points, rather than identifying them as if they were Site data. For example, three control points at three PCAP wells are shown on Figure 5-67 as if they are actual site data points. Pooled NAPL has never been observed in these three PCAP wells. Figure 5-67 should be revised to make clear that these points are control points and are not Site data. Battelle's 13 January 2016 Technical Memorandum states that control points indicating pooled NAPL presence were placed at three PCAP wells adjacent to the river (BW-1927B, BW-1927E, and BW-1928) due to observation of NAPL in these wells. This is incorrect. Pooled NAPL has never been observed in any of these wells.	
PolyOne, 4-28	5-31 to 5-37	The following NAPL source zone descriptions in the RI are inaccurate: a. West Floodplain Area (Horizon 1) (p. 5-31): The RI is missing a description of the NAPL source zone that occurs below the River Tank Farm in the 0-10 feet bgs horizon (see Comment 4-33). b. East Area (Horizon 1) (p. 5-31): The RI suggests that the B.F. Goodrich Landfill is a significant source of DNAPL in this area. This is incorrect. The primary source of NAPL in this area is seepage from former burn pits. c. West Floodplain Area (Horizon 2) (p. 5-32): The RI indicates that there is a NAPL source zone extending below the entire length of the rectangular Carbide Settling Pond above the floodplain interbeds (see RI Figure 5-65). This is incorrect. There is a small LNAPL (petroleum hydrocarbon) source zone in fill on the east side of the Carbide Settling Pond. This is a localized NAPL source zone that is limited to the east side of the Carbide Settling Pond (see Exhibit 4-1 – PolyOne 10 December 2015 letter). d. West Floodplain Area (Horizon 3) (p. 5-33): The RI indicates that NAPL seeped through the bottom of the Pond 1A sump directly into the floodplain interbeds. This is incorrect. The cross-section shown on Figure 4-4 along the west side of Pond 1A confirms that the bottom of the former sump was within the floodplain clay silt unit. NAPL would have migrated through about approximately 5 to 6 feet of the floodplain clay silt unit before it reached the underlying floodplain interbeds. Figure 4-4 also shows a photograph of NAPL seeping from clay in soil	Comment noted. See response to PolyOne Comment 4-24. The NAPL source zone descriptions are designed to be a summary of the results observed on the horizon-specific NAPL distribution maps generated using the NAPL model, and potential NAPL sources are identified based on the model output. The NAPL rubric model did not differentiate between organic NAPL source types (e.g., LNAPL vs. DNAPL). The report text that states NAPL near the Carbide ponds extends beneath the Tennessee river will be deleted.

Comment	Page, Section	Comment	Response
		boring A2SB-307 in a silt lens within the floodplain clay silt unit, which overlies the floodplain interbeds. e. West Floodplain Area (Horizon 3) (p. 5-33): The RI should include a reference to releases from the River Tank Farm as contributing to NAPL in the floodplain interbeds. NAPL source zones have been observed below the River Tank Farm, and NAPL migrates vertically downward through the floodplain clay silt into the underlying floodplain interbeds. f. West Floodplain Area (Horizon 4) (p. 5-34): The RI states that the NAPL source zone near the Carbide Ponds extends below the Tennessee River. Pending further investigation, this has not been confirmed and should be removed from the RI. This has been addressed through further investigation, as documented in the RI Addendum. g. West Floodplain Area (Horizon 4) (p. 5-34): The RI indicates that Respondents concluded that the NAPL source zone below the rectangular Carbide Settling Pond extends to the bottom of this horizon. This is incorrect. There are no positive NAPL indicators below the elevation of 297 feet amsl, as shown in the PolyOne 10 December 2015 letter (Exhibit 4-1).	
PolyOne, 4-29	5-36	Shallow soils at the Site are predominantly silt with lesser amounts of clay and sand that vary across the Site. These shallow soils are generally extensive, although there are locations where they are very thin or absent. The RI indicates on page 5-36 that these shallow soils may have significantly limited NAPL migration to underlying soils at the EDC VCM plant. This is incorrect. The RI NAPL source zones at the EDC VCM Plant (Figures 5-64 through 5-66) show a similar number of NAPL source zones both above and below these shallow soils. There are multiple mechanisms for NAPL migration through shallow soils at the Site, including: • desiccation fracturing of the shallow clay silt soils that occurs during dry periods. For example, Figure 4- 5 shows substantial desiccation fracturing of shallow soils near Shore Tank 1 (June 2003). Figure 4-6 shows an open fracture in a trench excavation that took place at South Cracking in June 2014. • other types of fractures created in shallow soils, including freeze thaw, cyclic mechanical loading as storage tanks are filled and emptied, bioturbation, and root traces. For example, the borehole log for P1MW-2 (adjacent to Pond 1A) notes the presence of sub-vertical fracture planes in shallow soils that coincided with a large spike in organic vapor concentrations to 3,000 ppm, indicating that VOCs were present. • variable matrix permeability of shallow soils due to varying contents of sand and clay in the clay silt soils across the Site. • areas where shallow clay silt soils are thin or absent (see Figure 4-1). • areas where infrastructure surrounded by permeable fill cuts partially or completely through shallow soils. For example, concrete sumps at the Site can have depths of 10 to 30 feet bgs, and permeable fill is used around the walls and base of these sumps.	See response to PolyOne Comment 4-24.

Comment	**Page, Section**	**Comment**	**Response**
		• leaking underground sewers and manholes. For example, crude EDC NAPL reached a nearby storm sewer system during the 2002 Halloween Spill at Shore Tank 1, and later tests showed that the storm sewer line was leaking. Site data exists supporting NAPL migration through clay silt shallow soils, including: • data and field observations showing preferential penetration of NAPL through localized areas in the vicinity of Shore Tank 1, where the shallow soils have a relatively high permeability due to the lower clay content (see Figure 4-7). • observations of NAPL within and below the shallow soils near Shore Tank 4 (see boring log for AOCD-rfi4 in Figure 4-8). • observations at a soil boring near underground leaks at North Cracking (boring NSC-02) showing the penetration of NAPL throughout the 6 feet of shallow soils (see Figure 4-9). • pooled NAPL observed in a silt seam within a clay silt matrix near the former Pond 1A sump at soil boring A2SB-307 (see photo on Figure 4-4). • pooled NAPL observed seeping from clay at the interfaces where marbling occurred over a 2.5-foot thick clay silt interval at boring A5SB-316 adjacent to the Barge Slip (see NAPL assessment field log for A5SB-316). • elemental mercury NAPL observed within and below shallow soils in the vicinity of the chlorine plant (see boring log for S35-3 and notes of visible mercury on the NAPL assessment field log for A8SB-315 showing mercury to depths of at least 70 feet bgs). • the presence of NAPL below the shallow clay silt unit near the shallow burn pits, indicating that NAPL migrated through the shallow soils. [See Comment 5-5 for additional examples of NAPL migration through clay silt shallow soils.]	
PolyOne, 4-30	5-36	Page 5-36, paragraph 4 and throughout RI: The RI states that the "NAPL-impacted soil volume estimates for the EDC VCM Plant area represent between 1.8 and 3.4% of the total NAPL-impacted soil at the site." This conclusion is based on the use of the NAPL indicator scoring system and NAPL source zone delineation methodology used in the RI (see Comments 4-24 through 4-26). That methodology underestimates the volume of NAPL-impacted soil at the EDC VCM plant because the scoring system fails to give adequate weight to many positive NAPL indicators in this area, where NAPL is generally clear in color and not visible. In addition, the inclusion of inappropriate pre-RI excavation soil sample data as negative NAPL indicators results in underestimation of NAPL-impacted soil volume in this area (see Comment 4-24).	See response to PolyOne Comment 4-24.
PolyOne, 4-31	Figures 5-48 to 5-51	The seeps figures do not include the AOI-2 or AOI-5 seeps.	Comment noted. These seep figures are designed to show the Northwest Area Seeps. No change to report text.
PolyOne, 4-32	Figures 5-56 to 5-59	Pond sediment data are missing from Figures 5-56 to 5-59.	Comment noted. This RI report discusses the sediment samples collected from the Tennessee River, the Barge Slip, and the Outfall Ditches.

Comment	Page, Section	Comment	Response
PolyOne, 4-33	Figure 5-64	Figure 5-64 of the RI shows the delineation of NAPL source zones in the first horizon (0 to 10 feet bgs). Figure 5-64 shows no potential or confirmed NAPL source zone below the River Tank Farm in this horizon. This is incorrect—there are ten positive NAPL indicators at seven different locations in the first horizon. Figure 4-10 shows an excerpt from Figure 5-64 and identifies the locations of positive NAPL indicators: A2SB-315, EKI-22, EKI-23, EKI-302, EKI-306, EKI-330, and an excavation location identified as "1997-10-14" (after a pipeline release). Figure 4-10 shows two types of NAPL presence indicators observed in this area: soil samples exceeding the partitioning threshold ratio (PTR), and stains with supporting evidence of contamination nearby (Stain+). The highest concentration of EDC at these NAPL indicator locations was 9,300 mg/kg (EKI-306), which is well above the partitioning threshold for EDC. EPA's 2009 NAPL delineation guidance states that confirmed NAPL source zones can be present even if only indirect NAPL indicators are present. The clustering of indirect positive NAPL indicators supports the existence of a NAPL source zone in the 0-10 feet bgs horizon beneath the River Tank Farm area. Respondents agreed with this conclusion in their separate 2013 Remedial Investigation Reports, which each identified a confirmed NAPL source zone in this area. In addition, the PI value at boring A2SB-315 is incorrect. Figure 5-65 indicates that the PI Value at boring A2SB-315 is 20 or less, when in fact that PI value should be 30 (PI=20 for the Stain+ indicator, plus PI=10 for PTR >1 at a depth of 0.4 feet below the first indicator). EPA should review the PI calculation for this sample, as well as all other samples in the dataset.	See response to PolyOne Comment 4-24. The PI value at boring A2SB-315 is model 30 in Interval 6 and 20 in model interval 7 and is correctly depicted on Figure 5-65.
PolyOne, 4-34	Figures 5-71 and 5-74	The NAPL source zones in the RI show NAPL as present in the low permeability CRH unit (see Figures 5-71, 5-74). No data collected during the RI investigation indicates that NAPL is present within the CRH unit. The projection of NAPL into the CRH unit is an artifact of the numerical algorithm used for contouring and is not supported by Site data.	See response to PolyOne Comment 4-24.
PolyOne, 4-35	6-8 to 6-9	Section 6.3.1 of the RI briefly discusses mass discharge of EDC. This discussion should be expanded to compare relative mass discharge and NAPL-impacted soil volumes to improve the conceptual model of NAPL source zones at the Site. Figure 4-11 illustrates the importance of evaluating mass discharge at the Site. The figure shows that the East Area has a high NAPL mass but low mass discharge (650 pounds/year), indicating that most of the NAPL is not in contact with groundwater flow in this area. In comparison, there is a smaller amount of NAPL at the Vinyl Tank Farm with a much higher mass discharge (55,000 pounds/year), indicating that NAPL in this area is more accessible to groundwater flow. An analysis of mass discharge at these and other areas of the Site would refine the understanding of the relative risk posed by different NAPL source zones and should be included in the RI in Section 6, Section 8, and the Executive Summary.	Comment noted. No change to report text.

Comment	**Page, Section**	**Comment**	**Response**
PolyOne, 4-36	7-3, Appendix 7-1	The Ecological Risk Assessment (ERA) in the RI uses a wildlife food chain model to evaluate the potential risk to avian piscivores (for example, great blue heron). The wildlife food chain model relies on 62 sediment samples collected from the river and Barge Slip during the RI. Each of these samples was analyzed for the constituents of potential ecological concern (COPECs), and the wildlife food chain model was used to determine the potential risk to wildlife foraging in the vicinity of the Site. Based on the assumptions used in the analysis, the RI identified "a potential risk to avian piscivores exposed to mercury." The ERA food chain model makes three assumptions that together significantly overestimate the risk that uncontrolled releases at the Site pose to great blue heron and other avian piscivores. Specifically, the model (1) inappropriately assumes that all mercury in river and Barge Slip sediments is present in the methylated form; (2) uses inappropriate exposure point concentrations; and (3) overestimates the incidental sediment ingestion rate for great blue heron. First, the ERA food chain model uses toxicity reference values (TRVs) that are based on the assumption that all mercury present in river and Barge Slip sediments is methyl mercury. This assumption is highly conservative and not realistic for sediments and surface water. There is no evidence that methyl mercury compounds represent a significant proportion of the mercury detected in sediment. Methyl mercury compounds are only ephemerally present in sediment and thus represent very low proportions of the total mercury in this media.[3] Rather, inorganic mercury is the dominant form of mercury in sediment (Hollweg et al., 2009; Kannan et al., 1998).[4] The use of methyl mercury-based TRVs for sediment samples significantly overestimates the risk to great blue heron. The food chain model for great blue heron should be modified to account for the relative percentages of methyl mercury and inorganic mercury in sediment and fish tissue. Kannan et al. (1998) reports that methyl mercury accounts for 0.77% of total mercury in sediment and 83% of total mercury in fish tissue. These percentages should be used in the ERA to calculate the concentrations of methyl mercury present in sediment and fish tissue samples collected from the river. Hazard quotients (HQs) for methyl mercury and inorganic mercury can be summed to provide a more realistic estimate of the potential for risk to great blue heron.[5] Second, the ERA's great blue heron food chain model uses values for the exposure point concentrations—the maximum detection and a 95% Upper Confidence Level (UCL) of the mean—that are also highly conservative and not representative of the potential exposure. The distribution of sediment samples collected during the RI is heavily weighted in favor of locations in the Barge Slip, where mercury concentrations are significantly higher than concentrations in the river.[6] Nineteen of the 62 total samples were from the 2.6 acre Barge Slip; the remaining 43	Comment noted. There are uncertainties associated with the great blue heron food chain risk estimates as identified in both the ERA and FS documents. These uncertainties are conservative in nature and most useful in identifying exposure areas and specific exposure pathways that may pose an unacceptable ecological risk warranting remedial measures. Consideration of these uncertainties were used to guide RAOs. No change to report text.

Comment	Page, Section	Comment	Response
		samples were from a 45.9-acre section of the river, resulting in a Barge Slip sampling density that is more than eight times higher than the sampling density in the river. This weighting does not accurately reflect great blue heron exposure to mercury in sediments. The Barge Slip ranges from 4.9 to 16.3 feet in depth, with a mean depth of 10.9 feet. This depth is too great for great blue heron to be exposed to sediment. In addition, industrial activity in the Barge Slip would severely limit and disrupt the birds' potential to feed. The surface area of the Barge Slip is also much smaller than the size of the heron's feeding range (which is approximately equal to the 48.5-acre area sampled during the RI). Given the depth of the water, the industrial activities in the Barge Slip, and the Barge Slip's small size, Barge Slip sample data should not be so heavily weighted in determining exposure point concentrations. It should be noted that the dataset of bulk sediment samples in the Tennessee River outside of the Barge Slip includes a total of 42 separate locations (plus 2 duplicate samples). The distribution of these 42 locations is essentially the same as the data set with the Barge Slip samples (approximately 250 acres). With few exceptions (SER12+50, SER15+50, SER15+100 and SER16+150+50), these 42 sediment samples are from locations in the river that are shallow enough to support use by great blue heron. Therefore, the Barge Slip samples are not necessary to provide an adequate data set for risk assessment for great blue heron. The ERA also uses the maximum mercury concentration detected in Barge Slip sediments (46 mg/kg) for one of the exposure scenarios to calculate risk to great blue heron. This value does not realistically represent the extent of exposure to mercury. As noted above, this sample was collected from a location under a significant depth of water (11.4 feet below the surface), where a great blue heron could not feed. Moreover, exposure point concentrations for non-threatened species such as the great blue heron should be based on conditions throughout the foraging range of the population, not on the maximum concentration (or even the concentration at the UCL). Because the foraging range of great blue heron is about the same size as the assessment area for the river and Barge Slip investigation, and given the concerns about the undue weight assigned to Barge Slip samples discussed above, the arithmetic mean concentration of all 62 sediment samples (1.4 mg/kg total mercury) is a more appropriate estimate of the exposure point concentration for mercury. The ERA should be revised to correct the unrepresentatively high exposure point concentration. Third, the ERA food chain model overestimates the rate of incidental sediment ingestion by great blue heron. The risk assessment uses an incidental sediment ingestion rate of 9.4% of dry-weight food ingestion (RI, Appendix 7-1, Table 37). This value cites "EPA 1993" as the source, but the ERA provides no description of this reference (which PolyOne was unable to identify).	

Comment	Page, Section	Comment	Response
		Regardless, the value used contradicts guidance that EPA has provided to Respondents. Brett Thomas of the EPA Region 4 Scientific Support Section directed Respondents to use an incidental sediment ingestion rate of 2% (personal communication, 2013). Thomas's instructions reflect the fact that great blue heron feed on prey in the water (above the sediment surface) and thus do not insert their bills into the sediment bed (in contrast to sandpipers, plovers, and other birds that feed on subsurface benthic prey). An ingestion rate of nearly 10% significantly overestimates incidental ingestion of sediment for birds with this type of foraging behavior. The ERA should be revised to use the appropriate incidental sediment ingestion rate. For these reasons, the RI's conclusion that mercury in river and Barge Slip sediments poses a potential risk to great blue heron is based on assumptions that significantly overestimate the risk to heron and other avian piscivores. EPA should revise the ERA to use more realistic input parameters for (1) mercury speciation and TRVs; (2) the mercury exposure point concentration; and (3) incidental sediment ingestion values. Proposed revisions to ERA Table 37 that incorporate these corrections are included as Exhibit 4-2.	
PolyOne, 4-37	Appendix 7-1	The ERA screens COPECs against a series of ecological screening values (ESVs) to identify the potential for risk to benthic invertebrates. For COPECs with specific (non-narcotic) modes of action and not subject to bioaccumulation, the ERA uses ESVs based on non-site-specific sediment quality benchmarks (SQBs) as the primary means of evaluating risk to benthic invertebrates. SQBs are very conservative and typically are used only to screen for COPECs. The risk posed by constituents identified as COPECs is typically refined in subsequent steps in the ERA process by considering site-specific conditions. The ERA did not conduct any analysis beyond the initial screening and did not consider site-specific conditions that potentially affect the exposure of receptors to COPECs. A more accurate estimate of risk requires an assessment of how receptors come into contact with COPECs. Sediment-dwelling benthic organisms primarily come into contact with interstitial pore water in the sediment; pore water concentrations are the most accurate exposure metric for these organisms. Accordingly, an accurate estimate of exposure requires the calculation of the equilibrium partitioning of COPECs between sediments and pore water using site-specific measurements of organic carbon content (EPA, 2008). These site-specific calculations are used to generate equilibrium partitioning sediment benchmarks (ESBs), which provide a more accurate assessment of exposure when compared with generic SQBs for bulk sediment. Although the ERA includes equilibrium partitioning calculations for the evaluation of narcosis-effect toxicity, ESBs were not considered in the ERA's evaluation of non-narcotic COPECs. This failure to consider ESBs has the greatest impact for low-solubility COPECs, which preferentially sorb onto organic carbon in sediments. For example, the ERA evaluated the potential risk from bis(2-ethylhexyl)phthalate using an SQB of 0.182 mg/kg. Taking solubility into account results	Comment noted. The ERA was designed such that there was a high level of certainty when analytes were eliminated as COPECs (i.e., these analytes do not pose an unacceptable risk to ecological receptors). However, there was less certainty, due to the conservative assumptions built into the ERA, as to which analytes retained as COPECs were actually adversely impacting ecological receptors. The analysis of potential risks to ecological receptors has significant implications given the high-quality habitat provided by the river, floodplain and upland areas along the river. In addition to providing a recreational fishery, the river serves as a significant food source to local avian and mammalian receptors. As with the HHRA, the primary purpose of the ERA is to provide risk managers with an understanding of the potential current and future risks to ecological receptors

Comment	Page, Section	Comment	Response
		in a site-specific ESB value of at least 5.8 mg/kg (conservatively assuming a value based on the lowest organic carbon fraction reported for sediments within the assessment area). Thus, the failure to calculate the equilibrium partitioning of bis(2-ethylhexyl)phthalate between sediment and pore water overestimates ecological risk from sediment exposure by at least a factor of 30. The ERA should be revised to calculate ESBs for bis(2-ethylhexyl)phthalate and other non-narcotic COPECs.	that may be posed by a site in the absence of remediation or exposure controls, and the uncertainties associated with the assessment. Consistent with USEPA guidance, the ERA utilized a risk-based framework that is iterative and did incorporate site-specifics as possible given the available data. Using site-specific data and information that characterizes the site is a key component in assessing the potential risks for selected receptors, thus providing sound information upon which risk management decisions can be made. No change to report text.
PolyOne, 4-38	Appendix 7-1	The ERA calculates final chronic value (FCV) benchmarks to assess chronic narcosis toxicity effects on benthic invertebrates. EPA guidance for assessing these effects is described in Procedures Used for Derivation of Equilibrium Partitioning Sediment Benchmarks for Protection of Benthic Organisms (EPA, 2008). The inputs used in the ERA to calculate FCV benchmarks depart without explanation from EPA guidance in a number of areas, including: • Acute Critical Lipid Concentration: The text of the ERA cites the use of an acute lipid concentration value of 35.3 µmol/g octanol, but Appendix A of the ERA identifies a value of 28.94 µmol/g. The value of 35.3 µmol/g is consistent with EPA guidance documents (EPA, 2003 and EPA, 2008). There is no explanation for the discrepancy, and it is unclear which value is used in assessing chronic narcosis toxicity. The higher value identified in EPA guidance documents is the appropriate value for acute lipid concentration that should be used in the ERA. • Acute-to-Chronic Toxicity Ratio: The ERA uses an acute-to-chronic toxicity ratio of 7.55 for chlorinated aliphatics. This value is a class-specific geometric mean, which should not be used where a chemical correction factor is also used (as was done in the ERA). Instead, the ERA should use the geometric mean of all acute-to-chronic toxicity ratios (5.09) for each compound and apply appropriate chemical class correction factors as noted below. • Universal Slope Factor: The ERA states that the universal slope factor used in the calculation of final chronic values is -0.945. This value is consistent with EPA's 2008 guidance (cited above). However, Appendix A of the ERA states that the universal slope factor is -0.936. The correct value of -0.945 should be used. • Chemical Class Correction Factor: The ERA uses chemical class correction factors of -0.339 for chlorinated aliphatics and -0.109 for ketones and non-halogenated aromatics. EPA guidance (2008) states that the values should be -0.244 for chlorinated aliphatics and -0.245 for ketones and non-halogenated aromatics. There is no explanation for the discrepancy between the	Comment noted. Remediation criteria for groundwater are based on state and federal water quality values and are not based on the FCV benchmarks. Thus, the discrepancies identified in this comment will not affect cleanup goals for the site. No change to report text.

Comment	Page, Section	Comment	Response
		values used in the ERA and EPA guidance values. The ERA should be corrected to use the chemical class correction factors published in EPA guidance. • Octanol-Water Partitioning Factors: The ERA uses octanol-water partitioning coefficient (Kow) values from the SPARCS on-line chemical property calculator (www.archemcalc.com sparc). FCVs are extremely sensitive to this parameter. There are a variety of sources for empirically derived, as well as theoretically derived, values. Although Kow values vary, both empirically and theoretically derived values should be evaluated to identify a central tendency, eliminating high and low values. EPA guidance (2008) describes the evaluation of Kow values based on these criteria. This process should be applied to generating values for Kow for use in the ERA. Table 1 demonstrates the effect of the parameter values used in the RI on the resulting FCVs for some of the key COPECs. As noted above, a number of the values selected as input for the FCV calculation could result in groundwater remediation criteria that are set at concentrations lower than needed to provide protection of receptors at the Site. The input values should be corrected to ensure that FCV values used to establish groundwater remediation criteria are supported by the best available science.	
PolyOne, 4-39	xv, 7-7 to 7-8, Appendix 7-2	The Human Health Risk Assessment (HHRA) in the RI uses concentrations of contaminants of concern in ambient air to assess the risk of exposure to contaminants in indoor and outdoor air at the Site. Based on ambient indoor and outdoor air concentrations, the HHRA concludes that "[f]or the industrial commercial worker, cancer risks are greater than the risk management range" and that noncancer risks are "greater than the noncancer threshold for inhalation based on measured outdoor air concentrations, primarily due to exposure to EDC" (p. xv.) The HHRA also concludes that "[f]or the industrial commercial worker, cancer risks are above the risk management range" and that noncancer risks are "above the noncancer threshold for inhalation of indoor air from vapor intrusion (VI) measured at Buildings 1, 2, 3 and 5, primarily because of EDC concentrations" (Id.). These conclusions are based on measured concentrations of EDC in indoor and outdoor air (RI, Appendix 7-2, Table 3-1). The conceptual model used in the HHRA incorrectly assumes that those measured concentrations of EDC are due solely to volatilization from soil and groundwater. The HHRA does not present data or analysis to support the assumption in the conceptual model that EDC in indoor and outdoor air originates from soil and or groundwater at the Site. In fact, the subslab soil gas, indoor air, and outdoor air data support the conclusion that concentrations of EDC in indoor air and outdoor air reflect background levels or non-CERCLA regulated sources. The data available for the Site are inconsistent with the conclusion that volatilization from soil and groundwater is the source of EDC in indoor and outdoor air.	Comment noted. The purpose of the HHRA was to assess and document the magnitude of potential risk to human receptors based on current and potential future exposures to COPCs identified in environmental media at the Site. In addition, the risk assessment assessed the overall cancer risks and noncancer hazards to human health to address requirements in the NCP. The results of the assessment were used to make informed risk management decisions regarding the need for remedial action. Inhalation risks to on-site industrial workers were provided in the risk assessment in order to characterize potential risks. Elevated risks associated with indoor and outdoor air for the industrial commercial worker were attributed to the presence of EDC.

Comment	Page, Section	Comment	Response
		These data are shown in Table 2, which shows soil gas and indoor air data collected from the investigation at Buildings 1, 2, 3, and 5. Typically, soil vapor concentrations of VOCs exceed indoor air concentrations by several orders of magnitude where vapor intrusion is the source of an indoor air quality issue. In its review of data from vapor intrusion studies, EPA concludes that the median subslab soil gas attenuation factor is approximately 0.003 and the 95th percentile value is approximately 0.03 (EPA, 2012). Thus, where vapor intrusion is the source of contaminants in indoor air, concentrations of contaminants in subslab soil vapor will be, on average, 333 times higher than concentrations in indoor air, and in 95% of cases concentrations in subslab soil vapor will be at least 33 times higher than those in indoor air. At the Site, indoor and outdoor air concentrations were greater than or equal to soil vapor concentrations at every location where EDC concentrations were above the detection limits. These concentrations vastly exceed the concentrations that could reasonably be attributed to volatilization of EDC in soil and ground water, which would be less than or equal to 1/33rd the concentration observed in subslab soil gas. These data indicate that almost none of the EDC detected in indoor air at Buildings 1, 2, 3, and 5 originates from the migration of subslab soil vapor. In outdoor air, soil gas concentrations would decrease even more because of the effect of dispersion. Accordingly, the HHRA's conclusion that EDC in indoor and outdoor air at the Site is attributable to volatilization of EDC from soil and groundwater is not supported by Site data and should be revised to state that EDC concentrations indoor and outdoor air are attributable to background levels or non-CERCLA regulated sources.	Management decisions regarding the estimated risk and presence of EDC in the air at the facility were made and are further addressed in the FS. The FS states that the inhalation risk to facility workers is due to exposures to regulated chemicals, including EDC, which are addressed by the Occupational Safety and Health Administration (OSHA). The FS further states that because OSHA does not address administrative personnel (or non-OSHA regulated workers) in office building who also may be exposed to EDC and other contaminants emanating from groundwater and subsurface soil, results of the risk assessment were used to support the need for vapor mitigation engineering controls for occupied structures at the facility. In addition, the FS states that further evaluation of the data suggests the COPC driving the outdoor air inhalation risk is not CERCLA-related. Sampling of outdoor and indoor air and subslab soil gas suggests the primary source of detectable EDC in outdoor air is related to emissions associated with facility operations. Measured EDC concentrations in subslab soil gas samples were generally lower than those observed in indoor air. Personnel exposures to regulated chemicals, including EDC, are addressed by the Occupational Safety and Health Administration (OSHA). Therefore, no RAO is required for outdoor air. For indoor air exposures, the FS states that

Comment	Page, Section	Comment	Response
			vapor mitigation engineering controls are in place for all occupied structures at the facility.
PolyOne, 4-40	8-2	The RI incorrectly states that the "Warsaw Formation is largely absent beneath the Site." Respondents have concluded that the Warsaw Formation is present beneath the Site. (Westlake, 2013, p. 87; PolyOne, 2013, p. 3-25.) Amos and Finch (1968) states that the Warsaw Formation is present beneath the Site. The RI should be revised to indicate the presence of the Warsaw Formation beneath the Site.	See response to PolyOne comment 4-19.
PolyOne, 4-41	8-3	The RI incorrectly states that the bedrock investigation revealed that the top of bedrock was "weathered, fractured and porous." This statement is incorrect. The bedrock investigation at the Site found that the bedrock is competent and weathering at the top of the bedrock is limited. Geophysical testing indicated a low density of fractures. The RI should be revised to reflect the results of Respondents' bedrock investigation.	See response to PolyOne Comment 4-20.
PolyOne, 4-42	8-15	Page 8-15 of the RI states that groundwater flow is north to south. Groundwater flow is from south to north.	Agree with comment. Text will be revised accordingly.
PolyOne, 4-43	8-1	Former River Tank 6 is not identified as SWMU 184 on Figure 8-1.	Agree with comment. Figure will be updated to note that Former River Tank 6 is SWMU 184.
PolyOne, 4-44	8-16	The RI states "The evaluation of the potential migration of VOCs to ambient air and indoor air is ongoing. As directed by EPA, the evaluation of this potential pathway will be submitted by the Respondents as an addendum to the RI." This statement was incorrect at the time it was made, is still incorrect, and should be deleted.	Agree with comment. The referenced text will be deleted from the report.
PolyOne, 4-45	Table 8-1	Table 8-1 is intended to include a list of "significant" releases that are purportedly based on a "review of the independent tabular historical release summaries prepared by Respondents in 2012" (RI, p. 8-5). Instead, it appears that Table 8-1 is based on the "Historical Release Summary" that Westlake provided to EPA on 20 September 2012. Thus, Table 8-1 omits numerous significant releases at the Site, including releases previously identified in PolyOne's 25 May 2012 Site History (see PolyOne, 2012, Table 3). In addition, Table 8-1 includes other releases that are not significant sources of subsurface contamination. Table 8-1 is incomplete and inaccurate for the following reasons: • It includes release events where only the volume or mass of water released or soil excavated was reported. The actual mass of contaminants in that water or soil was not quantified. The volume or mass of water released or soil excavated is not a basis for concluding that these were significant releases of contaminants, and there is insufficient evidence to show that these releases caused persistent subsurface contamination. • It includes descriptions copied directly from Westlake's 2012 table that are incorrect, incomplete, and biased.	Comment noted. The release information presented in Table 8-1 will be reviewed for completeness and accuracy and revised as necessary.

Comment	Page, Section	Comment	Response
		• It does not include significant releases from storage tank bottoms and underground pipelines that have been documented or investigated at the Site. These releases, directly to the subsurface, are significant based on location of release, length of time of release, and/or impacts to the subsurface. A more complete and accurate table of releases is included as Exhibit 4-3 to this memorandum. Exhibit 4-3 includes releases that have been identified as "significant" based on: • calculated release amounts of 1,000 pounds or more (based on the mass of contaminants released); or • facts or data showing that a release was long-term and directly to the subsurface, or that it resulted in persistent subsurface contamination. Examples of these releases include releases from burn pits, ponds, tank bottoms, and sewers At the same time, Exhibit 4-3 deletes those releases included in Table 8-1 on the basis of a quantity, where the quantity stated is the amount of contaminated water released or impacted soil excavated; these quantities are not indicative of the actual amount of contaminants released. In addition to Exhibit 4-3, an additional version of the table is provided for reference. Exhibit 4-3M is a "markup", where the first column identifies general changes that were made. Red text indicates deletion, and blue text indicates insertion. Exhibit 4-3M also provides supplemental information to correct the Westlake descriptions (some of which were copied into RI Table 8-1). EPA should replace Table 8-1 with the more complete and accurate table provided in Exhibit 4-3.	
Westlake, 1	iv	The RI Report states that the Plant-wide Corrective Action Program (PCAP) system consists of 47 extraction wells. However, on page 1- 14 the RI Report states that the PCAP system consists of 51 extraction wells. The correct number of extraction wells is 51.	Agree with comment. Text will be revised accordingly.
Westlake, 2	iv	The RI Report states that a remedial action in the burn pit area is the operation of a Soil Vapor Extraction (SVE) system. It should be noted that the SVE system was converted to a Dual Phase Extraction System (OPE) in 1996 (see Westlake RI Report page 11 and PolyOne RI Report page 1-31).	Agree with comment. Text will be revised accordingly.
Westlake, 3	vi, 8-3	The RI Report refers to an Intermediate "Confining Zone" when describing the Site geology. Although the report refers to this feature as a "confining zone," it describes the zone as follows: "[d]ue to its discontinuous and heterogeneous nature, the Intermediate Confining Zone is not an effective Site-wide barrier to vertical flow between the Upper and Lower Aquifers." On page 8-3 the report states that this zone is typically present between elevations 280 feet (ft) above mean sea level (amsl) and 295 ft amsl. The data collected during the RI demonstrate that there is not a "confining" zone at the Site. The cross-sections shown on Figures 4-18, 4-19, 4-20 and 4-21 in the RI Report do not show a discernible site-wide "confining zone" between elevations 280 ft amsl and 295 ft amsl. In fact,	Agree with comment in part. Figures and text will be revised to divide the groundwater into “shallow groundwater” and “deep groundwater with a boundary at 295 ft amsl. Text will be revised to state that due to the heterogeneity and discontinuity of the clay/silt zones, the Intermediate Confining Zone does not provide an effective barrier to vertical flow

Comment	Page, Section	Comment	Response
		Figures 4-19 and 4-21 show only a few small, isolated occurrences of interbeds or clay between elevations 280 ft amsl and 295 ft amsl. A few small, isolated occurrences cannot constitute a "zone," especially a "confining zone." Similarly, plan view maps from the geologic model developed by the Respondents during the RI demonstrate that areas of lower permeability that exist between elevations 280 ft amsland 295 ft amslare, consistent with the text and Figures 4-18 through 4-21 in the RI Report, discontinuous in nature and not a barrier to vertical flow in the aquifer. The figures attached at **1** and 2 to the Appendix are plan view figures showing areas of higher and lower permeability in one-foot intervals between elevations 280 ft amsl and 295 ft amsl. Because the areas of lower permeability that exist between elevations 280 ft amsl and 295 ft amsl are indisputably discontinuous and do not prevent vertical groundwater flow, it is not correct to state that an identifiable "zone" exists, or to imply that an area confines groundwater flow by naming it a "confining zone." Instead, the aquifer at the Site predominantly consists of fine and coarse grained sands, and also includes discontinuous areas that are of lower permeability. Not only does the data prove that a discernible "confining zone" across the Site does not exist, the text in the report stating that the zone is discontinuous and does not prevent the vertical flow of groundwater is consistent with the absence of such a zone rather than the presence of a zone. In addition, on pages vi and 8-3, the RI Report states that groundwater flow within the admittedly discontinuous units of lower permeability between elevations 280 ft amsl and 295 ft amsl "is predominately horizontal with specific flow paths driven by the depositional layer geometry." No monitoring wells or piezometers have been completed in these discontinuous units to establish groundwater flow conditions. Definitive statements concerning groundwater flow within the discontinuous units when no data have been collected to support the conclusion are notappropriate. Reference to an Intermediate Confining Zone should be deleted. The identification of such a zone is not consistent with the text of the RI Report nor is it consistent with the data, including data depicted on figures in the RI Report and the figures at I and 2 of the Appendix.	between the shallow and deep groundwater.
Westlake, 4	vi	The RI Report makes numerous references to an Upper Aquifer and a Lower Aquifer. Consistent with comment 3 above, there are no separate upper and lower aquifers at the Site. The RI Report is correct in stating (page vi) "As noted above, the Site is underlain by unconsolidated sediments that generally coarsen downwards and extend from the ground surface to either the low permeability CRH unit or directly to bedrock." The entire sequence should be referred to as a single aquifer. In depicting data from certain portions of the aquifer, however, it would be appropriate to refer to "the upper portion of the aquifer" and the "lower portion of the aquifer," or to specific ranges in elevation.	Agree with comment. See response to Westlake Comment 3.

Response to Comments on BF Goodrich RI Report

Comment	**Page, Section**	**Comment**	**Response**
Westlake, 5	v	The RI Report states that the land slopes from elevation 355 ft amsl to 325 ft amsl, and that the sloped area abuts a bluff that drops to the floodplain of the Tennessee River. This statement is not accurate. As shown on Figures 4-19 and 4-20 of the RI Report, the ground surface elevation at the south end of the Site is approximately 340 ft amsl and it slopes up to approximately 350 ft amsl at the contact point between the terrace and the floodplain. At that point the land slopes down to the Tennessee River floodplain. The text should be corrected to be consistent with the ground surface elevations depicted on Figures 4-19 and 4-20 of the RI Report.	Agree with comment. See response to PolyOne Comment 4-2.
Westlake, 6	v	The RI Report refers to a single interbedded unit on the terrace. However, as shown on Figures 4-18 through 4-20 of the RI Report, the figures attached at I and 2 of the Appendix and as discussed in the RI Report (e.g., pages iv of the Executive Summary and 8-3 of the text), the terrace has several discontinuous interbedded units, not a single continuous unit. Reference should be made to "interbedded units" on the terrace instead of "an interbedded unit."	Agree with comment. Text will be modified accordingly.
Westlake, 7	1-3, Figure 1-3	The RI Report states "[i]n 1963 and 1964, the Ethylene Plant and the North Synthesis Unit, including a low temperature direct chlorination unit, were constrncted to produce EDC from ethylene and chlorine." It is more accurate to state that the North Synthesis Unit and the Ethylene Plant were constructed and began operating in 1963 and1964, respectively (see Progress Report for November 1963 documenting the start-up of the EDC Plant on November 27, 1963 and the March 1964 Progress Report documenting the start-up of the Ethylene Plant in March 1964, both attached at 3 to the Appendix). In addition, as noted below, Figure 1-3 in the RI Report should be consistent with this text. Figure 1-3 currently states that construction and operation of the Ethylene Plant and North Synthesis began in 1964.	Agree with comment. Text will be updated accordingly to reflect the correct dates.
Westlake, 8	1-4	In referring to the landfill, the RI Report states that "Eastward expansion was accomplished by purchasing property from AIRCO, including a portion of AIRCO's existing landfill, which had been in use since 1956." AIRCO did not acquire the land at issue until 1956. The date of commencement of disposal activities is not known (see selected portions of January 2011 Draft Supplemental Assessment Report, Airco Landfill, Calvert City, Kentucky, which states that the date of the commencement of disposal activities is unknown, and the March 14, 1988 Remedial Investigation Report at 1-2 through 1-3, which notes that AIRCO acquired the land in 1956 and that filling activities may have commenced in 1959). Copies are attached at 4 to the Appendix.	Agree with comment. Text will be updated accordingly to reflect the correct dates.
Westlake, 9	1-5	The Geon Company did not become the owner and operator of the Ethylene and Chlorine plants in 1993. Goodrich retained ownership after 1993 and then Goodrich sold the Chlorine and Ethylene Plants to Westlake in 1997. A copy of the first page of the 1997 Purchase and Sale Agreement referencing Goodrich as the owner is attached at 5 to the Appendix.	Agree with comment. Text will be updated accordingly to reflect the correct ownership history.
Westlake, 10	1-6	The RI Report states that "[i]n 1991, the reactors were converted to the Oxy Vent Recycle (OVR) process to use pure oxygen rather than air." The correct year is 1990 (see the January 19, 1994 letter from Westlake to the Kentucky Division of Air Quality at page 1; attached at 6 to the Appendix).	Agree with comment. Text will be updated accordingly.

Comment	Page, Section	Comment	Response
		Page 1-6 of the RI Report also states that "Dry crude EDC from the direct chlorination reactor is passed through acid, caustic, and neutral wash water tanks to remove impurities, and the resulting wash waters from these tanks contain the impurities intended to be removed as well as EDC and other chlorinated organic compounds." In fact, wash tanks were only used in the Direct Chlorination Process at former North Synthesis, and wash tanks were no longer used when South Synthesis began operation and the process was converted to High Temperature Direct Chlorination (HTDC). The sentence should be clarified to state that originally, when North Synthesis was in operation, dry crude EDC from the direct chlorination reactor was passed through wash tanks, but then the process was converted to the HTDC process when South Synthesis began operations (see Westlake RI Report Appendix A at 5; PolyOne RI Report at page I-6).	
Westlake, 11	1-9	The RI Report states that "All of the ponds were closed by 1984." However, on page 2-1 the RI Report correctly states that pond closure activities took place between December 1985 and March 1988. The text on page 1-9 should be consistent with the correct dates on page 2-1. Also, Pond I was constructed in 1953 rather than 1954 as stated on page 1-9 (see February 9, 1953 Wastewater Permit Application of Goodrich and 1953 Plant Map; both attached at 7 to the Appendix).	Comment noted. Text will be updated to indicate the correct pond closure activities and dates.
Westlake, 12	1-9 to 1-10	The RI Report states that Pond P-1 "received wastewater containing acrylic acid and benzene." However, Pond P-1 also received wastewater from the acetylene VCM Plant and the EDC VCM Pilot Plant (see February 2, 1953 Wastewater Permit Application of Goodrich and July 9, 1959 Wastewater Permit Application of Goodrich; both attached at 8 to the Appendix).	Agree with comment. Text will be revised to state that Pond P-1 received water from the VCM plant and the EDC VCM pilot plant.
Westlake, 13	1-10	The RI Report states "[i]n 1974, Pond O was no longer used for waste disposal." However, Pond O received wastewater from the EDC VCM Plant from 1975 until the pond was closed in 1985 (see February 26, 1976 Goodrich Engineering Design Report at IO and selected pages of the Goodrich Interim RCRA Closure Plan; both attached at 9 to the Appendix). On page 1-10 the RI Report states that Pond IB was "constructed" in the 1970s. In reality, Pond IB was not "constructed," it was created by building a dike in Pond I in approximately 1976, which resulted in Pond I being renamed Pond IA and IB (see February 26, 1976 Goodrich Engineering Design Report at 4 attached at 9 to the Appendix and the aerial photographs at Figures X.012 and X.013 attached to the Westlake Draft RI Report at Appendix A showing the inclusion of the dike in Pond I). Finally, on page 1-10 the RI Report states that there are arc shaped bodies of silt that likely represent meander scars or point bar scrolls, and the type of soil development in the vicinity of the Site is characteristic of fluvial soils deposited by a meandering river system. However, the Tennessee River is not a classical meandering river system as described in published literature. Neither the landscape morphology nor the types of soils at the Site are unique to meander scars or point bar scrolls typical of a classical meandering river system.	Agree with comment in part. Report text will be updated to reflect the correct pond closure and construction information. No change to report text regarding the description of the river system.
Westlake, 14	1-11	The RI Report states that "[t]he National Carbide Settling Pond and Recycle Pond were constructed in the late 1950s." This date is not correct. Both ponds were constructed in 1952	Agree with comment. Text will be updated accordingly.

Response to Comments on BF Goodrich RI Report

Comment	Page, Section	Comment	Response
		(see February 11, 2010 Response of Carbide Industries, LLC to EPA's Request For Information attached at 10 to the Appendix). In addition, the RI Report states the following at the bottom of page 1-11: "[t]he additional land acquired included a portion of AIRCO's industrial landfill, which had operated since 1951." The basis for the date of 1951 is not clear. AIR.CO did not acquire the property until 1956. The start of waste disposal activities is uncertain, but filling activities may have commenced in 1959 (see documents referenced at numbered paragraph 8 above).	
Westlake, 15	1-12	The RI Report states "[from 1973 to 1980, the only material disposed of in the landfill was excavated soil from adjoining manufacturing areas." This is not correct. The Goodrich waste disposal questionnaire, dated October 20, 1976, states on page G0040a01471 that 50,000 gallons of EDC-containing tank sludge was disposed of in the landfill every two years. A copy of the Waste Disposal Questionnaire is attached at 11 to the Appendix.	Agree with comment. Text will be updated accordingly to note the additional contribution to the landfill.
Westlake, 16	1-12 to 1-13	The RI Report states that the industrial sewer system "is a combination of force mains and gravity sewers of varying composition, including PVC, polypropylene, corrugated steel, reinforced concrete, cast iron, ductile iron, carbon steel, and/or vitrified clay." No ductile iron or vitrified clay pipes are currently in use.	Agree with comment and text will be updated accordingly to list the correct construction material.
Westlake, 17	1-13	The RI Report states that the EDC VCM Plant Process Sewer is a carbon steel sewer pipe system contained in concrete lined trenches. This is not correct. The process sewer pipe is Yoloy, which is a high-strength low alloy steel.	Agree with comment and text will be updated accordingly to list the correct construction material.
Westlake, 18	1-13	The RI Report states that portions of the EDC VCM process sewer were constructed in the mid-1970's, and additions or changes occurred somewhere around 1985. This is not accurate. The original process sewer for the acetylene VCM plant was constructed in 1953. This process sewer system was modified throughout the 1960's to accommodate the construction and addition of the EDC VCM production facilities. In the late 1970's, Goodrich installed carbon steel or carbon steel Yoloy pipe within the concrete trenches located within North South Cracking and East Cracking to serve as enclosed headers. Thereafter, significant changes to the process sewer system occurred in 1982 as part of the wastewater improvement project, not 1985 as stated in the text. See Westlake RI Report Appendix A at 65-69 for a description of the history of the configurations of the EDC VCM process sewers. Facts related to the history of the configuration of the EDC VCM sewers are not disputed.	Agree with comment. Text will be updated accordingly to reflect the correct sewer construction activities and dates.
Westlake, 19	1-13	The RI Report states that approximately one third of the industrial sewer pipes at the Chlorine Plant are underground. No industrial process sewer pipes are underground.	Agree with comment. Text will be updated accordingly.
Westlake, 20	1-14	The RI Report does not accurately describe the process related to the stripper units. The RI Report states "[t]he water used in the cleaning of the stripper units is stored in a tank and reprocessed through the stripper units and discharged to the Secondary Wastewater Treatment System." However, the A and B Stripper Units employ steam, not water, to remove VOCs from process wastewater. Steam that condenses in the strippers is not stored in a tank, it is sent directly to the Secondary Wastewater Treatment System.	Agree with comment. Text will be updated accordingly to correctly describe the process related to the stripper units.

Response to Comments on BF Goodrich RI Report

Comment	Page, Section	Comment	Response
		Also, it appears on page 1-14 that C-Stripper operation is not accurately described. Carbon beds are not used for emission control. Non-condensable gases from C Stripper are sent to Westlake's Oxy or Primary Incinerators for treatment. The RI Report also states that "wastes from this unit are pumped back into the 'C' Stripper System." In actuality, steam and chlorinated and non-chlorinated compounds in a gaseous phase exit the top of the stripper and are passed through the overhead condenser. The condenser converts steam and gaseous chlorinated and non-chlorinated compounds into an aqueous phase and an organic liquid phase. The aqueous phase is returned to C Stripper and the organic liquid phase is recycled in the EDC VCM Plant.	
Westlake, 21	1-15	The RI Report states that Manhole #10 is manually diverted if the EDC concentration threshold is exceeded. This is not correct. Instead, Manhole #10 is automatically diverted.	Agree with comment. Text will be updated accordingly.
Westlake, 22	2-4	The RI Report states "[a] key source of soil and surface water data was the Soil and Groundwater study...." This sentence appears to include a typographical error. The text should refer to groundwater data, not surface water data.	Agree with comment. Text will be updated accordingly.
Westlake, 23	2-5	In referring to the 1989 Woodward Clyde report, the RI Report states that soil sampling by Woodward Clyde indicated concentrations of mercury, beryllium, copper and zinc were above "background" levels. Reference to background concentrations in this context is misleading to the reader because in 2004 the Commonwealth of Kentucky published guidance on background levels for metals in Kentucky. A copy is attached at 12 to the Appendix. The background levels established by Kentucky in 2004 are very different from the "background" levels utilized by Woodward Clyde in connection with its report, which were only based upon two borings drilled by Woodward Clyde. As drafted, the text leads the reader to believe that the background levels established by Kentucky in 2004 were exceeded when this is not the case. In fact, the metal concentrations reported by Woodward Clyde are consistent with background concentrations established by Kentucky in the 2004 guidance.	Comment noted. Report text will be modified to state that the 1989 soil sampling results were above background concentrations at that time, and that new background levels were established in 2004.
Westlake, 24	2-5	In reporting on "Other Investigations" that have been conducted at the Site, the RI Report only references investigations beginning in the 1980's. However, subsurface investigations occurred before that date. Monitoring wells were drilled and sampled in the 1960's, and separate phase hydrocarbons (DNAPL) were observed in the aquifer during this investigation (see April 3, 1967 *Soil and Underground Water Investigation*, B.F. Goodrich Inter-Organization Correspondence, attached at 13 to the Appendix). In addition, the Commonwealth of Kentucky required Goodrich to conduct groundwater sampling in 1978 (see July 22, 1977 letter from Kentucky Department of Natural Resources and Environmental Protection to Goodrich; September 13, 1977 letter from Goodrich to the Kentucky Department of Natural Resources and Environmental Protection, which proposes a plan for well installation; and December 6, 1981 Phase II Groundwater Study Ackenheil & Associates Geo Systems, Inc., which documents monitoring well sampling from August 24, 1978 to April 9, 1981 and summarizes the test results; all of which are attached at 14 to the Appendix).	Comment noted. Report text will be modified to note that several investigations were conducted prior to 1980.

Comment	Page, Section	Comment	Response
		By not documenting the existence of pre-1980 investigations, the public is left with the impression that no such investigations occurred. Therefore, the existence of subsurface investigations before the 1980's should be documented in the report.	
Westlake, 25	2-8	The history of the "PW" extraction wells on page 2-8 is not accurate. In 1985 Goodrich installed extraction wells PW-I, PW-2 and PW-3 on the dike that separates Pond IA and Pond 2 (see Presentation EDC VCM Manufacturing August 7, 1986, Figure 18 attached at 15 to the Appendix). These extraction wells experienced failures in 1986, and pumping of these wells ceased in approximately 1986 (see September 3, 1986 letter from Diehl Pump Company to Goodrich attached at 15 to the Appendix). These wells remained inactive until they were incorporated in the PCAP system as wells BW-1936, BW-1937 and BW-1938 (see March 29, 1991 letter from Dames & Moore to Goodrich, Figure 2 attached at 15 to the Appendix). In 1986, 1987 and 1988 Goodrich constructed a second set of extraction wells designated as extraction wells PW-1, PW-2 and PW-3, respectively (see Dames and Moore January 10, 1989 Report Evaluation of Effectiveness at page 1, attached at 15 to the Appendix). This second set of "PW" wells was located west of Pond IA (see Dames and Moore January 10, 1989 Report at Figure I, attached at 15 to the Appendix). PW-1 and PW-2 were subsequently incorporated into the PCAP system as wells BW-1935 and BW-1949, respectively. PW-3 was destroyed.	Agree with comment. Text will be updated accordingly.
Westlake, 26	2-8	The RI Report states that PW-3 is "not in operation." PW-3 has been destroyed and does not exist.	Agree with comment. Text will be updated accordingly.
Westlake, 27	2-9	The RI Report states that the PCAP system has been in operation since 1986. However, on page 2-7, Battelle states that Goodrich began operating the PCAP system in 1992. The modern PCAP system began operating in 1992, but Goodrich operated extraction wells before that date, which includes the PW extraction wells constructed in 1985 and 1986. The text should be consistent with respect to the fact that the modern PCAP system began operation in 1992.	Agree with comment. Text will be updated accordingly for consistency.
Westlake, 28	2-10 and 2-11	There is no indication in the documentation that data collected during historical investigations has less certainty for purposes ofreliability.	Comment noted. No change to report text.
Westlake, 29	3-4 and 3-6	The RI Report states that A2-PWI was installed as a temporary NAPL extraction well. Although PolyOne also stated in its Draft RI Report that A2- PWI was installed as a NAPL recovery well to conduct DNAPL recovery tests, this statement is not factually correct. A2-PWI was installed by Respondents during the RI investigation as a pumping well to perform an aquifer pumping test to obtain hydraulic conductivity data. However, NAPL was identified in the well after installation, and NAPL was periodically removed over time before the pumping test was conducted. When it appeared that the NAPL was removed from the well, Respondents conducted the aquifer pumping test utilizing A2-PWI (see September 27, 2012 Technical Memorandum prepared by Respondents that describes the A2PW-1 aquifer pumping test at page I attached at 16 to the Appendix).	Comment noted. Report text will be modified to note that A2-PW1 was also used for an aquifer pumping test.
Westlake, 30	3-23 and Appendix 3-37	The RI Report includes fraudulent and inaccurate information solely developed by PolyOne to describe the AOI-3 trench investigation. Specifically, the RI Report does not utilize the official RI trench log generated by Respondents during the RI field investigation that follows the soil classification system mandated by EPA in the RI FS work plan. In addition, the official trench log	Comment noted. No change to report text. Appendix 3-37 will be updated to include both field logs.

Comment	Page, Section	Comment	Response
		generated during the RI trench investigation was agreed to and signed by both the Westlake and PolyOne field geologists. Instead of using the correct and accurate log that follows the soil classification system required by EPA that was mutually agreed to by Westlake and PolyOne, the RI Report includes a trench log solely generated by PolyOne that PolyOne altered from the official RI trench log. When PolyOne submitted its draft RI Report, PolyOne did not provide any notice to EPA or third parties that the log had been altered from the official RI trench log and had not been agreed to by Westlake. The RI Repott acknowledges on page 3-2 that EPA mandated logging to be in accordance with the USCS system, but PolyOne's altered trench log incorrectly uses the USDA classification system. Attached at 17 to the Appendix is the official RI trench log that uses the correct soil classification system. In addition, PolyOne's fraudulent log contains observations that are not identified on the official RI trench log, nor did Westlake's field geologist observe or agree to such observations. PolyOne's log also omits observations included on the official RI trench log. Attached at 18 to the Appendix is the PolyOne trench log that is annotated to show those observations unilaterally added by PolyOne, and it shows facts deleted by PolyOne from the official RI trench log. Observations added by PolyOne to its altered log that were not observed or agreed to by Westlake's field geologist are outlined in red, and observations from the official RI trench log omitted by PolyOne are highlighted in yellow. Any reliance on PolyOne's fraudulent log should be removed from the RI Report. The purpose of having both geologists agree to a log in the field was to create a reliable record of the investigation conducted during the RI, and the official RI log cannot be disregarded. In addition, the RI Report includes as Appendix 3-37 a written summary of the trench investigation that was solely prepared by PolyOne that does not utilize USCS terminology, nor does it accurately describe the conditions observed in the trench. Finally, the RI Report includes photographs that were annotated solely by PolyOne, and Westlake never agreed to the annotated photographs. Several annotations to the photographs do not accurately describe the lithology in the trench. For example, PolyOne's reference to "elongate" Mn tubes and mottles on photographs 25 and 26 is not accurate, and such references are not documented on the official RI trench log. All material related to the trench investigation solely developed by PolyOne, which information is not accurate, should be removed from the RI Report. The official RI log signed by both field geologists created during the RI is the only log that should be utilized. Photographs taken by Respondents should be included, but without inaccurate annotations created solely by PolyOne, and the laboratory data collected during the investigation should be utilized.	
Westlake, 31	3-24	The RI Report states that the Respondents are currently performing dispersion modeling. However, the Respondents are not currently performing dispersion modeling.	Agree with comment. Text will be updated accordingly.

Response to Comments on BF Goodrich RI Report

Comment	Page, Section	Comment	Response
Westlake, 32	4-3, 8-2 through 8-3	The RI Report states that the bedrock investigation revealed that the top of bedrock was "weathered, fractured and porous" and references Figure 4-2. This is not a correct statement. As stated in the report on the bedrock investigation, the bedrock at the site is very competent and weathering at the top of the bedrock is limited. Geophysical testing indicated a low density of fractures. This finding is reported on Page 4-3 of the RI Report in the paragraph after the erroneous "weathered, fractured and porous" statement. In addition, the note on Figure 4-2, which is the figure cited to support the statement on weathering, specifically states that the rotosonic drilling method will shatter the bedrock and will pulverize the limestone into rock flour. Therefore, reference to Figure 4-2 to support the statement concerning weathering and fractures is not correct because the condition of the bedrock shown in the photograph was created by the rotosonic drilling.	See response to PolyOne Comment 4-20. The reference to Figure 4-2 to support a weathered bedrock surface will be removed.
Westlake, 33	4-3	Battelle states that the "Warsaw Formation is largely absent beneath the Site." This does not appear to be correct. Both Westlake and PolyOne conclude that the Warsaw Formation is present beneath the Site. (Westlake Draft RI Report at 87 and PolyOne RI Report at 3-25.) As referenced by Westlake and PolyOne, Amos and Finch (1968) states that the Warsaw Formation is present beneath the Site.	See response to PolyOne Comment 4-19.
Westlake, 34	4-8	The values listed for the Pre-RI laboratory results are not correct and are not consistent with the tables in the report. The correct values are: clay silt: 7.91e-5 ft d to 8.51e-3 ft d; Fine sand: 3.54e-3 ft d to 3.29e-1 ft d; Interbeds: 7.68e-5 ft d to 2.58e-1 ft d (see Appendix 4-2 of the RI Report, Table L-3).	Agree with comment. Report text will be modified to be consistent with the data presented in the appendix.
Westlake, 35	4-14	The text of the RI Report refers to seven ponds being depicted on Figure 4-44. However, figure 4-44 only depicts 6 ponds.	Agree with comment. Text will be revised accordingly.
Westlake, 36	5-24	The RI Report does not mention the dike breach that occurred between Pond I A and Pond 2 in March 2011. The RI Report does not contain data from the dike breach that indicate soil samples collected from the area of the breach contained soil concentrations greater than the NAPL partitioning threshold. The data from the dike breach is included in the EPA database, and reference to this event and the data should be included.	Comment noted. No change to report text.
Westlake, 37	8-8	The RI Report states that site-wide, elevated contaminants of potential concern (COPC) were typically greatest in the shallow vadose zone (0-10 ft below ground surface (bgs)) compared to the intermediate vadose zone (10 ft bgs to water table). This statement does not appear to be accurate. In select borings elevated COPCs may be higher in the shallow vadose zone than the intermediate vadose zone, but it is not accurate to state that this is the case on a site wide basis.	Agree with comment. Text will be revised accordingly.
Westlake, 38	8-9	The RI Report states "[b]ulk sediment was collected from the Tennessee River, from the Barge Slip, and from the Outfall 004 Ditch. 1,1,2-TCA, EDC, benzene, 1,1-DCA, chlorobenzene, hexachlorobenzene, mercury, and arsenic were detected in a significant number of samples at elevated concentrations." Arsenic was not detected in sediment samples at concentrations greater than the naturally occurring level of 21.2 mg kg in Kentucky soil determined by the Commonwealth of Kentucky Energy and Environment	Comment noted. Report text will be revised to include a reference to the background level for arsenic.

Response to Comments on BF Goodrich RI Report

Comment	Page, Section	Comment	Response
		Cabinet in its guidance, titled Kentucky Guidance for Ambient Background Assessment, dated January 8, 2004. The guidance is attached at 11 to the Appendix.	
Westlake, 39	8-12	No data indicates migration of NAPL along infrastructure pathways. The statement is theoretical only.	Comment noted. No change to report text.
Westlake, 40	8-15	In the second paragraph on the page the text states that groundwater flow is north to south. Groundwater flow is from south to north.	Agree with comment. Text will be modified accordingly.
Westlake, Figures 1	Figure 1-2	The chemical manufacturing plant owned by Cymetech is labeled as the Telene Plant. However, the text on pages iii and iv identifies this plant as the Ultrine Plant. Both the Westlake and PolyOne RI Reports refer to the Cymetech Plant as the Ultrine Plant. (Westlake RI Report page 5, PolyOne RI Report page 1-5.) Figure 1-2 should refer to the Ultrine Plant instead of the Telene Plant (the same error was inadvertently included on Figure 1- 2 of Westlake's RI Report).	Agree with comment. Figure will be updated accordingly.
Westlake, Figures 2	Figure 1-3	On the figure it is noted that Goodrich sold the EDC VCM Plant to Westlake Monomers in 1986. However, Goodrich sold the plant to Westlake in 1990. Also, North South Cracking, North Synthesis, and the Ethylene Plant were constructed and began operating in 1963 and 1964, not just 1964 as indicated on the figure (see comment 7 above). Finally, the statement regarding conversion to Oxy Vent Recycle (OVR) is incorrect. Westlake converted to the OVR process in 1990, not 1991 (see comment 10 above).	Agree with comment. Figure will be updated accordingly.
Westlake, Figure 3	Figure 1-10	Shore Tank #9 is incorrectly labeled as Shore Tank #6. Also, the figure states that former tank locations are to be depicted with a green circle, but the figure fails to depict former River Tanks I, 2, 3 and 5 as former tanks. The figure does not depict former Shore Tank #3 as a former tank, which was located immediately east of Shore Tank #2. The figure also does not depict the former Fuel Oil Storage tank that was previously located at the approximate location of numeral 35 on Figure 1-10 (see Westlake Figure ES-5 attached to the Westlake RI Report for the location of the former Fuel Oil Storage Tank.) Finally, the legend on Figure 1-10 refers to Table 2-1, when it should refer to Table 1-2. The tank numbering on Figure 1-10 does not match the tank numbering on Table 1-2.	Agree with comment. Figure will be updated accordingly.
Westlake, Figure 4	Figure 2-1	Extraction well PW-1 does not exist as shown on the figure. PW- 1 was renamed BW-1935 when it was incorporated into the PCAP system.	Agree with comment. Figure will be updated accordingly by placing the initial well identification in parentheses.
Westlake, Figure 5	Figure 5-28, 5-66 5-29 and 5-67	The groundwater contours for EDC on Figures 5-28 and 5-29 do not depict significant EDC contamination beneath the Carbide Pond. However, as shown on Figures 5-66 and 5-67, a significant amount of DNAPL containing EDC is present in the saturated zone beneath the Carbide Pond. Groundwater contamination should be depicted in a manner that is consistent with the distribution of DNAPL beneath the Carbide Pond. The figures attached at 19 to the Appendix depict groundwater contamination in a manner consistent with the DNAPL delineation set forth in the RI Report.	Comment noted. The groundwater contour maps were generated with a numerical algorithm using chemical concentration and NAPL indicator data. No change to report text.
Westlake, Figure 6	General	There are numerous factual errors with data contours. For example, several contours are shown on figures with no data presented. In addition, it does not appear that all contours were checked	See response to Westlake Figure 5.

Comment	Page, Section	Comment	Response
		against physical realities of sample locations. Furthermore, it appears that the contours were simply generated by a numerical algorithm, rather than a human being that can take into account important factors such as the direction of groundwater flow, the presence of NAPL zones, release locations and other known facts related to the Site. Specific errors with contours are shown on the figures attached at 20 to the Appendix.	
Westlake, Figure 7	Figures 5-48 to 5-51	The seep figures do not include the AOI-2 or AOI-5 seeps. These can be seen on Figures 2.2.5 and 2.5.5 of the Westlake RI Report.	Comment noted. These seep figures are designed to show the Northwest Area Seeps. No change to report text.
Westlake, Figure 8	Figures 5-56 to 5-59	Pond sediment data are missing from the figures. These data can be found in the EPA database.	Comment noted. This RI report discusses the sediment samples collected from the Tennessee River, the Barge Slip, and the Outfall Ditches.
Westlake, Figure 9	Figures 5-65	This figure shows a NAPL location on the east side of the Carbide Pond with a potential NAPL zone extending from that location to beneath the Carbide Pond. However, the NAPL identified at this discrete location consists of petroleum hydrocarbons, not EDC or other chlorinated organics, which are the primary constituents in the DNAPL located in the Elongate Floodplain Interbeds beneath the Carbide Pond. Because the NAPL location on the east side of the Carbide Pond only contains petroleum hydrocarbons it should not be depicted as being linked to the NAPL containing EDC and other chlorinated organics beneath the Carbide Pond.	See response to PolyOne Comment 4-24.
Westlake, Figure 10	Figures 5-67, 5-68, 5-69, and 5-70	As discussed previously with EPA, the data do not support the conclusion that NAPL is confirmed beneath the Tennessee River. No data has confirmed the presence of NAPL beneath the Tennessee River. Accordingly, NAPL zones should not be depicted beneath the Tennessee River.	See response to PolyOne Comment 4-24.
Westlake, Figure 11	Figures 5-71 and 5-74	DNAPL is depicted in low permeability CRH and clay. No data collected during the RI investigation indicates that DNAPL is located within the low permeability CRH and clay. The projection of DNAPL into the CRH and clay is an artifact of the numerical algorithm used for contouring and is not supported by site-specific data.	See response to PolyOne Comment 4-24.
Westlake, Figure 12	Figure 8-1	Former River Tank 6 is not identified as SWMU 184.	Agree with comment. Figure will be updated to note that Former River Tank 6 is SWMU 184.
Westlake, Table 1	Table 1-1	AOC R is omitted from this table.	Comment noted. AOC R will be added to Table 1.
Westlake, Table 2	Table 1-2	The tank numbering in the table does not correspond to the tank numbering on Figure 1-10. For example, Tank 61 is identified as Fuel Oil Storage Tank No. 3 in the table, but former River Tank No. 6 is identified on figure 1-10 as tank 61. Also, the contents listed for the Shore Tanks and River Tanks in Table 1-2 appear in several instances to be incorrect or incomplete. A corrected summary of product storage in the Vinyl Tank Farm and River Tank Farm, with supporting documentation, is attached at 21 to the Appendix.	Comment noted. Table 1-2 and Figure 1-10 will be cross-checked for accuracy and updated accordingly.

Response to Comments on BF Goodrich RI Report

Comment	Page, Section	Comment	Response
Westlake, Table 3	Table 3-2	Test trench Shelby tube data is missing. The data should be included on the table. The data can be found in the EPA database.	Comment noted. No change to report text.
Westlake, Table 4	Table 3-3 and 3-4	Data from bedrock wells is not included. The bedrock wells are discussed in the text of the RI Report and, therefore, data from those wells should be included.	Comment noted. The report that documents the bedrock well installation will be included as an Appendix to the RI.
Westlake Risk Assessment 1	General	The Risk Assessment includes an evaluation of inhalation risks to on-site industrial workers using EPA's Risk Assessment Guidance for Superfund (RAGS) approach. However, health risks to industrial workers at the Site are governed by the Occupational Safety and Health Administration (OSHA), which employs a fundamentally different assessment methodology from RAGS. EPA had previously agreed that inhalation risks would continue to be addressed by OSHA and not through the Superfund process.	Comment noted. The primary purpose of the risk assessment is to provide risk managers with an understanding of the potential current and future risks to human health and the environment that may be posed by a site in the absence of remediation or exposure controls, and the uncertainties associated with the assessment. Consistent with USEPA guidance, an evaluation of contaminated sites should utilize a risk-based framework that is iterative and as site-specific as possible given the available data. Using site-specific data and information that characterizes the site is a key component in defining the human health conceptual site model and for assessing the potential risks for selected receptors, thus providing sound information upon which risk management decisions can be made. Inhalation risks to on-site industrial workers were provided in the risk assessment in order to characterize potential risks. Risk managers have taken note of the inhalation risk to workers, along with the knowledge that site industrial worker exposures to regulated chemicals, including EDC, are addressed by the Occupational Safety and Health Administration (OSHA). Because OSHA does not address administrative personnel (or non-OSHA regulated workers) in office

Comment	Page, Section	Comment	Response
			building who also may be exposed to EDC and other contaminants emanating from groundwater and subsurface soil, results of the risk assessment were used to support the need for vapor mitigation engineering controls for occupied structures at the facility. The FS states that although the CERCLA risk assessment identifies a potential risk associated with the outdoor air inhalation pathway, further evaluation of the data suggests the COPC driving the risk is not CERCLA-related. Sampling of outdoor and indoor air and subslab soil gas suggests the primary source of detectable EDC in outdoor air is related to emissions associated with facility operations. Measured EDC concentrations in subslab soil gas samples were generally lower than those observed in indoor air. Personnel exposures to regulated chemicals, including EDC, are addressed by the Occupational Safety and Health Administration (OSHA). Therefore, no RAO is required for outdoor air. For indoor air exposures, the FS states that vapor mitigation engineering controls are in place for all occupied structures at the facility.
Westlake Risk Assessment 2	General	The Risk Assessment assumes a frequency and duration of exposure to sediment and seeps in the Tennessee River adjacent to the Site that is inconsistent with the restricted access industrial nature of the Site.	Comment noted. The Tennessee River shoreline adjacent to the Site does not have physical obstacles preventing access to the shoreline, nor is there security patrolling the shoreline area to keep out trespassers. The bank of the river adjacent to the Site is comprised of vegetation and, during the mid to late summer, much of the river bank is

Comment	Page, Section	Comment	Response
			exposed, becoming a mud-flat area where recreational users may walk around. There have been reports of people hunting for Indian artifacts and clamming along the river bank. Exposure parameters used in the exposure evaluation for seeps and sediment relied on EPA Region 4 Human Health Risk Assessment Supplemental Guidance (2014) for a trespasser scenario along with an assumption of the number of days during the summer months that a young person would be out exploring the area.

Response to Comments on BF Goodrich RI Addendum Report

Comment	Page, Section	Comment	Response
PolyOne, 4-46	4	Line 2 states than 22 offshore locations were sampled and Figure 2 identified these 22 locations. In Line 5, 23 locations are referenced. Line 5 should be corrected to read "collected from 22 locations".	Agree with comment. Text will be revised accordingly.
PolyOne, 4-47	4	Line 12 states that 38 offshore locations were sampled. Figure 2 identifies 40 locations. Sample IDs in Appendix I-3 suggest that the number of sample locations may be less than either 38 or 40. The number of sample locations for the Phase II offshore investigation needs to the verified and clearly presented.	Comment noted. A total of 42 locations were sampled during Phase II, as shown on Figure 2; 3 offshore of the carbide ponds, four from the Barge Slip, and 35 offshore of the remainder of the site. Report text will be updated accordingly.
PolyOne, 4-48	6 and Table 2	Source of the Ambient Water Quality Criteria (AWQC) used for evaluation of results is not identified. With the exception 1,1,1-trichloroethane and mercury, the source is neither the USEPA National Recommended Water Quality Criteria (NRWQC) nor the Kentucky 401 KAR 10.031 Surface Water Standards (KY SWS) for protection of human health. As an example, the AWQC identified in Table 2 for EDC is 13 μg/L. The NRWQC for human health are 9.9 μg/L for consumption of water and organisms and 650 μg/L for consumption of organisms only. With the exception of mercury, the values for AWQC identified in Table 2 do not appear to be for the protection of aquatic life. They are not ecological screening values for surface water identified in recent Region 4 guidance (USEPA, 2015) nor narcosis-based final chronic values (FCVs) for screening and refinement identified in Appendix A of the Ecological Risk Assessment (ERA) of the RI. Neither the NRWQC nor KY SWS identify a criterion or standard for protection of aquatic life for EDC. As presented, the data in Table 2 are not appropriate to evaluate risk to human or ecological receptors or risk management. The applicability of the AWQC identified in Table 2 cannot be verified. In addition, use of the average detected concentrations overestimates exposure point concentrations (EPCs) given that the majority of samples for all parameters have concentrations below detection limits. Presentation of the Kaplan-Meier (KM) mean, which accounts for non-detected concentrations, and 95% upper confidence limits (UCLs) calculated using ProUCL should be calculated and provided.	Comment noted. Consistent with that used in the RI, the source of the AWQC is the DRAFT 2014 National Recommended AWQC. Summary statistics are consistent with those used in RI data summary tables. No change to report text.
PolyOne, 4-49	7 and Table 3	In Phase I, samples were collected from depths ranging from 0-0.05 ft below the surface water sediment interface to 35-36 ft. For Phase II, samples were collected from depths ranging from 0-1 ft to 36-37 ft. Table 3 presents summary statistics for pooled sediment data (i.e., data from all depth intervals and locations in the Tennessee River and Barge Slip). This pooling of data provides little, if any, information regarding the horizontal vertical distribution of the four representative constituents or potential for impacted groundwater to upwell to the sediment surface water interface. From an ecological perspective, the narrative presented on Page 7 and summary statistics in Table 3 provide no information regarding the potential for risk to ecological receptors (i.e., benthic organisms) within the biologically active zone (BAZ) - the 0-	Comment noted. During offshore data summary and scoping meetings, it was brought into question as to whether the shallow sediment samples were representative of the BAZ. Accordingly, the sediment data were pooled for analysis. Individual sample analyses are presented in Appendix I. No change to report text.

Comment	Page, Section	Comment	Response
		0.5 ft depth interval. Of the 165 samples analyzed for in Phase I and Phase II, only 30 are from the BAZ of the Tennessee River and 5 are from the BAZ of the Barge Slip. To allow evaluation of risk to benthic organism, data for samples collected from the BAZ should be presented and discussed. No analysis of total organic carbon (TOC) was performed for any of the samples collected from the BAZ. In the absence of sample specific TOC, it is not possible to evaluate the potential for risk posed by narcotic organic constituents in the BAZ.	
PolyOne, 4-50	8 and Table 4	For Phase III, 20 samples of porewater were collected from the BAZ (0-0.5 ft depth interval) and analyzed for dissolved concentrations of VOCs. The stated objectives for collection of porewater were (1) "to evaluate the exposure of potential benthic organisms" and (2) "better understand the correlation with groundwater VOC concentrations measured at greater depths beneath the river." (quotes are from Page 4). The narrative on Page 7 and summary statistics accomplish neither objective. Concentrations of VOCs detected in porewater were compared to AWQC for surface water. As stated in a previous comment, the source of the AWQC is not identified nor could the sources be identified. Whatever the source, AWQC values do not appear to be based on protection of aquatic life. They are not ecological screening values identified by USEPA Region 4 (USEPA, 2015) nor are they FCVs for screening and refinement identified in the ERA (Battelle, 2015). Nowhere in the text of the Addendum is a correlation between concentrations at depth and in the BAZ evaluated or discussed. Neither objective is addressed in the Final Feasibility Study (FS) Report, also dated November 2017. Data summarized in Table 4 suggests potential for risk to benthic organisms. Exceedances of AWQC are identified for EDC, benzene, and vinyl chloride – all constituents detected in sediment below the BAZ. The limited narrative on Page 8 and identification of exceedances presented in Table 4 leads the reader to believe that VOCs in the NAPL zone have migrated upward and are present in the BAZ at concentrations that pose risk to benthic organisms. The data and conclusions presented in the Final FS Report (Battelle, 2017) document that this is not the case. Quoting from the Final FS Report (Section 2.3.2.5, page 45): *"An NI was estimated for each of the 20 porewater samples collected as part of the supplemental sampling program by summing the individual NQs (detected concentration divided by chemical-specific chronic value). NI values range from 0.0076 (25-PW1) to 0.026 (32-PW1), indicating narcosis-related effects are unlikely in river benthic biota currently exposed to sediment porewater. Narcosis effects do not appear to be a significant concern based on evaluation of current conditions in the supplemental sampling dataset."*	Comment noted. Consistent with that used in the RI, the source of the AWQC is the DRAFT 2014 National Recommended AWQC. The narrative on Page 8 will be updated to reflect the conclusions presented in the FS report.
PolyOne, 4-51	Figure 3 and	The sample locations identified in Figure 3 (August 2017 (Phase III) Offshore Sampling Locations) and Figure 17 (EDC), Figure 18 (Benzene), and Figure 19 (Total VOCs) are incorrect.	Comment noted. Figure 3 will be updated to show the correct location of

Comment	**Page, Section**	**Comment**	**Response**
	Figures 17-19	Figure 3 identifies two locations for sample "25-pw1". One location is the shoreline adjacent to the B.F. Goodrich Site between Transects 7 and 8. Figures 16 through 19 identify this location as 26-PW1. The other location is the furthest offshore sample between Transects 6 and 7. Figures 16 through 19 identify this location as 25-PW1. Figure 3 does not identify a 26-pw1 or 26-PW1. The issue is that Figure 17 identifies a detected concentration of EDC in porewater at the far offshore location (labeled as 25-PW1) and not detected at the nearshore location (labeled as 26-PW1). Similarly, Figure 18 identifies a detected concentration of benzene in porewater far offshore and not detected at the nearshore location. This suggests that EDC and benzene, two of the major constituents in NAPL, have migrated laterally over 500 ft and upward into the BAZ. The more plausible explanation is that labels for 25-PW1 and 26-PW1 on Figures 17 through 19 have been transposed. If this is the case, detected concentrations of EDC and benzene in porewater are limited to the nearshore sample locations. The locations of 25-PW1 and 26-PW1 need to be verified.	26-PW1, which is between Transects 7 and 8. Figures 17 through 19 show the correct locations of 25-PW1 and 26-PW1.
PolyOne, 4-52	Table 4 and Appendix I-4	Table 4 and Appendix I-4: Data summarized in Table 4 are not consistent with the laboratory analytical results for porewater provided in Appendix I-4. Notable examples of the inconsistencies are: • Table 4 identifies 1,2-dichlorobenzene as not detected in any of the 20 samples. Appendix I-4 identifies it as detected in 6 samples at concentrations ranging from 1.10 µg L to 1.4 µg L. • Appendix I-4 identifies indene and propene as being analyzed for, but neither is identified in Table 4. • Table 4 incorrectly identifies trans-1,3-dichloropropene as trans-1,3-dichloroethene. Table 4 and Appendix I-4 should be revised accordingly and reviewed for consistency and accuracy	Comment noted. Table 4 and Appendix I-4 will be reviewed for consistency and accuracy and Table 4 will be updated accordingly.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
PolyOne, 3-1	General	The NAPL Indicator Scoring System Is Biased Toward the Presence of Visible NAPL. The scoring system used in the FS (p. 30) is inappropriate for use at this Site because the scoring system is too heavily weighted in favor of the presence of visible NAPL. PolyOne refers to EPA to Comment 4-24 for a detailed discussion.	Comment noted. The NAPL rubric and NAPL model represent an unbiased and consistent evaluation of NAPL distribution at the site. The NAPL model may be updated with additional offshore information collected during the 2016 and 2017 offshore investigations and the offshore NAPL remedial design investigation. No change to report text.
PolyOne, 3-2	General	The FS Uses Unreliable Indicators of NAPL Absence. The FS inappropriately uses low concentrations of volatile organic compounds (VOCs) in excavation samples as indicators of NAPL absence.0F PolyOne refers EPA to Comment 4-25 for a detailed discussion.	See response to PolyOne Comment 3-1.
PolyOne, 3-3	General	EPA Should Not Rely Solely on a Numerical Model to Delineate NAPL Source Zones at the Site. EPA has delineated NAPL source zones at the Site based solely on PI values developed using the NAPL scoring system discussed above (FS, pp. 31-32). The use of threshold values and the modeling algorithm are highly subjective. Further, the contouring process does not take into account geologic features at the Site. EPA's failure to use independent professional judgment in delineating NAPL source zones resulted in significant errors in the source zone boundaries. PolyOne refers EPA to Comment 4-26 for a detailed discussion.	See response to PolyOne Comment 3-1.
PolyOne, 3-4	General	The Release Information in the FS is Incomplete and Inaccurate The FS describes Appendix 8-1 of the RI as "a tabulated summary of significant historical chemical releases" (FS, p. 16). Appendix 8-1 is purportedly based on a review of the "independent tabular historical release summaries prepared by Respondents in 2012" (*id.*). This is incorrect. Instead, it appears that Appendix 8-1 is based on the "Historical Release Summary" that Westlake provided to EPA on 20 September 2012. Thus, Appendix 8-1 omits numerous significant releases at the Site, including releases previously identified in PolyOne's 25 May 2012 Site History (see PolyOne, 2012, Table 3). In addition, Appendix 8-1 includes other releases that are not significant sources of subsurface contamination. Table 8-1 is incomplete and inaccurate, and should be deleted. PolyOne refers EPA to Comment 4-45 for a detailed discussion.	Comment noted. The release information presented in Appendix 8-1 will be reviewed for completeness and accuracy and revised as necessary.
PolyOne, 3-5	General	The Ecological Risk Assessment Overestimates Risk to the Great Blue Heron. The FS states that "the food chain model for the great blue heron identified a potential for risk to avian piscivores exposed to mercury, based in part on fish collected in the Tennessee River in the 1990s." (FS, p. 42). The EPA's August 2015 Ecological Risk Assessment (ERA) included in the RI that is the basis for these conclusions makes three assumptions that together significantly overestimate the risk that uncontrolled releases at the Site pose to great blue heron and other avian piscivores. Specifically, the model (1)	Comment noted. There are uncertainties associated with the great blue heron food chain risk estimates as identified in both the ERA and FS documents. These

Comment	Page, Section	Comment	Response
		inappropriately assumes that all mercury in river and Barge Slip sediments is present in the methylated form; (2) uses inappropriate exposure point concentrations; and (3) overestimates the incidental sediment ingestion rate for great blue heron. The FS acknowledges that the food chain model for the great blue heron is based on "conservative assumptions." (FS, pp. 42-43.) In fact, the assumptions are unrealistic, and greatly overstate any risk to the great blue heron posed by mercury in Tennessee River sediments.	uncertainties are conservative in nature and most useful in identifying exposure areas and specific exposure pathways that may pose an unacceptable ecological risk warranting remedial measures. Consideration of these uncertainties were used to guide RAOs. No change to report text.
PolyOne 3-6	iii, Contents	There are two sections listed as "2.2.3" in the table of contents. This also applies to the text. This error results in confusion later in the text where Section 2.2.3 is referenced. The table of contents and text should be corrected.	Agree with comment. Report text modified accordingly.
PolyOne 3-7	5, 2.1.4	1st paragraph: "A discussion of release history is presented in Section 2.3." The reference to Section 2.3 is incorrect. The release history discussion is presented in Section 2.2.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-8	12, 2.1.4.5	Page 12, Section 2.1.4.5 – Supplemental Offshore Investigation August 2017 (Phase III) Offshore Investigation paragraph: "During the August 2017 sampling event, sediment porewater samples were collected from 20 offshore locations, as shown in Figure 2-24." Figure 2-24 identifies two locations for sample "25-pw1". One location is the shoreline adjacent to the B.F. Goodrich Site between grid lines 7 and 8. Figures 2-96 through 2-99 identify this location as 26-PW1. The other location is the furthest offshore sample between grid lines 6 and 7. Figures 2-96 through 2-99 identify this location as 25-PW1. Figure 2-24 does not identify a 26-pw1 or 26-PW1. The locations of 25-PW1 and 26-PW1 need to be verified.	Agree with comment. The inconsistent location nomenclature was a typographical error and will be corrected accordingly in the text and figures.
PolyOne 3-9	16, 2.2.3	2nd paragraph: "As noted in Section 2.1.5, the Respondents interpret the specific history of chemical releases at the Site very differently, in terms of the specific nature and timing of various releases, specific release volumes, and the implementation efficacy of subsequent removal remedial actions." The reference to Section 2.1.5 is incorrect. The correct location of this reference is Section 2.1.4.	Agree with comment. Report text modified accordingly.
PolyOne 3-10	39, 2.3.11	2nd paragraph: "The ERA specifically evaluated the herring gull and great blue heron as avian benthivores (i.e., species that consume benthic organisms), the osprey as an avian piscivore (i.e., consumes fish), the raccoon as a mammalian benthivore (i.e., consumes benthic invertebrate organisms), and the mink as a mammalian piscivore." Great blue heron is incorrectly identified as an avian benthivore. The food web model for great blue heron in the ERA assumed its diet consists of 100% fish (Battelle, 2015). This text should be corrected to identify great blue heron as a piscivore.	Agree with comment and text will be revised as follows: The ERA specifically evaluated the herring gull as an avian benthivore (i.e., species that consume benthic organisms), the great blue heron and osprey as avian piscivores (i.e., consumes fish), the raccoon as a mammalian benthivore (i.e.,

Comment	Page, Section	Comment	Response
			consumes benthic invertebrate organisms), and the mink as a mammalian piscivore.
PolyOne 3-11	41-42, 2.3.2.4	The summary of exposure areas, media, receptors, and Constituents of Potential Ecological Concern (COPECs) presented in this section is based on the ERA included in the RI. PolyOne submitted extensive comments (see Attachment 4) which identified errors in the ERA. Major issues raised by PolyOne included: • Failure to acknowledge or follow then recent guidance issued by EPA Region 4 in 2015; • Overestimate of risk to great blue heron due to (1) the assumption that all mercury ingested is the most toxic methylmercury, (2) overly conservative exposure point concentrations (EPCs), (3) an assumed rate of 9.4% for incidental sediment ingestion rather than 2% identified in Region 4 guidance, and (4) use of toxicity reference values (TRVs) inconsistent with Region 4; • Failure to consider refinement screening values (RSVs) identified in the 2015 Region 4 guidance; and • Calculation of Final Chronic Values (FVCs) for narcosis toxicity using parameters inconsistent with a Region 4 White Paper and published literature. None of these comments have been incorporated into the summary presented in the FS. A reader looking only at the summary table in Section 2.3.2.4 is likely to conclude, incorrectly, that the surface water and sediment of the Tennessee River pose a significant potential for risk to benthic organisms and great blue heron. As pointed out in comments on the ERA provided by PolyOne, the ERA only addressed Steps 1, 2, and 3a of EPA's 8-step process. As such, the analyses presented in the ERA are insufficient for final risk determination and risk management decisions. The summary of the ERA presented in the FS should be revised to address PolyOne's original comments, including consistency with the 2015 Region 4 guidance, re-evaluation of risk to great blue heron, and re-calculation of FVCs using the appropriate parameters.	Comment noted. There are uncertainties associated with the great blue heron food chain risk estimates as identified in both the ERA and FS documents. These uncertainties are conservative in nature (as defined in the EPA risk assessment guidance) and most useful in identifying exposure areas and specific exposure pathways that may pose an unacceptable ecological risk warranting remedial measures. Consideration of these uncertainties were used to guide RAOs. The 2015 Region 4 guidance was issued after the Final RI was initially submitted. No change to report text.
PolyOne 3-12	45, 2.3.2.5	2nd paragraph. This paragraph states that, although not an exposure pathway for ecological receptors, concentrations of mercury and VOCs detected in groundwater were compared to chronic screening benchmarks identified in the 2015 Region 4 guidance. Documentation for these comparisons is not provided in tables or appendices for the FS. Table 2-3 is a summary of groundwater offshore sample analytical results. The only benchmarks identified in Table 2-3 are MCLs. Appendix B identifies ARARs, which includes 401 KAR 10:031 surface water standards for Kentucky. Appendix B does not provide Region 4 chronic screening values. Documentation for evaluation of risk for offshore groundwater was not provided in either the RI Addendum or FS. Documentation should be provided and included in the Administrative Record	Comment noted. A comparison of groundwater concentrations to chronic screening values is presented in table attached at the end of this document. No change to report text.
PolyOne 3-13	45, 2.3.2.5	3rd paragraph. This paragraph implies that data for surface water collected in 2016 were compared to ecological screening values, but supporting documentation is not provided. Table 2-6 is a summary of offshore surface water analytical results. The benchmarks are identified as Ambient Water Quality	Comment noted. Table 2-6 is not supposed to accompany the text in this 3rd paragraph.

Comment	Page, Section	Comment	Response
		Criteria (AWQC), not 2015 Region 4 ecological screening values. Moreover, the source of the AWQC is not identified nor was PolyOne able to verify that the values are AWQC for protection of aquatic life. For example, the value identified for the first constituent in Table 2-6, 1,1,1-trichloroethane, is 100,000 µg/L. Neither the EPA National Recommended Water Quality Criteria nor Kentucky 401 KAR 10:031 surface water standards identify a criterion or standard for protection of aquatic life for 1,1,1-trichloroethane. The 2015 Region 4 chronic freshwater screening value is 76 µg/L. Documentation for evaluation of risk for offshore surface water should be provided and included in the Administrative Record.	The ecological benchmarks referenced in the paragraph text are the 2015 chronic freshwater EPA Region IV screening benchmarks. The source of the AWQC is the DRAFT 2014 National Recommended AWQC. A comparison of surface water concentrations to chronic screening values is presented in table attached at the end of this document. No change to report text.
PolyOne 3-14	45, 2.3.2.5	4th paragraph. This paragraph implies that data for porewater collected in 2017 were compared to chronic surface water screening benchmarks. Again, documentation for this comparison is not provided. In addition to comparison to chronic surface water benchmarks, this paragraphs states that narcosis indices (NIs) were calculated for each of the 20 samples. Documentation for these calculations is not provided. Benchmarks identified in Table 2-9, which summarizes the porewater data, are identified as AWQC. As stated above, the source of the benchmarks could not be verified. Moreover, this paragraph reports that NI values range from 0.00076 for 25-PW1 to 0.026 for 32-PW1. While PolyOne is able to confirm the value of 0.00076 for 25-PW1 as the lowest NI, the value of 0.026 as the highest NI appears to be incorrect. According to Appendix I-4 of the RI Addendum (Battelle, 2017) porewater sample P16-A has detected concentrations of 1,1-dichloroethane, 1,2,4-trimethylbenzene, 1,2-dichlorobenzene, acetone, benzene, chlorobenzene, chloroform, ethylbenzene, indene, isopropylbenzene, m&p-xylenes, naphthalene, propane, n-propylbenzene, o-xylene, styrene, toluene, and trans-1,3-dichloropropene. By PolyOne's calculations, the NI for P16-A is greater than the NI for 32-PW1, but still below the risk threshold of 1. Documentation for evaluation of risk for offshore porewater should be provided and included in the Administrative Record. In addition, the results of the 2016 and 2017 offshore investigations should be integrated into an overall evaluation of risk. Whereas the data evaluated in the ERA indicate a potential for risk to benthic invertebrates in sediment of the Tennessee River, the porewater data, which is more representative of exposure and risk, document no risk and no need for remedial actions for protection of aquatic life. At minimum, a section that pulls together all the data and lines of evidence and presents a clear conclusion should be added to the FS and RI Addendum.	Agree in part with comment. See response to PolyOne comment 3-13. The highest NI is 0.99 from P16-A (sample E05-PW1), which is still below the risk threshold of 1. The risk assessment and FS will be updated accordingly. No other text changes will be made as the current text is sufficient.
PolyOne 3-15	51, 3.0	2nd paragraph: "The HHRA and ERA are summarized in Section 2.2 and documented in detail in the RI Report (Battelle, 2015)."	Agree with comment. Report text modified accordingly.

Comment	Page, Section	Comment	Response
		The reference to Section 2.2 is incorrect. The correct location of this reference is Section 2.3.	
PolyOne 3-16	53-54, 3.1.5	Bis(2-ethylhexyl)phthalate and several metals are identified as COPECs for sediment of the Tennessee River. Evaluation of these constituents in bulk sediment did not consider refinement screening benchmarks in accordance with 2015 Region 4 guidance nor consider all potential sources of metals as was done in the Respondents' ERA (Respondents, 2014). For bis(2-ethylhexyl)phthalate, a common laboratory contaminant, only one of 62 samples had a concentration that exceeded its conservative screening benchmark. This sample is a statistical outlier. This section also identifies risk to great blue heron due to mercury. The food web model incorrectly assumes that all mercury ingested is methylmercury, the most toxic form of mercury. This incorrect assumption results in a significant overestimate of the risk to the great blue heron. Correction of the food chain model for great blue heron in response to PolyOne's comments on the RI would show that there is no risk to the great blue heron. Similarly, the food web model in the ERA for Ponds 1A and 2 overestimates the potential for risk to great blue heron. The food web model for great blue heron should be revised to be consistent with Region 4 guidance and reasonable assumptions regarding exposure to methylmercury. As sediment is the primary medium of exposure for benthic organisms, risk to this receptor group should be re-evaluated and the results presented in the FS. The ERA evaluated risk due to VOCs and SVOCs with narcotic modes of action using refinement benchmarks. Risk due to inorganic chemicals and organic chemicals with non-narcotic modes of action were evaluated using only screening benchmarks. Because they are no effect values, screening benchmarks are not appropriate for development of remedial action objectives. Table 2a of the 2015 Region 4 guidance identifies refinement benchmarks for chemicals with non-narcotic modes of action. Risk to benthic organisms should be re-evaluated using refinement benchmarks for all chemicals, not only those with narcotic modes of action.	Comment noted. The risk assessment was conducted following appropriate conservative EPA guidance, and finalized before the new Region 4 guidance was promulgated. The great blue heron diet is composed mainly of fish, and therefore it is appropriate to conservatively use methlmercury as a surrogate. No change to report text.
PolyOne 3-17	57, 3.2	5th paragraph: "Based on a thorough analysis of the site data and factors such as the age of the release that occurred over 35 years ago, EPA has concluded that the NAPL is not generally mobile and can be reasonably contained." This statement, discussing whether source material at the Site is considered PTW, appears to suggest that a single release occurred at the Site more than 35 years ago. In fact, NAPL at the Site is present due to a large number of releases occurring over a period of many decades, including a large number of releases within the last 35 years. Further, the duration of time since a release occurred is not relevant to evaluating whether source material is PTW (see EPA, A Guide to Principal Threat and Low Level Threat Wastes, Nov. 1991). Site data showing that the extent of NAPL source zones is stable and that NAPL at the Site does not present a risk to human health or the environment are sufficient to support EPA's conclusion that NAPL at the Site is not PTW. The reference to "factors such of the age of the release that occurred more than 35 years ago" should be deleted from the FS.	Agree with comment in part. The text "that occurred over 35 years ago" will be removed from the document. No additional change to report text.
PolyOne 3-18	58, 3.3	5th paragraph: "Consistent with section 300.430(a)(1)(iii)(F), this FS will develop and evaluate alternatives that prevent further migration of the plume, prevents exposure to the contaminated	Agree with comment. Report text modified accordingly.

Comment	Page, Section	Comment	Response
		groundwater, further reduce risk." To be consistent with 300.430(a)(1)(iii)(F), this should be rewritten as: "Consistent with section 300.430(a)(1)(iii)(F), this FS will develop and evaluate alternatives that prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction."	
PolyOne 3-19	59, 3.5	1st paragraph: "PRGPRGs were selected to support development of a remedial footprint and appropriate remedial alternatives based on the RAOs. For purposes of this FS assessment, the PRGPRGs selected and that were used to generate the remedial footprint at the Site are as follows:" The term "PRGPRGs" is incorrect and both occurrences should be replaced with "PRGs".	Agree with comment. Report text modified accordingly.
PolyOne 3-20	111, 5.2.3	1st paragraph: "The barrier wall would be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-21	111, 5.2.3	2nd paragraph: "Sheet pile or cement bentonite construction would be used for portions of the wall downgradient along the shoreline in areas where potential NAPL-impacted soil may be encountered adjacent to the wall. Soil bentonite wall construction would be used in downgradient areas where potential NAPL-impacted soil is unlikely to be observed, and along the majority of the upgradient wall boundary." Figure 5-4 shows cement-bentonite at one NAPL area near the Carbide Ponds, but neither cement-bentonite nor sheet pile are shown at two other downgradient areas where NAPL may be present (north of Pond 2 and north of the landfills). Figure 5-4 should be revised to show a sheet pile or cement-bentonite wall at downgradient locations where NAPL-impacted soil may be present and a note should be added stating that final wall construction types will be determined during remedial design.	Comment noted. Report text will be modified to note that final wall construction types will be determined during remedial design, and that Figure 5-4 is an initial conceptual design of the proposed barrier wall.
PolyOne 3-22	112, 5.2.4	1st paragraph: "The barrier wing wall would be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wing wall would be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-23	112, 5.2.4	2nd paragraph: "Sheet pile and cement bentonite construction would be used downgradient along the shoreline in areas where potential NAPL-impacted soil may be encountered adjacent to the wall. Soil bentonite wall construction would be used in downgradient areas where potential NAPL-impacted soil is unlikely to be observed."'	See response to PolyOne Comment 3-21.

Comment	Page, Section	Comment	Response
		Figure 5-4 shows cement-bentonite at one NAPL area near the Carbide Ponds, but neither cement-bentonite nor sheet pile are shown at two other downgradient areas where NAPL may be present (north of Pond 2 and north of the landfills). Figure 5-4 should be revised to show a sheet pile or cement-bentonite wall at downgradient locations where NAPL-impacted soil may be present and a note should be added stating that final wall construction types will be determined during remedial design.	
PolyOne 3-24	113, 5.2.5	1st paragraph: "The barrier wing wall would be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wing wall would be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-25	113, 5.2.5	2nd paragraph: "Sheet pile and cement bentonite construction would be used downgradient along the shoreline in areas where potential NAPL-impacted soil may be encountered adjacent to the wall. Soil bentonite wall construction would be used in downgradient areas where potential NAPL-impacted soil is unlikely to be observed." Figure 5-4 shows cement-bentonite at one NAPL area near the Carbide Ponds, but neither cement-bentonite nor sheet pile are shown at another downgradient area where NAPL may be present (north of Pond 2). Figure 5-4 should be revised to show a sheet pile or cement-bentonite wall at downgradient locations where NAPL-impacted soil may be present and a note should be added stating that the final wall construction types will be determined during remedial design.	See response to PolyOne Comment 3-21.
PolyOne 3-26	115, 5.2.7	1st paragraph: "The barrier wall would extend from an approximate elevation of 320 ft amsl downward, and be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would extend from an approximate elevation of 320 ft amsl downward, and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-27	116, 5.2.8	1st paragraph: "The barrier wall would extend from an approximate elevation of 320 ft amsl downward, and be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall	Agree with comment. Report text modified accordingly.

Comment	Page, Section	Comment	Response
		would extend from an approximate elevation of 320 ft amsl downward, and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	
PolyOne 3-28	117, 5.2.9	1st paragraph: "The barrier wall would extend from an approximate elevation of 320 ft amsl downward, and be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would extend from an approximate elevation of 320 ft amsl downward, and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-29	119, 5.2.10	5th paragraph: "The downgradient extent of the PRB would be limited to where ground surface elevation is 320 ft amsl or higher, and be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The downgradient extent of the PRB would be limited to where ground surface elevation is 320 ft amsl or higher, and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-30	121, 5.3.2	4th paragraph: "Performance monitoring would initially be conducted on a regular basis to evaluate the continued effectiveness of the offshore NAPL excavation/disposal remedy and that the remedy continues to provide adequate protectiveness." Performance monitoring is not necessary for the complete NAPL excavation alternative. NAPL would be removed and therefore the source of contamination would be eliminated. Performance monitoring for this alternative should be deleted from the FS.	Comment noted. Performance monitoring will be performed after remedy implementation to ensure remedy protectiveness. No change to report text.
PolyOne 3-31	121, 5.3.3	1st paragraph: "The barrier wall would initially extend from the river surface downward through the sediment and be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would initially extend from the river surface downward through the sediment and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-32	122, 5.3.3	3rd paragraph: "At a minimum, this monitoring would include the collection and analysis of groundwater and/or surface water samples inside and outside of the barrier wall, and inspection of the	Agree with comment. Report text modified accordingly.

Comment	Page, Section	Comment	Response
		remedy to ensure the integrity of the armoring, low-permeability cap, and barrier wall." The FS does not contemplate installation of armoring or a low-permeability cap for Alternative RN3. The preceding paragraph states: *"...installation of a low permeability cap and or armoring material above the NAPL area is not deemed necessary."* Therefore, the sentence should be rewritten as: "At a minimum, this monitoring would include the collection and analysis of groundwater and or surface water samples inside and outside of the barrier wall and inspection of the remedy to ensure the integrity of the barrier wall."	
PolyOne 3-33	122, 5.3.4	2nd paragraph: "The barrier wall would initially extend from just above the river surface downward through the sediment, and be keyed to the bedrock and or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would initially extend from just above the river surface downward through the sediment, and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-34	122, 5.3.4	2nd paragraph: "Prior to cutting the sheet piling, water inside the wall (or smaller treatment cells) would need to be treated to comply with applicable Federal and state standards prior to discharge to the Tennessee River." The containment stabilization contemplates potential use of small treatment cells. If the design confirms smaller treatment cells are necessary, as could easily be the case, then a significant amount of additional sheet piles would be required, leading to a significantly increased cost compared to what is presented in Table 6-2. These costs should be accounted for in the FS.	Comment noted. Remedy design will determine the actual approach for the containment structure. The cost estimate is within the +50 -30% criteria for a FS. No change to report text.
PolyOne 3-35	122, 5.3.4	3rd paragraph: "Due to in-situ expansion associated with proposed solidifying stabilization material, it is assumed that up to 20% of the treatment volume (roughly 29,000 ft^3) would need to be excavated due to expansion into the surface water column beyond the existing volume of the offshore NAPL." The volume units "ft^3" are incorrect. The correct volume units are "yd^3".	Agree with comment. Report text modified accordingly.
PolyOne 3-36	125, 5.5	2nd paragraph: "Each on-shore alternative would be effective at achieving RAOs for the BF Goodrich site, with alternatives involving a complete barrier wall (SC3a and SC5a) and the complete treatment option providing the highest degree of effectiveness." It is incorrect to state that SC6 is a "complete" treatment option. As stated in Section 5.2.10 for SC6: "It should be noted that ISCO is unlikely to completely address the NAPL-impacted soil and groundwater in these inaccessible areas, and that significant contaminant mass will likely be left in place." The sentence should be rewritten as: "Each on-shore alternative would be effective at achieving RAOs for the B.F. Goodrich site, with alternatives involving a complete barrier wall (SC3a and SC5a) and the treatment option (SC6) providing the highest degree of effectiveness."	Agree with comment. Report text modified accordingly.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
PolyOne 3-37	130, 6.1.2	1st paragraph: "The barrier wall would be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-38	131, 6.1.3	Compliance with ARARs paragraph: "Potential ARARs identified for this alternative are summarized in Section 3.2 and are discussed in detail in Appendix B." The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-39	132, 6.1.3	1st paragraph: "The barrier wall would be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-40	134, 6.1.3	**Comment 3-40:** Page 134, Section 6.1.3 – Detailed Analysis of Alternative SC5a: Partial NAPL Source Treatment with Combined Hydraulic and Physical Containment – Complete Barrier Wall. Compliance with ARARs paragraph: "Potential ARARs identified for this alternative are summarized in Section 3.2 and are discussed in detail in Appendix B." The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-41	136, 6.1.4	4th paragraph: "The PRB would extend from an approximate elevation of 320 ft amsl downward, and be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The PRB would extend from an approximate elevation of 320 ft amsl downward, and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-42	138, 6.1.4	Compliance with ARARs paragraph: "Potential ARARs identified for this alternative are summarized in Section 3.2 and are discussed in detail in Appendix B." The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-43	140, 6.2.2	4th paragraph, 2nd bullet: "Obtain EPA and KDEP approval prior to dredging the river bottom or installing structures that may result in the exposure of NAPL-contaminated sediment that extends beneath the Tennessee River."	Agree with comment. Report text modified accordingly.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
		Following excavation of the river NAPL, there is no need to restrict or require approval for dredging or structure installation. This bullet item should be deleted.	
PolyOne 3-44	141, 6.2.2	Compliance with ARARs paragraph: "Potential ARARs identified for this alternative are summarized in Section 3.2 and are discussed in detail in Appendix B." The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-45	142, 6.2.2	Cost Effectiveness section: "For cost-estimating purposes, it is assumed that the duration of remedy implementation, would be approximately one year." This is an unrealistically short duration for remedy implementation. As stated in Section 5.3: "Because of extreme fluctuations in river elevation and water flow, suitable, cost-effective working conditions to actively address offshore NAPL would likely be limited to about six months per year." Due to this limitation, the remedy duration (not including design and permitting) would be, at a minimum, six years. Additionally, the high degree of risk associated with the challenges of construction, as identified under "Short-Term Effectiveness", would actually be present over a much longer period.	Comment noted. The duration of remedy implementation will be determined in remedial design. Increasing the duration of remedy implementation by several years would result in an increase in the O&M costs. An increase in such costs would be within the current +50/-30% FS cost estimate range for RN2. No change to report text.
PolyOne 3-46	142, 6.2.3	1st paragraph: "The barrier wall would initially extend from the river surface downward through the sediment and be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would initially extend from the river surface downward through the sediment and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-47	142, 6.2.3	3rd paragraph: "At a minimum, this monitoring would include the collection and analysis of groundwater and/or surface water samples inside and outside of the barrier wall, and inspection of the remedy to ensure the integrity of the armoring, low-permeability cap, and barrier wall." The FS does not contemplate installation of armoring or a low-permeability cap for Alternative RN3. The first paragraph of this section states: *"...installation of a low permeability cap and/or armoring material above the NAPL area is not deemed necessary."* Therefore, the sentence should be rewritten as: "At a minimum, this monitoring would include the collection and analysis of groundwater and/or surface water samples inside and outside of the barrier wall and inspection of the remedy to ensure the integrity of the barrier wall."	Agree with comment. Report text modified accordingly.
PolyOne 3-48	143-144, 6.2.4	Compliance with ARARs paragraph: "Potential ARARs identified for this alternative are summarized in Section 3.2 and are discussed in detail in Appendix B."	Agree with comment. Report text modified accordingly.

Comment	Page, Section	Comment	Response
		The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	
PolyOne 3-49	143-144, 6.2.4	1st paragraph: "The barrier wall would initially extend from just above the river surface downward through the sediment, and be keyed to the bedrock and/or low permeability CRH unit overlying the bedrock." It is too restrictive to say the barrier wall must be keyed into bedrock or CRH. There may be places where CRH is not present above bedrock, but other suitable clay material is present. Also, due to the competence of the bedrock it may not be possible to "key" the wall into the bedrock, but rather the wall would be installed to contact bedrock. The sentence should be revised to read: "The barrier wall would initially extend from just above the river surface downward through the sediment, and be keyed into the bedrock (if feasible, otherwise to the surface of the bedrock) and/or low permeability CRH or other suitable clay material overlying the bedrock."	Agree with comment. Report text modified accordingly.
PolyOne 3-50	144, 6.2.4	2nd paragraph: "Due to in-situ expansion associated with proposed solidifying stabilization material, it is assumed that up to 20% of the treatment area (roughly 29,000 ft^3) will need to be excavated due to expansion into the surface water column beyond the existing volume of the offshore NAPL." The volume units "ft^3" are incorrect. The correct volume units are "yd^3".	Agree with comment. Report text modified accordingly.
PolyOne 3-51	145, 6.2.4	Compliance with ARARs paragraph: "Potential ARARs identified for this alternative are summarized in Section 3.2 and are discussed in detail in Appendix B." The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-52	145, 6.2.4	Implementability paragraph: "Many technical and engineering issues would need to be overcome to successfully construct a barrier wall and implement the treatment component associated Alternative RN2." The reference to "associated Alternative RN2" should be "associated with Alternative RN4".	Agree with comment. Report text modified accordingly.
PolyOne 3-53	150, 6.3.2	Compliance with ARARs paragraph: "Potential ARARs identified for this alternative are summarized in Section 3.2 and are discussed in detail in Appendix B." The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-54	150, 6.3.3	Compliance with ARARs paragraph: "Potential ARARs identified for this alternative are summarized in Section 3.2 and are discussed in detail in Appendix B." The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-55	153, 7.1.2	1st paragraph: "Potential ARARs identified for on-shore source area Alternatives SC3a, SC5a, and SC6 are summarized in Section 3.2 and are discussed in detail in Appendix B." The reference to Section 3.2 is incorrect. The correct location of this reference is Section 3.3.	Agree with comment. Report text modified accordingly.
PolyOne 3-56	154, 7.1.3	1st paragraph: "Alternative SC6 includes active treatment components designed to ultimately treat all contamination within the remedial footprint, thereby providing a high degree of long term effectiveness and permanence by eliminating the on-shore source areas." It is incorrect to state that Alternative SC6 will treat all contamination, as stated in the FS in the immediately following sentence: "However, it should be noted that the ISCO treatment component proposed for SC6 is unlikely to completely address the NAPL-impacted soil and groundwater in inaccessible areas, and that significant contaminant mass will likely be left in place, thus reducing the long-term effectiveness and permanence of this alternative." The sentence should be rewritten as:	Agree with comment. Report text modified accordingly.

Comment	Page, Section	Comment	Response
		"Alternative SC6 includes active treatment components designed to treat a higher percentage of contamination within the remedial footprint than Alternative SC5a, thereby providing a higher degree of long term effectiveness and permanence."	
PolyOne 3-57	154, 7.1.4	1st paragraph: "Alternative SC6 includes active in-situ and ex-situ treatment components designed to ultimately treat all contamination within the remedial footprint, thereby providing reduction of contaminant toxicity, mobility, and volume through treatment. ICs would still be necessary for Alternative SC6 during remedy implementation, which could take up to 20 years." It is incorrect to state that Alternative SC6 will treat all contamination. As stated in Section 7.1.3: "However, it should be noted that the ISCO treatment component proposed for SC6 is unlikely to completely address the NAPL-impacted soil and groundwater in inaccessible areas, and that significant contaminant mass will likely be left in place, thus reducing the long-term effectiveness and permanence of this alternative." Additionally, as contaminant mass will remain, the ICs will be necessary beyond the 20 year remedy implementation period. These sentences should be rewritten as: "Alternative SC6 includes active in-situ and ex-situ treatment components designed to treat a higher percentage of contamination within the remedial footprint than Alternative SC5a, thereby providing a higher reduction of contaminant toxicity, mobility, and volume through treatment. ICs would still be necessary for Alternative SC6."	Agree with comment. Report text modified accordingly.
PolyOne 3-58	155, 7.1.5	2nd paragraph: "Alternative SC6 includes active in-situ and ex-situ treatment components only, designed to ultimately treat all contamination within the remedial footprint. This alternative requires a much longer implementation timeframe compared to SC3a and SC5a, thereby resulting in a lower degree of short-term effectiveness. In addition, because this alternative involves complete treatment of all contamination within the entire remedial footprint, there is a greater amount short term risk associated with releasing chemicals during remedy construction when compared to the other alternatives." It is incorrect to state that Alternative SC6 will treat all contamination. As stated in FS Section 7.1.3: "However, it should be noted that the ISCO treatment component proposed for SC6 is unlikely to completely address the NAPL-impacted soil and groundwater in inaccessible areas, and that significant contaminant mass will likely be left in place, thus reducing the long-term effectiveness and permanence of this alternative." These sentences should be rewritten as: "Alternative SC6 includes active in-situ and ex-situ treatment components only, designed to treat a higher percentage of contamination within the remedial footprint than alternative SC5a. This alternative requires a much longer implementation timeframe compared to SC3a and SC5a, thereby resulting in a lower degree of short-term effectiveness. In addition, because this alternative involves treatment of a higher percentage of contamination within the entire remedial footprint, there is a greater amount short term risk associated with releasing chemicals during remedy construction when compared to the other alternatives."	Agree with comment. Report text modified accordingly.
PolyOne 3-59	157, 7.2.5	1st paragraph: "The barrier wall design will be optimized to ensure short-term effectiveness, and a low permeability cap will further isolate the NAPL source area." As noted in previous comments to Sections 5.3.3 and 6.2.3, the FS does not contemplate installation of	Agree with comment. Report text modified accordingly.

Comment	Page, Section	Comment	Response
		a low permeability cap for Alternative RN3. The sentence should be rewritten as: "The barrier wall design will be optimized to ensure short-term effectiveness."	
PolyOne 3-60	159, 7.3.1	1st paragraph: "Alternative RG3 would include a hydraulic containment component for targeted extraction and treatment of contaminated offshore groundwater, further reducing the potential for risk associated with offshore groundwater concentrations." Alternative RG3 does not include a hydraulic containment component. The sentence should be rewritten as: "Alternative RG3 would include targeted extraction and treatment of contaminated offshore groundwater, further reducing the potential for risk associated with offshore groundwater concentrations."	Agree with comment. Report text modified accordingly.
PolyOne 3-61	Table 6-1	The unit costs do not provide for the transportation and disposal of excess soils excavated during construction of the cement-bentonite section(s) of the wall for alternatives SC3a and SC5a. This would be a very significant cost as it is anticipated that such soils would include soils characterized as hazardous waste. The FS should be revised to account for these costs.	Comment noted. The construction materials for the barrier wall will be determined during remedial design. The change in costs associated with additional soil disposal for SC3a and SC5a would be within the +50 -30% cost range assumed for a FS remedy estimate. No change to report text.
PolyOne 3-62	Table 6-2	The sheet pile wall cost for RN4 is the same as for RN3, and therefore does not provide for conducting the NAPL solidification methodology in "cells", as identified as a possibility in Section 5.3.4 of the FS. The FS should be revised to account for these costs.	Comment noted. The need for wall cells will be determined during remedial design. The change in costs associated with the wall cells for RN4 would be within the +50 -30% cost range assumed for a FS remedy estimate. No change to report text.
PolyOne 3-63	Appendix D	Offshore NAPL Remedial Alternative RN2 table: This table lists a soil disposal cost of $56,000,000. However, the calculated total capital costs for RN2 in this table are based on a lower disposal cost of $23,434,400, which is consistent with FS Table 6.2. The detailed cost estimate table in Appendix D should be revised to correct his error.	Agree with comment. Report text modified accordingly.
Westlake, V-1	13	The FS states that “A barge slip, docks, and other marine improvements associated with the Site are located in the floodplain.” For the sake of completeness, the following phrase should be added to the end of the sentence: “, as are the historical waste pond system, the historic burn pits, and the RCRA closure cell.” In addition, because this is a river system, the word “marine” should be deleted.	Agree with comment. Report text modified accordingly.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
Westlake, V-2	13	The FS states that "The terrace is a broad, flat plain situated approximately 25 feet above the floodplain." To be more precise, "flat plain," should be replaced with "nearly flat plain sloping gently toward the south."	Agree with comment. Report text modified accordingly.
Westlake, V-3	13	The FS states that "The spatial and vertical distribution of the hydrocodes was further reviewed through the creation of plan view maps showing the spatial distribution of each hydrocode (see Figures 2-26 through 2-31)[.]" "Figures 2-26" should be replaced with "Figures 2-27," as Figure 2-26 is the Bedrock Contour Map.	Agree with comment. Report text modified accordingly.
Westlake, V-4	13	The FS states that "A map decpicting the spatial distribution of the C hydrocode is shown in Figure 2-30[.]" "Decpicting" should be replaced with "depicting."	Agree with comment. Report text modified accordingly.
Westlake, V-5	13	The FS states that "Therefore, where present at appreciable thicknesses, the clay silt likely acts to inhibit vertical migration of chemical releases from the surface." To be accurate, this sentence should be replaced with "Therefore, where present, the clay silt inhibits the infiltration of rain water, snowmelt and NAPL. The ability of clay silt to inhibit NAPL migration is not a function of thickness".	Agree with comment in part. Report text modified to state that the presence of clay silt inhibits the infiltration of rain water, snowmelt, and chemical releases.
Westlake, V-6	13	The FS states that "A map showing the spatial distribution of the I hydrocode is shown in figure 2-29, which shows that the I hydrocode is fairly continuous throughout the entire Site[.]" To be accurate, the sentence should be replaced with "A map showing the spatial distribution of the I hydrocode is shown in figure 2-29, which shows that the I hydrocode is widespread. In addition, the various occurrences of the I hydrocode on the terrace are discontinuous from each other, and the Elongate Floodplain Interbeds do not abut the terrace interbeds."	Comment noted. The identified sentence is sufficient to describe the I hydrocode in the FS. No change to report text.
Westlake, V-7	14	With respect to the Elongate Floodplain Interbeds, the FS states that "As shown in a two-dimensional (2D) cross section parallel to the Tennessee River (Figure 2-37), the unit is of relatively uniform thickness (15 to 25 feet) and fairly continuous across the Site." The words "across the Site" should be changed to "within the floodplain" as the unit is not present on the terrace and it is not present everywhere across the floodplain.	Agree with comment. Report text modified accordingly.
Westlake, V-8	14	The FS states that "The overall thickness of unconsolidated overburden at the Site ranges from approximately 80 to 120 feet, increasing in thickness from north to south with the dip of the underlying bedrock surface." This statement is technically incorrect. The bedrock surface is actually an unconformable sloping surface associated with the bedrock not the bedrock's dip. An unconformity is a surface of erosion dissolution and or nondeposition atop the limestone bedrock at the Site. This general surface is also noted on the 1968 geologic map of Calvert City, KY. Accordingly, "with the dip of the underlying bedrock surface," should be replaced with "associated with the general south-oriented slope of the underlying bedrock surface."	Agree with comment. Report text modified accordingly.
Westlake, V-9	15 and elsewhere in FS	The FS provides a description of the following three terms: "Shallow Groundwater," "Intermediate Confining Zone," and "Deeper Groundwater." As previously discussed in Westlake's comments to the RI, the data collected during the RI demonstrate that there is not a "confining" zone at the Site. The cross-sections shown on figures 4-18, 4-19, 4-20 and 4-21 in the RI report do not show a discernible site-wide "confining zone"; in fact, figures 4-19 and 4-21 show only a few small, isolated occurrences of interbeds or clay between elevations 280 ft amsl and 295 amsl. A few small, isolated	Agree with comment in part. Figures and text will be revised to divide the groundwater into "shallow groundwater" and "deep groundwater with a boundary

Comment	Page, Section	Comment	Response
		occurrences do not constitute a "confining zone." Furthermore, the Respondents jointly conducted an aquifer pumping test in AOI3 during the RI, and subsequently, the Respondents jointly prepared an AOI 3 pumping test memo, dated July 31, 2012, that was jointly submitted to EPA via the Respondents Portals on September 28, 2012 (included Attachment 4). Based on the language in the subject joint memo, the following description should replace all three bullets noted above: "In general, the subsurface comprises a sandy aquifer that is approximately 60-70 feet thick, situated between either clays or interbedded zones above and overlying a clay-rich heterolithics (CRH) aquitard. Clay lenses are present, in particular within the ranges of 40-45 feet below ground surface (ft bgs) and 55-65 ft bgs, corresponding to approximately 305-310 ft amsl and 280-290 ft amsl, respectively. CRH is observed at depths of 85 to over 100 ft bgs (deeper than approximately 260-265 ft amsl)." Further, all references to the "intermediate confining zone" throughout the FS should be deleted.	at 295 ft amsl. Text will be revised to state that due to the heterogeneity and discontinuity of the clay silt zones, the Intermediate Confining Zone does not provide an effective barrier to vertical flow between the shallow and deep groundwater.
Westlake, V-10	17	The "Nature and Extent of Contamination" section on page 17 is the second section 2.2.3; the first section 2.2.3 is on page 16. The numbering throughout section 2 should be corrected.	Agree with comment. Report text modified accordingly.
Westlake, V-11	17	The FS states that "The extensive distribution of organic NAPL beneath the Carbide Ponds in the West Floodplain Area is due to the downgradient transport of NAPL through the Elongate Floodplain Interbeds and other more permeable units . . ." The term "downgradient transport of NAPL" should be replaced with "westward migration of NAPL". The hydraulically downgradient direction is to the north, not to the west.	Agree with comment. Report text modified accordingly.
Westlake, V-12	17	In Section 2.2.3.3., the FS states that NAPL migrated "downgradient" through the Elongate Floodplain Interbeds. NAPL migrated westward through the Elongate Floodplain Interbeds. Accordingly, "downgradient" should be replaced with "westward."	Agree with comment. Report text modified accordingly.
Westlake, V-13	19	The FS states that "The MCL for benzene (5 ug/L) was exceeded in 36.8% of groundwater samples collected during the RI, with an average detected concentration of 5,194 ug/L." "5,194 ug/L" should be replaced with "4,208 ug/L."	Comment noted. The average detected benzene concentration of 5,194 µg/L matches the value reported in Table 2-2 of the FS and the value reported in the RI. No change to report text.
Westlake, V-14	22	The FS states that "The AWQC for mercury (0.77 ug/L) was exceeded in 7% of seep samples collected, with an average detected concentration of 17.1 ug/L." "17.1 ug/L" should be replaced with "8.9 ug/L."	Comment noted. The average detected benzene concentration of 17 µg/L matches the value reported in Table 2-4 of the FS and the value reported in the RI. No change to report text.
Westlake, V-15	22	The FS states that 1,1,2-TCA was detected above the AWQC of 12 ug/L in the BS South Seep (11,000 ug/L)[.]" "11,000 ug/L" should be replaced with "330 ug/L."	Agree with comment and text will be modified accordingly.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
Westlake, V-16	22	The FS states that "EDC was detected above the AWQC of 13 ug/L in the BS South Seep (480 ug/L)[.]" "480 ug/L" should be replaced by "11,000 ug/L."	Agree with comment and text will be modified accordingly.
Westlake, V-17	24	The FS states that "The AWQC for 1,1,2-TCA (12 ug/L) was exceeded in 4 of the 49 (8%) of the surface water samples collected, with a maximum detected concentration of 38 ug/L (Barge Slip location BS-03)[.]" "BS-03" should be replaced with "BS-B8," which is where the 38 ug/L was reported.	Agree with comment and text will be modified accordingly.
Westlake, V-18	25	The FS states that "The AWQC for mercury (0.77 ug/L) was exceeded in only 1 of the 52 (1%) surface waste samples collected at a concentration of 1.1 ug/L[.]" "(1%)" should be replaced with "(2%)."	Agree with comment and text will be modified accordingly.
Westlake, V-19	26	The FS states that "Mercury was detected in 92% of the Tennessee River and Barge Slip sediment samples collected during the RI at a maximum concentration of 46 ug/kg (SER4+50-3 in the Barge Slip) and an average detected concentration of 1.5 ug/kg." "46 ug/kg" should be replaced with "46 mg/kg" and "1.5 ug/kg" should be replaced with "1.5 mg/kg."	Agree with comment and text will be modified accordingly.
Westlake, V-20	26	The FS states that "Mercury was detected in all 13 of the Outfall Ditch sediment samples collected during the RI at a maximum concentration of 23 ug/kg (downstream of the berm in SE004-2) and an average detected concentration of 7.8 ug/kg." "23 ug/kg" should be replaced with "23 mg/kg" and "7.8 ug/kg" should be replaced with "7.8 mg/kg."	Agree with comment and text will be modified accordingly.
Westlake, V-21	27	The FS states that "Mercury was detected in 94 of the 177 (53%) sediment samples collected during the offshore investigation, with a maximum detected concentration of 13 ug/kg (Pond 2 area location E-03) and an average detected concentration of 0.3 ug/kg." "13 ug/kg" should be replaced with "13 mg/kg" and "0.3 ug/kg" should be replaced with "0.3 mg/kg."	Agree with comment and text will be modified accordingly.
Westlake, V-22	27	The FS states that "1,4-Dioxane was detected in five of the 70 (7%) sediment samples collected during the offshore investigation, with a maximum detected concentration of 5.1 ug/kg (Pond 2 area location E-03)." "(Pond 2 area location E-03)" should be "(A10-SB-1-10-16)."	Agree with comment and text will be modified accordingly.
Westlake, V-23	34	The FS states that "The subsurface migration of separate-phase NAPL is a complex process that is strongly influenced by surface soil properties, subsurface geology, properties of the NAPL, and release location." To be more precise, "surface soil properties" and "release location" should be deleted, and "magnitude of the source," and "nature of the pathways from the source into the subsurface" should be added.	Comment noted. Text revised to be more precise with regard to the factors affecting NAPL migration as noted in the comment.
Westlake, V-24	34	Following the first paragraph in section 2.2.4.1, the following additional clarifying paragraph should be added: "In areas where the pond system is the NAPL source, separate-phase DNAPL migrates from the pond (both from the base of the pond and from within the ponds) into the saturated zone primarily driven by the elevated applied hydraulic pressure from the generally continuous discharges of DNAPL and wastewater to the ponds. As a result of this high-volume, long-term release, relatively broad areas of pooled DNAPL were formed in the West Floodplain, extending all the way to AOC-R."	Comment noted. The current text is sufficient for describing the NAPL migration. No change to report text.
Westlake, V-25	34	The FS states that "At the Site, NAPL consists of both dense non-aqueous phase liquid (DNAPL) and light non-aqueous phase liquid (LNAPL). DNAPLs consist of EDC and other chlorinated organics. LNAPLs at the Site include aromatic gasoline, fuel oil, and SolvessoTM (with benzene and/or naphthalene as primary constituents)." To provide a full description, the following additional sentences should be added: "NAPL beneath the river is predominantly DRO/GRO with naphthalene compounds, which is a signature for Ethylene Plant NAPL. The NAPL beneath the river originated	Comment noted. The current text is sufficient for describing the NAPL composition and migration. No change to report text.

Comment	Page, Section	Comment	Response
		from the historical leaking pond system where it is known that Ethylene Plant NAPL was disposed of." This addition is consistent with EPA's Memorandum Regarding the Request to Conduct Engineering Evaluation Cost Analysis (April 12, 2017) (Attachment 5), which concluded that the NAPL beneath the river came from a series of unlined ponds known as ponds 3A, 3B, and 3C.	
Westlake, V-26	35	The FS states that "At the Site, NAPL migration pathways can be grouped into two categories: infrastructure pathways and natural geologic pathways." "Infrastructure pathways" and natural geologic pathways" should be switched. Consistent with prior comments, the following sentence should be added after the sentence quoted above: "NAPL releases from wastewater ponds enter permeable units within the subsurface and migrate along geologic structures driven by the hydraulic pressures from the continuous releases of wastewater and product into the ponds."	Comment noted. The current text is sufficient for describing the NAPL migration. No change to report text.
Westlake, V-27	35	The FS states that "The surficial fill present at many portions of the Site commonly acts as a preferential pathway for surface or near-surface releases to migrate vertically to underlying units. Beneath the fill, a fairly continuous clay silt layer (C Hydrocode) is present and likely acts to prevent or inhibit vertical migration of chemical releases. However, DNAPL may migrate vertically though areas where the clay silt is absent or present as a very thin layer, or through secondary permeability features in the clay silt layer. Once the NAPL migrates through these surficial soils on the terrace and floodplain of the Site, it can migrate into and through the more permeable underlying fluvial sands. Beneath the floodplain, fluvial interbedded deposits of interlayered sand and mud act to inhibit the rate of DNAPL migration." This entire paragraph should be deleted. The RI did not find that the surficial fill acted as a preferential pathway for surface or near-surface releases nor did it identify DNAPL migration pathways through areas where the clay silt is absent or present as a very thin layer or identify DNAPL migration pathways through secondary permeability features. The RI correctly concluded, and the data illustrates, that significant migration of DNAPL did not occur in areas where DNAPL was released to the surficial soils on the terrace and floodplain of the Site	Comment noted. The current text is sufficient for describing the NAPL migration. No change to report text.
Westlake, V-28	35	The FS states that "Beneath the floodplain, fluvial interbedded deposits of interlayered sand and mud act to inhibit the rate of DNAPL migration." If this sentence is to be retained, it should be modified by replacing "act to inhibit the rate" with "will bring about lower rates," and the following clause should be added at the end of the sentence "than in more permeable units, however the DNAPL sources in the floodplain were relatively large, which led to significant migration of NAPL in the floodplain."	Comment noted. The current text is sufficient for describing the NAPL migration. No change to report text.
Westlake, V-29	37	The FS states that "Groundwater flowing from north to south through these units has resulted in a dissolved-phase aqueous plume that is migrating toward the Tennessee River[.]" "North to south" should be changed to "south to north."	Agree with comment. Report text modified accordingly.
Westlake, V-30	38	The FS states that "These seeps are located in areas where, under certain conditions, shallow groundwater bypasses the PCAP system, flowing between or beneath the PCAP wells." To be more precise, this sentence should be revised to read: "These seeps are located in areas where, during the receding portion of a rise fall river stage cycle, the loss of river bank storage manifests as seeps, i.e., rivulets that form along the sandy beach and discharge to the Tennessee River."	Comment noted. Text will be updated to note that several factors can be contributing to the groundwater seeps.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
Westlake, V-31	40	The FS states that one potential pathway for an Industrial Commercial Worker is "Inhalation of volatile and fugitive dusts in outdoor air." "Volatile" should be replaced with "vapors."	Agree with comment. Report text modified accordingly.
Westlake, V-32	43 to 44	The FS states that "Risk was estimated using . . . fish tissue collected form the ponds." "Form" should be replaced with "from."	Agree with comment. Report text modified accordingly.
Westlake, V-33	44	The FS states that "It is extremely unlikely that the maximum concentrations of all groundwater analytes would be present at the same place and time[.]" It is actually impossible; the solubility of NAPL is governed by Raoult's Law and the effective solubility is less than that of the pure solute.	Agree with comment. Report text modified accordingly.
Westlake, V-34	45	The FS states that "However, the NAPL and contaminated sediment is serving as a reservoir of contaminants that may dissolve into the groundwater and subsequently discharge into aquatic habitat[.]" It should be noted that, based on the sediment porewater data, any such discharges would be attenuated.	Comment noted. Text will be updated to note that attenuation likely will occur between sediment and discharge to surface water.
Westlake, V-35	45	The FS states that "In the future, the contaminants discussed in Section 2.2.3.3 could pose a risk to river biota assuming no attenuation occurred prior to discharge to ecological habitat in the Tennessee River." As noted in several other comments, the assumption of "no attenuation" is inconsistent with Site data and not credible.	Comment noted. Text will be updated to note that attenuation likely will occur between sediment and discharge to surface water.
Westlake, V-36	45	The FS states that "Mercury concentrations protective of aquatic and wildlife exposures are 0.77 and 0.0013 µg/L, respectively." This is a highly conservative and unnecessary assumption since fish tissue data (reflecting actual bioaccumulation) is available.	Comment noted. The data available for fish and mussel tissue were limited to a 1999 EPA study. The tissue dataset is limited, both in terms of the number of samples and the age of the study. So, comparison to AWQC is necessary. No change to report text.
Westlake, V-37	45	The FS states that "[W]hereas average and maximum HQs based on potential bioaccumulation hazards are 37 and 85, respectively." As noted in the prior comment, this is a highly conservative and unnecessary assumption since fish tissue data (reflecting actual bioaccumulation) is available.	See response to Westlake Comment V-37.
Westlake, V-38	45	The FS states that "In addition to comparing the concentrations to individual screen benchmarks, the combined narcotic effects associated with exposure to detected VOCs were estimated using narcosis-based chronic values (developed as described in the ERA)." This analysis is more reliable than that based on individual benchmarks; individual benchmarks by their nature are very conservative, and a narcosis-based approach is intended to be more representative.	Agree with comment. Results of the narcosis analysis ultimately were used for determining risk for the VOCs. No change to report text.
Westlake, V-39	46	The FS states that "Data for the HHRA were compiled by chemical, medium, sample identification, and sample depth, and sample-specific quantification limits were included for all non-detects." Non-detects should be included as half the sample-specific detection limit (not the quantification limit).	Comment noted. As stated in the HHRA, the method detection limit (MDL) was used as the value for non-detect results in the calculation

Comment	Page, Section	Comment	Response
			of 95% UCL values. Current guidance along with the use of EPA's ProUCL do not recommend using ½ the MDL for calculation UCLs. No change to report text.
Westlake, V-40	48	The FS states in note (1) that "Although the CERCLA risk assessment identifies a potential risk associated with this pathway, further evaluation of the data suggests the COPC driving the risk is not CERCLA-related. Sampling of outdoor and indoor air and subslab soil gas suggests the primary source of detectable EDC in outdoor air is related to emissions associated with facility operations." This statement should be clarified and made more precise by replacing further evaluation of the data suggests the COPC driving the risk is not CERCLA-related" with "the calculated risk is driven by EDC, which is a chemical in use at the facility and therefore regulated by OSHA." The second sentence should then be deleted.	Comment noted. No change to report text.
Westlake, V-41	50	The FS states that "For an indirect human exposure to shallow groundwater (i.e., through consumption of clams and fish) there may be potential risk associated with a single benzene detection of 280 ug/L based on comparison to AWQC." This "potential risk" is overstated; as noted in this sentence, there was only one single benzene detection.	Comment noted. A definitive risk conclusion was not provided, hence the "there may be potential" risk description. Given the lack of any current fish tissue data to negate or support exposure, the recognition of potential risk is appropriate. No change to report text.
Westlake, V-42	51	The FS states that "The highest concentrations of EDC are present at the EDC-VCM Plant Area, benzene in the Ethylene Plant Area, and mercury in the Chlorine Plant Area." To be more precise and accurately capture Site conditions, this sentence should be deleted and replaced with the following language: "Elevated concentrations of EDC were detected in all areas of the site, with the highest in the East and West Floodplain areas, and the EDC-VCM Plant Area. Benzene concentrations are the highest in the Ethylene Plant Area, though are elevated also in the East and West Floodplain Areas. Mercury concentrations are highest in the Chlorine Plant Area."	Agree with comment. Report text modified accordingly.
Westlake, V-43	51	The FS states that "Sitewide, COPC concentrations in soil are most elevated in the shallow vadose zone (0 to 10 feet bgs) when compared to the intermediate vadose zone (10 feet bgs to the water table)." This is incorrect and should be rewritten as follows: "Sitewide, COPC concentrations in soil are more elevated in the deeper vadose zone (10 feet bgs to the water table) when compared to the shallow vadose zone (0 to 10 feet bgs)." To provide further detail, the following two sentences should be added to the end: "Below the water table, COPC concentrations are higher than in the vadose zone, due to the presence of larger volumes of DNAPL below the water table. The highest soil concentrations below the water table are found in the shallowest saturated zone (water table to 295 ft msl) and decrease in concentration with depth, in general."	Agree with comment. Report text modified accordingly.

Comment	Page, Section	Comment	Response
Westlake, V-44	51 to 52	The FS states that "Based on surface soil samples collected east of the Barge Slip area and comparison of detected concentrations to ESVs, PCE, TCE, barium, chromium, mercury, vanadium, and zinc were identified as COPECs." To be more precise, "east of the Barge slip" should be deleted and the following phrase should be added to the end of the sentence: "in the terrestrial habitat east of the Barge Slip."	Agree with comment. Report text modified accordingly.
Westlake, V-45	52	The FS states that "In addition, the HHRA evaluated volatilization of contamination from soil (and contaminant vapors present in soil gas) and inhalation of contaminant vapors as a potential human health exposure pathway." But, the FS does not state what the conclusion of the HHRA was with respect to volatilization and inhalation or whether there was any risk. The conclusion should be briefly stated here.	Agree with comment. A brief conclusion of the HHRA conclusion for the pathway will be provided in the FS.
Westlake, V-46	52	The FS states that "The HHRA evaluated volatilization of contaminants from shallow groundwater and inhalation of contaminant vapors as a potential human health exposure pathway." But, the FS does not state what the conclusion of the HHRA was with respect to volatilization and inhalation or whether there was any risk. The conclusion should be briefly stated here.	Agree with comment. A brief conclusion of the HHRA conclusion for the pathway will be provided in the FS.
Westlake, V-47	52	The FS states that "Mercury and 29 VOCs were detected in offshore groundwater samples and the maximum detected concentrations for mercury and 17 VOCs exceeded ecological comparison levels (i.e., the chronic freshwater Region IV screening benchmarks for surface waters)." This sentence uses surface water standards for comparison to groundwater concentrations, which is misleading.	Comment noted. The assumption is that thee offshore groundwater would potentially discharge to sediment porewater and surface water, where the chronic freshwater Region IV screening benchmarks are applicable. No change to report text.
Westlake, V-48	53	The FS states that "The Northwest Area and Pond 2 seeps are hydraulically downgradient of the West Floodplain Area." This is either unclear or incorrect, and should be revised. The Northwest Area and Pond 2 seeps are within the West Floodplain Area.	Agree with comment. Report text modified accordingly.
Westlake, V-49	56	The FS states that "Mercury was retained as a COPEC for air at the Site because mercury has been detected in soil vapor and there is no ESV." This statement should be clarified as follows to reflect the fact that mercury was only detected in soil vapor in a few samples in one area of the Site: "Mercury was retained as a COPEC for air at the Site because mercury has been detected in soil vapor in a few samples under the slab of the former mercury cell building and there is no ESV."	Agree with comment. Report text modified accordingly.
Westlake, V-50	56	The FS states that "However, where toxicity and mobility of source material combine to pose a potential risk of 10-3 or greater, generally treatment alternatives should be evaluated[.]" "10-3" should be replaced with "10-3."	Agree with comment. Report text modified accordingly.
Westlake, V-51	57	The FS states that "This extraction system functions to contain contaminated groundwater and minimize the continued discharge of organic NAPL and associated dissolved groundwater contamination to the offshore area." To be consistent with the next paragraph, "of organic NAPL and associated dissolved groundwater contamination" should be deleted, as should the word "the" before	Comment noted. The current text is sufficient and no change will be made to report text.

Comment	Page, Section	Comment	Response
		"continued."	
Westlake, V-52	57	The FS states that "As noted above, the main factors that determine whether source material is considered PTW are whether the source is mobile or highly toxic, or cannot be reliably contained or would pose a significant risk if the exposure occurred." The words "or cannot" should be replaced with "that cannot" to be consistent with EPA's guidance on PTW. EPA, A Guide to Principal Threat and Low Level Threat Wastes (Nov. 1992), at 2.	Agree with comment. Report text modified accordingly.
Westlake, V-53	57	The FS states that "Based on a thorough analysis of the site data and factors such as the age of the release that occurred over 35 years ago, EPA has concluded that the NAPL is not generally mobile and can be reasonably contained." To be consistent with EPA guidance, "reasonably" should be replaced with "reliably."	Agree with comment. Report text modified accordingly.
Westlake, V-54	58	The FS states that "Consistent with section 300.430(a)(1)(iii)(F), this FS will develop and evaluate alternatives that prevent further migration of the plume, prevents exposure to the contaminated groundwater, further reduce risk." The word "prevents" should be replaced with "prevent," and an "and" should be added before "further reduce risk."	Agree with comment. Report text modified accordingly.
Westlake, V-55	58	The FS states that an RAO for groundwater is to "Prevent future migration of contaminated groundwater (above MCLs or resulting in an excess cancer risk of greater than 10-6 to 10-4 or a HQ >1 for non-carcinogens or to natural background) beyond the Site boundary." The word "to" should be deleted.	Agree with comment. Report text modified accordingly.
Westlake, V-56	59	The FS states than an RAO for groundwater is to "Restore groundwater that is considered by the State of Kentucky to be an available drinking water resource (e.g., groundwater that is not physically isolated in a self-contained inoperable aquifer sub-unit) to its beneficial use (reduce groundwater contaminant levels to MCLs or an excess cancer risk of 10-6 to 10-4 or a HQ of 1 for non-carcinogens or to natural background)." The word "to" should be deleted. In addition, the first parenthetical is not clear.	Agree with comment. Report text modified accordingly.
Westlake, V-57	59	The FS states than an RAO for surface water, sediment, and sediment porewater is to "Prevent exposure of ecological receptors to contaminants in sediment pore water or the water column at levels in excess of narcosis-based criteria for organics or chronic AWQC for mercury." AWQC apply only to the water column and are not appropriate criteria for sediment porewater; this should be clarified in the text.	See response to Westlake Comment V-47.
Westlake, V-58	59	The FS states than an RAO for surface indoor air is to "Prevent exposure to industrial commercial workers to contaminants in indoor air that originate from subsurface contamination at levels that could pose an excess cancer risk above 10-6 or 10-4 or a HQ > 1 for non-carcinogens." The word "to" should be replaced with "of."	Agree with comment. Report text modified accordingly.
Westlake, V-59	59	The FS states that an RAO for NAPL is to "Treat NAPL where necessary to mitigate unacceptable risks and practicable within a reasonable time frame." As written this sentence is confusing; Westlake's proposed revision is as follows: "Treat NAPL, if practicable and necessary to mitigate unacceptable risk, where doing so would restore groundwater within a reasonable timeframe." In addition, Westlake notes that prior RAOs approved by EPA did not include the RAO quoted above. EPA should therefore remove this RAO entirely, or else clarify what additional information warrants the addition of a new RAO.	Agree with comment. The NAPL RAO will be modified accordingly, consistent with the language in the ROD.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
Westlake, V-60	59	The FS states that “PRGPRGs were selected to support development of a remedial footprint and appropriate remedial alternatives based on the RAOs. For purposes of this FS assessment, the PRGPRGs selected and that were used to generate the remedial footprint at the Site are as follows[.]” Both instances of “PRGPRGs” should be replaced with “PRGs.” In addition, “that were” should be deleted.	Agree with comment. Report text modified accordingly.
Westlake, V-61	59	The FS states that “The areal extent of organic and elemental mercury NAPL in the subsurface, in both onshore and offshore areas. This extent was determined on the basis of the RI modeling assessment of NAPL extent (Battelle, 2015). Specifically, the PRG for this FS is containment of the potential NAPL extent defined by a PI value greater than or equal to 30, modified by the direct observations and validation of the NAPL model during the 2016 2017 offshore investigation.” The first two sentences of this bullet point paragraph are unnecessary and inconsistent with the other bullet points in this section. This paragraph should be replaced with the following: “The potential NAPL extent defined by a PI value greater or equal to 30, modified by direct observations and validation of the NAPL model during the 2016 2017 investigation.”	Agree with comment. Report text modified accordingly.
Westlake, V-62	105	The FS states that “NA-2 is subject to a number of the same physical access limitations and propensity to flooding as NA-1, depending on specific location.” “NA-2” should be changed to “NA-4.”	Agree with comment. Report text modified accordingly.
Westlake, V-63	106	The FS states that “In the evaluation of alternatives, the relative costs for each alternative are estimated. Costs are not quantified for the screening evaluation.” To be complete, the following sentence should be added to this description: “Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives (40 CFR§ 300.420 (2)(3)(7)(iii)).”	Comment noted. No change to report text.
Westlake, V-64	107	“Accordingly, the soil and remedial alternatives provided in this FS are conceptually adequate to address existing Site risks and the interaction between various media.” “Groundwater” should be inserted before “remedial alternatives.”	Agree with comment. Report text modified accordingly.
Westlake, V-65	108	The FS states that “Significant work backfilling portions of the drainage ditch has already been undertaken; the remaining length of the 2,000-ft long drainage ditch would be excavated and lined with pipe to prevent further erosion. Runoff from this area would be diverted to catch basins at the land surface and then to the underground pipe. Stormwater runoff collected through the pipe would continue to be managed through the KPDES permit.” To be more precise, “with pipe” and “collected through the pipe” should be deleted. The words “underground pipe” should be replaced with “lined ditch pipe.”	Agree with comment. Report text modified accordingly.
Westlake, V-66	108	The FS discusses the closure of Ponds 1A and 2 and states that “The ponds would be closed by either installing an impermeable bottom liner or regrading and backfilling, or a combination of the two.” As discussed in Section II.D, *supra*, a sentence should be added that states that “Soils that are non-hazardous and geotechnically suitable may be used as onsite backfill.” In addition, Westlake suggests that this sentence should be clarified to state that regrading and backfilling are necessary, but an impermeable bottom liner will be installed only if also determined to be necessary.	Agree with comment. Report text modified accordingly.
Westlake, V-67	108	The FS states that “At a minimum, the monitoring program would include the following[.]” This should be revised to state “Monitoring programs may include the following:”. Some of the monitoring programs listed would not make sense if a particular remedial alternative is ultimately selected. For	Comment noted. Text will be updated to note that monitoring programs may

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
		example, if off-shore NAPL were removed, there would no porewater monitoring to evaluate performance. For similar reasons, "Monitoring of sediment porewater to evaluate offshore groundwater remedy performance" should be deleted from the list.	include the listed elements. Monitoring of sediment porewater will remain in the document as a monitoring option.
Westlake, V-68	111, elsewhere	The FS states that "Sheet pile or cement bentonite wall construction would be used for portions of the wall downgradient along the shoreline areas where potential NAPL-impacted soil may be encountered adjacent to the wall. Soil bentonite wall construction would be used in downgradient areas where potential NAPL-impacted soil is unlikely to be observed, and along the majority of the upgradient wall boundary." As discussed in prior comments, specifying different slurry wall backfill mixtures is overly prescriptive, especially given that site-specific compatibility design testing has not yet been performed. Further, the use of soil bentonite wall should not be limited to locations free of NAPL occurrence. Such walls have been used in locations where NAPL contact was likely, and design backfill chemical compatibility testing will be conducted to demonstrate site specific applicability during design. These two sentences should therefore be removed, and other clarifications made in the FS where necessary.	See response to PolyOne Comment 3-21.
Westlake, V-69	118	The FS states that, with respect to SC6, "This alternative would address all of the contaminated areas, except for the NAPL and contaminated groundwater that has migrated beneath the Tennessee River." To reflect the fact that SC6 will not be able to address the inaccessible areas, the words "attempt to" should be added before "address."	Agree with comment. Report text modified accordingly.
Westlake, V-70	120	The FS states that "There is currently no evidence that the offshore NAPL is migrating directly into the river, although major scouring of the river bottom or excessive dredging in this area could result in direct exposure of the NAPL to the river water. Such conditions are unlikely to occur because this is a deposition area and ICs would be implemented to limit the depth of future maintenance dredging." The supposition regarding "major scouring of the river bottom or excessive dredging in this area" is an extreme hypothetical, as shown by the following statement in the FS. Accordingly, "although major scouring of the river bottom or excessive dredging in this area could result in direct exposure of the NAPL to the river water" should be deleted, and "Such conditions" should be replaced with "Major scouring or excessive dredging."	Comment noted. No change to report text.
Westlake, V-71	121	The FS states that "The propane dock would need to be removed, temporarily relocated, and subsequently reconstructed at the original location to minimize disruption to active plant operations. Costs associated with this relocation process are high." The word "extremely" should be added before "high," and the phrase "as well as those for the associated relocation of Outfall 001" should be added after "process."	Comment noted. The current language is sufficient for describing the alternative. No change to report text.
Westlake, V-72	121	The FS states that "At a minimum, this monitoring would include the collection and analysis of groundwater and/or surface water samples inside and outside of the excavated area." Because sediment porewater samples are more relevant, "groundwater" should be replaced with "sediment porewater."	Comment noted and agree in part. Report text will be modified to state that sediment porewater also may be collected in addition to

Comment	Page, Section	Comment	Response
			groundwater and surface water samples.
Westlake, V-73	121 and 140	The FS states on these pages that monitoring is assumed to be quarterly for one year after remedy implementation. Quarterly monitoring is too frequent and does not provide data that are useful. Semi-annual monitoring would be a more logical monitoring frequency. In addition, sampling should continue for more than a year because conditions will not return to equilibrium that quickly.	Comment noted. Report text states that the performance monitoring details will be defined in the O&M plan. No change to report text.
Westlake, V-74	122	The FS states that “At a minimum, this monitoring would include the collection and analysis of groundwater and/or surface water samples inside and outside of the barrier wall, and inspection of the remedy to ensure the integrity of the armoring, low-permeability cap, and barrier wall.” Because sediment porewater samples are more relevant, “groundwater” should be replaced with “sediment porewater.” The references to armoring and the low-permeability cap should be also deleted in light of the statement on page 142 that for RN3, armoring and/or a low permeability cap are deemed not necessary.	Comment noted. See response to Westlake Comment V-72. References to armoring and the lower permeability cap will be revised to be consistent with those presented in the RN3 detailed discussion on Page 142.
Westlake, V-75	122	The FS states that “This remedial alternative would rely on a combination of physical containment and source zone stabilization to meet the RAOs, with the goal of reducing the overall risk associated with leaving contamination in place within the barrier wall.” It is not clear how risk reduction under RN4 is achieved when the short-term risks are exacerbated by this alternative.	Comment noted. No change to report text.
Westlake, V-76	122	The FS states that “After installation, the sheet piling in the river column would be cut flush with the river bottom.” This should be reworded to clarify that this work would need to follow in-situ stabilization.	Agree with comment and modified text accordingly.
Westlake, V-77	123	The FS states that “The propane dock would need to be removed, temporarily relocated, and subsequently reconstructed at the original location to minimize disruption to active plant operations. Costs associated with this relocation process are high.” The word “extremely” should be added before “high,” and the phrase “as well as those for the associated relocation of Outfall 001” should be added after “process.”	See response to Westlake Comment V-71.
Westlake, V-78	123	The FS states that “At a minimum, this monitoring would include the collection and analysis of groundwater and/or surface water samples inside and outside of the barrier wall, and inspection of the remedy to ensure the integrity of the armoring and barrier wall.” Because sediment porewater samples are more relevant, “groundwater” should be replaced with “sediment porewater.”	See response to Westlake Comment V-72.
Westlake, V-79	124	The FS states, with respect to RG3, that “Assuming a 40% porosity, and recovery and treatment of five pore volumes of groundwater, approximately 436,000,000 gallons of water would require recovery and treatment.” This type of recovery would be an extremely inefficient way to address removal of groundwater containment mass because of short-circuiting to the river.	Comment noted. No change to report text.
Westlake, V-80	125	The FS states that “Each on-shore alternative would be effective at achieving RAOs for the BF Goodrich site, with alternatives involving a complete barrier wall (SC3a and SC5a) and the complete treatment option providing the highest degree of effectiveness.” This statement on the “highest degree of effectiveness” from SC6 is highly questionable given the short-term effectiveness and risk associated with this alternative.	Comment noted. No change to report text.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
Westlake, V-81	125	The FS states that "Each offshore NAPL alternative would be effective at achieving RAOs for the BF Goodrich site, with alternatives involving a NAPL removal or treatment (RN2 and RN4) providing the highest degree of effectiveness." This statement on the "highest degree of effectiveness" for RN2 and RN4 are highly questionable given the short-term effectiveness and risk associated with these alternatives.	Comment noted. No change to report text.
Westlake, V-82	126	The FS states that "Each offshore NAPL alternative would be effective at achieving RAOs for the BF Goodrich site, with the alternative involving active groundwater treatment (RG3) likely reducing the timeframe necessary to achieve RAOs. "Likely" should be replaced with "possibly".	Comment noted. No change to report text.
Westlake, V-83	130, 133, 137	The FS states that "All new buildings and building expansions will be constructed using VOC and mercury vapor intrusion-resistant construction." The requirement for mercury vapor intrusion-resistant construction is only necessary for buildings constructed or expanded in the vicinity of the former Mercury Cell Building. This requirement should be revised accordingly in these sections of the FS.	Agree with comment and revised text accordingly.
Westlake, V-84	134	The FS states that "Alternative SC5a also includes an active treatment component designed to reduce roughly 40% of the potential NAPL-impacted soil volume below risk-based levels, therefore increasing the degree of effectiveness and permanence compared to a containment-only remedy." To make this analysis complete, the following qualifying language should be added to follow this sentence: "However, given that the treatment component would not target all NAPL-impacted soil and will not be fully successful in the areas it does target, the improvements to effectiveness and permanence over Alternative SC3a would only be marginal."	Agree with comment and revised text accordingly to clarify the anticipated effectiveness of the remedy.
Westlake, V-85	136	The FS states that "This remedial alternative would include targeted ISTT treatment of potential organic NAPL source areas identified as having a PI value _30 (lower bound confirmed NAPL) using ISTT, with the exception of inaccessible areas beneath the Carbide Ponds and the RCRA closure cell." An additional statement should be added after this sentence to clarify that, due to the plant infrastructure and complex site stratigraphy, Alternative SC6 would not be able to address all of the NAPL.	Comment noted. The current report text is adequate to describe the remedy. No change to report text.
Westlake, V-86	139	The FS states that "In addition, river bottom scouring due to barge traffic or changes in river flow conditions could potentially result in NAPL being exposed directly to the river." To reflect how extremely unlikely this is, "In addition" should be replaced with "Although unlikely due to NAPL being at least 7 feet below the base of the river."	Agree with comment and revised text accordingly.
Westlake, V-87	140	The FS states that one of the environmental covenants associated with RN2 is "Obtain EPA and KDEP approval prior to dredging the river bottom or installing structures that may result in the exposure of NAPL-contaminated sediment that extends beneath the Tennessee River." Since RN2 would purportedly excavate the off-shore NAPL beneath the river, this covenant is unnecessary and should be deleted from this section of the FS.	Comment noted. No change to report text.
Westlake, V-88	141	The FS states that, with respect to RN2, "For cost-estimating purposes, it is assumed that the duration of remedy implementation, would be approximately one year." As previously discussed in several other comments, one year is too short a period and does not account for the time that could be needed to design and implement the relocation of Outfall 001, the propane dock relocation, and removal of the existing dock, and then return the propane dock to its original location.	See response to PolyOne comment 3-45.

Comment	Page, Section	Comment	Response
Westlake, V-89	142	The FS states that, with respect to RN3, "Sheet pile construction would be used given that the wall is offshore and that potential NAPL-impacted soil may be encountered adjacent to the wall." Relative to the on-shore portion of RN3 containment and as discussed in prior comments, soil bentonite walls should not be limited to locations free of NAPL occurrence. Such walls have been used in locations where NAPL contact was likely, and design backfill chemical compatibility testing will be conducted to demonstrate site specific applicability during design. Accordingly, "and that potential NAPL-impacted soil may be encountered adjacent to the wall" should be deleted.	Comment noted. See response to PolyOne Comment 3-61.
Westlake, V-90	142	The FS states that, with respect to RN3, "At a minimum, this monitoring would include the collection and analysis of groundwater and/or surface water samples inside and outside of the barrier wall, and inspection of the remedy to ensure the integrity of the armoring, low-permeability cap, and barrier wall." The references to armoring and the low-permeability cap should be deleted in light of the statement earlier on the same page that armoring and/or a low permeability cap are deemed not necessary.	Agree with comment and text modified accordingly.
Westlake, V-91	146	The FS states that "It was assumed that without [the current] collection system in place, NAPL could be present in zones of groundwater discharge at the Tennessee River. The assessments concluded that without the reduction in the discharge of contaminated groundwater to the Tennessee River, human cancer risks and noncancer hazards from exposure to contaminated river water would be orders of magnitude above acceptable risk levels. The detailed assessment of the RG remedial alternatives assumes implementation of one of the SC and RN remedial alternatives to eliminate further release of contaminants to groundwater, seeps, and surface water from on-shore area and offshore NAPL areas at the BF Goodrich site." This paragraph suggests that the RG alternatives are not necessary in light of (1) the currently operational PCAP system, and (2) the SC and RN remedies that will be implemented. That is, NAPL "could be" present in zones of groundwater discharge without the PCAP system – but the PCAP system is in place, and implementation of SC3a will further ensure discharge to the river. Accordingly, EPA statements in this paragraph suggest, correctly in Westlake's view, that no RG remedy should be required because it would not provide for additional risk reduction.	Comment noted. No change to report text.
Westlake, V-92	146 to 147	The FS states that, with respect to RG1, "The ecological risk evaluation of offshore investigation groundwater data suggests groundwater contaminants could pose a risk to river biota assuming no attenuation occurred prior to discharge to ecological habitat in the Tennessee River." Attenuation, however, does occur. The FS previously confirms on page 146 that there is no human health risk associated with exposure to surface water or direct exposure to off-shore sediment porewater. Accordingly, the conclusion on page 147 that RG1 would not be protective of human health and the environment is incorrect.	Comment noted. No change to report text.
Westlake, V-93	154	The FS states that "However, it should be noted that the ISCO treatment component proposed for SC6 is unlikely to completely address the NAPL-impacted soil and groundwater in inaccessible areas, and that significant contaminant mass will likely be left in place, thus reducing the long-term effectiveness and permanence of this alternative." This statement is correct, but should be expanded to note that SC5a also will not be able to completely address the NAPL-impacted soil and groundwater in inaccessible areas.	Agree with comment and text modified accordingly.

Response to Comments on BF Goodrich Feasibility Study

Comment	Page, Section	Comment	Response
Westlake, V-94	154	The FS states that "Alternative SC6 includes active in-situ and ex-situ treatment components designed to ultimately treat all contamination within the remedial footprint, thereby providing reduction of contaminant toxicity, mobility, and volume through treatment." A qualifier should be added to this sentence to clarify that treatment would not be 100% effective.	Comment noted. No change to report text.
Westlake, V-95	155	The FS states that "Alternatives SC5a and SC6 would be more implementable from an administrative perspective given the inclusion of a treatment component that would actively reduce source area concentrations." To be consistent with the rest of the FS, the following qualifying statement should be added to the beginning of the first sentence: "Although not physically implementable,".	Comment noted. No change to report text.
Westlake, V-96	158	The FS states that "For cost estimate purposes, it is assumed that the duration of remedy implementation, IC monitoring, and long-term monitoring would be 100 years for RN3 and RN4, but only one year for RN2 assuming long-term monitoring results after remedy implementation indicate effectiveness." As discussed in prior comments, one year is too short a period and does not account for the time that could be needed to design and implement the relocation of Outfall 001, the propane dock relocation, and the removal the existing dock, and then return the propane dock to its original location.	See response to PolyOne comment 3-45.
Westlake, V-97	160	The FS states that "Offshore groundwater Alternative RG2 includes MNA only, and does not include an active treatment component." The following portion of this sentence is misleading, and should be deleted: "only, and does not include an active treatment component."	Agree with comment and text modified accordingly.
Westlake, V-98	160	The FS states that "Offshore NAPL Alternative RG2 is easily implementable because there is no active construction or treatment component[.]" To say there is no "treatment component" is misleading, and therefore the words "or treatment component" should be deleted.	Agree with comment and text modified accordingly.
Westlake, V-99	Figures 2-39, 2-41, 2-43, 2-45	"Upper Aquifer" should be replaced with "Shallow Groundwater" in the titles of these figures.	Agree with comment and text modified accordingly.
Westlake, V-100	Figures 2-40, 2-42, 2-44, 2-46	"Lower Aquifer" should be replaced with "Deep Groundwater" in the titles of these figures.	Agree with comment and text modified accordingly.
Westlake, V-100	Figure 3-1	The base map used to generate Figure 3.1 should be a groundwater MCL exceedance map, not a 30% confidence NAPL map.	Comment noted. No change to figure.

Table X. Comparison of Maximum Detected Groundwater to EPA Region IV Surface Water Screening Benchmarks

Parameter	2015 Region IV Screening Values	Unit	Maximum Detected Result	Maximum > SW Screening	Hazard Quotient
1,1,2,2-Tetrachloroethane	200	ug/L	1.3	No	
1,1,2-Trichloroethane	730	ug/L	150	No	
1,2,4-Trichlorobenzene	130	ug/L	3.7	No	
1,3-Dichlorobenzene	22	ug/L	3.3	No	
1,4-Dichlorobenzene	9.4	ug/L	7.1	No	
Acetone	1700	ug/L	42	No	
Carbon Disulfide	15	ug/L	0.98	No	
Chloroethane	930	ug/L	430	No	
Cyclohexane	230	ug/L	1.2	No	
Methylene Chloride	1500	ug/L	5.5	No	
trans-1,2-Dichloroethene	558	ug/L	200	No	
1,1-Dichloroethane	410	ug/L	1600	Yes	3.9
1,1-Dichloroethene	130	ug/L	840	Yes	6.5
1,2-Dichlorobenzene	23	ug/L	140	Yes	6.1
1,2-Dichloroethane (EDC)	970	ug/L	2000	Yes	2.1
Benzene	160	ug/L	26000	Yes	163
Chlorobenzene	25	ug/L	630	Yes	25
Chloroform (Trichloromethane)	140	ug/L	720	Yes	5.1
cis-1,2-Dichloroethene	620	ug/L	1400	Yes	2.3
Ethylbenzene	61	ug/L	3800	Yes	62
Isopropylbenzene	4.8	ug/L	34	Yes	7.1
m,p-Xylenes	27	ug/L	470	Yes	17
o-Xylene	27	ug/L	370	Yes	14
Styrene	32	ug/L	2700	Yes	84
Tetrachloroethene	53	ug/L	140	Yes	2.6
Toluene	62	ug/L	3800	Yes	61
Trichloroethene	200	ug/L	260	Yes	1.3
Vinyl Chloride	930	ug/L	7600	Yes	8.2
Mercury	0.77	ug/L	7.3	Yes	9.5

Table Y. Comparison of Maximum Surface Water Concentrations to EPA Region IV Surface Water Screening Benchmarks

Parameter	Region IV Screening Values	Unit	AWQC	Minimum Detected Result	Maximum Detected Result	Average Detected Result	Maximum > SW Screening
1,1,2-Trichloroethane	730	ug/L	12	0.28	38	22	No
1,1-Dichloroethane	410	ug/L		9.4	24	16.1	No
1,2-Dichloroethane (EDC)	2000	ug/L	13	1.4	260	60.3	No
Benzene	160	ug/L	6.2	11	14	12.5	No
Chlorobenzene	25	ug/L	600	4.3	11	7.42	No
Chloroform (Trichloromethane)	140	ug/L	1000	17	17	17	No
cis-1,2-Dichloroethene	970	ug/L		1.8	5.2	3.32	No
Ethylbenzene	61	ug/L	1000	0.25	0.25	0.25	No
Methyl Butyl Ketone	99	ug/L		28	28	28	No
Tetrachloroethene	53	ug/L	40	1.2	4	2.4	No
Toluene	62	ug/L	2000	0.19	1	0.5	No
trans-1,2-Dichloroethene	970	ug/L		0.61	1.9	1.3	No
Trichloroethene	200	ug/L	4	1	2.3	1.7	No
Vinyl Chloride	930	ug/L	0.68	8.3	33	20.1	No
Mercury	0.77	ug/L	0.77	0.17	1.1	0.5	Yes
Mercury (wildlife for bioaccumulation)	0.0013	ug/L	0.013	0.17	1.1	0.5	Yes

Table Y. Comparison of Maximum Pore Water Concentrations to EPA Region IV Surface Water Screening Benchmarks

Parameter	Region IV Screening Values	Unit	Minimum Detected Result	Maximum Detected Result	Average Detected Result	Maximum > SW Screening
1,1,2,2-Tetrachloroethane	200	ug/L	0.14	0.14	0.14	No
1,1,2-Trichloroethane	730	ug/L	0.52	2	1.26	No
1,1-Dichloroethane	410	ug/L	0.63	6.6	2.51	No
1,2,4-Trimethylbenzene	130	ug/L	0.16	0.36	0.23	No
1,2-Dichloroethane (EDC)	2000	ug/L	0.26	15	3.98	No
Acetone	1700	ug/L	4.5	7.4	5.82	No
Chlorobenzene	25	ug/L	0.86	6.5	3.08	No
Chloroform (Trichloromethane)	140	ug/L	0.35	1.1	0.78	No
cis-1,2-Dichloroethene	620	ug/L	0.33	0.33	0.33	No
Ethylbenzene	61	ug/L	0.09	23	1.91	No
Isopropylbenzene	4.8	ug/L	0.19	0.47	0.33	No
m,p-Xylenes	27	ug/L	0.17	5.6	0.74	No
n-Propylbenzene	4.8	ug/L	0.29	0.29	0.29	No
o-Xylene	27	ug/L	0.09	4.1	0.54	No
Styrene	32	ug/L	7.6	7.6	7.60	No
Tetrachloroethene	53	ug/L	0.3	0.3	0.30	No
Toluene	62	ug/L	0.08	34	3.30	No
trans-1,3-Dichloroethene	558	ug/L	0.72	0.72	0.72	No
Trichloroethene	200	ug/L	0.21	0.21	0.21	No
Vinyl Chloride	930	ug/L	0.13	1.4	0.72	No
Benzene	160	ug/L	0.08	280	37	Yes
Naphthalene	21	ug/L	83	83	83	Yes

Table Z. Narcosis Index Estimates for Pore Water Samples

All concentrations in ug/L		21-PW1			22-PW1			23-PW1			24-PW1			25-PW1			26-PW1			27-PW1			28-PW1			29-PW1			30-PW1		
Analyte	narcosis-based chronic values (developed as described in the ERA)	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ
Dichlorodifluoromethane (Freon 12)	725.38	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Chloromethane	2892.70	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Bromomethane	4707.98	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Vinyl chloride	1308.78	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	1.4	1.1E-03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.13	9.9E-05	0.50	U	0.0E+00
Chloroethane	2523.79	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Trichlorofluoromethane (Freon 11)	371.23	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1-Dichloroethene	468.82	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	130.26	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methylene Chloride	7700.64	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Methyl T-Butyl Ether (MTBE)	7332.43	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Acetone	276960.20	4.1	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	5.0	U	0.0E+00	4.0	U	0.0E+00	4.4	U	0.0E+00
Carbon disulfide	3307.25	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Methyl Acetate	142880.09	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
1,1-Dichloroethane	1860.57	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	1.4	7.5E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
cis-1,2-Dichloroethene	821.13	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.33	4.0E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
2,2-Dichloropropane	1187.26	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methyl Ethyl Ketone	109725.17	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00
Bromochloromethane	3908.17	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dichloroethene, Total	737.17	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Chloroform	2666.84	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.88	3.3E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dichloroethane	2989.27	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	15	5.0E-03	0.50	0.26	8.7E-05	0.50	0.41	1.4E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.85	2.8E-04	0.50	U	0.0E+00
1,1,1-Trichloroethane	410.30	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Cyclohexane	144.22	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1-Dichloropropene	548.34	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Carbon Tetrachloride	349.88	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Bromodichloromethane	1387.33	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methyl Isobutyl Ketone	16915.51	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
1,2-Dichloropropane	1187.26	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methylcyclohexane	90.75	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Dibromomethane	2810.71	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
trans-1,3-Dichloropropene	881.03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Trichloroethene	216.31	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.21	9.7E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Benzene	2038.44	0.50	0.080	3.9E-05	0.50	U	0.0E+00	0.50	0.98	4.8E-04	0.50	0.11	5.4E-05	0.50	0.10	4.9E-05	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	1.0	4.9E-04	0.50	U	0.0E+00
Dibromochloromethane	1249.55	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1,2-Trichloroethane	2021.82	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	2.0	9.9E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
cis-1,3-Dichloropropene	881.03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Bromoform	903.90	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
Bromobenzene	288.80	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1,2,2-Tetrachloroethane	985.52	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.14	1.4E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Tetrachloroethene	60.39	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.30	5.0E-03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,3-Dichloropropane	1266.44	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methyl Butyl Ketone	16915.51	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
Toluene	734.92	0.50	0.12	1.6E-04	0.50	U	0.0E+00	0.50	0.13	1.8E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.14	1.9E-04	0.50	U	0.0E+00	0.50	0.11	1.5E-04	0.50	0.17	2.3E-04	0.50	0.12	1.6E-04
Chlorobenzene	557.98	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.97	1.7E-03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1,1,2-Tetrachloroethane	443.83	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Ethylbenzene	300.96	0.50	0.18	6.0E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.18	6.0E-04	0.50	0.12	4.0E-04	0.50	0.18	6.0E-04	0.50	U	0.0E+00	0.50	0.17	5.6E-04
p-Xylene	294.55	1.0	0.64	2.2E-03	1.0	0.23	7.8E-04	1.0	U	0.0E+00	1.0	0.28	9.5E-04	1.0	0.17	5.8E-04	1.0	0.75	2.5E-03	1.0	0.50	1.7E-03	1.0	0.74	2.5E-03	1.0	0.25	8.5E-04	1.0	0.66	2.2E-03
o-Xylene	349.97	0.50	0.25	7.1E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.26	7.4E-04	0.50	0.20	5.7E-04	0.50	0.24	6.9E-04	0.50	0.090	2.6E-04	0.50	0.18	5.1E-04
Styrene	399.22	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2,3-Trichloropropane	1248.68	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
o-Chlorotoluene	92.17	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
p-Chlorotoluene	111.90	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,3-Dichlorobenzene	199.96	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,4-Dichlorobenzene	217.97	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dichlorobenzene	208.77	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.59	2.8E-03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dibromoethane (EDB)	1734.36	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Isopropylbenzene	99.75	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
n-Propylbenzene	93.50	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,3,5-Trimethylbenzene	167.30	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
tert-Butylbenzene	42.23	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2,4-Trimethylbenzene	106.40	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.17	1.6E-03	0.50	0.16	1.5E-03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
sec-Butylbenzene	15.67	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
p-Isopropyltoluene	43.15	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
n-Butylbenzene	23.60	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dibromo-3-Chloropropane (DBCP)	252.83	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
1,2,4-Trichlorobenzene	62.14	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Naphthalene	127.88	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Hexachlorobutadiene	5.52	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2,3-Trichlorobenzene	60.80	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Tentatively Identified Compounds	5.50	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00
Narcosis Index				**3.7E-03**			**7.8E-04**			**2.0E-02**			**1.1E-03**			**7.6E-04**			**5.7E-03**			**4.2E-03**			**3.9E-03**			**2.2E-03**			**3.5E-03**

Table Z. Narcosis Index Estimates for Pore Water Samples (continued)

Response to Comments on BF Goodrich Feasibility Study

All concentrations in ug/L		31-PW1			32-PW1			33-PW1			34-PW1			35-PW1			A11-PW1			A3-250-PW1			E05-PW1			E09-PW1			E11A-PW1		
Analyte	narcosis-based chronic values (developed as described in the ERA)	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ	Reporting Limit	Result	NQ
Dichlorodifluoromethane (Freon 12)	725.38	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Chloromethane	2892.70	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Bromomethane	4707.98	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Vinyl chloride	1308.78	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.62	4.7E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Chloroethane	2523.79	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Trichlorofluoromethane (Freon 11)	371.23	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1-Dichloroethene	468.82	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	130.26	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Methylene Chloride	7700.64	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methyl T-Butyl Ether (MTBE)	7332.43	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Acetone	276960.20	4.0	4.6	1.7E-05	4.0	U	0.0E+00	4.0	4.5	1.6E-05	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	7.4	2.7E-05	4.0	U	0.0E+00	4.0	7.3	2.6E-05	4.0	U	0.0E+00	4.0	5.3	1.9E-05
Carbon disulfide	3307.25	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Methyl Acetate	142880.09	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
1,1-Dichloroethane	1860.57	0.50	U	0.0E+00	0.50	1.4	7.5E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.63	3.4E-04	0.50	6.6	3.5E-03	0.50	U	0.0E+00	0.50	U	0.0E+00
cis-1,2-Dichloroethene	821.13	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
2,2-Dichloropropane	1187.26	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methyl Ethyl Ketone	109725.17	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00	4.0	U	0.0E+00
Bromochloromethane	3908.17	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dichloroethene, Total	737.17	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Chloroform	2666.84	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.35	1.3E-04	0.50	1.1	4.1E-04	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dichloroethane	2989.27	0.50	U	0.0E+00	0.69	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.87	2.9E-04	0.50	6.5	2.2E-03	8.4	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1,1-Trichloroethane	410.30	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Cyclohexane	144.22	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1-Dichloropropene	548.34	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Carbon Tetrachloride	349.88	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Bromodichloromethane	1387.33	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methyl Isobutyl Ketone	16915.51	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
1,2-Dichloropropane	1187.26	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methylcyclohexane	90.75	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
Dibromomethane	2810.71	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
trans-1,3-Dichloropropene	881.03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.72	8.2E-04	0.50	U	0.0E+00	0.50	U	0.0E+00
Trichloroethene	216.31	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Benzene	2038.44	0.50	U	0.0E+00	0.50	9.5	4.7E-03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	1.0	4.9E-04	5.0	280	1.4E-01	0.50	U	0.0E+00	0.50	U	0.0E+00
Dibromochloromethane	1249.55	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1,2-Trichloroethane	2021.82	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.52	2.6E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
cis-1,3-Dichloropropene	881.03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Bromoform	903.90	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
Bromobenzene	288.80	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1,2,2-Tetrachloroethane	985.52	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Tetrachloroethene	60.39	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,3-Dichloropropane	1266.44	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Methyl Butyl Ketone	16915.51	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
Toluene	734.92	0.50	U	0.0E+00	0.50	1.2	1.6E-03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.090	1.2E-04	0.50	0.17	2.3E-04	0.50	34	4.6E-02	0.50	U	0.0E+00	0.50	0.080	1.1E-04
Chlorobenzene	557.98	0.50	U	0.0E+00	0.50	6.5	1.2E-02	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.86	1.5E-03	0.50	4.0	7.2E-03	0.50	U	0.0E+00	0.50	U	0.0E+00
1,1,1,2-Tetrachloroethane	443.83	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Ethylbenzene	300.96	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.14	4.7E-04	0.50	0.090	3.0E-04	0.50	0.11	3.7E-04	0.50	0.21	7.0E-04	0.50	0.19	6.3E-04	0.50	23	7.6E-02	0.50	0.11	3.7E-04	0.50	0.14	4.7E-04
p-Xylene	294.55	1.0	0.35	1.2E-03	1.0	0.32	1.1E-03	1.0	0.48	1.6E-03	1.0	0.32	1.1E-03	1.0	0.39	1.3E-03	1.0	0.82	2.8E-03	1.0	0.70	2.4E-03	1.0	5.6	1.9E-02	1.0	0.41	1.4E-03	1.0	0.50	1.7E-03
o-Xylene	349.97	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.090	2.6E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.22	6.3E-04	0.50	0.20	5.7E-04	0.50	4.1	1.2E-02	0.50	U	0.0E+00	0.50	0.13	3.7E-04
Styrene	399.22	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	7.6	1.9E-02	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2,3-Trichloropropane	1248.68	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00	2.0	U	0.0E+00
o-Chlorotoluene	92.17	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
p-Chlorotoluene	111.90	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,3-Dichlorobenzene	199.96	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,4-Dichlorobenzene	217.97	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dichlorobenzene	208.77	0.50	U	0.0E+00	0.50	0.90	4.3E-03	0.50	0.10	4.8E-04	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.14	6.7E-04	0.50	1.4	6.7E-03	0.50	U	0.0E+00	0.50	0.18	8.6E-04
1,2-Dibromoethane (EDB)	1734.36	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Isopropylbenzene	99.75	0.50	U	0.0E+00	0.50	0.19	1.9E-03	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.47	4.7E-03	0.50	U	0.0E+00	0.50	U	0.0E+00
n-Propylbenzene	93.50	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.29	3.1E-03	0.50	U	0.0E+00	0.50	U	0.0E+00
1,3,5-Trimethylbenzene	167.30	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
tert-Butylbenzene	42.23	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2,4-Trimethylbenzene	106.40	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	0.36	3.4E-03	0.50	U	0.0E+00	0.50	U	0.0E+00
sec-Butylbenzene	15.67	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
p-Isopropyltoluene	43.15	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
n-Butylbenzene	23.60	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2-Dibromo-3-Chloropropane (DBCP)	252.83	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00	1.0	U	0.0E+00
1,2,4-Trichlorobenzene	62.14	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Naphthalene	127.88	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	83	6.5E-01	0.50	U	0.0E+00	0.50	U	0.0E+00
Hexachlorobutadiene	5.52	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
1,2,3-Trichlorobenzene	60.80	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00	0.50	U	0.0E+00
Tentatively Identified Compounds	5.50	10	U	0.0E+00		40	7.3E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	10	U	0.0E+00	#N/A	#N/A	0.0E+00	10	U	0.0E+00	10	U	0.0E+00
Narcosis Index				**1.2E-03**			**2.6E-02**			**2.8E-03**			**1.4E-03**			**1.7E-03**			**4.6E-03**			**9.9E-03**			**9.9E-01**			**1.8E-03**			**3.5E-03**

APPENDIX D

RISK ASSESSMENT TABLES

SUMMARY OF PRELIMINARY ECOLOGICAL RISK ESTIMATES FOR RETAINED COPECs
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

Exposure Area	Medium	COPEC[1]	Quotient[2]	Basis	Receptor
Tennessee River	Surface Water	barium	7.4	95% UCL	Aquatic invertebrate
		lead	1.1	95% UCL	Aquatic invertebrate
		mercury	0.034	95% UCL	Aquatic invertebrate
	Sediment	bis(2-ethylhexyl)phthalate	5.8	95% UCL	Aquatic invertebrate
		arsenic	3.6	95% UCL	Aquatic invertebrate
		barium	4	95% UCL	Aquatic invertebrate
		chromium	27	95% UCL	Aquatic invertebrate
		copper	2.5	95% UCL	Aquatic invertebrate
		cyanide	1.4	95% UCL	Aquatic invertebrate
		mercury	4.4	95% UCL	Aquatic invertebrate
		nickel	61	95% UCL	Aquatic invertebrate
		vanadium	5.9	95% UCL	Aquatic invertebrate
	Seep Water	1,1,2-trichloroethane	6.6	maximum	Aquatic invertebrate
		1,1-dichloroethane	1.4	maximum	Aquatic invertebrate
		1,1-dichloroethene	1.1	maximum	Aquatic invertebrate
		1,2-dichlorobenzene	3.1	maximum	Aquatic invertebrate
		1,2-dichloroethane	84	maximum	Aquatic invertebrate
		benzene	1.3	maximum	Aquatic invertebrate
		chlorobenzene	3.9	maximum	Aquatic invertebrate
		chloroform	1.1	maximum	Aquatic invertebrate
		naphthalene	11	maximum	Aquatic invertebrate
		tetrachloroethene	27	maximum	Aquatic invertebrate
		trichloroethene	8.8	maximum	Aquatic invertebrate
		vinyl chloride	2.7	maximum	Aquatic invertebrate
		barium	98	maximum	Aquatic invertebrate
		cadmium	15	maximum	Aquatic invertebrate
		cobalt	50	maximum	Aquatic invertebrate
		cyanide	5.1	maximum	Aquatic invertebrate
		lead	2.9	maximum	Aquatic invertebrate
		mercury	0.21	maximum	Aquatic invertebrate
		nickel	2.8	maximum	Aquatic invertebrate
		zinc	2.1	maximum	Aquatic invertebrate
	Combined (surface water, sediment, fish tissue)	mercury	2.6	geomean (NOAEL/LOAEL)	Great blue heron
Barge Slip	Surface Water	bis(2-ethylhexyl)phthalate	3.3	95% UCL	Aquatic invertebrate
		barium	8.7	95% UCL	Aquatic invertebrate
		mercury (total)	0.022	95% UCL	Aquatic invertebrate
		mercury (dissolved)	0.088	95% UCL	Aquatic invertebrate
	Sediment	chlorobenzene	1.1	maximum	Aquatic invertebrate
		naphthalene	2.3	maximum	Aquatic invertebrate
		bis(2-ethylhexyl)phthalate	43	95% UCL	Aquatic invertebrate
		mercury	70	95% UCL	Aquatic invertebrate
	Seep Water	1,2-dichlorobenzene	2.3	maximum	Aquatic invertebrate
		1,2-dichloroethane	1.3	maximum	Aquatic invertebrate
		1,2-dichloroethene,total	2.3	maximum	Aquatic invertebrate
		chlorobenzene	9.9	maximum	Aquatic invertebrate
		naphthalene	2.5	maximum	Aquatic invertebrate
		barium	727	average	Aquatic invertebrate
		beryllium	86	average	Aquatic invertebrate
		cadmium	233	average	Aquatic invertebrate
		chromium	5.0	average	Aquatic invertebrate
		cobalt	860	average	Aquatic invertebrate
		copper	33	average	Aquatic invertebrate
		lead	238	average	Aquatic invertebrate
		mercury	0.86	average	Aquatic invertebrate
		nickel	25	average	Aquatic invertebrate
		selenium	7	average	Aquatic invertebrate
		silver	37	average	Aquatic invertebrate
		vanadium	8.6	average	Aquatic invertebrate
		zinc	86	average	Aquatic invertebrate

SUMMARY OF PRELIMINARY ECOLOGICAL RISK ESTIMATES FOR RETAINED COPECs
B.F. GOODRICH SUPERFUND SITE
CALVERT CITY, KENTUCKY

Exposure Area	Medium	COPEC [1]	Quotient [2]	Basis	Receptor
Barge Slip (cont)	Pore Water	chlorobenzene	1.3	maximum	Aquatic invertebrate
		bis(2-ethylhexyl)phthalate	2.2	95% UCL	Aquatic invertebrate
		mercury (dissolved)	0.041	95% UCL	Aquatic invertebrate
		mercury (total)	14	95% UCL	Aquatic invertebrate
Ponds 1A/2	Combined (surface water, sediment and fish tissue)	mercury	4.9	geomean (NOAEL/LOAEL)	Great blue heron
Outfall 004 Ditch	Surface Water	bis(2-ethylhexyl)phthalate	2.7	95% UCL	Aquatic invertebrate
		mercury	0.65	95% UCL	Aquatic invertebrate
	Sediment	bis(2-ethylhexyl)phthalate	4.7	95% UCL	Aquatic invertebrate
		copper	1.5	95% UCL	Aquatic invertebrate
		mercury	82	95% UCL	Aquatic invertebrate
		nickel	1.2	95% UCL	Aquatic invertebrate
		zinc	2.0	95% UCL	Aquatic invertebrate
Terrestrial Habitat	Soil	tetrachloroethene	1.6	maximum	Soil invertebrate
		trichloroethene	1.5	maximum	Soil invertebrate
		barium	1.2	maximum	Soil invertebrate
		chromium	20	maximum	Soil invertebrate
		mercury	120	maximum	Soil invertebrate
		vanadium	3.1	maximum	Soil invertebrate
		zinc	1.2	maximum	Soil invertebrate
	Soil gas/Soil vapor	mercury	nc	-	-
	Combined (surface water, surface soil, earthworm tissue)	mercury	6.9	geomean (NOAEL/LOAEL)	American woodcock

Footnotes:

1. Retained COPECs are those remaining following screening and refinement evaluations for those analytes with risk quotients values exceed one. Mercury was retained for each medium where it was detected because of bioaccumulation hazard concerns.
2. Quotients (either narcosis or hazard) based on ratio of exposure term (see next column for basis) and toxicological benchmark.

nc - Not calculated due to lack of an appropriate toxcicological benchmark.

Table 1. Summary of Cancer Risk/Noncancer Hazards for the Industrial/Commercial Worker

Medium	Route	RME Cancer Risk	RME Noncancer HI	CTE Cancer Risk	CTE Noncancer HI
On-site Surface Soil (0-1 ft bgs)	Ingestion Dermal Inhalation	3.E-05	8.E-01	4.E-06	9.E-02
Barge Slip Surface Water(1)	Ingestion Dermal	5.E-08	3.E-04	NC	NC
Outfall Ditch Surface Water(1)	Dermal	9.E-08	8.E-06	NC	NC
Outfall Ditch Sediment	Dermal	3.E-08	6.E-05	NC	NC
Pond 1A 2 Surface Water(1)	Dermal	3.E-09	3.E-05	NC	NC
Outdoor Air	Inhalation	1.E-04	3.E+00	1.E-05	1.E+00
Total for Surface Water, Sediment, and Outdoor Air		**1E-04**	**3.E+00**	**1.E-05**	**1.E+00**

Note: Scientific notation such as 1.E-03 is equivalent to 0.001.

CTE – central tendency exposure scenario

HI – hazard index

NC – not calculated. Only the RME was evaluated for exposure to these environmental media due to the limited exposure time and frequency for surface water sediment exposures.

RME – reasonable maximum exposure scenario

(1) Baseline conditions cannot be assessed due to the presence of the PCAP system; therefore, the residual risk and hazard estimates are presented here for the COPCs identified in these environmental media.

Table 2. Detailed Summary of Cancer Risk for Exposure to Chemicals in Surface Soil for the Industrial/Commercial Worker

COPC	Ingestion	Dermal	Inhalation	Total Cancer Risk	Percent Contribution to Total Risk
1,1,2-Trichloroethane	2.E-09	NC	4.E-08	4.E-08	0.15%
1,1-Dichloroethane	1.E-10	NC	7.E-09	7.E-09	0.02%
1,1-Dichloroethene	NC	NC	NC	NC	--
1,2-Dichloroethane	1.E-07	NC	5.E-06	5.E-06	16%
1,2-Dichloroethene, Total	NC	NC	NC	NC	--
1,4-Dichlorobenzene	4.E-11	NC	4.E-09	4.E-09	0.01%
Benzene	1.E-09	NC	2.E-08	2.E-08	0.08%
Carbon Tetrachloride	5.E-10	NC	2.E-08	2.E-08	0.05%
Chloroform	NC	NC	NC	NC	--
Naphthalene	NC	NC	1.E-05	1.E-05	35%
Tetrachloroethene	7.E-11	NC	2.E-09	2.E-09	0.01%
Trichloroethene	4.E-10	NC	8.E-09	8.E-09	0.03%
Vinyl Chloride	1.E-08	NC	3.E-08	4.E-08	0.14%
Benzo[a]anthracene	5.E-07	5.E-07	3.E-11	1.E-06	3.5%
Benzo[a]pyrene	4.E-06	4.E-06	2.E-10	8.E-06	28%
Benzo[b]fluoranthene	4.E-07	5.E-07	3.E-11	9.E-07	3.1%
Benzo[k]fluoranthene	3.E-08	3.E-08	2.E-11	5.E-08	0.18%
Bis(2-ethylhexyl) Phthalate	1.E-07	1.E-07	8.E-12	2.E-07	0.72%
Chrysene	5.E-09	5.E-09	3.E-12	1.E-08	0.03%
Dibenzo[a,h]anthracene	2.E-07	2.E-07	1.E-11	4.E-07	1.5%
Indeno[1,2,3-cd]pyrene	2.E-07	2.E-07	1.E-11	4.E-07	1.4%
Arsenic	1.E-06	2.E-07	1.E-09	1.E-06	4.0%
Chromium	2.E-06	NC	1.E-07	2.E-06	5.5%
Cobalt	NC	NC	1.E-07	1.E-07	0.40%
Mercury	NC	NC	NC	NC	--
Total	**8.E-06**	**6.E-06**	**2.E-05**	**3.E-05**	--

Note: Scientific notation such as 1.E-03 is equivalent to 0.001.
NC – not calculated

Table 3. Summary of Risks/Hazards Associated with Maximum Concentrations Detected in Outdoor Air Samples

	RME		CTE		Percent Contribution(1)		Critical Effect/ Target Organ
Analyte	**Cancer Risk**	**Hazard Index**	**Cancer Risk**	**Hazard Index**	**RME Risk**	**RME Hazard**	
1,1,2-Trichloroethane	1.E-06	1.E+00	2.E-07	6.E-01	1.3%	43%	gastric symptoms, fat deposition in kidneys, and damage to the lungs(2)
1,1-Dichloroethane	2.E-06	NC	3.E-07	NC	2.1%	--	
1,2-Dichloroethane	9.E-05	1.E+00	1.E-05	7.E-01	84%	47%	CNS
1,2-Dichloroethene, Total	NC	7.E-03	NC	4.E-03	--	0.25%	CNS
Benzene	4.E-06	4.E-02	5.E-07	2.E-02	3.5%	1.5%	Blood
Carbon Tetrachloride	5.E-06	2.E-02	7.E-07	1.E-02	4.5%	0.76%	Liver
Chloroethane	NC	1.E-03	NC	5.E-04	--	0.03%	Developmental
Chloroform	NC	2.E-02	NC	1.E-02	--	0.77%	Liver
Toluene	NC	8.E-05	NC	4.E-05	--	0.00%	CNS
Trichloroethene	5.E-07	2.E-01	7.E-08	9.E-02	0.50%	6.2%	CNS
Vinyl Chloride	4.E-06	2.E-02	5.E-07	1.E-02	3.7%	0.84%	Liver
Xylenes, Total	NC	4.E-03	NC	2.E-03	--	0.15%	CNS
Site Total	**1.E-04**	**3.E+00**	**1.E-05**	**1.E+00**	--	--	
						HI CNS	**2.E+00**
						HI Blood	**4.E-02**
						HI Liver	**7.E-02**
						HI Developmental	**1.E-03**

Note: Scientific notation such as 1.E-03 is equivalent to 0.001.

CNS – central nervous system

CTE – central tendency exposure scenario

NC – not calculated

RME – reasonable maximum exposure scenario

(1) Percent contribution is based on the RME results.

(2) Available data do not permit determination of primary target organs. Long-term human exposure to 1,1,2-trichloroethane vapor has been reported to cause chronic gastric symptoms, fat deposition in the kidneys, and damage to the lungs. In animals, short-term exposure to high concentrations has produced central nervous system depression as well as liver and kidney damage (Oak Ridge National Laboratory and The University of Tennessee, 2015)

Table 4. Summary of Risks/Hazards Associated with Vapor Intrusion

Building Where Indoor Air Samples Collected	RME Indoor Air		CTE Indoor Air	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
Building 1	1.E-04	2.E+00	2.E-05	9.E-01
Building 2	5.E-04	2.E+01	7.E-05	8.E+00
Building 3	2.E-04	3.E+00	3.E-05	2.E+00
Building 4	2.E-05	1.E+00	3.E-06	6.E-01
Building 5	3.E-04	3.E+00	4.E-05	1.E+00
Building 6	6.E-05	8.E-01	8.E-06	4.E-01
Building 7	2.E-05	1.E+00	3.E-06	7.E-01
Building 8	4.E-05	4.E-01	5.E-06	2.E-01
Building 9	6.E-05	9.E-01	9.E-06	4.E-01
Building 10	1.E-05	2.E-01	2.E-06	1.E-01
Building 11	9.E-07	2.E-02	1.E-07	1.E-02
Building 12	1.E-06	1.E-02	1.E-07	7.E-03
Building 13	8.E-07	9.E-03	1.E-07	5.E-03

Note: Scientific notation such as 1.E-03 is equivalent to 0.001.
CTE – central tendency exposure scenario
RME – reasonable maximum exposure scenario

Table 5. Percent Contribution for RME Indoor Air Risks at Buildings 1, 2, 3, and 5

Building Where Air Samples Collected	COPC Measured in Building	Cancer Risk	Percent Contribution[1]	Noncancer Hazard	Percent Contribution[1]
Building 1	1,2-Dichloroethane	1.E-04	97%	2.E+00	97%
	Benzene	6.E-07	0.54%	8.E-03	0.42%
	Carbon Tetrachloride	6.E-07	0.54%	3.E-03	0.16%
	Chloroform	NC	--	5.E-03	0.26%
	Methylene Chloride	2.E-09	0.00%	8.E-04	0.04%
	Tetrachloroethene	6.E-08	0.05%	2.E-02	0.85%
	Toluene	NC	--	9.E-05	0.01%
	Vinyl Chloride	3.E-06	2.1%	2.E-02	0.90%
	Xylenes, Total	NC	--	2.E-03	0.12%
	Exp. Route Total	**1.E-04**		**2.E+00**	
Building 2	1,1,2-Trichloroethane	9.E-06	1.9%	8.E+00	52%
	1,1-Dichloroethane	6.E-06	1.3%	NC	--
	1,1-Dichloroethene	NC	--	5.E-03	0.03%
	1,2-Dichloroethane	4.E-04	86%	6.E+00	42%
	1,2-Dichloroethene, Total	NC	--	1.E-02	0.07%
	Benzene	1.E-05	2.1%	1.E-01	0.78%
	Carbon Tetrachloride	3.E-05	6.0%	1.E-01	0.86%
	Chloroethane	NC	--	1.E-03	0.01%
	Chloroform	NC	--	1.E-01	0.73%
	Trichloroethene	1.E-06	0.31%	5.E-01	3.3%
	Vinyl Chloride	1.E-05	2.1%	6.E-02	0.41%
	Exp. Route Total	**5.E-04**		**2.E+01**	
Building 3	1,1-Dichloroethane	4.E-06	1.7%	NC	--
	1,1-Dichloroethene	NC	--	2.E-03	0.07%
	1,2-Dichloroethane	2.E-04	83%	3.E+00	83%
	1,2-Dichloroethene, Total	NC	--	6.E-03	0.19%
	Benzene	7.E-06	3.2%	8.E-02	2.5%
	Carbon Tetrachloride	2.E-05	7.6%	8.E-02	2.3%
	Chloroethane	NC	--	7.E-04	0.02%
	Chloroform	NC	--	5.E-02	1.5%
	Methylene Chloride	3.E-09	0.00%	1.E-03	0.03%
	Toluene	NC	--	1.E-04	0.00%
	Trichloroethene	9.E-07	0.40%	3.E-01	8.8%
	Vinyl Chloride	8.E-06	3.6%	5.E-02	1.5%
	Xylenes, Total	NC	--	4.E-03	0.11%
	Exp. Route Total	**2.E-04**		**3.E+00**	
Building 5	1,1-Dichloroethane	2.E-07	0.05%	NC	--
	1,1-Dichloroethene	NC	--	2.E-03	0.07%
	1,2-Dichloroethane	2.E-04	50%	2.E+00	92%
	1,2-Dichloroethene, Total	NC	--	1.E-02	0.37%
	1,4-Dichlorobenzene	1.E-04	45%	5.E-02	1.7%
	Benzene	2.E-06	0.64%	2.E-02	0.92%
	Carbon Tetrachloride	7.E-06	2.3%	3.E-02	1.3%
	Chloroethane	NC	--	9.E-04	0.04%
	Chloroform	NC	--	5.E-02	1.8%
	Methylene Chloride	2.E-09	0.00%	8.E-04	0.03%
	Toluene	NC	--	8.E-05	0.00%
	Vinyl Chloride	7.E-06	2.1%	4.E-02	1.6%
	Xylenes, Total	NC	--	3.E-03	0.11%
	Exp. Route Total	**3.E-04**		**3.E+00**	

Note: Scientific notation such as 1.E-03 is equivalent to 0.001.

NC – not calculated

(1) The result, 0.00%, indicates percent contribution for COPC is less than 0.01%.

Table 6. Summary of Cancer Risk/Noncancer Hazards for the Adolescent Recreational User

Medium	Route	Cancer Risk	Noncancer HI
Tennessee River Surface Water (1)	Ingestion Dermal Inhalation	1.E-05	8.E-02
Tennessee River Sediment	Ingestion Dermal	1.E-04	2.E-01
	Total	**1.E-04**	**3.E-01**
Tennessee River Finfish	Ingestion	2.E-05	4.E-01
Tennessee River Shellfish	Ingestion	1.E-05	3.E-01

HI – hazard index

(1) Baseline conditions cannot be assessed due to the presence of the PCAP system; therefore, the residual risk and hazard estimates are presented here for the COPCs identified in these environmental media.

Table 7. Summary of Cancer Risk/Noncancer Hazards for the Adult Recreational User

Medium	Route	Cancer Risk	Noncancer HI
Tennessee River Surface Water (1)	Ingestion Dermal Inhalation	6.E-06	8.E-02
Tennessee River Sediment	Ingestion Dermal	4.E-05	1.E-01
	Total	**4.E-05**	**2E-01**
Tennessee River Finfish(2)	Ingestion	7.E-05	4.E-01
Tennessee River Shellfish(2)	Ingestion	4.E-05	3.E-01

HI – hazard index

(1) Baseline conditions cannot be assessed due to the presence of the PCAP system; therefore, the residual risk and hazard estimates are presented here for the COPCs identified in these environmental media.

(2) Cancer risks and noncancer HI provided for an age-adjusted adult child receptor.

Table 8. Summary of Cancer Risk/Noncancer Hazards for the Adolescent Trespasser

Medium	Route	Cancer Risk	Noncancer HI
Tennessee River Seeps(1)	Ingestion Dermal Inhalation	6.E-03	5.E+02

HI – hazard index

(1) Baseline conditions cannot be assessed due to the presence of the PCAP system; therefore, the residual risk and hazard estimates are presented here for the COPCs identified in these environmental media. See Section 4.6.2 for discussion of uncertainties associated with residual risk/hazard results and presence of the PCAP.

Table 9. Detailed Summary of Cancer Risk for Exposure to Chemicals in Seeps for the Adolescent Trespasser

COPC	Ingestion	Dermal Contact	Inhalation	Total	Percent Contribution to Total Cancer Risk(1)
1,1,2,2-Tetrachloroethane	8.E-09	5.E-08	9.E-07	9.E-07	0.02%
1,1,2-Trichloroethane	1.E-06	6.E-06	2.E-04	2.E-04	2.7%
1,1-Dichloroethane	3.E-08	1.E-07	5.E-06	5.E-06	0.08%
1,1-Dichloroethene	NC	NC	NC	NC	--
1,2-Dichlorobenzene	NC	NC	NC	NC	--
1,2-Dichloroethane	4.E-05	1.E-04	5.E-03	5.E-03	93%
1,2-Dichloroethene, Total	NC	NC	NC	NC	--
1,3-Dichlorobenzene	NC	NC	NC	NC	--
Benzene	1.E-07	1.E-06	1.E-05	1.E-05	0.24%
Chlorobenzene	NC	NC	NC	NC	--
Chloroform	NC	NC	NC	NC	--
Naphthalene	NC	NC	8.E-06	8.E-06	0.13%
Styrene	NC	NC	NC	NC	--
Tetrachloroethene	5.E-09	2.E-07	2.E-07	4.E-07	0.01%
Toluene	NC	NC	NC	NC	--
Trichloroethene	2.E-07	2.E-06	1.E-05	1.E-05	0.23%
Vinyl Chloride	2.E-05	8.E-05	6.E-05	2.E-04	2.7%
Xylenes, Total	NC	NC	NC	NC	--
2-Methylnaphthalene	NC	NC	NC	NC	--
Bis(2-chloroethyl) Ether	2.E-07	3.E-07	5.E-06	6.E-06	0.10%
Bis(2-ethylhexyl) Phthalate	3.E-11	3.E-09	NC	3.E-09	0.00%
Arsenic	2.E-07	8.E-08	NC	2.E-07	0.00%
Barium	NC	NC	NC	NC	--
Beryllium	NC	NC	NC	NC	--
Cadmium	NC	NC	NC	NC	--
Chromium	2.E-07	3.E-05	NC	3.E-05	0.52%
Cobalt	NC	NC	NC	NC	--
Lead	NC	NC	NC	NC	--
Mercury	NC	NC	NC	NC	--
Nickel	NC	NC	NC	NC	--
Vanadium	NC	NC	NC	NC	--
Total	**5.E-05**	**2.E-04**	**6.E-03**	**6.E-03**	

NC – not calculated

(1) The result, 0.00%, indicates percent contribution for COPC is less than 0.01%. Risk/hazard is presented as one significant figure; therefore, rounding issues may result in percent contributions not precisely matching if calculations performed by hand because percent contributions performed in Excel®.

Table 10. Detailed Summary of Noncancer Hazard for Exposure to Chemicals in Seeps for the Adolescent Trespasser

COPC	Ingestion	Dermal Contact	Inhalation	Total	Percent Contribution to Total Hazard(1)
1,1,2,2-Tetrachloroethane	1.E-05	1.E-04	NC	1.E-04	0.00%
1,1,2-Trichloroethane	4.E-02	2.E-01	3.E+02	3.E+02	60%
1,1-Dichloroethane	2.E-04	9.E-04	NC	9.E-04	0.00%
1,1-Dichloroethene	1.E-04	9.E-04	1.E-02	2.E-02	0.00%
1,2-Dichlorobenzene	7.E-05	3.E-03	1.E-02	2.E-02	0.00%
1,2-Dichloroethane	5.E-01	1.E+00	2.E+02	2.E+02	38%
1,2-Dichloroethene, Total	2.E-03	1.E-02	4.E-02	5.E-02	0.01%
1,3-Dichlorobenzene	NC	NC	NC	NC	--
Benzene	5.E-03	4.E-02	4.E-01	4.E-01	0.08%
Chlorobenzene	7.E-04	1.E-02	1.E-01	2.E-01	0.03%
Chloroform	5.E-03	2.E-02	2.E-01	2.E-01	0.04%
Naphthalene	2.E-04	7.E-03	5.E-01	5.E-01	0.10%
Styrene	1.E-06	4.E-05	1.E-04	2.E-04	0.00%
Tetrachloroethene	3.E-03	8.E-02	2.E-01	3.E-01	0.05%
Toluene	2.E-05	4.E-04	2.E-04	6.E-04	0.00%
Trichloroethene	5.E-02	5.E-01	6.E+00	7.E+00	1.2%
Vinyl Chloride	2.E-02	9.E-02	3.E-01	4.E-01	0.08%
Xylenes, Total	1.E-06	5.E-05	1.E-03	1.E-03	0.00%
2-Methylnaphthalene	2.E-02	1.E+00	NC	1.E+00	0.22%
Bis(2-chloroethyl) Ether	NC	NC	NC	NC	--
Bis(2-ethylhexyl) Phthalate	8.E-07	8.E-05	NC	8.E-05	0.00%
Arsenic	2.E-03	1.E-03	NC	1.E-03	0.00%
Barium	3.E-05	2.E-04	NC	2.E-04	0.00%
Beryllium	6.E-05	5.E-03	NC	5.E-03	0.00%
Cadmium	1.E-04	1.E-03	NC	1.E-03	0.00%
Chromium	1.E-03	5.E-02	NC	5.E-02	0.01%
Cobalt	8.E-03	2.E-03	NC	2.E-03	0.00%
Lead	NC	NC	NC	NC	--
Mercury	2.E-03	1.E-02	6.E-01	7.E-01	0.12%
Nickel	1.E-04	3.E-04	NC	3.E-04	0.00%
Vanadium	7.E-04	1.E-02	NC	1.E-02	0.00%
Total	**6.E-01**	**4.E+00**	**5.E+02**	**5.E+02**	

NC - not calculated

(1) The result, 0.00%, indicates percent contribution for COPC is less than 0.01%. Risk/hazard is presented as one significant figure; therefore, rounding issues may result in percent contributions not precisely matching if calculations performed by hand because percent contributions performed in Excel®.

Table 11. Summary of Cancer Risk/Noncancer Hazards for the Construction Worker

Medium	Route	Cancer Risk	Noncancer HI
Subsurface Soil	Ingestion Dermal Inhalation	1.E-05	6.E+01

HI – hazard index

Table 12. Detailed Summary of Cancer Risk for Exposure to Chemicals in Soil for the Construction Worker

COPC	Ingestion	Dermal	Inhalation	Total	Percent Contribution to Total Risk
1,1,2,2-Tetrachloroethane	2.E-07	NC	3.E-07	4.E-07	3.1%
1,1,2-Trichloroethane	8.E-07	NC	2.E-06	3.E-06	23%
1,1-Dichloroethane	7.E-09	NC	8.E-08	8.E-08	0.58%
1,1-Dichloroethene	NC	NC	NC	NC	--
1,2-Dichloroethane	2.E-06	NC	8.E-06	1.E-05	68%
1,2-Dichloroethene, Total	NC	NC	NC	NC	--
1,3-Dichlorobenzene	NC	NC	NC	NC	--
1,4-Dichlorobenzene	3.E-12	NC	5.E-11	5.E-11	0.00%
Benzene	2.E-08	NC	6.E-08	8.E-08	0.55%
Carbon Tetrachloride	1.E-08	NC	7.E-08	8.E-08	0.55%
Chlorobenzene	NC	NC	NC	NC	--
Chloroform	NC	NC	NC	NC	--
Ethylbenzene	9.E-12	NC	3.E-11	4.E-11	0.00%
Naphthalene	NC	NC	6.E-09	6.E-09	0.04%
Tetrachloroethene	1.E-09	NC	5.E-09	7.E-09	0.05%
Trichloroethene	1.E-08	NC	5.E-08	6.E-08	0.41%
Vinyl Chloride	5.E-08	NC	3.E-08	8.E-08	0.57%
1,2,3,4-Tetrachlorobenzene	NC	NC	NC	NC	--
1,2,4,5-Tetrachlorobenzene	NC	NC	NC	NC	--
1,2,4-Trichlorobenzene	2.E-10	NC	NC	2.E-10	0.00%
2-Methylnaphthalene	NC	NC	NC	NC	--
Benzo[a]anthracene	4.E-09	2.E-09	4.E-14	6.E-09	0.04%
Benzo[a]pyrene	4.E-08	1.E-08	3.E-13	5.E-08	0.34%
Benzo[b]fluoranthene	4.E-09	2.E-09	4.E-14	6.E-09	0.04%
Benzo[k]fluoranthene	2.E-10	8.E-11	2.E-14	3.E-10	0.00%
Bis(2-ethylhexyl) Phthalate	5.E-10	2.E-10	5.E-15	7.E-10	0.00%
Bis(2-chloroethyl) Ether	6.E-08	NC	3.E-08	9.E-08	0.60%
Chrysene	4.E-11	2.E-11	4.E-15	6.E-11	0.00%
Dibenzo[a,h]anthracene	1.E-09	6.E-10	1.E-14	2.E-09	0.01%
Hexachlorobenzene	2.E-07	7.E-08	4.E-12	3.E-07	2.1%
Indeno[1,2,3-cd]pyrene	2.E-09	7.E-10	1.E-14	2.E-09	0.02%
Pentachlorobenzene	NC	NC	NC	NC	--
Arsenic	2.E-08	2.E-09	4.E-12	2.E-08	0.16%
Chromium	5.E-08	NC	5.E-10	5.E-08	0.37%
Cobalt	NC	NC	7.E-11	7.E-11	0.00%
Copper	NC	NC	NC	NC	--
Cyanide	NC	NC	NC	NC	--
Mercury	NC	NC	NC	NC	--
Total	3.E-06	1.E-07	1.E-05	1.E-05	

NC – not calculated

(1) The result, 0.00%, indicates percent contribution for COPC is less than 0.01%. Risk hazard is presented as one significant figure; therefore, rounding issues may result in percent contributions not precisely matching if calculations performed by hand because percent contributions performed in Excel® along with the Excel® risk hazard calculations.

Table 13. Detailed Summary of Noncancer Hazards for Exposure to Chemicals in Soil for the Construction Worker

COPC	Ingestion	Dermal	Inhalation	Total	Percent Contribution to Total Hazard
1,1,2,2-Tetrachloroethane	3.E-03	NC	NC	3.E-03	0.01%
1,1,2-Trichloroethane	2.E-01	NC	5.E+01	5.E+01	93%
1,1-Dichloroethane	4.E-04	NC	NC	4.E-04	0.00%
1,1-Dichloroethene	9.E-06	NC	2.E-04	2.E-04	0.00%
1,2-Dichloroethane	2.E-01	NC	3.E+00	3.E+00	5.7%
1,2-Dichloroethene, Total	3.E-02	NC	3.E-02	6.E-02	0.10%
1,3-Dichlorobenzene	NC	NC	NC	NC	--
1,4-Dichlorobenzene	6.E-07	NC	4.E-07	1.E-06	0.00%
Benzene	6.E-03	NC	2.E-02	2.E-02	0.04%
Carbon Tetrachloride	4.E-03	NC	8.E-03	1.E-02	0.02%
Chlorobenzene	1.E-03	NC	7.E-03	9.E-03	0.01%
Chloroform	4.E-02	NC	1.E-01	2.E-01	0.31%
Ethylbenzene	5.E-07	NC	8.E-07	1.E-06	0.00%
Naphthalene	4.E-04	1.E-04	4.E-03	5.E-03	0.01%
Tetrachloroethene	7.E-03	NC	4.E-02	4.E-02	0.07%
Trichloroethene	4.E-02	NC	4.E-01	4.E-01	0.73%
Vinyl Chloride	2.E-03	NC	4.E-03	6.E-03	0.01%
1,2,3,4-Tetrachlorobenzene	NC	NC	NC	NC	--
1,2,4,5-Tetrachlorobenzene	1.E-03	5.E-04	NC	2.E-03	0.00%
1,2,4-Trichlorobenzene	6.E-05	NC	8.E-04	8.E-04	0.00%
2-Methylnaphthalene	9.E-04	4.E-04	NC	1.E-03	0.00%
Benzo[a]anthracene	NC	NC	NC	NC	--
Benzo[a]pyrene	NC	NC	NC	NC	--
Benzo[b]fluoranthene	NC	NC	NC	NC	--
Benzo[k]fluoranthene	NC	NC	NC	NC	--
Bis(2-ethylhexyl) Phthalate	1.E-04	4.E-05	NC	2.E-04	0.00%
Bis(2-chloroethyl) Ether	NC	NC	NC	NC	--
Chrysene	NC	NC	NC	NC	--
Dibenzo[a,h]anthracene	NC	NC	NC	NC	--
Hexachlorobenzene	1.E-02	4.E-03	NC	2.E-02	0.03%
Indeno[1,2,3-cd]pyrene	NC	NC	NC	NC	--
Pentachlorobenzene	3.E-03	1.E-03	NC	4.E-03	0.01%
Arsenic	3.E-03	3.E-04	4.E-06	4.E-03	0.01%
Chromium	2.E-03	NC	4.E-06	2.E-03	0.00%
Cobalt	3.E-02	NC	9.E-05	3.E-02	0.05%
Copper	8.E-04	NC	NC	8.E-04	0.00%
Cyanide	4.E-04	NC	2.E-08	4.E-04	0.00%
Mercury	9.E-03	NC	5.E-07	9.E-03	0.02%
Total	7.E-01	6.E-03	6.E+01	6.E+01	

NC – not calculated

(1) The result, 0.00%, indicates percent contribution for COPC is less than 0.01%. Risk hazard is presented as one significant figure; therefore, rounding issues may result in percent contributions not precisely matching if calculations performed by hand because percent contributions performed in Excel®.

Table 14. Summary of Cancer Risk/Noncancer Hazards for the Hypothetical Resident

Medium	Route	Cancer Risk	Noncancer HI
Subsurface Soil (0-10 ft bgs)	Ingestion Dermal Inhalation	2.E-02	3.E+03

HI – hazard index

Note: Cancer risk and noncancer hazard provided for the age-adjusted resident (i.e., 6 years as a child and 20 years as an adult for a total 26-year exposure time period)

Table 15. Detailed Summary of Cancer Risk for Exposure to Chemicals in Subsurface Soil for the Residential Receptor(1)

COPC	Ingestion	Dermal	Inhalation	Total Cancer Risk	Percent Contribution to Total Risk(2)
1,1,2,2-Tetrachloroethane	8.E-05	NC	4.E-04	5.E-04	1.9%
1,1,2-Trichloroethane	4.E-04	NC	3.E-03	4.E-03	16%
1,1-Dichloroethane	3.E-06	NC	1.E-04	1.E-04	0.46%
1,1-Dichloroethene	NC	NC	NC	NC	--
1,2-Dichloroethane	7.E-04	NC	1.E-02	1.E-02	51%
1,2-Dichloroethene, Total	NC	NC	NC	NC	--
1,3-Dichlorobenzene	NC	NC	NC	NC	--
1,4-Dichlorobenzene	1.E-09	NC	7.E-08	7.E-08	0.00%
Benzene	8.E-06	NC	8.E-05	9.E-05	0.39%
Carbon Tetrachloride	6.E-06	NC	9.E-05	1.E-04	0.41%
Chlorobenzene	NC	NC	NC	NC	--
Chloroform	NC	NC	6.E-03	6.E-03	26%
Ethylbenzene	4.E-09	NC	4.E-08	4.E-08	0.00%
Naphthalene	NC	NC	8.E-06	8.E-06	0.04%
Tetrachloroethene	6.E-07	NC	7.E-06	8.E-06	0.03%
Trichloroethene	1.E-05	NC	9.E-05	1.E-04	0.43%
Vinyl Chloride	1.E-04	NC	1.E-04	2.E-04	0.93%
1,2,3,4-Tetrachlorobenzene	NC	NC	NC	NC	--
1,2,4,5-Tetrachlorobenzene	NC	NC	NC	NC	--
1,2,4-Trichlorobenzene	1.E-07	NC	NC	1.E-07	0.00%
2-Methylnaphthalene	NC	NC	NC	NC	--
Benzo[a]anthracene	8.E-06	3.E-06	1.E-10	1.E-05	0.05%
Benzo[a]pyrene	7.E-05	3.E-05	1.E-09	1.E-04	0.42%
Benzo[b]fluoranthene	9.E-06	3.E-06	1.E-10	1.E-05	0.05%
Benzo[k]fluoranthene	4.E-07	1.E-07	7.E-11	6.E-07	0.00%
Bis(2-ethylhexyl) Phthalate	2.E-07	7.E-08	7.E-12	3.E-07	0.00%
Bis(2-chloroethyl) Ether	2.E-05	NC	4.E-05	7.E-05	0.29%
Chrysene	8.E-08	3.E-08	1.E-11	1.E-07	0.00%
Dibenzo[a,h]anthracene	3.E-06	1.E-06	6.E-11	4.E-06	0.02%
Hexachlorobenzene	1.E-04	3.E-05	5.E-09	1.E-04	0.56%
Indeno[1,2,3-cd]pyrene	3.E-06	1.E-06	6.E-11	5.E-06	0.02%
Pentachlorobenzene	NC	NC	NC	NC	--
Arsenic	1.E-05	8.E-07	5.E-09	1.E-05	0.04%
Chromium	1.E-04	NC	2.E-06	1.E-04	0.46%
Cobalt	NC	NC	1.E-07	1.E-07	0.00%
Copper	NC	NC	NC	NC	--
Cyanide	NC	NC	NC	NC	--
Mercury	NC	NC	NC	NC	--
Total	2.E-03	6.E-05	2.E-02	2.E-02	

NC –not calculated

(1) Values reported for the age-adjusted adult child receptor.

(2) The result, 0.00%, indicates percent contribution for COPC is less than 0.01%. Risk hazard is presented as one significant figure; therefore, rounding issues may result in percent contributions not precisely matching if calculations performed by hand because percent contributions performed in Excel®.

Table 16. Detailed Summary of Noncancer Hazard for Exposure to Chemicals in Subsurface Soil for the Residential Receptor(1)

COPC	Ingestion	Dermal	Inhalation	Total	Percent Contribution to HI(1)
1,1,2,2-Tetrachloroethane	5.E-02	NC	NC	5.E-02	0.00%
1,1,2-Trichloroethane	4.E+00	NC	3.E+03	3.E+03	93%
1,1-Dichloroethane	7.E-03	NC	NC	7.E-03	0.00%
1,1-Dichloroethene	2.E-04	NC	8.E-03	8.E-03	0.00%
1,2-Dichloroethane	4.E+00	NC	2.E+02	2.E+02	5.5%
1,2-Dichloroethene, Total	5.E-01	NC	2.E+00	2.E+00	0.07%
1,3-Dichlorobenzene	NC	NC	NC	NC	--
1,4-Dichlorobenzene	1.E-05	NC	2.E-05	3.E-05	0.00%
Benzene	1.E-01	NC	1.E+00	1.E+00	0.03%
Carbon Tetrachloride	6.E-02	NC	4.E-01	5.E-01	0.02%
Chlorobenzene	3.E-02	NC	4.E-01	4.E-01	0.01%
Chloroform	7.E-01	NC	7.E+00	8.E+00	0.26%
Ethylbenzene	9.E-06	NC	4.E-05	5.E-05	0.00%
Naphthalene	6.E-03	2.E-03	2.E-01	2.E-01	0.01%
Tetrachloroethene	1.E-01	NC	2.E+00	2.E+00	0.07%
Trichloroethene	7.E-01	NC	2.E+01	2.E+01	0.69%
Vinyl Chloride	3.E-02	NC	2.E-01	3.E-01	0.01%
1,2,3,4-Tetrachlorobenzene	NC	NC	NC	NC	--
1,2,4,5-Tetrachlorobenzene	3.E-02	7.E-03	NC	3.E-02	0.00%
1,2,4-Trichlorobenzene	1.E-03	NC	4.E-02	4.E-02	0.00%
2-Methylnaphthalene	1.E-02	5.E-03	NC	2.E-02	0.00%
Benzo[a]anthracene	NC	NC	NC	NC	--
Benzo[a]pyrene	NC	NC	NC	NC	--
Benzo[b]fluoranthene	NC	NC	NC	NC	--
Benzo[k]fluoranthene	NC	NC	NC	NC	--
Bis(2-ethylhexyl) Phthalate	2.E-03	6.E-04	NC	3.E-03	0.00%
Bis(2-chloroethyl) Ether	NC	NC	NC	NC	--
Chrysene	NC	NC	NC	NC	--
Dibenzo[a,h]anthracene	NC	NC	NC	NC	--
Hexachlorobenzene	2.E-01	6.E-02	NC	3.E-01	0.01%
Indeno[1,2,3-cd]pyrene	NC	NC	NC	NC	--
Pentachlorobenzene	5.E-02	2.E-02	NC	7.E-02	0.00%
Arsenic	6.E-02	5.E-03	2.E-04	6.E-02	0.00%
Chromium	4.E-02	NC	2.E-04	4.E-02	0.00%
Cobalt	5.E-01	NC	5.E-03	6.E-01	0.02%
Copper	1.E-02	NC	NC	1.E-02	0.00%
Cyanide	7.E-03	NC	9.E-07	7.E-03	0.00%
Mercury	2.E-01	NC	3.E-05	2.E-01	0.01%
Total	1.E+01	1.E-01	3.E+03	3.E+03	

NC – not calculated

(1) The result, 0.00%, indicates percent contribution for COPC is less than 0.01%. Risk hazard is presented as one significant figure; therefore, rounding issues may result in percent contributions not precisely matching if calculations performed by hand because percent contributions performed in Excel® along with the Excel® risk hazard calculations.

APPENDIX E

REMEDIAL ALTERNATIVE COSTING TABLES

On-Shore Source Area Remedial Alternative SC3a

Technology	Quantity	Measure	Unit Cost	Extended Cost	Source
Capital Costs					
Backfill Pond 1A and Pond 2	218,000	cy	$25	$5,450,000	RSMeans/Engineering Estimate
Dredge Barge Slip	4,743	cy	$150	$711,389	Engineering Estimate
Barge Slip Sediment Dewatering/Treatment	1,897	cy	$150	$284,556	Engineering Estimate
Barge Slip Disposal - Hazardous	3,557	cy	$300	$1,067,083	Engineering Estimate
Barge Slip Disposal - Non Hazardous	1,186	cy	$100	$118,565	Engineering Estimate
Barge Slip backfill	4,743	cy	$35	$166,005	Engineering Estimate
Barge Slip Habitat Restoration	1	ea	$50,000	$50,000	Engineering Estimate
Outfall ditch relining	2,000	ft	$100	$200,000	Engineering Estimate
Outfall ditch excavation	370	cy	$25	$9,259	Engineering Estimate
Outfall Ditch sediment disposal	370	cy	$100	$37,000	Engineering Estimate
Pump and Treat	36,792	1,000 gal/yr	$94	$3,468,014	USEPA (2001)
Complete Barrier Wall - Sheet pile	214,175	sf	$47	$9,959,138	Average of contractor quotes
Complete Barrier Wall - Jet grout	64,700	sf	$127	$8,184,550	Average of contractor quotes
Complete Barrier Wall - Cement Bentonite	63,200	sf	$20	$1,264,000	Average of contractor quotes
Complete Barrier Wall - Soil Bentonite	1,133,200	sf	$14	$15,864,800	Average of contractor quotes
Contingency (Bid, 10% + Scope, 20%)	30	%	$46,834,358	$14,050,307	USEPA OSWER (2000)
PM/Design/Technical Services	17	%	$60,884,666	$10,350,393	USEPA OSWER (2000)
TOTAL CAPITAL COST				$71,235,059	
Annual O&M Costs					
Pump and Treat, Annual O&M	36,792	LS	$10	$367,920	USEPA (2001)
LTM/ICs	1	yr	$250,000	$250,000	Internal estimate
Contingency (Bid, 10% + Scope, 20%)	30	%	$617,920	$185,376	USEPA OSWER (2000)
PM/Technical Services (5% + 10%)	15	%	$803,296	$120,494	USEPA OSWER (2000)
SUBTOTAL ANNUAL O&M COST				$923,790	
TOTAL O&M COST	100	yr	$923,790	$92,379,040	
TOTAL COST				**$163,614,099**	
NPV (7%)				**$84,416,856**	

On-Shore Source Area Remedial Alternative SC5a

Technology	Quantity	Measure	Unit Cost	Extended Cost	Source
Capital Costs					
Backfill Pond 1A and Pond 2	218,000	cy	$25	$5,450,000	RSMeans/Engineering Estimtae
Dredge Barge Slip	4,743	cy	$150	$711,389	Engineering Estimate
Barge Slip Sediment Dewatering/Treatment	1,897	cy	$150	$284,556	Engineering Estimate
Barge Slip Disposal - Hazardous	3,557	cy	$300	$1,067,083	Engineering Estimate
Barge Slip Disposal - Non Hazardous	1,186	cy	$100	$118,565	Engineering Estimate
Barge Slip backfill	4,743	cy	$35	$166,005	Engineering Estimate
Barge Slip Habitat Restoration	1	ea	$50,000	$50,000	Engineering Estimate
Outfall ditch relining	2,000	ft	$100	$200,000	Engineering Estimate
Outfall ditch excavation	370	cy	$25	$9,259	Engineering Estimate
Outfall Ditch sediment disposal	370	cy	$100	$37,000	Engineering Estimate
ISTT	1,443,191	cy	$200	$288,638,200	NAVFAC ESC (2007)
In-situ S/S (Hg areas)	26,100	cy	$180	$4,698,000	USEPA (2004a)
Pump and Treat	36,792	1,000 gal/yr	$94	$3,468,014	USEPA (2001)
Complete Barrier Wall - Sheet pile	214,175	sf	$47	$9,959,138	Average of contractor quotes
Complete Barrier Wall - Jet grout	64,700	sf	$127	$8,184,550	Average of contractor quotes
Complete Barrier Wall - Cement Bentonite	63,200	sf	$20	$1,264,000	Average of contractor quotes
Complete Barrier Wall - Soil Bentonite	1,133,200	sf	$14	$15,864,800	Average of contractor quotes
Contingency (Bid, 10% + Scope, 25%)	35	%	$340,170,558	$119,059,695	USEPA OSWER (2000)
PM/Design/Technical Services	17	%	$459,230,254	$78,069,143	USEPA OSWER (2000)
			TOTAL CAPITAL COST	$537,299,397	
Annual O&M Costs					
Pump and Treat, Annual O&M	36,792	LS	$17	$625,464	USEPA (2001)
LTM/ICs	1	yr	$250,000	$250,000	Internal estimate
Contingency (Bid, 10% + Scope, 20%)	30	%	$875,464	$262,639	USEPA OSWER (2000)
PM/Technical Services (5% + 10%)	15	%	$1,138,103	$170,715	USEPA OSWER (2000)
			SUBTOTAL ANNUAL O&M COST	$1,308,819	
TOTAL O&M COST	100	yr	$1,308,819	$130,881,868	
			TOTAL COST	**$668,181,265**	
			NPV (7%)	**$555,975,259**	

On-Shore Source Area Remedial Alternative SC6

Technology	Quantity	Measure	Unit Cost	Extended Cost	Source
Capital Costs					
Backfill Pond 1A and Pond 2	218,000	cy	$25	$5,450,000	RSMeans/Engineering Estimtae
Dredge Barge Slip	4,743	cy	$150	$711,389	Engineering Estimate
Barge Slip Sediment Dewatering/Treatment	1,897	cy	$150	$284,556	Engineering Estimate
Barge Slip Disposal - Hazardous	3,557	cy	$300	$1,067,083	Engineering Estimate
Barge Slip Disposal - Non Hazardous	1,186	cy	$100	$118,565	Engineering Estimate
Barge Slip backfill	4,743	cy	$35	$166,005	Engineering Estimate
Barge Slip Habitat Restoration	1	ea	$50,000	$50,000	Engineering Estimate
Outfall ditch relining	2,000	ft	$100	$200,000	Engineering Estimate
Outfall ditch excavation	370	cy	$25	$9,259	Engineering Estimate
Outfall Ditch sediment disposal	370	cy	$100	$37,000	Engineering Estimate
ISTT	2,453,000	cy	$200	$490,600,000	NAVFAC ESC (2007)
In-situ S/S (Hg areas)	26,100	cy	$180	$4,698,000	USEPA (2004a)
ISCO	1,092,600	cy	$106	$115,815,600	Krembs, et. al. (2010)
Pump and Treat (ISCO recirculation)	81,994	1,000 gal/yr	$64	$5,269,729	USEPA (2001)
PRB	58,356	cy	$2,508	$146,355,733	FRTR (Screening Matrix 4.0)
Contingency (Bid, 10% + Scope, 30%)	40	%	$770,832,919	$308,333,168	USEPA OSWER (2000)
PM/Design/Technical Services	17	%	$932,810,353	$158,577,760	USEPA OSWER (2000)
TOTAL CAPITAL COST				$1,237,743,846	
Annual O&M Costs					
Pump and Treat, Annual O&M (3 yr only)	81,994	1,000 gal/yr	$9	$702,685	USEPA (2001)
LTM/ICs	1	yr	$250,000	$250,000	Internal estimate
Contingency (Bid, 10% + Scope, 20%)	30	%	$952,685	$285,806	USEPA OSWER (2000)
PM/Technical Services (5% + 10%)	15	%	$1,238,491	$185,774	USEPA OSWER (2000)
ontingency LTM Only (Bid, 10% + Scope, 20%)	30	%	$250,000	$75,000	USEPA OSWER (2000)
PM/Technical Services LTM Only (5% + 10%)	15	%	$325,000	$48,750	USEPA OSWER (2000)
SUBTOTAL ANNUAL O&M COST (with P&T)				$1,424,264	
SUBTOTAL ANNUAL O&M COST (without P&T)				$373,750	
TOTAL O&M COST (with P&T)	3	yr	$1,424,264	$4,272,793	
TOTAL O&M COST (without P&T)	97	yr	$373,750	$36,253,750	
TOTAL COST				**$1,278,270,389**	
NPV (7%)				**$1,244,921,047**	

Offshore Groundwater Remedial Alternative RG2

Technology	Quantity	Measure	Unit Cost	Extended Cost	Source
Annual O&M Costs					
LTM/ICs	1	yr	$25,000	$25,000	Internal estimate
Contingency (Bid, 10% + Scope, 20%)	30	%	$25,000	$7,500	USEPA OSWER (2000)
PM/Design/Technical Services	45	%	$32,500	$14,625	USEPA OSWER (2000)
SUBTOTAL ANNUAL O&M COST				$47,125	
TOTAL O&M COST	20	yr	$47,125	$942,500	
TOTAL COST				**$942,500**	
NPV (7%)				**$672,438**	

Offshore Groundwater Remedial Alternative RG3

Technology	Quantity	Measure	Unit Cost	Extended Cost	Source
Capital Costs					
Horizontal well installation surcharge	20,000	ft	$75	$1,500,000	Contractor quote
Pump and Treat	131,400	1,000 gal/yr	$46	$6,079,878	USEPA (2001)
Contingency (Bid, 10% + Scope, 20%)	30	%	$7,579,878	$2,273,963	USEPA OSWER (2000)
PM/Design/Technical Services	19	%	$9,853,841	$1,872,230	USEPA OSWER (2000)
TOTAL CAPITAL COST				$11,726,071	
Annual O&M Costs					
Pump and Treat, Annual O&M (4 yr only)	131,400	1,000 gal/yr	$7	$901,404	USEPA (2001)
LTM/ICs	1	yr	$25,000	$25,000	Internal estimate
Contingency (Bid, 10% + Scope, 20%)	30	%	$926,404	$277,921	USEPA OSWER (2000)
PM/Technical Services (5% + 10%)	15	%	$1,204,325	$180,649	USEPA OSWER (2000)
ontingency LTM Only (Bid, 10% + Scope, 20%)	30	%	$25,000	$7,500	USEPA OSWER (2000)
PM/Technical Services LTM Only (5% + 10%)	45	%	$32,500	$14,625	USEPA OSWER (2000)
SUBTOTAL ANNUAL O&M COST (with P&T)				$1,384,974	
SUBTOTAL ANNUAL O&M COST (without P&T)				$47,125	
TOTAL O&M COST (with P&T)	4	yr	1384973.98	$5,539,896	
TOTAL O&M COST (without P&T)	11	yr	$47,125	$518,375	
TOTAL COST				**$17,784,342**	
NPV (7%)				**$16,033,119**	

References

USEPA OSWER. 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibilty Study. 540-R-00-002. July.

USEPA OSWER. 1999. Subusrface Containment and Monitoring Systems: Barriers and Beyond (Overview Report). March.

USEPA. 2001. Remediation Technology cost Compendium - Year 2000. 542+R01-009. September.

USEPA. 2004a. Memorandum: Transmittal of Average Cost of Investigation Derived from Fund-Lead Superfund Costs, Interim Measures cost Compendium, and Compendium of Related Guidance Documents. November 1.

USEPA. 2004 b. In Situ Thermal Treatment of Chlorinated Solvents: Fundamentals and Field Applications. March.

USACE. 2014. Design: In Situ Thermal Remediation. May.

NAVFAC ESC. 2010. Cost and Performance Report for Persulfate Treatability Studies

Krembs., F.J., R.L. Siegrist, M. Crimi, R.F. Furrer, and B.G. Petri. 2010. In Situ Chemical Oxidation for Groundawater Remediation: Analysis of Field Applications and Performance Experiences. Groundwater Monitoirng and Remediation. 30(4), 42-53.

NAVFAC ESC. 2007. Final Report - Cost and Performance Review of Electrical Resistance Heating (ERH) for Source Treatment. March.

APPENDIX F

ARAR TABLES

Table 1 – Chemical-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Media/Action	Requirement	Prerequisite	Citation
Protection of Surface Water Quality			
Minimum criteria applicable to all surface waters	Surface waters shall not be aesthetically or otherwise degraded by substances that: • Settle to form objectionable deposits; • Float as debris, scum, oil, or other matter to form a nuisance; • Produce objectionable color, odor, taste, or turbidity; • Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life; • Produce undesirable aquatic life or result in the dominance of nuisance species; • Cause fish flesh tainting. 2. The concentration of phenol shall not exceed 300 mg/l as an instream value.	Presence of pollutants in surface waters of the Commonwealth (including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 *KAR* 10:029, Section 4) – **applicable**	401 *KAR* 10:031 § 2(1)(a-f)
	The water quality criteria for the protection of human health related to fish consumption in Table 1 of 401 *KAR* 10:031 § 6 are applicable to all surface water at the edge of assigned mixing zone except for those points where water is withdrawn for domestic water supply use. (a) The criteria are established to protect human health from the consumption of fish tissue and shall not be exceeded. (b) For those substances associated with a cancer risk, an acceptable risk level of not more than one (1) additional cancer case in a population of 1,000,000 people, (or 1 x 10^{-6}) shall be utilized to establish the allowable concentration.		401 *KAR* 10:031 § 2 (3)(a) and (b)
Numeric AWQC for pollutants in surface waters impacted by the Site	Table 1 of 401 *KAR* 10:031 § 6(1) provides allowable instream concentrations (measured in *u*g/L unless reported in different units on the table) of pollutants that may be found in surface waters or discharged into surface waters with listed pollutants. These numeric ambient water quality criteria (AWQC) shall not be exceeded. [NOTE: Identification of the Site contaminants of concern that have been detected in surface water above the AWQC are provided in various sections of the RI Report and FS documents.]	Discharge of pollutants to surface waters of the Commonwealth designated as *Warm Water Aquatic Life Habitat* and *Outstanding State Resource Waters* – **applicable**	401 *KAR* 10:031 § 6(1) *Pollutants*

Table 1 – Chemical-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Media/Action	Requirement	Prerequisite	Citation
Criteria for surface water designated as *Warm Water Aquatic Life Habitat*	The following parameters and associated criteria shall apply for the protection of productive warm water aquatic communities, fowl, animal wildlife, arboreous growth, agricultural, and industrial uses: • Natural alkalinity as CaCO3 shall not be reduced by more than 25 percent; • pH shall not be less than 6.0 nor more than 9.0 and shall not fluctuate more than 1.0 pH units over a period of 24 hours; • Flow shall not be altered to a degree that will adversely affect the aquatic community; • Temperature shall not exceed 31.7°C (89°F); • Dissolved oxygen shall be maintained at a minimum concentration of 5.0 mg/l as a 24 hour average; instantaneous minimum shall not be less than 4.0 mg/l; • Total dissolved solids or specific conductance shall not be changed to the extent that the indigenous aquatic community is adversely affected; • Total suspended solids shall not be changed to the extent that the indigenous aquatic community is adversely affected; • Addition of settleable solids that may alter the stream bottom so as to adversely affect productive aquatic communities shall be prohibited; • Concentration of the un-ionized ammonia shall not be greater than 0.05 mg/l at any time instream after mixing; • Instream concentrations for total residual chlorine shall not exceed an acute criteria value of 19 µg/l or a chronic criteria value of 11 µg/l.	Discharge of pollutants to surface waters of the Commonwealth designated as *Warm Water Aquatic Life Habitat* – **applicable**.	401 *KAR* 10:031 § 4(1)(a)-(i) and (k)
Criteria for surface water designated as *Warm Water*	The allowable instream concentration of toxic substances, or whole effluents containing toxic substances, which are noncumulative or non-persistent with a half-life of less than 96	Discharge of toxic pollutants to surface waters of the Commonwealth designated as *Warm Water Aquatic Life Habitat* –	401 *KAR* 10:031 § 4(1)(j)(1)

Table 1 – Chemical-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Media/Action	Requirement	Prerequisite	Citation
Aquatic Life Habitat	hours, shall not exceed: a. 0.1 of the 96 hour median LC_{50} of representative indigenous or indicator aquatic organisms; or b. A chronic toxicity unit of 1.00 utilizing the 25 percent inhibition concentration, or LC_{25}.	**applicable**	
	The allowable instream concentration of toxic substances, or whole effluents containing toxic substances, which are bioaccumulative or persistent, including pesticides, if not otherwise regulated, shall not exceed: a. 0.01 of the 96 hour median LC_{50} of representative indigenous or indicator aquatic organisms; or b. A chronic toxicity unit of 1.00 utilizing the LC_{25}.		401 *KAR* 10:031 § 4(1)(j)(2)
Criteria for surface water designated as *Warm Water Aquatic Life Habitat*	In the absence of acute criteria for pollutants listed in Table 1 of 401 *KAR* 10:031 § 6, for other substances known to be toxic but not listed in this regulation, or for whole effluents that are acutely toxic, the allowable instream concentration shall not exceed the LC1 or 1/3 LC50 concentration derived from toxicity tests on representative indigenous or indicator aquatic organisms or exceed 0.3 acute toxicity units.	Discharge of toxic pollutants to surface waters of the Commonwealth designated as *Warm Water Aquatic Life Habitat* – **applicable**	401 *KAR* 10:031 § 4(1)(j)(3)
	If specific factors have been determined for a toxic substance or whole effluent such as an acute to chronic ratio or water effect ratio, they may be used instead of the 0.1 and 0.01 factors upon demonstration that such factors are scientifically defensible. *NOTE:* Demonstration that such factors are scientifically defensible will be reflected in an appropriate CERCLA document.		401 *KAR* 10:031 § 4(1)(j)(4)
	Allowable instream concentrations for specific pollutants for the protection of warm water aquatic habitat are listed in Table 1 of 401 *KAR* 10:031 § 6 shall not be exceeded.		401 *KAR* 10:031 § 4(1)(j)(5)
Criteria for surface water designated as *Outstanding State Resource Waters*	At a minimum, the criteria of 401 *KAR* 10:031 § 2 and Table 1 of Section 6 of this administrative regulation and the appropriate criteria associated with the stream use designation assignments in 401 KAR 10:026, shall be applicable to these waters.	Waters designated *Outstanding State Resource Waters* that support federally recognized endangered or threatened species pursuant to the Endangered Species Act of 1973, as amended, 16 U.S.C. 1531-1544 – **applicable**	401 *KAR* 10:031 § 8(2)(a)

Table 1 – Chemical-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Media/Action	Requirement	Prerequisite	Citation
	Existing water quality and habitat shall be maintained and protected in those waters designated as *Outstanding State Resource Water*s that support federally threatened and endangered species of aquatic organisms, unless it can be demonstrated that lowering of water quality or a habitat modification will not have a harmful effect on the threatened or endangered species that the water supports.		401 *KAR* 10:031 § 8(2)(c)(2.)
	Remediation of Contaminated Groundwater		
Restoration of groundwater (*areas located outside the identified TI waiver zones*)	Shall not exceed the Safe Drinking Water Act (SDWA) National Revised Primary Drinking Water Regulations: maximum contaminant levels (MCLs) for *organic and synthetic contaminants* specified in 40 CFR 141.61(a) and (c). • Vinyl chloride 2 *u*g/L • Benzene 5 *u*g/L • Carbon tetrachloride 5 *u*g/L • 1,2-Dichloroethane (EDC) 5 *u*g/L • Trichloroethylene (TCE) 5 *u*g/L • 1,1-Dichloroethylene (DCE) 7 *u*g/L • cis-1,2-Dichloroethylene (DCE) 70 *u*g/L • Monochlorobenzene 100 *u*g/L • Tetrachloroethylene (PCE) 5 *u*g/L • 1,1,2-Trichloro-ethane (TCA) 5 *u*g/L	Restoration of groundwater classified as Class IIA or Class IIB (which are an existing or potential source of drinking water) – **relevant and appropriate**	40 C.F.R. § 141.61(a) and (c) Maximum contaminant levels for organic contaminants 401 *KAR* 8:250 Section 1
	Shall not exceed the SDWA National Revised Primary Drinking Water Regulations: maximum contaminant levels (MCLs) for *inorganic contaminants* specified in 40 CFR 141.62(b). • Arsenic 10 *u*g/L • Mercury 2 *u*g/L		40 C.F.R. § 141.62(b) Maximum contaminant levels for inorganic contaminants 401 *KAR* 8:250 Section 1
	Shall not exceed the SDWA maximum contaminant level goal (MCLG) specified listed below. • Chholorform 70 ug/L	Restoration of groundwater classified as Class IIA or Class IIB (which are an existing or potential source of drinking water) – **TBC**	40 C.F.R. § 141.53 Maximum contaminant level goals for disinfection byproducts

Table 1 – Chemical-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

ARARs = applicable or relevant and appropriate requirements
AWQC = ambient water quality criteria
CERCLA = Comprehensive Environmental Response, Compensation,
and Liability Act of 1980
C.F.R. = *Code of Federal Regulations*
CWA = Clean Water Act
FS = Feasibility Study
KAR = Kentucky Administrative Regulations
MCLs = maximum contaminant levels
MCLGs = maximum contaminant level goals
RI = Remedial Investigation
SDWA = Safe Drinking Water Act
TBC = to be considered [guidance]
TI = Technical Impracticability [waiver of attainment of chemical -specific requirements under CERCLA Section 121(d)(4)(C)]
U.S.C.= *United States Code*

401 KAR 10:031 Surface water standards

Section 6. Pollutants. (1) Allowable instream concentrations of pollutants are listed as water column values in Table 1 of this section unless otherwise indicated.

Table 1					
Pollutant	CAS[1] Number	Water Quality Criteria μg/L[2]			
		Human Health:		Warm Water Aquatic Habitat[3]:	
		DWS[4]	Fish[5]	Acute[6]	Chronic[7]
Acenaphthene	83329	670	990	-	-
Acrolein	107028	190	6	3	3
Acrylonitrile	107131	0.051	0.25	-	-
Aldrin	309002	0.000049	0.000050	3.0	-
alpha-BHC	319846	0.0026	0.0049	-	-
alpha-Endosulfan	959988	62	89	0.22	0.056
Anthracene	120127	8,300	40,000	-	-
Antimony	7440360	5.6	640	-	-
Arsenic	7440382	10.0	-	340	150
Asbestos	1332214	7 million fibers/L	-	-	-
Barium	7440393	1,000	-	-	-
Benzene	71432	2.2	51	-	-
Benzidine	92875	0.000086	0.00020	-	-
Benzo(a)anthracene	56553	0.0038	0.018	-	-
Benzo(a)pyrene	50328	0.0038	0.018	-	-
Benzo(b)fluoranthene	205992	0.0038	0.018	-	-
Benzo(k)fluoranthene	207089	0.0038	0.018	-	-
Beryllium	7440417	4	-	-	-
Beta-BHC	319857	0.0091	0.017	-	-
Beta-Endosulfan	33213659	62	89	0.22	0.056
bis(chloromethyl)ether	542881	0.00010	0.00029	-	-
bis(2-chloroethyl)ether	111444	0.030	0.53	-	-
bis(2-chloroisopropyl)ether	108601	1,400	65,000	-	-
bis(2-ethylhexyl)phthalate	117817	1.2	2.2	-	-
Bromoform	75252	4.3	140	-	-
Butylbenzyl phthalate	85687	1,500	1,900	-	-
Cadmium	7440439	5	-	e(1.0166 (ln Hard*)-3.924)	e(0.7409 (ln Hard*)-4.719)
Carbon tetrachloride	56235	0.23	1.6	-	-
Chlordane	57749	0.00080	0.00081	2.4	0.0043
Chloride	16887006	250,000	-	1,200,000	600,000
Chlorobenzene	108907	130	1600	-	-
Chlorodibromomethane	124481	0.40	13	-	-
Chloroform	67663	5.7	470	-	-
Chloropyrifos	2921882	-	-	0.083	0.041
Chromium	N/A	100	-	-	-
Chromium (III)	16065831	-	-	e(0.8190 (ln Hard*)+3.7256)	e(0.8190 (ln Hard*)+0.6848)
Chromium (VI)	18540299	-	-	16	11
Chrysene	218019	0.0038	0.018	-	-
Color	N/A	75 Platinum Cobalt Units	-	-	-
Copper	7440508	1,300	-	e(0.9422 (ln Hard*)-1.700)	e(0.8545 (ln Hard*)-1.702)
Cyanide, Free	57125	140	140	22	5.2
Demeton	8065483	-	-	-	0.1
Diazinon	333415			0.17	0.17
Dibenzo(a,h)anthracene	53703	0.0038	0.018	-	-
Dichlorobromomethane	75274	0.55	17	-	-
Dieldrin	60571	0.000052	0.000054	0.24	0.056
Diethyl phthalate	84662	17,000	44,000	-	-
Dimethyl phthalate	131113	270,000	1,100,000	-	-
Di-n-butyl phthalate	84742	2,000	4,500	-	-
Dinitrophenols	25550587	69	5300	-	-
Endosulfan sulfate	1031078	62	89	-	-
Endrin	72208	0.059	0.060	0.086	0.036
Endrin aldehyde	7421934	0.29	0.30	-	-

Ethylbenzene	100414	530	2100	-	-
Fluoranthene	206440	130	140	-	-
Fluorene	86737	1,100	5,300	-	-
Fluoride	N/A	4,000	-	-	-
Guthion	86500	-	-	-	0.01
Heptachlor	76448	0.000079	0.000079	0.52	0.0038
Heptachlor epoxide	1024573	0.000039	0.000039	0.52	0.0038
Hexachlorobenzene	118741	0.00028	0.00029	-	-
Hexachlorobutadiene	87683	0.44	18	-	-
Hexachlorocyclo-hexane-Technical	319868	0.0123	0.0414	-	-
Hexachlorocyclopentadiene	77474	40	1100	-	-
Hexachloroethane	67721	1.4	3.3	-	-
Ideno(1,2,3-cd)pyrene	193395	0.0038	0.018	-	-
Iron[8]	7439896	300	-	4,000	1,000
Isophorone	78591	35.0	960	-	-
Lead	7439921	15	-	e(1.273 (ln Hard*)-1.460)	e(1.273 (ln Hard*)-4.705)
Lindane (gamma-BHC)	58899	0.98	1.8	0.95	
Malathion	121755	-	-	-	0.1
Mercury	7439976	2.0	0.051	1.4	0.77
Methylmercury	22967926		0.3 mg/Kg		
Methoxychlor	72435	100	-	-	0.03
Methylbromide	74839	47	1,500	-	-
Methylene Chloride	75092	4.6	590	-	-
Mirex	2385855	-	-	-	0.001
Nickel	7440020	610	4,600	e(0.8460 (ln Hard*)+2.255)	e(0.8460 (ln Hard*)+0.0584)
Nitrate (as N)	14797558	10,000	-	-	-
Nitrobenzene	98953	17	690	-	-
Nitrosamines, Other	N/A	0.0008	1.24	-	-
N-Nitrosodibutylamine	924163	0.0063	0.22	-	-
N-Nitrosodiethylamine	55185	0.0008	1.24	-	-
N-Nitrosodimethylamine	62759	0.00069	3.0	-	-
N-Nitrosodi-n-Propylamine	621647	0.0050	0.51	-	-
N-Nitrosodiphenylamine	86306	3.3	6.0	-	-
N-Nitrosopyrrolidine	930552	0.016	34	-	-
Nonylphenol	1044051			28	6.6
Parathion	56382	-	-	0.065	0.013
Pentachlorobenzene	608935	1.4	1.5	-	-
Pentachlorophenol	87865	0.27	3.0	e(1.005(pH)-4.869)	e(1.005(pH)-5.134)
Phenol	108952	21,000	860,000	-	-
Polychlorinated Biphenyls (PCBs)	N/A	0.000064	0.000064	-	0.014
Pyrene	129000	830	4,000	-	-
Selenium	7782492	170	4,200		5.0[9] 8.6[10, 11] 19.3[11, 12]
Silver	7440224	-	-	e(1.72 (ln Hard*)-6.59)	-
Sulfate	N/A	250,000	-	-	-
Hydrogen Sulfide, Undissociated	7783064	-	-	-	2.0
Tetrachloroethylene	127184	0.69	3.3	-	-
Thallium	7440280	0.24	0.47	-	-
Toluene	108883	1300	15,000	-	-
Total Dissolved Solids	N/A	250,000	-	-	-
Toxaphene	8001352	0.00028	0.00028	0.73	0.0002
Tributyltin (TBT)				0.46	0.072
Trichloroethylene	79016	2.5	30	-	-
Vinyl Chloride	75014	0.025	2.4	-	-
Zinc	7440666	7,400	26,000	e(0.8473 (ln Hard*)+0.884)	e(0.8473 (ln Hard*)+0.884)
1,1-dichloroethylene	75354	330	7100	-	-
1,1,1-trichloroethane	71556	200	-	-	-
1,1,2-trichloroethane	79005	0.59	16	-	-

1,1,2,2-tetrachloroethane	79345	0.17	4.0	-	-
1,2-dichlorobenzene	95501	420	1300	-	-
1,2-dichloroethane	107062	0.38	37	-	-
1,2-dichloropropane	78875	0.50	15	-	-
1,2-diphenylhydrazine	122667	0.036	0.20	-	-
1,2-trans-dichloroethylene	156605	140	10,000	-	-
1,2,4-trichlorobenzene	120821	35	70	-	-
1,2,4,5-tetrachlorobenzene	95943	0.97	1.1	-	-
1,3-dichlorobenzene	541731	320	960	-	-
1,3-dichloropropene	542756	0.34	21	-	-
1,4-dichlorobenzene	106467	63	190	-	-
2-chloronaphthalene	91587	1,000	1,600	-	-
2-chlorophenol	95578	81	150	-	-
2-methyl-4,6-dinitrophenol	534521	13	280	-	-
2,3,7,8-TCDD (Dioxin)	1746016	5.0 E - 9	5.1 E - 9	-	-
2,4-D	94757	100	-	-	-
2,4-dichlorophenol	120832	77	290	-	-
2,4-dimethylphenol	105679	380	850	-	-
2,4-dinitrophenol	51285	69	5,300	-	-
2,4-dinitrotoluene	121142	0.11	3.4	-	-
2,4,5-TP (Silvex)	93721	10	-	-	-
2,4,5-trichlorophenol	95954	1,800	3,600	-	-
2,4,6-trichlorophenol	88062	1.4	2.4	-	-
3,3'-dichlorobenzidine	91941	0.021	0.028	-	-
4,4'-DDD	72548	0.00031	0.00031	-	-
4,4'-DDE	72559	0.00022	0.00022	-	-
4,4'-DDT	50293	0.00022	0.00022	1.1	0.001

[1] CAS = Chemical Abstracts Service.

[2] Water quality criteria in µg/L unless reported in different units.

[3] Metal concentrations shall be total recoverable metals to be measured in an unfiltered sample, unless it can be demonstrated that a more appropriate analytical technique is available that provides a measurement of that portion of the metal present which causes toxicity to aquatic life.

[4] DWS = Domestic Water Supply Source.

[5] Fish = protecting human health regarding fish consumption.

[6] Acute criteria = protective of aquatic life based on one (1) hour exposure that does not exceed the criterion for a given pollutant.

[7] Chronic = protective of aquatic life based on ninety-six (96) hour exposure that does not exceed the criterion of a given pollutant more than once every three (3) years on the average.

[8] The chronic criterion for iron shall not exceed three and five tenths (3.5) mg/L (thirty-five hundred µg/L) if aquatic life has not been shown to be adversely affected.

[9] If fish tissue data are available, fish tissue data shall take precedence over water column data.

[10] This value is the concentration in micrograms/g (dry weight) of whole fish tissue.

[11] A concentration of five and zero tenths (5.0) µg/L or greater selenium in the water column shall trigger further sampling and analysis of whole-body fish tissue or alternately of fish egg/ovary tissue.

[12] This value is the concentration in µg/g (dry weight) of fish egg/ovary tissue.

Table 2 – Location-Specific ARARs and TBCs for the B.F. Goodrich Superfund Site
Calvert City, Kentucky

Location	Requirement	Prerequisite	Citation
Wetlands			
Presence of Wetlands	Shall take action to minimize the destruction, loss or degradation of wetlands and to preserve and enhance beneficial values of wetlands.	Federal actions that involve potential impacts to, or take place within, wetlands – **TBC**	Executive Order 11990 Section 1(a) *Protection of Wetlands*
	Shall avoid undertaking construction located in wetlands unless: (1) there is no practicable alternative to such construction, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use.		Executive Order 11990, Section 2(a) *Protection of Wetlands*
Floodplains			
Presence of Floodplains designated as such on a map[1]	Shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains.	Federal actions that involve potential impacts to, or take place within, floodplains – **TBC**	Executive Order 11988 Section 1. *Floodplain Management*
	Shall consider alternatives to avoid, to the extent possible, adverse effects and incompatible development in the floodplain. Design or modify its action in order to minimize potential harm to or within the floodplain		Executive Order 11988 Section 2(a)(2) *Floodplain Management*
	Where possible, an agency shall use natural systems, ecosystem processes, and nature-based approaches when developing alternatives for consideration.		Executive Order 13690 Section 2(c)
Presence of floodplain designated as such on a map	The Agency shall design or modify its actions so as to minimize[2] harm to or within the floodplain.	Federal actions affecting or affected by Floodplain as defined in 44 C.F.R. § 9.4 – **relevant and appropriate**	44 C.F.R. § 9.11(b)(1) *Mitigation*
	The Agency shall restore and preserve natural and beneficial floodplain values.		44 C.F.R. § 9.11(b)(3) *Mitigation*
	The Agency shall minimize: • Potential harm to lives and the investment at risk from		44 C.F.R. § 9.11(c)(1) and (3) *Minimization provisions*

---

[1] Under 44 C.F.R. § 9.7 *Determination of proposed action's location*, Paragraph (c) Floodplain determination. One should consult the FEMA Flood Insurance Rate Map (FIRM), the Flood Boundary Floodway Map (FBFM) and the Flood Insurance Study (FIS) to determine if the Agency proposed action is within the base floodplain.

[2] Minimize means to reduce to smallest amount or degree possible. See 44 C.F.R. § 9.4 *Definitions.*

Table 2 – Location-Specific ARARs and TBCs for the B.F. Goodrich Superfund Site
Calvert City, Kentucky

Location	Requirement	Prerequisite	Citation
	base flood, or in the case of critical actions[3] from the 500-year flood; - Potential adverse impacts that action may have on floodplain values.		
	Aquatic Resources		
Location encompassing aquatic ecosystem as defined in 40 C.F.R. § 230.3(c)	Except as provided under section 404(b)(2), no discharge of dredged or fill material is permitted if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem or if it will cause or contribute to significant degradation of the waters of the United States.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **relevant and appropriate**.	40 C.F.R. § 230.10(a) and (c)
	Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem. 40 C.F.R. § 230.70 *et seq.* identifies such possible steps.		40 C.F.R. § 230.10(d)
Nationwide Permit Program	Must comply with the substantive requirements of the NWP 38, General Conditions, as appropriate.	Discharge of dredged or fill material into *waters of the United States*, including jurisdictional wetlands – **relevant and appropriate**.	Nation Wide Permit (38) Cleanup of Hazardous and Toxic Waste 33 C.F.R. § 323.3(b)
	Wildlife, Threatened or Endangered Species		
Presence of Migratory birds listed in 50 *C.F.R.* § 10.13	No person may take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such bird except as may be permitted under the terms of a valid permit issued pursuant to the provisions of this part and part 13 of this chapter, or as permitted by regulations in this part, or part 20 of this subchapter (the hunting regulations).	Action that have potential impacts on, or is likely to result in a 'take' (as defined in 50 C.F.R. § 10.12) of migratory birds – **applicable**	*Migratory Bird Treaty Act*, 16 U.S.C. §703(a) 50 C.F.R. § 21.11
Presence of federally Endangered and Threatened species	Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened	Agency action that may jeopardize listed wildlife species, or destroy or adversely modify critical habitat – **applicable**	16 U.S.C. §1536 (a)(2) –or Section 7(a)(2) of *the Endangered Species Act of 1973*

---

[3] See 44 C.F.R. § 9.4 *Definitions, Critical action*. Critical actions include, but are not limited to, those which create or extend the useful life of structures or facilities such as those that produce, use or store highly volatile, flammable, explosive, toxic or water-reactive materials.

Table 2 – Location-Specific ARARs and TBCs for the B.F. Goodrich Superfund Site
Calvert City, Kentucky

Location	Requirement	Prerequisite	Citation
listed in 50 C.F.R. 17.11(h) – or critical habitat of such species listed in 50 C.F.R. § 17.95	species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary of Interior, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action by the Committee pursuant to subsection (h) of this section. *NOTE:* Despite that consultation may be considered an administrative requirement, it should be performed to ensure activities are in compliance with substantive provisions of the Endangered Species Act and regulations.		

ARAR = applicable or relevant and appropriate requirement
C.F.R. = *Code of Federal Regulations*
E.O. = Executive Order
KAR = *Kentucky Administrative Regulations*
NWP = Nationwide Permit
TBC = To Be Considered [guidance]
U.S.C. = *United States Code*

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Site Preparation, Construction, and Excavation			
Activities causing fugitive dust emissions	No person shall cause, suffer, or allow any material to be handled, processed, transported, or stored; a building or its appurtenances to be constructed, altered, repaired, or demolished, or a road to be used without taking reasonable precaution to prevent particulate matter from becoming airborne. Such reasonable precautions shall include, when applicable, but not be limited to the following: • Use, where possible, of water or chemicals for control of dust in the demolition of existing buildings or structures, construction operations, the grading of roads or the clearing of land; • Application and maintenance of asphalt, oil, water, or suitable chemicals on roads, materials stockpiles, and other surfaces which can create airborne dusts; • Covering, at all times when in motion, open bodied trucks transporting materials likely to become airborne; • The maintenance of paved roadways in a clean condition; and • The prompt removal of earth or other material from a paved street which earth or other material has been transported thereto by trucking or earth moving equipment or erosion by water.	Fugitive emissions from land-disturbing activities (e.g., handling, processing, transporting or storing of any material, demolition of structures, construction operations, grading of roads, or the clearing of land, etc.) – **applicable**	401 *KAR* 63:010 § 3(1) and (1)(a), (b), (d), (e) and (f)
	No person shall cause or permit the discharge of visible fugitive dust emissions beyond the lot line of the property on which the emissions originate.		401 *KAR* 63:010 § 3(2)
Activities causing storm-water runoff (e.g., clearing, grading, excavation)	Implement good construction techniques to control pollutants in storm-water discharges during and after construction in accordance with substantive requirements provided by permits issued pursuant to 40 C.F.R.§ 122.26(c).	Storm water discharges associated with small construction activities as defined in 40 *C.F.R.*§ 122.26(b)(15) and 401 *KAR* 5:002 § 1 (157) – **applicable**	40 C.F.R.§ 122.26(c)(1) (ii)(C) and (D) 401 *KAR* 5:060 § 8
	Storm water runoff associated with construction activities taking place at a facility with an existing Best Management Practices (BMP) Plan shall be addressed under the facility BMP and not under a storm water general permit.	Storm water discharges associated with small construction activities as defined in 40 C.F.R.§ 122.26(b)(15) and 401 *KAR* 5:002 § 1 (157) – **TBC**	Fact Sheet for the KPDES General Permit For Storm water Discharges Associated with Construction Activities, June 2009

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Waste Characterization – Primary Wastes (contaminated media and debris) and Secondary Wastes (wastewaters, spent treatment media, etc.)			
Characterization of solid waste	Must determine if solid waste is excluded from regulation under 40 *C.F.R.* § 261.4.	Generation of solid waste as defined in 40 *C.F.R.* § 261.2 – **applicable**	40 *C.F.R.* § 262.11(a) 401 *KAR* 32:010 § 2
	Must determine if waste is listed as a hazardous waste in Subpart D of 40 C.F.R. Part 261.	Generation of solid waste which is not excluded under 40 C.F.R. § 261.4 – **applicable**	40 *C.F.R.* § 262.11(b) 401 *KAR* 32:010 § 2
	Must determine whether the waste is (characteristic waste) identified in subpart C of 40 C.F.R. part 261 by either: (1) Testing the waste according to the methods set forth in subpart C of 40 C.F.R. part 261, or according to an equivalent method approved by the Administrator under 40 C.F.R. §260.21; <u>or</u> (2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.	Generation of solid waste that is not listed in Subpart D of 40 C.F.R. Part 261 and not excluded under 40 *C.F.R.* § 261.4 – **applicable**	40 *C.F.R.* § 262.11(c) 401 *KAR* 32:010 § 2
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be hazardous waste – **applicable**	40 *C.F.R.* § 262.11(d) 401 *KAR* 32:010 § 2
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 *C.F.R.* §§ 264 and 268.	Generation of RCRA-hazardous waste for storage, treatment or disposal – **applicable**	40 *C.F.R.* § 264.13(a)(1) 401 *KAR* 34:020 § 4

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Characterization of industrial wastewater	Industrial wastewater discharges that are point source discharges subject to regulation under § 402 of the Clean Water Act, as amended, are not solid wastes for the purpose of hazardous waste management. [Comment: This exclusion applies only to the actual point source discharge. It does not exclude industrial wastewaters while they are being collected, stored or treated before discharge, nor does it exclude sludges that are generated by industrial wastewater treatment.] *NOTE:* For purpose of this exclusion, the CERCLA on-site treatment system for groundwater will be considered equivalent to a wastewater treatment unit and the point source discharges subject to regulation under CWA § 402, provided the effluent meets all identified CWA ARARs.	Generation of industrial wastewater and discharge into surface water – **applicable**	40 *C.F.R.*§ 261.4(a)(2) 401 *KAR* 31:010 § 4
Determinations for management of hazardous waste	Must determine if the hazardous waste has to be treated before land disposed. This is done by determining if the waste meets the treatment standards in 40 C.F.R.268.40, 268.45, or 268.49 by testing in accordance with prescribed methods <u>or</u> use of generator knowledge of waste. This determination can be made concurrently with the hazardous waste determination required in 40 C.F.R.§ 262.11.	Generation of hazardous waste – **applicable**	40 *C.F.R.*§ 268.7(a) 401 *KAR* 37:020 § 7
	Must comply with the special requirements of 40 C.F.R.§ 268.9 in addition to any applicable requirements in 40 C.F.R.§ 268.7.	Generation of waste or soil that displays a hazardous characteristic of ignitability, corrosivity, reactivity, or toxicity for storage, treatment or disposal – **applicable**	40 C.F.R.§ 268.7(a)(1) 401 *KAR* 37:020 § 7
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 *C.F.R.*§ 268.40 *et. seq*. *Note:* This determination may be made concurrently with the hazardous waste determination required in 40 *C.F.R.*§ 262.11.	Generation of hazardous waste – **applicable**	40 *C.F.R.*§ 268.9(a) 401 *KAR* 37:010 § 8
	Must determine the underlying hazardous constituents [as defined in 40 *C.F.R.*§ 268.2(i)] in the characteristic waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal – **applicable**	40 *C.F.R.*§ 268.9(a) 401 *KAR* 37:010 § 8

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Treatment/Disposal of Wastes – Primary (contaminated media and debris) and Secondary Wastes (wastewaters, spent treatment media, etc.)			
Disposal of RCRA characteristic wastewaters in an NPDES permitted wastewater treatment unit	Are not prohibited, if the wastes are managed in a treatment system which subsequently discharges to waters of the U.S. pursuant to a permit issued under 402 of the CWA (i.e., NPDES permitted) unless the wastes are subject to a specified method of treatment other than DEACT in 40 *C.F.R.* § 268.40, or are D003 reactive cyanide. *NOTE:* For purposes of this exclusion, a CERCLA on-site wastewater treatment unit that meets all of the identified CWA ARARs for point source discharges from such a system, is considered a wastewater treatment system that is NPDES permitted.	Land disposal of hazardous wastewaters that are hazardous only because they exhibit a hazardous characteristic and are not otherwise prohibited under 40 *C.F.R.* Part 268 – **applicable**	40 *C.F.R.* § 268.1(c)(4)(i) 401 *KAR* 37:010 §2
Disposal of prohibited RCRA hazardous waste in a land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *C.F.R.* § 268.40 before land disposal.	Land disposal, as defined in 40 *C.F.R.* § 268.2, of prohibited RCRA waste – **applicable**	40 *C.F.R.* § 268.40(a) 401 *KAR* 37:040 § 2
	All underlying hazardous constituents [as defined in 40 *C.F.R.* § 268.2(i)] must meet the Universal Treatment Standards, found in 40 *C.F.R.* § 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well – **applicable**	40 *C.F.R.* § 268.40(e) 401 *KAR* 37:040 § 2
Disposal of RCRA hazardous waste soil in a land-based unit	Must be treated according to the alternative treatment standards of 40 *C.F.R.* § 268.49(c) <u>or</u> according to the UTSs specified in 40 *C.F.R.* § 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 *C.F.R.* § 268.2, of restricted hazardous soils – **applicable**	40 *C.F.R.* § 268.49(b) 401 *KAR* 37:040 § 10
Treatment of RCRA hazardous waste soil	Prior to land disposal, all "constituents subject to treatment" as defined in 40 *C.F.R.* § 268.49(d) must be treated as follows.	Treatment of restricted hazardous waste soils – **applicable**	40 *C.F.R.* § 268.49(c)(1) 401 *KAR* 37:040 § 10
	For non-metals (except carbon disulfide, cyclohexanone, and methanol), treatment must achieve a 90 percent reduction in total constituent concentrations, except as provided in 40 *C.F.R.* § 268.49(c)(1)(C).		40 *C.F.R.* § 268.49(c)(1)(A) 401 *KAR* 37:040 § 10

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	For metals and carbon disulfide, cyclohexanone, and methanol), treatment must achieve a 90 percent reduction in total constituent concentrations as measured in leachate from the treated media (tested according to TCLP) or 90 percent reduction in total constituent concentrations (when a metal removal technology is used), except as provided in 40 *C.F.R.* § 268.49(c)(1)(C).		40 *C.F.R.* § 268.49(c)(1)(B) 401 *KAR* 37:040 § 10
Treatment of RCRA hazardous waste soil *con't*	When treatment of any constituent subject to treatment to a 90 percent reduction standard would result in a concentration less than 10 times the Universal Treatment Standard for that constituent, treatment to achieve constituent concentrations less than 10 times the universal treatment standard is not required. [Universal Treatment Standards (UTS) are identified in 40 *C.F.R.* § 268.48 Table UTS].	Treatment of restricted hazardous waste soils – **applicable**	40 *C.F.R.* § 268.49(c)(1)(C) 401 *KAR* 37:040 § 10
	In addition to the treatment requirement required by paragraph (c)(1) of 40 *C.F.R.* § 268.49, soils must be treated to eliminate these characteristics.	Treatment of soils that exhibit the hazardous characteristic of ignitability, corrosivity, or reactivity – **applicable**	40 *C.F.R.* § 268.49(c)(2) 401 *KAR* 37:040 § 10
Disposal of RCRA hazardous debris in a land-based unit	Must be treated prior to land disposal as provided in 40 *C.F.R.* § 268.45(a)(1)-(5) unless EPA determines under 40 *C.F.R.* § 261.3(f)(2) that the debris no longer contaminated with hazardous waste or the debris is treated to the waste-specific treatment standard provided in 40 *C.F.R.* § 268.40 for the waste contaminating the debris.	Land disposal, as defined in 40 *C.F.R.* § 268.2, of RCRA-hazardous debris – **applicable**	40 *C.F.R.* § 268.45(a) 401 *KAR* 37:040 § 7
Disposal of treated hazardous debris	Debris treated by one of the specified extraction or destruction technologies on Table 1 of 40 *C.F.R.* § 268.45 and which no longer exhibits a characteristic is not a hazardous waste and need not be managed in RCRA Subtitle C facility. Hazardous debris contaminated with listed waste that is treated by immobilization technology must be managed in a RCRA Subtitle C facility.	Treated debris contaminated with RCRA-listed or characteristic waste – **applicable**	40 *C.F.R.* § 268.45(c) 401 *KAR* 37:040 § 7
Disposal of hazardous debris treatment residues	Except as provided in 268.45(d)(2) and (d)(4), must be separated from debris by simple physical or mechanical means, and such residues are subject to the waste-specific treatment standards for the waste contaminating the debris.	Residue from treatment of hazardous debris – **applicable**	40 *C.F.R.* § 268.45(d)(1) 401 *KAR* 37:040 § 7

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Waste Staging and Storage – Primary Wastes (contaminated media and debris) and Secondary Wastes (wastewaters, spent treatment media, etc.)			
Temporary Storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that: • waste is placed in containers that comply with 40 C.F.R.265.171–173; and	Accumulation of RCRA hazardous waste on site as defined in 40 C.F.R.§260.10 – **applicable**	40 C.F.R.§ 262.34(a); 40 C.F.R.§262.34(a)(1)(i); 401 *KAR* 32:030 § 5
	• the date upon which accumulation begins is clearly marked and visible for inspection on each container; • container is marked with the words "hazardous waste"; or		40 C.F.R.§ 262.34(a)(2) and (3) 401 *KAR* 32:030 § 5
	• container may be marked with other words that identify the contents.	Accumulation of 55 gal. or less of RCRA hazardous waste <u>or</u> one quart of acutely hazardous waste listed in §261.33(e) at or near any point of generation – **applicable**	40 C.F.R.§ 262.34(c)(1)
Use and management of hazardous waste in containers	If container is not in good condition (e.g. severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers – **applicable**	40 C.F.R.§ 265.171 401 *KAR* 35:180 § 2
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 C.F.R.§ 265.172 401 *KAR* 35:180 § 3
	Keep containers closed during storage, except to add/remove waste. Open, handle and store containers in a manner that will not cause containers to rupture or leak.		40 *C.F.R.*§ 265.173(a) and (b) 401 *KAR* 35:180 § 4
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 *C.F.R.*§ 264.175(b).	Storage of RCRA hazardous waste in containers with free liquids – **applicable**	40 *C.F.R.*§ 264.175(a) 401 *KAR* 34:180 § 6
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage of RCRA hazardous waste in containers that do not contain free liquids (other than F020, F021, F022, F023, F026 and F027) – **applicable**	40 *C.F.R.*§ 264.175(c) 401 *KAR* 34:180 § 6
Closure of RCRA container storage	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining	Storage of RCRA hazardous waste in containers in a unit with a containment	40 C.F.R.§ 264.178

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
unit	containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with40 C.F.R.261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of parts 262 through 266 of this chapter].	system **– applicable**	401 *KAR* 34:180 § 8
Temporary on–site storage of remediation waste in RCRA staging pile	Must be located within the contiguous property under the control of the owner/operator where the wastes are to be managed in the staging pile originated. For purposes of this section, storage includes mixing, sizing, blending or other similar physical operations so long as intended to prepare the wastes for subsequent management or treatment.	Accumulation of ***solid non–flowing hazardous remediation waste*** (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 C.F.R.260.10 **– applicable**	40 C.F.R.§ 264.554(a)(1) 401 *KAR* 34:287 § 5
	Staging piles may be used to store hazardous remediation waste (or remediation waste otherwise subject to land disposal restrictions) based on approved standards and design criteria designated for that staging pile. *NOTE*: Design and standards of the staging pile should be included in CERCLA Remedial Design document approved or issued by EPA.		40 C.F.R.§ 264.554(b) 401 *KAR* 34:287 § 5
Performance criteria for RCRA staging pile	Staging pile must be designed to: • facilitate a reliable, effective and protective remedy; • must be designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross–media transfer as necessary to protect human health and the environment (for example through use of liners, covers, run–off/run–on controls, as appropriate).	Storage of remediation waste in a staging pile **– applicable**	40 C.F.R.§ 264.554(d)(1)(i) and (ii) 401 *KAR* 34:287 § 5
Design criteria for RCRA staging pile	In setting standards and design criteria must consider the following factors:	Storage of remediation waste in a staging pile **– applicable**	40 C.F.R.§ 264.554(d)(2)(i) – (vi) 401 *KAR* 34:287 § 5

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	• Length of time pile will be in operation; • Volumes of waste you intend to store in the pile; • Physical and chemical characteristics of the wastes to be stored in the unit; • Potential for releases from the unit; • Hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and • Potential for human and environmental exposure to potential releases from the unit.		
Temporary on–site storage of ignitable or reactive remediation waste in RCRA staging pile	Must not place ignitable or reactive remediation waste in a staging pile unless the remediation waste has been treated, rendered, or mixed before placed in the staging pile so that: (i) The remediation waste no longer meets the definition of ignitable or reactive under 401 *KAR* 31:030 § 2 and § 4; and (ii) You have complied with 401 *KAR* 34:020 § 8, General Requirements for Ignitable, Reactive, or Incompatible Wastes.	Storage of ignitable or reactive remediation waste in staging piles in **– applicable**	40 *C.F.R.*§ 264.554(e)(1)(i) and (ii) 401 *KAR* 34:287 § 5
	Alternatively, instead of meeting the above requirements in 40 *C.F.R.*264.554(e)(1), the remediation waste may be managed to protect it from exposure to any material or condition that may cause it to ignite or react.		40 *C.F.R.*§ 264.554(e)(2) 401 *KAR* 34:287 § 5
	Must not place in the same staging pile unless you have complied with 40 *C.F.R.*§ 264.17(b).	Storage of incompatible remediation waste in staging piles in **– applicable**	40 *C.F.R.*§ 264.554(f)(1) 401 *KAR* 34:287 § 5
	Must separate the incompatible materials or protect them from one another by using a dike, berm, wall, or other device.		40 *C.F.R.*§ 264.554(f)(2) 401 *KAR* 34:287 § 5
	Must not pile remediation waste on the same base where incompatible wastes or materials were previously piled, unless the base has been decontaminated sufficiently to comply with 40 *C.F.R.*§ 264.17(b).		40 *C.F.R.*§ 264.554(f)(3) 401 *KAR* 34:287 § 5
Closure of RCRA staging pile of remediation waste	Must be closed within 180 days after the operating term by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate.	Storage of remediation waste in staging pile in ***previously contaminated area*** – **applicable**	40 C.F.R.§ 264.554(j)(1) and (2) 401 *KAR* 34:287 § 5

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	Must decontaminate contaminated sub-soils in a manner that EPA determines will protect human and the environment.		
	Must be closed within 180 days after the operating term according to 40 C.F.R.§ 264.258(a) and § 264.111 or §265.258(a) and § 265.111.	Storage of remediation waste in staging pile ***in uncontaminated area*** – **applicable**	40 C.F.R.§ 264.554(k) 401 *KAR* 34:287 § 5
Operational limits of a RCRA staging pile	Must not operate for more than 2 years, except when an operating term extension under 40 C.F.R.§ 264.554(i) is granted. *NOTE:* Must measure the 2-year limit (or other operating term specified) from first time remediation waste placed in staging pile	Storage of remediation waste in a staging pile **– applicable**	40 C.F.R.§264.554(d)(1)(iii) 401 *KAR* 34:287 § 5
	Must not use staging pile longer than the length of time designated by EPA in appropriate decision document.		40 C.F.R.§264.554(h) 401 *KAR* 34:287 § 5
Groundwater or Soil Vapor Treatment using Heat with Air Stripper System and/or Activated Carbon Filter			
Activities causing toxic substances or potentially hazardous matter emissions	Persons responsible for a source from which hazardous matter or toxic substances may be emitted shall provide the utmost care and consideration in the handling of these materials to the potentially harmful effects of the emissions resulting from such activities. Shall not allow any affected facility to emit potentially hazardous matter or toxic substances in such quantities or duration as to be harmful to the health and welfare of humans, animals and plants.	Emissions of potentially hazardous matter or toxic substances as defined in 401 *KAR* 63:020 § 2 (2) – **applicable**	401 *KAR* 63:020 § 3
Treatment of hazardous waste in a miscellaneous treatment unit	Unit must be located, designed, constructed, operated and maintained, and closed in a manner that will ensure protection of human health and the environment.	Treatment of RCRA hazardous waste in miscellaneous units, unless exempt in 40 *C.F.R.*§ 264.1, (e.g., thermal desorber not meeting the definition of a hazardous waste incinerator in 40 *C.F.R.*§ 260.10) – **applicable**	40 *C.F.R.*§ 264.601
	Protection of human health and the environment includes, but is not limited to: prevention of any release that may have adverse effects on human health or the environment due to migration of waste constituents in the air, considering the factors listed in 40 *C.F.R.*§ 264.601(c)(1) thru (7).		40 *C.F.R.*§ 264.601(c)

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
General standards for process vents used in treatment of VOCs	Select and meet the requirements under one of the options specified below: • Control hazardous air pollutants (HAP) emissions from the affected process vents according to the applicable standards specified in §§ 63.7890 through 63.7893. • Determine for the remediation material treated or managed by the process vented through the affected process vents that the average total volatile organic hazardous air pollutant (VOHAP) concentration, as defined in § 63.7957, of this material is less than 10 (ppmw). Determination of VOHAP concentration will be made using procedures specified in § 63.7943. • Control HAP emissions from affected process vents subject to another subpart under 40 *C.F.R.*part 61 or 40 *C.F.R.*part 63 in compliance with the standards specified in the applicable subpart.	Process vents as defined in 40 *C.F.R.*§ 63.7957 used in site remediation of media (e.g., soil and groundwater) that could emit HAP listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 *C.F.R.*§ 63.7885(c)(1) – **relevant and appropriate**	40 *C.F.R.*§ 63:7885(b) 401 *KAR* 63:002, §§ 1 and 2, except for 40 *C.F.R.*§ 63.72 as incorporated in § 2(3)
Emission limitations for process vents used in treatment of VOCs	Meet the requirements under one of the options specified below: • Reduce from all affected process vents the total emissions of the HAP to a level less than 1.4 kilograms per hour (kg/hr) and 2.8 Mg/yr (3.0 pounds per hour (lb/hr) and 3.1 tpy); or • Reduce from all affected process vents the emissions of total organic compounds (TOC) (minus methane and ethane) to a level below 1.4 kg/hr and 2.8 Mg/yr (3.0 lb/hr and 3.1 tpy); or • Reduce from all affected process vents the total emissions of the HAP by 95 percent by weight or more; or • Reduce from all affected process vents the emissions of TOC (minus methane and ethane) by 95 percent by weight or more.	Process vents as defined in 40 *C.F.R.*§ 63.7957 used in site remediation of media (e.g., soil and groundwater) that could emit hazardous air pollutants (HAP) listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 *C.F.R.*§ 63.7885(c)(1) – **relevant and appropriate**	40 *C.F.R.*§ 63.7890(b)(1)-(4) 401 *KAR* 63:002, §§ 1 and 2, except for 40 *C.F.R.*§ 63.72 as incorporated in § 2(3)
Standards for closed vent systems and control devices used in treatment of VOCs	For each closed vent system and control device you use to comply with the requirements above, you must meet the operating limit requirements and work practice standards in Sec. 63.7925(d) through (j) that apply to the closed vent system and control device.	Closed vent system and control devices as defined in 40 *C.F.R.*§ 63.7957 that are used to comply with § 63.7890(b) – **relevant and appropriate**	40 *C.F.R.*§ 63.7890(c)

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	NOTE: EPA approval to use alternate work practices under paragraph (j) in 40 *C.F.R.* § 63.7925 will be obtained in a CERCLA document (e.g., Remedial Design).		
Monitoring of closed vent systems and control devices used in treatment of VOCs	Must monitor and inspect the closed vent system and control device according to the requirements in 40 *C.F.R.* § 63.7927 that apply to the affected source. *NOTE:* Monitoring program will be developed as part of the CERCLA process and included in a Remedial Design or other appropriate CERCLA document.	Closed vent system and control devices as defined in 40 *C.F.R.* § 63.7957 that are used to comply with § 63.7890(b) – **relevant and appropriate**	40 *C.F.R.* § 63.7892
Temporary tanks and container storage areas used to treat or store hazardous remediation wastes	The Regional Administrator may designate a unit at the facility, as a temporary unit. A temporary unit must be located within the contiguous property under the control of the owner/operator where the wastes to be managed in the temporary unit originated. EPA may replace the design, operating, or closure standards under this part 264 or part 265 with alternate requirements that protect human health and the environment. *NOTE:* EPA approval of design, operating, or closure requirements for a temporary unit will be obtained by approval of a CERCLA decision document	Generation of RCRA remediation waste during remedial activities that require treatment or storage – **applicable**	40 *C.F.R.* § 264.553(a) 401 *KAR* 34:287
	Any temporary unit to which alternative requirements are applied in accordance with paragraph (a) of this section shall be: (1) Located within the facility boundary; and (2) Used only for treatment or storage of remediation wastes.		40 *C.F.R.* § 264.553(b) 401 *KAR* 34:287
	In establishing standards to be applied to a temporary unit, the following factors shall be considered: • Length of time such unit will be in operation; • Type of unit; • Volumes of wastes to be managed; • Physical and chemical characteristics of the wastes to		40 *C.F.R.* § 264.553(c)(1)-(7) 401 *KAR* 34:287

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	be managed in the unit; - Potential for releases from the unit; - Hydrogeological and other relevant environmental conditions at the facility which may influence the migration of any potential releases; and - Potential for exposure of humans and environmental receptors if releases were to occur from the unit.		
Operational period for temporary tanks or container storage areas	The Regional Administrator shall specify in the permit or order the length of time a temporary unit will be allowed to operate, to be no longer than a period of one year. The Regional Administrator shall also specify the design, operating, and closure requirements for the unit.	Use of temporary tanks and container storage areas to treat or store hazardous remediation wastes during remedial activities – **applicable**	40 *C.F.R.* § 264.553(d) 401 *KAR* 34:287
	The Regional Administrator may extend the operational period of a temporary unit once for no longer than a period of one year beyond that originally specified in the permit or order, if the Regional Administrator determines that: (1) Continued operation of the unit will not pose a threat to human health and the environment; and (2) Continued operation of the unit is necessary to ensure timely and efficient implementation of remedial actions at the facility.		40 *C.F.R.* § 264.553(e) 401 *KAR* 34:287
	The Regional Administrator shall document the rationale for designating a temporary unit and for granting time extensions for temporary units and shall make such documentation available to the public. *NOTE:* The rationale for designating temporary units will be documented in a CERCLA decision document (e.g. ROD, ROD Amendment or ESD). Any time extensions for a temporary unit along with the rationale will be documented in the appropriate CERCLA decision document.		40 *C.F.R.* § 264.553(g) 401 *KAR* 34:287
Transport or conveyance of collected RCRA wastewater to a WWTU located on the facility	Any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey wastewater to an on-site KPDES-permitted wastewater treatment facility are exempt from the requirements of RCRA Subtitle C standards. *NOTE:* For purposes of this exclusion, any dedicated tank	On-site wastewater treatment unit (as defined in 40 *C.F.R.* § 260.10) subject to regulation under § 402 or § 307(b) of the CWA (i.e., KPDES-permitted) that manages hazardous wastewaters – **applicable**.	40 *C.F.R.* § 264.1(g)(6) 401 *KAR* 34:010 § 1

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	systems, conveyance systems, and ancillary equipment used to treat, store or convey CERCLA remediation wastewater to a CERCLA on-site wastewater treatment unit that meets all of the identified CWA ARARs for point source discharges from such a facility, are exempt from the requirements of RCRA Subtitle C standards.		
Groundwater Monitoring, Extraction, and Injection Well Installation and Abandonment			
Monitoring well installation	Permanent monitoring wells shall be constructed, modified, and abandoned in such a manner as to prevent the introduction or migration of contamination to a water-bearing zone or aquifer through the casing, drill hole, or annular materials.	Construction of monitoring well as defined in 401 *KAR* 6:001 § 1(18) for remedial action – **applicable**	401 *KAR* 6:350 § 1(2)
	All permanent monitoring wells (including boreholes) shall be constructed to comply with the substantive requirements provided in the following Sections of 401 *KAR* 6:350: • Section 2. Design Factors; • Section 3. Monitoring Well Construction; • Section 7. Materials for Monitoring Wells; and • Section 8. Surface Completion.		401 *KAR* 6:350 § 2, 3, 7, and 8
Monitoring well installation con't	If conditions exist or are believed to exist that preclude compliance with the requirements of 401 *KAR* 6:350, may request a variance prior to well construction or well abandonment. *NOTE:* Variance shall be made as part of the CERCLA document review and approval process and shall include: • A justification for the variance; and • Proposed construction, modification, or abandonment procedures to be used in lieu of compliance with 401 *KAR* 6:350 and an explanation as to how the alternate well construction procedures ensure the protection of the quality of the groundwater and the protection of public health and safety.	Construction of monitoring well as defined in 401 *KAR* 6:001 § 1(18) for remedial action – **applicable**	401 *KAR* 6:350 § 6 (a)(6) and (7)
Development of monitoring well	Newly installed wells shall be developed until the column of water in the well is free of visible sediment. This well-development protocol shall not be used as a method	Construction of monitoring well as defined in 401 *KAR* 6:001 § 1(18) for remedial action – **applicable**	401 *KAR* 6:350 § 9

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	for purging prior to water quality sampling.		
Direct Push monitoring well installation	Wells installed using direct push technology shall be constructed, modified, and abandoned in such a manner as to prevent the introduction or migration of contamination to a water-bearing zone or aquifer through the casing, drill hole, or annular materials.	Construction of direct push monitoring well as defined in 401 *KAR* 6:001 § 1(18) for remedial action – **applicable**	401 *KAR* 6:350 § 5 (1)
	Shall also comply with the following additional standards: (a) The outside diameter of the borehole shall be a minimum of 1 inch greater than the outside diameter of the well casing; (b) Premixed bentonite slurry or bentonite chips with a minimum of one-eighth (1/8) diameter shall be used in the sealed interval below the static water level; an (c) 1. Direct push wells shall not be constructed through more than one water-bearing formation unless the upper water bearing zone is isolated by temporary or permanent casing. 2. The direct push tool string may serve as the temporary casing.		401 *KAR* 6:350 § 5 (3)
Monitoring well abandonment	A monitoring well that has been damaged or is otherwise unsuitable for use as a monitoring well, shall be abandoned within 30 days from the last sampling date or 30 days from the date it is determined that the well is no longer suitable for its intended use.	Construction of monitoring well as defined in 401 *KAR* 6:001 § 1(18) for remedial action **– applicable**	401 *KAR* 6:350 § 11 (1)
	Wells shall be abandoned in such a manner as to prevent the migration of surface water or contaminants to the subsurface and to prevent migration of contaminants among water bearing zones.		401 *KAR* 6:350 § 11 (1)(a)
	Abandonment methods and sealing materials for all types of monitoring wells provided in subparagraphs (a)-(b) and (d)-(e) shall be followed.		401 *KAR* 6:350 § 11 (2)
Extraction well installation for use in 'pump and treat system'	Wells shall be constructed, modified, and abandoned in such a manner as to prevent the introduction or migration of contamination to a water-bearing zone or aquifer through the casing, drill hole, or annular materials.	Construction of extraction well for remedial action – **relevant and appropriate**	401 *KAR* 6:350 § 1 (2)

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Underground injection for remediation	No owner or operator shall construct, operate, maintain, convert, plug, abandon, or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 *C.F.R.* Part 142 or may otherwise adversely affect the health of persons.	Underground injection into an underground source of drinking water – **relevant and appropriate**	40 *C.F.R.* § 144.12(a)
Reinjection of treated contaminated groundwater	Wells are not prohibited if injection is approved by EPA or a State pursuant to provisions for cleanup of releases under CERCLA or RCRA *as provided in the CERCLA document.*	Class IV wells [as defined in 40 *C.F.R.* § 144.6(d)] used to reinject treated contaminated groundwater into the same formation from which it was drawn – **relevant and appropriate**	40 *C.F.R.* § 144.13(c) RCRA § 3020(b)
	Prior to abandonment any Class IV well, the owner or operator shall plug or otherwise close the well in a manner *as provided in the CERCLA document.*	Class IV wells [as defined in 40 *C.F.R.* § 144.6(d)] used to reinject of treated contaminated groundwater into the same formation from which it was drawn – **relevant and appropriate**	40 *C.F.R.* § 144.23(b)(1)
Plugging and abandonment of Class IV injection wells	Prior to abandoning the well, the owner or operator shall close the well in accordance with 40 *C.F.R.* § 144.23(b).	Operation of a Class IV injection well [as defined in 40 *C.F.R.* § 144.6(d)] – **relevant and appropriate**	40 *C.F.R.* § 146.10(b)
Injection of fluids for Class V injection wells	Injection activity cannot allow movement of fluid containing any contaminant into an underground source of drinking water (USDW), if the presence of that contaminant may cause a violation of the primary drinking water standards under 40 C.F.R. Part 141, or other health-based standards, or may otherwise adversely affect the health of persons. This prohibition applies to well construction, operation, maintenance, conversion, plugging, closure, or any other injection activity.	Operation of a Class V injection well for remediation – **relevant and appropriate**	40 *C.F.R.* § 144.82(a)
Closure of Class V injection wells	Close the well in a manner that complies with the above prohibition of fluid movement [40 *C.F.R.* § 144.82(a)]. Also must dispose of or otherwise manage any soil, gravel, sludge, liquids, or other material removed from or adjacent to well in accordance with all applicable federal, state, and local regulations and requirements.		40 *C.F.R.* § 144.82(b)
Plugging and abandonment of	Prior to abandoning a Class V well the owner or operator shall close the well in a manner that prevents the movement of fluid	Closure of a Class V injection well for remediation – **relevant and appropriate**	40 *C.F.R.* § 146.10(c)(1)

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Class V injection wells	containing any contaminant into an underground source of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 C.F.R. part 141 or may otherwise adversely affect the health of persons.		Requirements for Class V wells
Groundwater monitoring requirements for RCRA hazardous waste landfills	All or part of the requirements for releases from solid waste management units of 40 *C.F.R.* §§ 264.91 through 264.100 may be replaced with alternative requirements for groundwater monitoring and corrective action for releases to groundwater set out in the enforceable CERCLA document where it has been determined that: (1) The regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release; and (2) It is not necessary to apply the groundwater monitoring and corrective action requirements of 40 *C.F.R.* §§ 264.91 through 264.100 because alternative requirements will protect human health and the environment.	Conducting monitoring for responding to releases from landfills under 40 *C.F.R.* § 264.90 – **applicable to Ponds 1A and 2**	40 *C.F.R.* § 264.90(f)(1) and (2) 401 *KAR* 34:060 § 1
Discharge of Wastewater from Groundwater Treatment and De-watering of stockpiled soil and sediments			
General duty to mitigate for discharge	Take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of effluent standards which has a reasonable likelihood of adversely affecting human health or the environment.	Discharge of pollutants to surface waters of the State – **applicable**	40 C.F.R.§ 122.41(d) 401 *KAR* 5:065 § 2(1)
Operation and maintenance of treatment system	Properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used to achieve compliance with the effluent standards. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures.	Discharge of pollutants to surface waters of the State – **applicable**	40 C.F.R.§ 122.41(e) 401 *KAR* 5:065 § 2(1)
Technology-based treatment requirements for wastewater discharge	To the extent that EPA promulgated effluent limitations are inapplicable, develop on a case-by-case Best Professional Judgment (BPJ) basis under Section 402(a)(1)(B) of the CWA, technology based effluent limitations by applying the factors listed in section 125.3(d) and shall consider:	Discharge of pollutants to surface waters from other than a POTW – **applicable**	40 C.F.R.§ 125.3(c)(2) *Effluent Limitations*

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	• The appropriate technology for this category or class of point sources, based upon all available information; and • Any unique factors relating to the discharger.		
Water quality-based effluent limits for wastewater discharge	Must develop water quality based effluent limits that ensure that: • The level of water quality to be achieved by limits on point source(s) established under 40 C.F.R.§ 122.44(d)(1)(vii) is derived from, and complies with all applicable water quality standards; and • Effluent limits developed to protect narrative or numeric water quality criteria are consistent with the assumptions and any available waste load allocation for the discharge prepared by the State and approved by EPA pursuant to 40 *C.F.R.*§ 130.7.	Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard – **applicable**	40 C.F.R.§ 122.44(d)(1)(vii) 401 *KAR* 5:065 § 2(4)
	Must attain or maintain a specified water quality through water quality related effluent limits established under § 302 of the CWA.	Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard – **applicable**	40 *C.F.R.*§ 122.44(d)(2) 401 *KAR* 5:065 § 2(4)
	If a discharge causes, has the reasonable potential to cause, or contribute to an in-stream excursion above the numeric criterion for whole effluent toxicity using the procedures in paragraph (d)(1)(ii), must develop effluent limits for whole effluent toxicity.	Discharge of wastewater that causes, has the reasonable potential to cause, or contributes to an in-stream excursion above the numeric criterion for whole effluent toxicity – **applicable**	40 *C.F.R.*§ 122.44(d)(1) (iv) 401 *KAR* § 5:065 2(4)
Monitoring requirements for discharges	In addition to 40 C.F.R.§ 122.48 (a) and (b) and to assure compliance with effluent limitations requirements to monitor, one must monitor, as appropriate, according to the substantive requirements provided in 40 C.F.R.§ 122.44(i)(1)(i) through (iv). *NOTE:* Monitoring location and frequency will be conducted in accordance with CERCLA Remedial Action Work Plan.	Discharge of pollutants to surface waters – **applicable**	40 C.F.R.§ 122.44(i)(1) *Monitoring Requirements* 401 *KAR* § 5:065 2(4) 40 C.F.R.§ 122.44(i)(2)
	All effluent limitations, standards and prohibitions shall be established for each outfall or discharge point, except as		40 *C.F.R.*§ 122.45(a)

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	provided under 40 C.F.R.§ 122.44(k).		401 *KAR* § 5:065 2(5)
	All effluent limitations, standards and prohibitions, including those necessary to achieve water quality standards, shall unless impracticable be stated as: Maximum daily and average monthly discharge limitations for all discharges	Continuous discharge of pollutants to surface waters – **applicable**	40 *C.F.R.*§ 122.45(d)(1) 401 *KAR* § 5:065 2(5)
Mixing zone requirements for discharge of pollutants to surface water	The relevant requirements provided in 401 *KAR* 10:029 § 4 shall apply to a mixing zone for a discharge of pollutants. *NOTE*: Determination of the appropriate mixing zone will, if necessary, involve consultation with KDEP and will be documented in the CERCLA Remedial Design or other appropriate CERCLA document.	Discharge of pollutants to surface waters of the Commonwealth – **applicable**	401 *KAR* 10:029 § 4
Capping Waste in Place – Landfill or Surface Impoundment Closure and Post-Closure			
Installation of low-permeability cover for Ponds 1A and 2	Must cover the surface impoundment with a final cover designed and constructed to: (1) provide long-term minimization of migration of liquids through the closed impoundment; (2) function with minimum maintenance; (3) promote drainage and minimize erosion or abrasion of the final cover; (4) accommodate settling and subsidence so that the cover's integrity is maintained; and (5) have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	Closure of RCRA hazardous waste landfill – **relevant and appropriate**	40 *C.F.R.*§ 264. 228(a) (2)(iii)(A)-(E) 401 *KAR* 34:230 § 7

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Installation of low-permeability cover (Ponds 1A and 2)	EPA guidance provides technical recommendations on the design parameters for a multi-layer low permeability cover including a two component low permeability layer, a soil drainage layer, and a two component top layer. The guidance acknowledges that other final cover designs may be acceptable.	Design and construction of cover – **TBC**	Sections 1.4.1, 2, 3, and 4 of the EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments, EPA OSWER 530- SW-89-047, (July 1989)
Post-closure care of surface impoundment (Ponds 1A and 2)	. The owner and operator must: • Maintain the integrity and effectiveness making repairs to the cap as necessary to correct the effects of settling, subsidence erosion, or other events; • Maintain and monitor the ground-water monitoring systems and comply with all other applicable requirements of subpart F of this part; and • Prevent run-on and run-off form eroding or otherwise damaging the final cover.	Closure of RCRA hazardous waste surface impoundment with some waste residues or contaminated materials left in place – **relevant and appropriate**	40 *C.F.R.*§ 264.228(b) (1), (3) and (4)
Post-closure care and use of property	Must begin after completion of the closure of the unit and continue for 30 years after that date and must consist of: • Monitoring and reporting; and • Maintenance and monitoring of waste containment systems. *NOTE:* Monitoring of final cover and groundwater will be performed in accordance with a CERCLA Remedial Action Work Plan.	Closure of RCRA hazardous waste management unit – **relevant and appropriate**	40 *C.F.R.*§ 264.117(a)(1) 401 *KAR* 34:070 § 8

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
Disturbance of integrity of low-permeability cover	Must never allow disturbance of the integrity of the cover, or any other components of the containment system, or the function of the facility's monitoring systems, unless the disturbance: • Is necessary to the proposed use of the property, and will not increase the potential hazard to human health or the environment; or • Is necessary to reduce a threat to human health or the environment.		40 *C.F.R.* § 264.117(c) 401 *KAR* 34:070 § 8
Post-closure notices (former RCRA surface impoundments closed as landfill)	Must record, in accordance with State law, a notation on the deed to the facility property, or on some other instrument which is normally examined during a title search, that will in perpetuity notify any potential purchaser of the property that: • Land has been used to manage hazardous wastes; • Its use is restricted under 40 *C.F.R.* Part 264 Subpart G regulations; and • The survey plat and record of the type, location, and quantity of hazardous wastes disposed within each cell or other hazardous waste disposal unit of the facility required by Sections 264.116 and 264.119(a) have been filed with the local zoning authority and with the EPA Regional Administrator.	Closure of a RCRA hazardous waste surface impoundment or landfill with some waste residues or contaminated materials left in place – **applicable**	40 C.F.R.§ 264.119(b)(1)(i)-(iii)
	Waste Transportation		
Transportation of samples (i.e., contaminated soils and wastewaters)	Are not subject to any requirements of 40 *C.F.R.* Parts 261 through 268 or 270 when: • The sample is being transported to a laboratory for the purpose of testing; or • The sample is being transported back to the sample collector after testing.	Samples of solid waste or a sample of water, soil for purpose of conducting testing to determine its characteristics or composition – **applicable**	40 *C.F.R.* § 261.4(d)(1)(i) and (ii) 401 *KAR* 31:010 § 4
	In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements. • Assure that the information provided in (1) thru (5) of this		40 *C.F.R.* § 261.4(d)(2)(i) 401 *KAR* 31:010 § 4 40 *C.F.R.* § 261.4(d)(2)(i)(A) 401 *KAR* 31:010 § 4

Table 3 – Action-Specific ARARs and TBCs for B.F. Goodrich Superfund Site
Calvert City, Kentucky

Action	Requirement	Prerequisite	Citation
	section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.		40 *C.F.R.*§ 261.4(d)(2)(i)(B) 401 *KAR* 31:010 § 4
Transportation of RCRA hazardous waste *on-site*	The generator manifesting requirements of 40 *C.F.R.*§ 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 *C.F.R.*§ 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way –**applicable**	40 *C.F.R.*§ 262.20(f) 401 *KAR* 32:020 § 1
Transportation of RCRA hazardous waste *off-site*	Must comply with the generator requirements of 40 *C.F.R.*§ 262.20–23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain EPA ID number.	Preparation and initiation of shipment of hazardous waste off-site – **applicable**	40 *C.F.R.*§ 262.10(h) 401 *KAR* 32:010 § 1
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMR at 49 *C.F.R.*§§ 171–180 related to marking, labeling, placarding, packaging, emergency response, etc.	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material – **applicable**.	49 *C.F.R.*§ 171.1(c)

ARAR = applicable or relevant and appropriate requirement
BAT = best available technology
BMP = Best Management Practices
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
C.F.R. = *Code of Federal Regulations*
CWA = Clean Water Act
DOT = U.S. Department of Transportation
E.O. = Executive Order
EPA = U.S. Environmental Protection Agency
FFA = federal facility agreement
HAP = hazardous air pollutant

HMR = Hazardous Material Regulations
KAR = *Kentucky Administrative Regulations*
KPDES = Kentucky Pollutant Discharge Elimination System
LDR = land disposal restrictions

NAAQS = National Ambient Air Quality Standards
NESHAP = National Emissions Standards for Hazardous Air Pollutant
NSPR = New Source Performance Standards
NWP = Nationwide Permits
PPE = personal protective equipment
RCRA = Resource Conservation and Recovery Act
SWMU = solid waste management unit

TBC = to be considered
TCLP = Toxicity Characteristic Leaching Procedure
TOC = total organic compound
UTS = Universal Treatment Standards

VOC = Volatile organic compound
VOHAP = volatile organic hazardous air pollutant
WWTU = wastewater treatment unit

APPENDIX G

STATE CONCURRENCE LETTER

MATTHEW G. BEVIN
GOVERNOR

CHARLES G. SNAVELY
SECRETARY

ENERGY AND ENVIRONMENT CABINET
Department for Environmental Protection

ANTHONY R. HATTON
COMMISSIONER

300 SOWER BOULEVARD
FRANKFORT, KENTUCKY 40601

August 30, 2018

Mr. Franklin Hill, Director
U.S. EPA Region 4 Superfund
61 Forsythe St. SW #9
Atlanta, GA, 30303

Re: **Letter of Concurrence**
Record of Decision (August 2018)
EPA ID# KYD 006 370 167
KDEP AI# 2919
Goodrich Corporation (aka BF Goodrich)
2468 Industrial Parkway
Calvert City, KY
Marshall County

Dear Director Hill:

The Kentucky Department for Environmental Protection (KDEP) has reviewed the Record of Decision (ROD) supplied by the U.S. Environmental Protection Agency (EPA), in addition to pertinent and appropriate historic data and the EPA's Proposed Plan as relates to Remedial Action at the above referenced site. The ROD was developed by EPA and included consultation with KDEP to address KDEP concerns and state requirements.

The KDEP concurs with the ROD, and looks forward to continuing to work collaboratively with the EPA to move toward site remediation at the BF Goodrich Superfund Site.

Please contact Sheri Uhlenbruch at sheri.adkins@ky.gov or 502-782-6536 should you have any questions regarding this letter.

Sincerely,

Anthony R. Hatton, P.G.
Commissioner

TH/su

c: Jon Maybriar, Director DWM
Larry Hughes, P.G., Manager, SFB
Christoph Uhlenbruch, P.G., Supervisor SFB
Sheri Uhlenbruch, P.G., SFB
Daniel Cleveland, J.D., OLS