U.S. ENVIRONMENTAL PROTECTION AGENCY
SUPERFUND PROGRAM

RECORD OF DECISION

for

RIVERFRONT SUPERFUND SITE
OPERABLE UNIT 2

and

OPERABLE UNIT 6
NEW HAVEN, MISSOURI

May 2011

Prepared by
U.S. Environmental Protection Agency
Region 7
Kansas City, Kansas

RECORD OF DECISION
RIVEFRONT SITE
OPERABLE UNIT 2 AND OPERABLE UNIT 6

Part I – DECLARATION 1

1.1 Site Name and Location 1
1.2 Statement of Basis and Purpose 1
1.3 Assessment of Site 1
1.4 Description of Selected Remedy 1
1.5 Statutory Determinations 3
1.6 Record of Decision Data Certification Checklist 4
1.7 Authorizing Signature 4

Part II – DECISION SUMMARY 1

1.0 Site Name, Location, and Description 1

2.0 Site History and Enforcement Activities 1
2.1 Site History 1
2.2 Investigation Activities at OU2 and OU6 3
2.2.1 Missouri Department of Natural Resources (1989-1993) 3
2.2.2 Geotechnology (1991-1998) 3
2.2.3 Environmental Management Alternatives 5
2.2.4 USGS and Black & Veatch (2000 to Present) 6
2.2.5 Parsons (2004 to Present) 9
2.2.6 Remedial Investigation for OU2 and OU6 10

3.0 Community Participation 17

4.0 Scope and Role of Operable Unit and Response Action 17

5.0 Conceptual Site Model 18
5.1 Site Characteristics 18
5.1.1 Physical Characteristics 19
5.1.2 Demography, Land Use, and Wildlife 19
5.1.3 Hydrogeology of the New Haven Area 20
5.1.4 Surficial Geology 22
5.1.5 Structural Geology 23
5.1.6 Fractures, Jointing, and Weathering 24
5.1.7 Groundwater Flow 24

5.2 Nature and Extent of Contamination 25
5.2.1 Distribution of PCE and Other VOCs in Soils 25
5.2.2 Distribution of PCE as DNAPL at OU2 26

5.2.3 Distribution of PCE and Other VOCs in Groundwater 27
5.2.4 Distribution of PCE and Other VOCs in Sanitary Sewers and Adjacent Soils 32
5.2.5 Distribution of PCE and Other VOCs in Sediment and Surface Water 33

6.0 Current and Potential Future Site and Resource Use 33

7.0 Summary of Site Risks 34
7.1 Summary of Human Health Risk Assessment 34
7.1.1 Identification of Contaminants of Concern 34
7.1.2 Physical and Chemical Properties of COPCs 38
7.1.3 Exposure Assessment 38
7.1.4 Conceptual Site Model 38
7.1.5 Known and Suspected Sources of COPCs and Release Mechanisms 39
7.1.6 Retention or Transport Media 39
7.1.7 Transport Pathways 39
7.1.8 Exposure Routes and Exposure Points 40
7.1.9 Receptors and Exposure Scenarios 40
7.1.10 Exposure Point Concentrations and Chemical Intakes 41
7.1.11 Toxicity Assessment 42
7.1.12 Risk Characterization 43
7.1.13 Risk Characterization for Multiple COCs 45
7.1.14 Uncertainty 47
7.1.15 Uncertainty Associated with Data Evaluations and Selection of COCs 48

7.2 Ecological Risk Assessment 49
7.2.1 2002 Ecological Risk Assessment Summary 49
7.2.2 Updates to the Ecological Risk Assessment 50

7.3 Risk Assessment Summary and Conclusion 52

8.0 Remedial Action Objectives 52

9.0 Description of Remedial Alternatives 53

9.1 Description of Alternatives 55

9.1.1 Alternative 1: No Action 55

9.1.2 Alternative 2: DNAPL Recovery Followed by In situ Chemical Oxidation, ICs, Groundwater Monitoring, and
a) Whole-house Treatment Units
b) Alternate Water Supply, Whole-house Treatment Units (interim)
c) Whole-house Treatment Units, In situ Groundwater Remediation
d) Alternate Water Supply, Whole-house Treatment Units (interim), In situ Groundwater Remediation 55

9.1.3 Alternative 3: Thermally Enhanced Vapor Extraction for DNAPL, ICs, Groundwater Monitoring, and
a) Whole-house Treatment Units
b) Alternate Water Supply, Whole-house Treatment Units (interim) 57

9.1.4 Alternative 4: Thermally-Enhanced Vapor Extraction for Soils and DNAPL, Whole-house Treatment Units, ICs, Groundwater Monitoring, and
a) No Groundwater Treatment
b) Bioremediation for Groundwater
c) In situ Chemical Oxidation for Groundwater
d) In situ Reduction for Groundwater 58

9.1.5 Alternative 5: In situ Chemical Oxidation (DNAPL, Area A-3, Groundwater), Whole-house Treatment Units, ICs, and Groundwater Monitoring 59

9.1.6 Alternative 6: In situ Chemical Reduction (DNAPL, Area A-3, Groundwater), Whole-house Treatment Units, ICs, and Groundwater Monitoring 59

10.0 Comparative Analysis of Alternatives 60
10.1 Overall Protection of Human Health and the Environment 62
10.2 Compliance with ARARs 63
10.3 Long-term Effectiveness and Permanence 64
10.4 Reduction of Toxicity, Mobility, or Volume of Contaminants Through Treatment 65
10.5 Short-term Effectiveness 66
10.6 Implementability 67
10.7 Cost 69
10.8 State/Support Agency Acceptance 69
10.9 Community Acceptance 69

11.0 Principal Threat Wastes 69

12.0 Selected Remedy 70
12.1 Summary of the Rationale for the Selected Remedy 71
12.2 Description of the Selected Remedy 72

12.3 Summary of the Estimated Costs 74
12.4 Expected Outcomes of the Selected Remedy 74

13.0 Statutory Determinations 75
13.1 Protection of Human Health and Environment 76
13.2 Compliance with Applicable or Relevant and Appropriate Requirements 76
13.3 Cost Effectiveness 77
13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable 78
13.5 Preference for Treatment Which Reduces Toxicity, Mobility or Volume 78
13.6 Five-Year Review Requirements 78

14.0 Documentation of Significant Changes from Preferred Alternative of Proposed Plan 79

PART III – RESPONSIVENESS SUMMARY 79

1.0 Introduction 79

2.0 Summary of Commenter's Major Issues and Concerns and EPA's Responses 80

3.0 Technical and Legal Issues 85
3.1 Technical Issues 85
3.2 Legal Issues 85

LIST OF FIGURES

1-1 Location of New Haven, Missouri
1-2 Riverfront Site Operable Unit Locations
2-1 Location of Former Kellwood facility and land-farm area
2-2 Location of Sampling Points at OU2
2-3 Locations of Pre-RI Groundwater Samples
2-4 Special Area 3 Boundary
2-5 Locations of Pre-RI Surface Water Samples
2-6 Locations of USGS Sanitary Sewer Samples
2-7 Locations of USGS Tree Core Samples
2-8 Interval Screening Report's Transmissive Zones
2-9 Soil Investigation Sampling Locations at OU2
2-10 Residential Well Sampling Locations
2-11 Sitewide Groundwater Sampling Locations
2-12 DNAPL Investigation Sampling Locations
2-13 Sediment and Surface Water Sampling Locations
2-14 Sewer Sediment, Water, and Soil Sampling Locations
2-15 Soil Gas Sampling Locations

5-1 Conceptual Site Model
5-2 DNAPL Treatment Area A-1 and Soil Treatment A-1
5-3 Estimated Extent of Groundwater Contamination Above RAOs
5-4 Geologic Structure Beneath New Haven
5-5 Groundwater Divide
5-6 Location of Contaminated Soils at OU2
5-7 Extent of DNAPL Detections at OU2
5-8 Detections of PCE in Primary Transmissive Zones
5-9 PCE Detections in All Groundwater Zones
5-10 PCE Detections in Sanitary Sewer Sediment and Soils Adjacent to Sewer Lines
5-11 PCE Detections in Sanitary Sewer Water
5-12 PCE Detections in Surface Water in OU2 and OU6
7-1 Ecological Risk Assessment Study Zone
12-1 DNAPL and Chemical Oxidation Treatment Areas in OU2
12-2 Area A-4 Groundwater Treatment Well Locations

LIST OF TABLES

2-2 Chronology of Investigations at OU2 and OU6
2-3 Historic Soil Sampling Results at OU2 and OU6
2-4 USGS Monitoring Well Construction
2-5 Historical Groundwater Sampling Results
2-6 Residential Well Sampling Locations
5a Subslab Sampling Results
5b Indoor Air Sampling Results
5-1 Geologic Units of the Ozark Aquifer
5-2 Groundwater Sampling Results in Unconsolidated Deposits
7-1 Chemical of Concern
7-2 Exposure Point Concentration, Ambient Air
7-3 Exposure Point Concentration, Groundwater
7-4 Exposure Point Concentration, Soil
7-5 Exposure Point Concentration, Indoor Air
7-6 Exposure Point Concentration, Sediments
7-7 Exposure Point Concentration, Surface Water
7-8 Exposure Point Concentration, Mixed Soil
7-9 Noncancer Toxicity Data (Oral/Dermal)
7-10 Noncancer Toxicity Data (Inhalation)
7-11 Cancer Toxicity Data (Oral/Dermal)
7-12 Cancer Toxicity Data (Inhalation)
8-1 RAOs for Ecological Receptors
10.1 Evaluation of ARARs

ABBREVIATIONS

AMSL	above mean sea level
AOC	Administrative Order on Consent
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
cis-1,2-DCE	cis-1,2-dichloroethene
COPCs	chemicals of potential concern
CR	cancer risk
CVOCs	chlorinated volatile organic compounds
DNAPL	dense non-aqueous phase liquid
DPT	direct-push technology
EMA	Environmental Management Alternatives
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
ESLs	Ecological Screening Levels
FSP	Field Sampling Plan
ft/min	feet per minute
GC	gas chromatograph
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
IDW	investigation-derived waste
IRIS	Integrated Risk Information System
MCL	maximum contaminant level
MDNR	Missouri Department of Natural Resources
mg/L	milligrams per liter
ml	milliliters
MRLs	Minimal Risk Levels
MSI	Mount Sopris Instrument Company, Inc.
MTBE	Methyl-tert-butyl ether
NWI	National Wetlands Inventory
OU	Operable Unit
PCBs	polychlorinated biphenyls
PCE	Tetrachloroethylene (also known as perchloroethylene and tetrachloroethene)
PID	photoionization detector
POTW	Publicly-Owned Treatment Works
ppb	parts per billion
ppm	parts per million
PPRTVs	Provisional Peer Reviewed Toxicity Values
PRGs	Preliminary Remediation Goals
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RQD	rock quality designation

RWI	Residential Well Investigation
SOP	Standard Operating Procedure
SOW	statement of work
SP	self potential
SPR	single-point resistivity
STL	Severn-Trent Laboratories, Inc. (now TestAmerica Laboratories, Inc.)
SVOCs	semivolatile organic compounds
T&E	threatened and endangered
TCE	Trichloroethylene (also known as trichloroethene)
TCLP	Toxic Characteristic Leaching Procedure
TESS	Threatened and Endangered Species Database System
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VC	vinyl chloride
VOCs	volatile organic compounds

PART I THE DECLARATION

1.1 Site Name and Location

Riverfront Site (MOD981720246)
Operable Unit 2 Industrial Drive
Operable Unit 6 Wildcat Creek Estates
New Haven, Missouri 63068

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) presents the United States Environmental Protection Agency's (EPA) selected remedy for the Riverfront Superfund site (Site), Operable Unit 2 (OU2) and OU6 located in and adjacent to New Haven, Missouri. The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §§ 9601-9675, as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. This decision is based on the Administrative Record file for OU2 and OU6. OUs 2 and 6 represent the last two OUs; thus, this will be the last ROD for the Site.

The state of Missouri, acting through the Missouri Department of Natural Resources (MDNR), concurs with the selected remedy.

1.3 Assessment of Site

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from the actual or threatened release of hazardous substances into the environment at and/or from OU2 and OU6.

1.4 Description of Selected Remedy

The remedial action selected for OU2 and OU6[1] addresses contaminated soil and dense nonaqueous phase liquid (DNAPL) contamination in the fractured bedrock in the source area (OU2) and the dissolved phase contamination in the groundwater within the unconsolidated deposits downgradient of the source area (OU6) and is described in detail below.

Soils – The contaminants of concern (COCs) in the soils at OU2 are tetrachloroethene (PCE); trichloroethene (TCE); 1,2-dichloroethene (1,2-DCE); and vinyl chloride (VC). Analytical results of soil samples collected as part of the remedial investigation (RI) conducted by Kellwood Company (Kellwood), along with prior sampling by EPA and the U.S. Geological Survey (USGS), on behalf of EPA, indicate that the extent of PCE; TCE; 1,2-DCE; and VC contamination is limited to a land-farm area north of the former

[1] The remedial action selected for OU2 and OU6 appeared as "Alternative 2c" in the Proposed Plan.

Kellwood facility which was located at 202 Industrial Drive, beneath the former Kellwood facility, beneath Industrial Drive, and at the vacant lot northwest of the former Kellwood facility across Industrial Drive.

While the contaminated soil in the land-farm area would remain in place, DNAPL recovery would be conducted as described below. In addition, institutional controls[2] (ICs) would be implemented to help prevent any unacceptable exposures to the contamination. After the remedial action is complete in the land-farm area and DNAPL recovery wells are abandoned, the area will be regraded and reseeded.

DNAPL Recovery – DNAPLs located in the land-farm area are considered to be "principal threat wastes" because they mobilize into the groundwater. Although contaminated groundwater also poses a risk, it is not considered a principal threat as defined by EPA guidance.[3]

Remediation of DNAPL in the source area will eliminate the continued migration of COCs into the groundwater. DNAPL recovery would continue in existing wells in the land-farm area, and additional DNAPL recovery wells would be installed in the area north and west of the former Kellwood facility where DNAPL was detected during the RI. DNAPL recovery would continue until it becomes technically impractical to continue.

Once DNAPL recovery efforts are complete, DNAPL recovery wells may be utilized for in situ chemical oxidation treatment along with additional wells for any residual contamination. With the remediation of the contaminant source area located within the land-farm, the contaminant levels in the groundwater downgradient are expected to decrease to a level that is protective of human health.

OU2 and OU6 are within an area designated as a "Sensitive Area" by the state (10 CSR § 23-3.100). Specifically, OU2 and OU6 are included in "Special Area 3" as set forth at 10 CSR § 23-3.100(7) which imposes requirements on well drilling in the area designed to prevent the installation of any well within or near the contamination that may result in an unacceptable human exposure. In addition to these restrictions, EPA, through the five-year review process required by CERCLA § 121(c), will continue to review the remedy for protectiveness. As part of this process, EPA will inform and educate the owners of the properties where groundwater contamination is present of the potential health hazards posed by COCs and the need to comply with state well installation requirements.

Long-term groundwater monitoring will be conducted to track COC movement and attenuation. This monitoring will serve two functions: it will alert the potentially responsible party (PRP) to any changes in plume migration which may result in

[2] ICs are nonengineered controls, such as administrative and/or legal controls, that are intended to help minimize the potential for human exposure to contamination.
[3] *A Guide to Principal Threat and Low Level Threat Wastes*, OSWER 9380.3-06FS (November 1991).

unacceptable exposures, enabling the PRP to take action to prevent such exposures; and it will generate data on the expected attenuation of COCs in the groundwater plume, thus providing information to EPA regarding the potential need for additional response actions.

Residences (current and future) with groundwater impacted with COCs above their respective maximum contaminant level (MCL)[4] would be provided whole-house water treatment units which will be maintained until the remedial action objectives are achieved.

Dissolved Phase VOCs

The installation and operation of a line of groundwater treatment wells downgradient of the land-farm, which will be used for the injection of chemical oxidants, is expected to reduce concentrations of dissolved phase PCE in the nondrinking zone of the unconsolidated deposits. This zone of water has no discernible hydraulic connectivity with the drinking water in the Lower Jefferson City/Roubidoux Formations. This water discharges to the unnamed creeks running behind the homes in the Wildcat Creek subdivision and west of JS-14 and JS-36. COCs in the water that discharges to these creeks are below the established human health and ecological risk-based criteria in surface water in the creeks as they rapidly volatilize and are quickly reduced to levels below the Missouri surface water standards. The addition of the groundwater treatment wells is expected to lower the concentrations in the upper aquifer approximately 10 years (shortening from 30 to 20 years) earlier than would be the case without it.

1.5 Statutory Determination

The selected remedy is consistent with CERCLA and the NCP. The selected remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate, and is cost effective.

Because the selected remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, EPA will review the remedy no less often than every five years after initiation of the selected remedy to ensure that the remedy remains protective of human health and the environment.

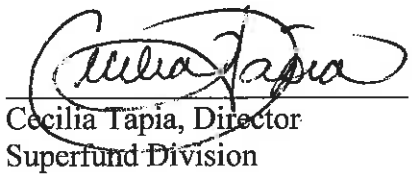
[4] MCLs are maximum permissible levels of contaminants in water which are delivered to a user of public water system. MCLs are promulgated by EPA pursuant to the Safe Drinking Water Act.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for OU2 and OU6 of this Site:

- Identification of Contaminants of Concern – Section 7.1.1
- Receptors and Exposure Scenarios – Section 7.1.9
- Principal Threat Wastes – Section 11.0
- Site Characteristics – Section 5.1
- Compliance with Applicable or Relevant and Appropriate Requirements – Section 13.2
- Description of the Selected Remedy – Section 12.2
- Expected Outcomes of the Selected Remedy – Section 12.4

1.7 Authorizing Signature



Cecilia Tapia, Director
Superfund Division

5/13/11
Date

PART II THE DECISION SUMMARY

1.0 Site Name, Location, and Description

The Riverfront Superfund site (Site), Operable Unit 2 (OU2) and OU6 are referred to as the Industrial Drive and Wildcat Creek Estates areas, respectively. Both OUs are located south of State Highway 100, with OU2 being a contaminant source area located within the New Haven city limits and OU6 being the contaminant groundwater plume that emanates from the OU2 source area and extends into an unincorporated area south of New Haven. New Haven (population 2,029) is located along the southern bank of the Missouri River in Franklin County, Missouri, about 50 miles west of St. Louis, Missouri (Figure 1-1). The Comprehensive Environmental Response, Compensation, and Liability Information System Identification Number for the Site, which includes OU1 through OU6, is MOD981720246. The lead agency for the Site is the U.S. Environmental Protection Agency (EPA). The Missouri Department of Natural Resources (MDNR) is the support agency. It is expected that the Kellwood Company (Kellwood), the responsible party who conducted the remedial investigation/feasibility study (RI/FS) for these OUs, will conduct the required remedial design/remedial action.

OU2 and OU6 at the Site are located in and immediately to the south of New Haven, Missouri. These OUs constitute two of the six OUs of the Site (Figure 1-2). OU2 includes the historic operations at the former Kellwood facility located at 202 Industrial Drive, New Haven, Missouri. Previous investigations found tetrachloroethene (PCE) as dense nonaqueous phase liquids (DNAPL) in a former land-farm area at OU2. OU6, which is the contaminant groundwater plume that emanates from the OU2 source area, extends to the south of the city and has contaminated numerous residential wells in the area.

2.0 Site History and Enforcement Activities

2.1 Site History

In 1986, MDNR began analyzing samples collected from public supply wells for volatile organic compounds (VOCs). During this initial sampling effort, PCE and trichloroethene (TCE) were detected in New Haven's public supply wells W1 and W2. These wells are located in the northern part of the city. Concentrations of PCE in water samples from W2 increased steadily from 28 micrograms per liter (µg/L) in 1986 to 140 µg/L in 1993 when the well was removed from service. Concentrations of PCE in water samples from W1 were generally less than 5 µg/L; however, because W1, which is located in the Missouri River flood plain, had a history of bacterial contamination attributed to a poor surface-casing seal, it was disconnected from the city's distribution system in 1989. In late 1988 and early 1994, two additional wells (W3 and W4, respectively) were installed in the southern part of the city. No VOCs have been detected in wells W3 and W4.

Following the discovery of the contamination, several investigations of the potential sources were conducted by MDNR and EPA beginning in the late 1980s and extending into the early 1990s. The initial investigations of contamination of the public supply wells included a preliminary assessment conducted by MDNR and an expanded site investigation (ESI) conducted by EPA. The ESI concluded that PCE was released at a former manufacturing facility in downtown New Haven but was inconclusive about other PCE sources because of the limited amount of data on groundwater flow in the area.

In 1998, EPA tasked the U.S. Geological Survey (USGS) for technical assistance in understanding the hydrogeology of the New Haven area and to provide information on the possible directions of groundwater flow and PCE migration from potential sources identified in the ESI. USGS conducted an ESI/RI that was completed in early 2000. In July 2000 as a result of the additional data collected during the ESI/RI, EPA proposed the Site for inclusion on the National Priorities List (NPL)[5] and asked USGS for further assistance in conducting an RI. The Site was officially placed on the NPL in December 2000, and EPA initiated an RI of what is now referred to as the Site. The focus of this RI was generally that portion of the city to the north of Highway 100. A natural groundwater divide is present along the Highway 100 route so as the contaminated city wells were located north of Highway 100, it was expected that the contaminant source areas would also be located north of Highway 100.

The Site is made up of six OUs in and around the city of New Haven (Figure 1-2). The OUs have been designated based on the results of prior investigations and information received through interviews with local citizens regarding waste generation and disposal. These areas have facilities which were considered to be possible sources of the PCE contamination and included a former manufacturing facility in downtown New Haven (OU1), a metal fabrication plant on Industrial Drive (OU2), the Old City Dump (OU3), an undeveloped area south of contaminated city well 2 (OU4), a former hat factory (OU5), and an area with contaminated domestic wells south of the city (OU6).

Kellwood fabricated aluminum at 202 Industrial Drive (OU2) between 1973 and 1985. PCE was used to remove oil residue from fabricated parts. Kellwood sold the facility in 1985. EPA has evidence indicating that waste PCE was disposed of by Kellwood's employees on a vacant lot immediately to the north of Kellwood's facility.

Investigations of VOCs in the area of the former Kellwood facility and the lot immediately to the north of the facility began in 1989. In 1990, the state of Missouri informed Kellwood that there were reports of the disposal of solvents on the adjacent lot (Figure 2-1). In 1994, pursuant to agreement between MDNR and Kellwood, contaminated soil from the adjacent lot containing PCE at levels over 380,000 micrograms per kilogram (µg/kg) was excavated and transported off-site for incineration. From 1994 to 1996, soil remaining on the lot was tilled to maximize the volatilization of the residual PCE. While this appears to have been effective in addressing soil contamination, DNAPL remains present in the deeper soil/ground rock interface; this

[5] The National Priorities List is EPA's list of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response.

contamination continues to migrate into the groundwater. Since March 2008, approximately six liters of DNAPL have been removed from this area through periodic recovery operations.

Kellwood was identified by EPA as a responsible party at OU2 and OU6. EPA and Kellwood have entered in two Administrative Orders on Consent (AOCs) to investigate and/or address contamination at OU2 and OU6. The first AOC became effective on March 25, 2002, and is on file with EPA's Regional Hearing Clerk under Docket No. CERCLA-07-2002-0091. Pursuant to this AOC, Kellwood agreed to provide whole-house filtration devices for any residents in the area whose wells were contaminated with contaminants of concern (COCs) from OU2. In the second AOC, having an effective date of March 16, 2004, and on file with EPA's Regional Hearing Clerk under Docket No. CERCLA-07-2004-0078, Kellwood agreed to conduct an RI/FS to fully determine the nature, rate, and extent of the contamination at OU2 and OU6 and to propose alternatives for addressing that contamination. Kellwood has submitted an RI/FS to EPA for review and approval.

2.2 Investigation Activities at OU2 and OU6

This section provides a description of historical investigative events that have occurred in and around OU2 and OU6 since 1989. A summary of these investigations is also presented in Table 2.2.

2.2.1 Missouri Department of Natural Resources (1989-1993)

Soil Investigation

In September 1989, MDNR's Division of Environmental Quality, Laboratory Services Program, collected four soil samples and one groundwater sample at OU2. One of these soil samples was collected from the vacant lot on the northern side of the former Kellwood facility. The samples were analyzed for metals and VOCs. PCE was detected in the soil sample collected from the vacant lot at 13,000 µg/kg and TCE was detected at 6,500 µg/kg.

Groundwater Investigation

Between May 1988 and September 1993, MDNR collected numerous samples from city well W3 and one sample from a well owned and operated by a local beverage distributor. Neither PCE nor TCE were detected in these samples above laboratory detection limits.

2.2.2 Geotechnology (1991-1998)

In 1991, Geotechnology, Inc., on behalf of Kellwood, submitted a Final Contamination Delineation Plan for the former Kellwood facility to MDNR. In 1994, an agreement was reached between Kellwood and MDNR for the remediation of soils containing PCE and TCE at the vacant lot located immediately to the north of Kellwood's former facility.

Pursuant to this agreement, soils with concentrations of PCE exceeding 380,000 µg/kg (approximately 90 cubic yards) were excavated and sent to an off-site incinerator. To meet the remedial objective of reducing the highest observed levels of PCE and its degradation products in the soil to a concentration of 1,000 µg/kg or less, the remaining soil was land-farmed. The results of soil investigations performed prior to and after the land-farming are described below.

Soil Investigation

In 1991, prior to the land-farming activities, 16 soil borings were advanced at OU2. Continuous soil samples were collected and field screened with a photoionization detector (PID) for the presence of volatile organic vapors. Laboratory analysis of these samples indicated that the primary COC present was PCE.

One composite sample was collected over the entire depth of each boring. Total boring depths ranged from one foot to nine feet below ground surface (bgs). PCE was detected in 11 of the 16 samples. The highest level of PCE (810,000 µg/kg) was found approximately 80 feet north of the former Kellwood facility and 150 feet east of Industrial Drive. Several other VOCs were also encountered in various borings.

In addition, a composite sample prepared from aliquots of the most impacted boring according to PID readings was analyzed for Toxic Characteristics Leaching Procedure (TCLP) metals. No metals were detected above TCLP limits in this sample.

In 1993, Geotechnology installed three monitoring wells north of the former Kellwood facility. During the installation of these wells, soil samples were also collected from each of the well boreholes between zero and three feet bgs. VOCs were not detected in any of the three soil samples.

Removal Action/Land-Farming

In 1994, Geotechnology, on behalf of Kellwood, began the off-site disposal of soil contaminated with PCE at concentrations greater than or equal to 380,000 µg/kg or 260,000 µg/kg of TCE. Soil and weathered rock, totaling approximately 90 cubic yards, with VOC levels between 610,000 and 3,000,000 µg/kg were removed using a track-hoe and transported to an off-site location for incineration. Additionally, as part of the subsequent land-farming effort, the area was periodically plowed/disked to facilitate the volatilization of any VOCs absorbed in the remaining soil to meet a cleanup objective of 1,000 µg/kg.

To monitor the progress of the land-farming activities, the soil was periodically sampled; and in 1998, a Final Soil Sampling Report was submitted by Kellwood to MDNR. The results of the last round of sampling, which occurred in June 1998, indicated that the VOC concentrations in the soil at the land-farm area were below 1,000 µg/kg. Kellwood received a letter in August 1998 from MDNR stating no further action regarding the soil was required.

Subsequent soil sampling performed by USGS on EPA's behalf in 2001 found elevated levels of PCE (3,300 µg/kg in a laboratory sample and 17,600 µg/kg from the field gas chromatograph) in selected soil samples.

Groundwater Investigation

In 1993, three monitoring wells (MW-101, MW-102, and MW-103) were installed in the land-farm area. MW-101 and MW-102 were screened between 35 and 55 feet bgs, and MW-103 was screened between 40 and 60 feet bgs tapping the upper sandstone marker bed of the Cottter Dolomite. Between 1993 and 2004, these wells were monitored quarterly as described in an agreement between Kellwood and MDNR. The results showed low levels of VOCs (less than 10 µg/L) in MW-101. The results for MW-102 and MW-103 were nondetect. These sampling results are consistent with results from the RI. These historic sampling results are shown in Figure 2.2.

2.2.3 Environmental Management Alternatives

Groundwater Investigation

In 1993, Environmental Management Alternatives (EMA) conducted a Phase I and limited Phase II Environmental Site Assessment (ESA) of the former Kellwood facility. At that time and to date, this was the site of a metal fabrication facility operated by Metalcraft Enterprises. The Phases I and II were done on behalf of Excaliber Acquisition Corporation as part of a proposed property transfer.

As part of the Phase II ESA, EMA installed six monitoring wells. Three of the wells (MW-1, MW-2, and MW-5) were screened from 45 to 55 feet bgs; MW-4 was screened from approximately 41 to 51 feet bgs; and MW-2A was screened between approximately two and three feet bgs. The report concluded that groundwater flow at the former Kellwood facility was to the south-southwest.

EMA collected groundwater samples from each well. PCE; TCE; and cis-1,2-dichloroethene (cis-1,2-DCE) were detected below the loading dock area and to the south-southwest of the facility.

In its site assessment report, EMA indicated that VOCs detected in the deeper groundwater at MW-2 and MW-4 may have migrated downward during the drilling of these wells. It also indicated that the presence of organic compounds during the second round of sampling two months later suggested probable long-term presence of these compounds. The analytical results of the EMA sampling are shown in Figure 2-2.

Soil Investigation

As part of the Phase II ESA, EMA drilled five test borings, field screened soil boring samples, and collected one soil sample (MW-2) for analysis. The sample contained PCE

at a concentration of 339,000 µg/kg; TCE at 2,100 µg/kg; and cis-1,2-DCE at 5,620 µg/kg. The location where this sample was collected coincides with the location of borehole N-12 installed as part of the DNAPL investigation component of the recently completed RI.

2.2.4 USGS and Black & Veatch (2000 to Present)

USGS (EPA's RI contractor) and Black & Veatch (EPA's FS contractor) conducted an investigation of the New Haven area as part of the OU1 and OU3 RIs. Results of these investigations as they pertain to OU2 are described below.

Soil Investigation

In 2001, USGS collected samples from five test pits located in the land-farm area. The test pits ranged from one to two feet deep. In addition, soil samples were collected during the installation of monitoring well BW-21A and direct push boring OU2-GRM01. PCE was detected in several test pits and in the borehole samples from BW-21A and OU2-GRM01. Soil samples from the test pits had concentrations of VOCs that were consistent with the samples collected as part of the RI. The analytical results of the USGS soil sampling are presented in Table 2-3.

Groundwater and Residential Well Investigation

From 2000 to 2002, USGS installed and sampled new monitoring wells in OU2, sampled existing wells in the area that had been installed as part of previous investigations, and sampled city well W3. PCE was detected in several of the monitoring wells but not in W3. The construction of the USGS monitoring wells is provided in Table 2-4.

Since 1999, USGS has inventoried and sampled residential wells in the New Haven area. Five residential wells to the south-southwest of the former Kellwood facility (JS-14, JS-36, JS-37, JS-38, and JS-52) (Figure 2-3) were found to contain elevated levels of PCE. Table 2-5 lists the results of historical groundwater sampling of completed wells by EPA and USGS. In response to these detections, Kellwood installed whole-house water treatment units (carbon filtration systems) at four of these residences (JS-14, JS-36, JS-38, and JS-52), and maintained and sampled those wells in accordance with an AOC signed in 2002. As described in the AOC, the whole-house water treatment units are sampled on a quarterly basis to measure treatment effectiveness.

Well Installation Advisory

In response to the detections of PCE in residential wells, MDNR issued an initial water well installation advisory for the New Haven area in September 2002. For the Wildcat Creek Estates subdivision, which is located in the area of the contaminant plume, the advisory recommended 200 feet of casing, full-length grouting, and a 10-inch borehole diameter for any new residential well.

A rule amendment became effective on April 30, 2006, that applied to wells in an area referred to as Special Area 3[6], defined as all of Township 45N, Range 3W, Section 36; Township 44N, Range 3W, Sec 2: West Half of Township 44N, Range 3W, Section 1; Township 44N, Range 3W, Section 11 north of Beouf Creek; and West Half of Township 44N, Range 3W, Section 12, north of Beouf Creek (Figure 2-4).

In addition to specific instructions that are required by MDNR pursuant to 10 CSR 23-3.100(7)(A) and (7)(B), the following must be performed for all new wells installed in Special Area 3:

- Consultation with MDNR prior to drilling for any water well or heat pump well
- Analysis of a water sample prior to the deepening of any existing well
- Containerization of drilling-derived solids and liquids and analysis for determination of proper disposal
- Including a sampling port within 10 feet of the wellhead for any new or deepened wells in the area
- Analysis of a water sample from any new or deepened well will be conducted, and the data will be submitted by the well installer within 60 days
- In the event DNAPL is encountered, cease drilling, collect a DNAPL sample for analysis, and plug the borehole full-length with high solids bentonite grout

Surface Water and Sediment Investigation

During 2000 through 2002, USGS, on behalf of EPA, conducted a surface water and sediment investigation in the area of OU2/OU6. As part of this investigation, USGS sampled Boeuf Creek and several tributaries in the vicinity of OU2/OU6 for VOCs. PCE and TCE were found in several stream water samples collected in the 500 and 510 tributaries that run west of OU2/OU6. Concentrations up to 100 µg/L were detected near the confluence of the 500 and 510 tributaries (Figure 2-5). Only one sample (OUX-710TB-6) in the eastern tributaries had detections of PCE and TCE in 2000; when this location was resampled in 2002, neither PCE nor TCE were detected.

Stream sediment samples were collected from 0 to 0.2 feet bgs in the 510 tributary that runs just west of OU2/OU6. PCE was detected at an estimated concentration of 1.8 µg/kg in sample OUX-EC06. No other chemicals were detected in any sediment samples. Soil samples were also collected from 0 to 0.5 feet bgs from the sediment sampling locations, and no PCE was detected in the soil samples.

[6] Missouri Code of State Regulations, *10 CSR 23-3.100(7)*

Sewer Investigation

An investigation of the sewer lines servicing New Haven was performed for EPA by USGS during 2001 and 2002. This investigation was conducted as it was alleged that Kellwood's employees regularly disposed of waste solvents by pouring them down floor drains at the former Kellwood facility. At one time before the Maiden Lane (OU4) source area was discovered, there was speculation that the groundwater contaminant plume located to the north of Highway 100 may have originated from the seepage of solvents from the sewers that ran through the OU2/OU6 area.

EPA's investigation showed PCE and TCE at certain locations—lift stations and manholes in the sanitary sewer system. Slightly elevated levels of VOCs including PCE and TCE were found in a sewer lift station (LS5) located west of the former Kellwood facility. Numerous field Gas Chromatograph (GC) samples and samples for laboratory analysis were collected from this lift station. Field GC results indicated that PCE was present at LS5 at concentrations ranging from 0.05 µg/L to 24.46 µg/L whereas laboratory sample results detected PCE concentrations ranging from 1.6 µg/L to 5.4 µg/L. TCE (up to 69.8 µg/L); 1,2-DCE (201 µg/L); vinyl chloride (up to 97.7 µg/L); and benzene (up to 7.3 µg/L) were also detected in field GC samples collected from LS5. Low levels of VOCs including PCE and TCE were also found in LS4—a lift station located east of the former Kellwood facility. Field GC results indicated that PCE was present at LS4 at a concentration of 0.03 µg/L, whereas laboratory samples detected PCE at a concentration of 1.2 µg/L. TCE (0.04 µg/L); 1,2-DCE (0.18 µg/L); and benzene (0.34µg/L) were also detected in field GC samples collected from LS4.

PCE was detected in samples collected from manholes northeast of the former Kellwood facility (up to 7 µg/L at MH407 and 3.2 µg/L at MH154) and north of the former facility (up to 19.6 µg/L at MH156S and up to 0.45 µg/L at MH156N).

While VOCs have been found in the sewers leading from the former Kellwood facility, it does not appear that this contamination spread beyond the sewers or caused or contributed to the contamination found elsewhere in the community.

Biota Sampling

In 2001 and 2002, a tree core survey was completed in the vicinity of OU2 by USGS. Tree-core sampling is a reliable and inexpensive tool to quickly assess the presence of solvents in shallow (less than 30 feet deep) soils and groundwater. Several tree-core samples collected directly to the north of the former Kellwood facility contained PCE. PCE was also detected in samples collected southwest of the former Kellwood facility. The extent of PCE detections in the tree-core samples is consistent with the extent of detections in shallow groundwater for samples collected as part of the RI. The USGS tree-core sampling results are shown in Figure 2-7.

2.2.5 Parsons (2004 to Present)

Residential Well Investigation

In June 2004 pursuant to the RI/FS AOC, Parsons, on behalf of Kellwood, conducted an expedited bedrock well installation and residential well sampling effort. The purpose of this Residential Well Investigation (RWI) was to gain an additional understanding about detections of PCE in certain residential wells at OU6, south of OU2 along Boeuf-Lutheran Road, and in the Wildcat Creek Estates along Highway C. The RWI was conducted in phases—the first of which was the interval screening, followed by monitoring well installation, and two rounds of groundwater sampling. Details of this investigation can be found in the Interval Screening Report dated April 2005. A summary of that report is provided below.

Interval Screening

Interval screening was performed at two residential wells—JS-37 and JS-38—in July 2004. Borehole geophysics including an optical televiewer, a natural gamma probe, and a heat pulse flow meter were used to identify transmissive intervals with the potential to carry VOCs into each well. Flow, fluid resistivity, and temperature measurements were collected both during static conditions (to identify the intervals that provided the greatest yield to the well) and while pumping (to verify the highest yielding intervals under residential well pumping conditions).

Based on the interval screening results, there appeared to be multiple transmissive zones present in the vicinity of the residential wells (Figure 2-8). At JS-37, four intervals were identified that contributed significant flow to the well. At well JS-38, two such zones were identified.

Monitoring Well Installation

Between September and November 2004, a total of eight monitoring wells were installed south of OU2 at the MW-1 (northern) and MW-2 (southern) locations (Figure 2-3). These wells were sampled during drilling to provide information on the extent and magnitude of impacted groundwater and to screen wells at the appropriate depths.

During the first round of monitoring well sampling conducted in December 2004, VOCs were only detected in the shallowest wells in each well cluster. A second round of sampling was conducted in February 2005 to verify these results. The data were compiled and submitted to EPA in the *Draft Residential Well Investigation Report* in April 2005. The results from the second round of sampling showed the presence of VOCs above the Maximum Contaminant Levels (MCLs) in groundwater in the vicinity of well nest MW-1. These VOCs were limited to the interface between the unconsolidated deposits and the bedrock (MW-1S). Impacts in groundwater below the MCLs were encountered at depths of 49 to 75 feet in MW-1T1 (1 µg/L of PCE detected in February 2005, the concentrations were below detection limits in December 2004).

Monitoring well MW-1SW was not impacted. This well was cased through the zone encompassing the unconsolidated deposits/bedrock interface and the next transmissive zone (49 to 75 feet bgs) and was installed as an open hole in the deeper transmissive zone (Swan Creek Sandstone).

Monitoring well (MW-2S), which is screened across the unconsolidated deposits/bedrock interface, contained PCE at estimated concentrations less than the detection limit of 1 µg/L during both sampling events. The four deeper wells in the MW-2 cluster (MW-2SW, MW-2T2, MW-2T3, and MW-2R) were all nondetect in both sampling events.

2.2.6 Remedial Investigation OU2 and OU6

The RI summarizes all activities and results concerning OU2 and OU6 of the Site located in New Haven, Missouri. The work was performed to fulfill the requirements of the AOC, Docket No. CERCLA-07-2004-0078, dated March 22, 2004.

The overall objectives of the RI as defined in the AOC were to:

- characterize the nature and extent of the impacts from COCs
- assess the risks posed by these impacts
- provide information needed to evaluate potential remedial alternatives

The RI included a number of field activities followed by completion of a baseline human health risk assessment. The primary work tasks were:

Task 1 – Soil Investigation (Section 3.1.1 in the RI) – The goal of the soil investigation was to characterize the extent and magnitude of VOCs in the soil in the immediate vicinity of the former Kellwood facility. Select samples were also analyzed for semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals for risk assessment purposes.

To achieve this characterization, a sampling grid was surveyed over the land-farm area, the loading dock of the former Kellwood facility, and the area to the southwest of the land-farm area. A 30-foot by 30-foot grid was laid out in these areas starting with west/east rows designated by letters A through U (letters I and O were not used). Row A was the southernmost and row U was the northernmost. Numbered south/north columns started in the west with column 1 and the easternmost column was number 17 (Figure 2-9).

A total of 81 soil samples were collected from 42 soil borings in the vicinity of the land-farm area and the former Kellwood facility. The samples were collected in September 2007 and June 2008.

Task 2 – Groundwater Investigation (Section 3.1.2 of the RI) – The goal of the groundwater investigation at OU2, combined with the data gathered from OU6, was to characterize the horizontal and vertical extent and magnitude of COCs in groundwater and to identify the geologic, hydrologic, and geochemical factors that affect the distribution and migration of COCs, especially PCE, in the subsurface. The groundwater investigation was divided into seven components or subtasks: interval screening, direct-push sampling, residential well sampling, monitoring well installation and sampling, sitewide groundwater sampling, aquifer testing, and surveying. Each subtask is described in the following sections.

Task 2A – Interval Screening (Section 3.1.2.1 of the RI)

Interval screening was performed at domestic wells JS-14 and JS-36 (Figure 2-3) in April 2006 and April 2007 with discrete samples being collected at a number of depths under both static and pumping conditions. In addition, geophysical logging was performed which included:

- Borehole visual imaging using an optical televiewer and borehole diameter measurement with a caliper to identify well construction and any significant bedding planes, fracture zones, and solution cavities that may provide a preferential groundwater migration pathway.
- Borehole natural gamma, single point resistivity, and self-potential surveys to assist in correlating the location-specific stratigraphy to other well locations within OU2 and OU6.
- Interval water characteristics and flow measurements using a fluid resistivity/temperature probe and heat-pulse flowmeter during ambient conditions to identify those intervals providing the greatest yield to the well.
- Interval flow measurements while pumping from the top of the borehole at a constant rate to verify the highest yielding intervals to the well under stressed conditions.
- Discrete sampling at selected depths under both static and pumping conditions.

Task 2B – Direct Push Borings (Section 3.1.2.2 of the RI)

To further evaluate the depth to bedrock and distribution of COCs in the shallow groundwater at OU6, direct push borings were advanced at 18 locations north of Boeuf Lutheran Road (Figure 2-9). Twelve borings were advanced along an east-west line. Two lines of borings were completed during this subtask—one generally trending north-south, and the other trending east-west. Geologic cross-sections were created to illustrate the varying depth to refusal (assumed to be approximately the depth to the bedrock) in the area.

Task 2C – Residential Well Sampling (Section 3.1.2.3 in the RI)

Prior to the start of the OU2 RI, EPA and USGS had begun sampling selected residential drinking water wells located in the area now designated as OU6 (Figure 2-10). As part of the groundwater investigation portion of the RI, another round of sampling was conducted at these wells. The wells sampled are shown in Table 2.6. Wells denoted with an asterisk (*) are located at residences that are sampled on a quarterly basis as required in the 2002 AOC. The historical sampling by EPA and USGS included several wells for which Parsons was not granted access for the most recent sampling event, including JS-06, JS-45, and JS-46, all of which were previously nondetect.

Task 2D – Monitoring Well Installation (Section 3.1.2.4 in the RI)

This subtask involved the drilling, construction, development, and sampling of 18 new individual monitoring wells. The Work Plan proposed installation of 11 well nests during this phase (MW-3 through MW-13). The Work Plan and Field Sampling Plan (FSP) included a decision tree that would identify the final locations and total depths of each well. Wells installed by Parsons followed a naming convention in which "MW" indicated a monitoring well location—either a single well or a cluster—followed by a hyphen and the location number. The interval being monitored in the well is indicated by one or two characters after the location number. The following codes were utilized:

S	unconsolidated deposits
UB	uppermost bedrock
US	upper sandstone marker bed
T1	transmissive zone located above the Swan Creek sandstone
SW	Swan Creek sandstone member
T2 and T3	transmissive zones in dolostone
R	Roubidoux Formation

USGS installed wells for this RI that did not utilize this convention. Where multiple wells were installed at a single location, the wells were identified with "MW" followed by a hyphen, followed by a location number, followed by a letter. This RI included sampling of existing USGS monitoring wells BW-20, BW-21, BW-21A, and BW-22. The "BW" of these identification numbers refers to bedrock wells.

Task 2E – Sitewide Monitoring Well Sampling (Section 3.1.2.5 in the RI)

Due to the extended period of time required to drill and construct the new monitoring wells, a round of groundwater sampling was started prior to completion of Task 2D. Locations of sampled monitoring wells are shown in Figure 2-11.

Task 2F – Aquifer Testing (Section 3.1.2.6 in the RI)

Two forms of aquifer tests were performed in the OU2/OU6 area—single-well tests (slug

tests) and a pumping test. The primary purpose of these tests was to characterize the hydraulic interconnectivity of the various bedrock flow systems; secondly, the tests were used to evaluate the interaquifer characteristics.

Single Well Tests

Slug tests were performed on 18 wells:

- MW-1 cluster (MW-1S, MW-1T1, MW-1SW, MW-1UB)
- MW-2 cluster (MW-2, MW-2SW, MW-2T2, MW-2T3)
- MW-5UB
- MW-6 cluster (MW-6US, MW-6SW, MW-6R)
- MW-7 cluster (MW-7US, MW-7SW)
- MW-8US
- MW-9 cluster (MW-9US, MW-9SW)
- MW-10UB

Slug tests were not performed on MW-9R or MW-14US as these monitoring wells had not been completed at the time the testing was conducted.

Pumping Test

A pumping test on city wells W3 and W4 was used to characterize the interconnectivity of the various bedrock flow systems within the area. The pumping test performed during the RI was conducted differently from the methods described in the Work Plan because of concerns from the city of New Haven. An alternative method was proposed to and concurred with by the city of New Haven, EPA, and USGS. This alternative method provided adequate results for the evaluation of the bedrock flow systems.

Task 2G – Surveying (Section 3.1.2.7 in the RI)

A final survey of the monitoring wells utilized in the RI (inclusive of USGS wells BW-20, BW-21, and BW-21A) was completed in early September 2009. A temporary control point was set near the source area and was related back to the USGS benchmark located near Trinity Lutheran Church in New Haven.

USGS also conducted a survey of the area during the same time frame. Results of that survey were used for points/monitoring wells where Parsons did not have access.

Task 3 – DNAPL Investigation (Section 3.1.3 in the RI)

DNAPL investigation consisted of installing core holes into the upper portion of the bedrock in the land-farm area where the disposal of PCE occurred. Core holes were drilled at selected nodes on the survey grid (Figure 2-12). FLUTe™ liners were then placed in the boreholes as described in the FSP. The FLUTe™ liners have a treated surface that produces a stain when it is comes in contact with free-phase hydrocarbons.

The FLUTe™ liners only indicate the presence of DNAPL at the point in time that the liner is in the borehole. Areas where DNAPL may have previously been present but is no longer present would not leave an indication on the liner even though residual PCE had sorbed onto the rock matrix. Elevated PID readings were noted on the core at locations where DNAPL was not indicated to be present. The possibility exists that the water circulation during coring displaced the DNAPL from the immediate vicinity of the borehole. This is not likely to lead to a false negative indication because the water circulation would have to push DNAPL upward into the fracture because if the fracture has a downward avenue for movement, however slight, DNAPL would have already followed it. The density of the displaced DNAPL would drive it back down into the fracture once the water circulation ceased. The boreholes were purged following drilling; and the FLUTe™ liners were placed into the borehole and left for a minimum of two hours, and in many cases, were left in place overnight. DNAPL displaced by the water circulation would have had sufficient time to flow back to the low point of the fracture adjacent to the borehole during this time.

Note that because both borings for soil samples (Task 1) and DNAPL holes were advanced on the same surveyed grid, both soil boring and DNAPL core holes are identified by a letter followed by a number. For the purposes of the boring logs and text, core holes have a hyphen separator, i.e., P-14 whereas soil borings do not have a hyphen, i.e., P14. For analytical samples (and the figures which were generated using the analytical samples), the hyphen could not be retained. Therefore, on the analytical result tables and figures, the presence of a hyphen cannot be used as a guide. However, the title of the figure or table is definitive in whether the information presented is from a soil boring (soil sample) or DNAPL core hole (aqueous sample).

Task 4 – Sediment and Surface Water Investigation (Section 3.1.4 in the RI)

Surface Water

Sixteen surface water samples were collected as part of the RI (Figure 2-13). Four of the samples were collected by USGS, three of which were on property to which Parsons was not granted access. Several other sample locations were moved to alternate locations to gain access either from a cooperative property owner or to reach a public right-of-way. Two of the surface water samples were collected from the same location at different times.

Surface water samples were collected in accordance with the FSP. Samples were collected directly into the sample containers and then shipped to the laboratory to be analyzed for VOCs. One sample was also analyzed for SVOCs, pesticides, PCBs, and metals. Three samples were collected upstream of SW-08 to delineate the distribution of PCE upstream from a positive detection in a sample collected during the RI (sample SW8-SW01-080804) and a detection from a USGS grab sample.

Sediment

Sediment samples were collected from eight locations (Figure 2-13). These samples were collected in accordance with the FSP. The samples were analyzed for VOCs. One sample was also analyzed for SVOCs, pesticides, PCBs, and selected metals for risk-assessment purposes. Sediment was collected using a stainless steel scoop. The sample location was approached from downstream so that the movement of the sampler would not disturb the sample location. The locations for the sampling were selected to maximize the amount of fine-grained material in the sample. Once the sample was in the scoop, larger gravel pieces were discarded. This was necessary to allow the use of the measuring syringe of the Terra Core™ kit that was utilized for the VOC samples.

Task 5 – Sewer Investigation (Section 3.1.5 in the RI)

Sanitary Sewer Connected to the Former Kellwood Facility

Sampling within and alongside the sanitary sewer downstream of the former Kellwood facility included the sampling of sewer water and sediment, video inspection of the interior of the sewer line, and direct-push sampling of soils immediately outside of the sewer at defects identified during the video inspection. Sewer water and sediment samples were collected from manholes and lift stations at locations proposed in the FSP (Figure 2-14).

Sewer water and sediment sampling was the first task performed. The locations of manholes to be sampled were reviewed with the Public Works Manager for the city of New Haven. Upon arrival at each sampling site, the lid of the manhole was removed and the conditions of the manhole were noted including flow state, inlet and outlet directions and sizes, and amount of sediment present. A bailer was then lowered into the manhole to capture the sewer water sample. The sewer water was transferred into laboratory preserved sample vials, and the vials were labeled and placed on ice.

Sewer sediment was collected using a disposable stainless-steel scoop attached to a pole. A disposable soil sampling syringe was used to transfer the proper volume of sample to the vials of a Terra Core™ sampling kit. The vials were labeled and placed on ice.

Suspected Abandoned Sewer Line Adjacent to the Former Kellwood Facility

The RI work plan called for the investigation of the sewer line that was suspected to have been abandoned adjacent to the former Kellwood facility. While preparing for this task, the Public Works Manager for the city of New Haven was interviewed regarding this portion of the sewer system. He indicated that during the initial development of the industrial park, a six-inch sewer line was constructed from MH-407 northward to MH-156S (Figure 2-13). Given the age of the construction, he stated that this line was probably constructed using PVC pipe. MH-407 receives effluent from the former Kellwood facility.

When the GDX manufacturing facility was constructed southeast of the former Kellwood facility, lift station 7 was constructed to pump waste water from that facility to MH-07 where it would flow by gravity northward to MH-156S, then west to lift station 4. With the added flow, the six-inch pipe from MH-407 to MH-156S was undersized so it was replaced with an eight-inch PVC line. Because of the configuration of the line, the six-inch line was removed, instead of abandoned in place, to make room for the new eight-inch line. Since the original line was removed, the evaluation of this portion of the sewer system was not performed.

Older Sewer Line Sections Located North of Highway 100

Direct-push borings were installed along three sewer segments north of Highway 100 to evaluate the potential for exfiltration of wastewater containing COCs from the sewer lines. Sampling and analysis were conducted as described above. Five borings were planned along each of the three sewer segments. Due to access issues and an inability to accurately identify the location of the sewer line, only 11 of 15 proposed borings were advanced. The borings were advanced to refusal or to a depth of four to six feet deeper than the depth of the sewer line. Soil cores from the direct-push sampler were logged and headspace samples were screened with a PID. Soil samples were collected from the depth of the highest headspace PID reading and the depth corresponding to the depth of the sewer pipe. Where headspace readings were very low to zero, soil samples were collected from the depth corresponding to the bottom of the sewer pipe and the bottom of the boring.

Five soil borings were proposed for each of the three sewer segments north of Highway 100 to evaluate whether VOCs in wastewater could have exfiltrated the sewer segments in transit to the wastewater treatment facility. At the time this task was developed, the source of VOCs in the Maiden Lane area (OU4) was not known. Prior to execution of this task, a source of VOCs in this area was identified. Four of the boring sites were not advanced due to either access issues or difficulty in determining the location of the sewer line.

Soil Vapor Sampling (Section 3.1.6 in the RI)

Based on the detection of PCE in a shallow (10 feet bgs) groundwater sample near the southeast corner of the New Haven High School building (MW-14X), soil vapor sampling was conducted in this area at the request of EPA.

The purpose of the sampling was to evaluate whether soil vapors from VOCs detected in the groundwater in the unconsolidated deposits had or might infiltrate the school building. The locations of the soil vapor monitoring points are shown on Figure 2-15. The monitoring points varied from 9.8 to 10 feet deep. The length of the open interval of the monitoring points varied from 0.8 to 1.3 feet. Soils encountered were silts with varying quantities of clay. The results of the comparison of soil gas samples collected

near the high school show that PCE, the only detected constituent (and only detected at location SVI-5), is below the EPA industrial air screening level and all specified Missouri target levels for both residential and nonresidential use.

3.0 Community Participation

Community relation activities for the Site were initiated by EPA prior to the issuance of the Records of Decision (RODs) for OU1 and OU3, with a notice of the availability of these documents in the *New Haven Leader* on July 30, 2003. The public meeting for these RODs was held on July 29, 2003. Since then, EPA has conducted numerous meetings (e.g., Proposed Plan for OU4, Proposed Plan for OU5) with New Haven officials and the general public to update them regarding the Site work. Fact sheets, publication of notices, development of a Riverfront Web site for public use, and attendance by EPA representatives at city council meetings have been utilized to address comments from concerned citizens.

The Proposed Plan for OU2 and OU6 was made available to the public on August 4, 2010, and can be found in the Administrative Record file maintained at the EPA Region 7 Records Center, 901 North 5th Street, Kansas City, Kansas, and at the New Haven Scenic Regional Library, 109 Maupin, New Haven, Missouri. A public meeting for the Proposed Plan was held on August 10, 2010. The transcript from the Public Meeting is included in the Administrative Record. The public comment period for the Proposed Plan began on August 4, 2010, and ended on October 4, 2010. Numerous comments were received at the public meeting while others were submitted electronically to EPA. Those comments are addressed in the Responsiveness Summary component (Part III) of this ROD.

4.0 Scope and Role of the Operable Unit and Response Action

The Site, as with many Superfund sites with multiple OUs, is complex and challenging. A number of removal actions have been conducted at the Site to address soil source areas and exposures to contaminated groundwater. The removal action at OU1 consisted of the excavation and disposal of approximately 500 cubic yards (yd^3) of PCE-contaminated soil and the rerouting and replacement of polyethylene that was part of the city's public water supply. The removal action conducted by EPA at OU4 in 2007 consisted of the injection of sodium permanganate into the Maiden Lane contaminant source area. While this action resulted in the destruction of some of the PCE, recent sampling data indicate that the contaminants remain in the soils and must be further addressed as described in the OU4 ROD. The OU6 removal action conducted by Kellwood consisted of one household being connected to the public water supply and the installation of whole-house filtration units to other households located outside of the city limits. In accordance with the AOC for OU6 (EPA Docket No. 07-2002-0091), Kellwood continues to monitor and maintain the filtration units, sample the groundwater for COCs on a quarterly basis, and predicated on other considerations (e.g., public water supply) the continued use of the whole-house filtration units on affected residences will be reevaluated during the sitewide five-year review process.

OU2 and OU6 are discrete areas of contamination that do not affect and are not affected by the other OUs at the Site. OUs 1, 3, and 5 have remedial actions in place while OU4 is in the remedy design phase.

5.0 Conceptual Site Model

The Conceptual Site Model (Figure 5-1) illustrates the exposure pathways that identify the focus of the risk assessment. Exposure pathways describe the movement of chemicals from sources (e.g., chemicals in soil or surface water) to exposure points where receptors (i.e., potentially exposed populations) may come in contact with the chemicals. An exposure pathway is typically defined by the following elements:

- A source and mechanism of contaminant release to the environment
- An environmental transport medium (e.g., soil, water) for the released contaminants
- A point of potential contact with the contaminated medium (i.e., point of exposure)
- An exposure route (e.g., inhalation, ingestion, dermal contact) at the point of exposure

An exposure pathway is considered complete only if all four components are present. In conducting the risk assessment, only complete exposure pathways were evaluated quantitatively.

5.1 Site Characteristics

Information concerning the nature and extent of impacts of contamination in the soil and groundwater and the extent of DNAPL at OU2 and OU6 was used to estimate the area or volume of material or media for which remediation would be evaluated:

- The soil in the vicinity of the former Kellwood facility only exceeds the remedial action objectives (RAOs) for a future residential-use scenario. As OU2 is currently used for commercial/industrial purposes, the concern for soil in this area is focused on the effects that this contamination may have on the air within the buildings located in this area through vapor intrusion from contaminated soil. Subslab and indoor air sampling conducted at the former Kellwood facility indicated detections of selected VOCs in both subslab and indoor air samples. Screening criteria for PCE and TCE were exceeded in several subslab samples (Table 5-1a). In indoor air, PCE exceeded EPA screening criterion based on a cancer risk of 1×10^{-6} in several samples. TCE slightly exceeded the 1×10^{-6} screening criterion in one sample (Table 5-1b).

If soil areas are to be remediated, there are two separate areas: A-1 (Figure 5-2) is the open lot north of the former Kellwood facility and a small area immediately to the west of the north end of the former Kellwood facility, and A-3 (Figure 5-2) located in a small area beneath the former Kellwood facility floor in the center of the building. The A-1 area is slightly less than ½ acre. The thickness of the soil varies over the bedrock. Based on an average soil depth of 1.5 feet, the volume of contaminated soil is estimated to be 1,000 cubic yards. The A-3 area is approximately 1,200 square feet with an estimated 400 cubic yards of contaminated soil. The contamination at A-2, located under Industrial Drive, would not require remediation in order for the RAOs to be achieved (not shown).

- The area in the land-farm area that has been determined to contain DNAPL is estimated to be approximately ¼ acre, and DNAPL is present at depths ranging from 4 feet to 20 feet bgs. The area where shallow bedrock groundwater samples in the land-farm area exceeded the MCL is closely aligned with the soil area A-1 and is approximately ½ acre in size.

- Groundwater is contaminated primarily in two zones: the unconsolidated deposits south of the former Kellwood facility, and the upper sandstone/upper bedrock unit (Figure 5-3). These zones have no discernible hydraulic connectivity with the lower formations (Lower Jefferson City/Roubidoux) that are used in the region as a source of drinking water. There is no contamination in the Swan Creek sandstone which would result in the RAOs not being achieved. A few isolated impacts above the RAOs were identified in the Roubidoux Formation. The total area over which groundwater is impacted is shown in Figure 5-3. The impacted groundwater above the RAOs in the unconsolidated/upper sandstone/upper bedrock is estimated to be present over an area of approximately 170 acres. The impacted groundwater in the Lower Jefferson City/Roubidoux Formations is estimated to be present in isolated areas totaling approximately 15 acres.

5.1.1 Physical Characteristics

References/sources for the following physical characteristics data can be found in the RI and FS reports.

5.1.2 Demography, Land Use, and Wildlife

New Haven, Missouri, is about 50 miles west of St. Louis, Missouri (Figure 1-1). The city is similar in character to other small Missouri towns and cities along the Missouri River with historic late 1800-era homes along the steep river valley slopes overlooking a downtown business district adjacent to the river. The region is generally rural and consists of gently rolling hills with farm land and scattered deciduous forests. Near the Missouri River, the topography becomes more rugged. New Haven straddles an east-west trending topographic divide that separates the Missouri River valley to the north from the Boeuf Creek valley to the south. The divide is about one mile south of the

Missouri River and is asymmetrical with steep slopes to the north and shallow slopes to the south. State Highway 100 runs east-west through the city just south of the topographic divide.

New Haven has a population of 2,029 with an incorporated area of approximately 2.7 square miles (mi^2). New Haven contains a mixture of medium- to high-density single-family and multi-family residential areas. Land use in the area between the Missouri River and State Highway 100 is predominantly single-family homes with several churches. The New Haven downtown business district is located on a narrow (less than 600 feet wide) strip of the Missouri River flood plain and consists of retail, government buildings, a few homes, and small commercial facilities. The eastern part of the city is mostly deciduous forest, and areas outside the city are mostly mixed agricultural use of row crops (corn and soybeans) and pasture with scattered deciduous forests.

New Haven is located along the northern boundary of the Salem Plateau physiographic subprovince of the Ozark Plateaus Province. The Salem Plateau is characterized by a moderate to rugged terrain with thin soils and narrow steep-walled valleys. Topographic relief is the result of gradual uplift of the Ozark Dome in southern Missouri and erosion of the uplifted rocks by precipitation runoff and streamflow. The topographic relief in the New Haven area is accentuated because of its proximity to the Missouri River which controls the base level for most streams in western and central Missouri.

South of State Highway 100 land use is mostly commercial and industrial with smaller amounts of rural and new residential areas and park land. Several manufacturing facilities are within the city limits. These facilities produce automotive door seals, custom aluminum tubing, and synthetic fabrics. These facilities employ several hundred residents, some living outside of the city limits.

New Haven is located in the Central Irregular Plains ecological region. As such, the Missouri River has six designated beneficial uses including protection of warm water aquatic life and human health fish consumption, irrigation, livestock and wildlife watering, boating and canoeing, drinking water supply, and industrial water supply. The river is a riparian wetland and supports a wide variety of wildlife including five rare or endangered species—the sickelfin chub (*Macrhybopsis meeki)*, sturgeon chub (*Macrhybopsis gelida*), plains killfish (*Fundulus zebrinus*), lake sturgeon (*Acipenser fulvescens*), and the pallid sturgeon (*Scaphirhynchus albus*). The river is also a sanctuary for a wide variety of waterfowl and birds. An inventory from the *Clarence Cannon National Wildlife Refuge*, which is located approximately 60 miles northeast of New Haven, indicates endangered birds such as the commonly observed bald eagle (*Haliaeetus leucocephalus*), rarely observed peregrine falcon (*Falco pereginus anatum*), and the piping plover (*Charadrius melodus*) may be found in the area.

5.1.3 Hydrogeology of the New Haven Area

Two major aquifers are important in the New Haven area—the Ozark aquifer and the Missouri River alluvial aquifer. These aquifers are used extensively in Missouri for

domestic, industrial, and public water supply. In the New Haven area, the Ozark aquifer provides all domestic, industrial, and public water. MDNR has determined there are no Missouri River alluvial sediments in the vicinity of OU2 or OU6. Although there are Quaternary alluvial deposits southwest of the Site, the only aquifer in the vicinity of OU2/OU6 is the bedrock Ozark aquifer.

Ozark Aquifer

The Ozark aquifer is a thick sequence of water-bearing dolostone, limestone, and sandstone formations ranging in age from Late Cambrian to Middle Devonian. Although these units collectively are a regional aquifer, the water-yielding capacity of the individual units varies. Geologic units of the Ozark aquifer present in the New Haven area range in age from Late Cambrian through Ordovician and increasing in age are the St. Peter Sandstone, Powell Dolomite, Cotter Dolomite, Jefferson City Dolomite, Roubidoux Formation, Gasconade Dolomite (including the basal Gunter Sandstone Member), Eminence Dolomite, and Potosi Dolomite (Table 5-1). The geologic names used here conform to terminology used by MDNR's Division of Geology and Land Survey. In the New Haven area, the Ozark aquifer is more than 1,000 feet thick.

The Ozark Aquifer is found throughout New Haven and OU2. It consists of a thick sequence of water-bearing dolostone, limestone, and sandstone formations with varying water-yielding capacities. Table 5-1 shows the bedrock units of the Ozark Aquifer. The upper-most bedrock units found in New Haven are the St. Peter Sandstone, Powell Dolomite, Cotter Dolomite, and the Jefferson City Dolomite. Beneath the Cotter and the Jefferson City Dolomites, the geologic formations that make up the Ozark Aquifer are, in order of increasing age, the Roubidoux Formation, the Gasconade Dolomite, the Gunter Sandstone Member of the Gasconade Formation, the Eminence Dolomite, and the Potosi Dolomite.

Overall, the Cotter Dolomite and the Jefferson City Dolomite are poor water-producing formations and typically have low vertical and horizontal hydraulic conductivities. Where these units are exposed at the surface, they can impede vertical infiltration of precipitation more than older units such as the Roubidoux Formation.

The Roubidoux Formation underlies the Cotter and Jefferson City Dolomites. The Roubidoux Formation is the first unit encountered in the New Haven area that yields reliable quantities of water. Slug-test data from several monitoring wells completed in the Roubidoux Formation indicate that the average hydraulic conductivity is 1.8 feet per day, about 10 times higher than that of the overlying Cotter and Jefferson City Dolomites. In the New Haven area, the Roubidoux Formation is about 110 to 120 feet thick. Yields from monitoring wells range from 5 to 80 gallons per minute (gal/min).

The Gasconade Dolomite underlies the Roubidoux Formation with an average thickness in the New Haven area of about 300 feet. The Gasconade Dolomite is divided into two informal units—the upper and lower Gasconade Dolomite and the basal Gunter Sandstone Member. The upper Gasconade Dolomite tends to be less permeable than the

overlying Roubidoux Formation or the underlying lower Gasconade Dolomite. Yields from wells to both the upper and lower Gasconade Dolomite generally range from 50 to 75 gal/min. The Gunter Sandstone Member is the basal unit of the Gasconade Dolomite and is a target zone for many high-capacity wells in southern Missouri. Yields from the Gunter Sandstone Member typically range from 40 to 50 gal/min; however, yields from production wells open to this unit just east of New Haven can be as high as several hundred gal/min.

The Eminence Dolomite, which underlies the Gasconade Dolomite, is a medium to coarsely crystalline dolostone with little or no chert. Well logs indicate that the Eminence Dolomite averages about 160 feet thick in the New Haven area. The Potosi Dolomite is the lowermost unit in the Ozark aquifer and consists primarily of massive to thickly bedded "vuggy" dolostone with abundant drusy quartz. The lower Gasconade Dolomite and the underlying Eminence and Potosi Dolomites are important sources of water for high-capacity wells in New Haven and throughout most of southern Missouri. Yields from these wells typically range in the hundreds of gal/min or more. Closed city wells W1 and W2 were completed in the Potosi Dolomite.

5.1.4 Surficial Geology

New Haven, Missouri, is covered by several unconsolidated surficial deposits including Quaternary-Age loess, residual deposits of the Buffalo Series, Quaternary-Age alluvium, and Quaternary-Age terrace deposits. The youngest of these is the loess, wind-blown particles deposited in the Pleistocene epoch, which consists of uniform-size silt with small amounts of clay. The loess is located primarily at topographic highs in the area and ranges from 0 to greater than 20 feet thick.

The Buffalo Series deposits are residual deposits from the weathering of the underlying Powell and Cotter Dolomites. They are divided into two subunits—the Buffalo "A" Subunit and the Buffalo "O" Subunit. The Buffalo "A" Subunit is generally a stiff, orange-brown sandy or silty clay with small quantities of chert, less than five feet thick and underlying the Quaternary-Age loess. The Buffalo "O" Subunit is much thinner than the Buffalo "A" Subunit and is mixed with colluvial deposits (deposited near the base of a slope) so that the combined deposit is less than one foot thick and is generally only found on slopes along the bluffs on the Missouri River Valley and, therefore, is not likely to be found in OU2.

The Quaternary-Age alluvium is found in the flood plains of the streams and tends to consist of organic-rich deposits of silt and clay. The area around Boeuf Creek and its tributaries, including Wildcat Creek, contains large alluvial deposits (from running water) with chert gravel. The Quaternary-Age Terrace deposits are also found near Boeuf Creek and are similar to the alluvial deposits but are at a higher altitude and were deposited in an earlier stream deposition event.

5.1.5 Structural Geology

New Haven is part of the Ozark Plateau—a broad structural and topographic dome characterized by karst (dissolved limestone) topography. Regionally, the Ozark Plateau is characterized by dissolution-induced sinkholes, caves, fractures, and underground drainage. The Ozark Plateau is underlain by a broad asymmetrical anticlinal arch whose gently dipping limb faces south toward the Ouachita Mountains.

Bedrock units in New Haven regionally dip to the northeast. The bedrock is fractured and jointed throughout, southeast-northwest and southwest-northeast.

Observations of outcrops along Highway 100 in western Franklin County and in the vicinity of OU2/OU6 indicate that the surficial bedrock contains a number of local variations in the dip of the rock units. There are three major structures in the OU2 area—the Wildcat Creek Anticline, the Park Creek Structure, and the Berger Creek Bluff Fault—all trending northwest-southeast. The locations of these structures are shown on Figure 5-4.

The Berger Creek Fault is northeast of OU2 and runs through the center of New Haven just to the northeast of the Pepsi facility and southwest of OU4. This structure is exposed along a bluff to the northwest of New Haven where it is a series of three faults about 50 feet apart with offsets of 3 to 10 feet. The Berger Creek Bluff Fault most likely extends to the southeast following highs in the upper sandstone marker bed unit and a lineament to the southeast of New Haven.

The Wildcat Creek Anticline, lying to the southeast of OU2, was observed in an outcrop along a branch of Wildcat Creek. Flanks of this anticline dip to the southwest and northeast. More evidence of folded bedrock was also observed north of the outcrop along the same branch of Wildcat Creek.

The Park Creek Structure is delimited by faults trending to the northwest and northeast. The structure is expressed through uncharacteristic dips and altitudes of the upper sandstone marker bed of the Cotter Dolomite along a creek to the southwest of OU2, exposures of St. Peter Sandstone encountered at altitudes much lower than anticipated, and a northeast trending fault bounding an outcrop of the St. Peter Sandstone just south of Highway 100 in the western part of the city, west of OU2.

Geophysical surveying performed by Parsons in July 2004 identified a resistivity anomaly west of the northern well cluster (MW-1) installed as part of the RWI. This trough in the bedrock was interpreted to be a geologic feature and may indicate a vertical offset of strata. A possible fault was also identified east of the southern well cluster (MW-2) and JS-38 in MDNR's geophysical results from September 2004. The Interval Screening performed in July 2004 identified an offset in the transmissive zones between JS-37 and JS-38 that could indicate a fault or that beds are dipping to the north.

Based on the logs of the monitoring wells (MW-101, MW-9SW, MW-9US, BW-21, MW-6SW, MW-6US, MW-7SW, MW-7US, MW-1SW, MW-11, MW-12, MW-2SW, and MW-4B) and domestic wells with geophysical logs (JS-25, JS-14, JS-36, JS-37, PA-55, and JS-38), the surface of both the upper sandstone marker bed and the Swan Creek dips very gently to the southwest in the immediate vicinity of OU2/OU6. The difference in dip in the vicinity of OU2/OU6 compared to the dip between JS-37 and JS-38 reflects the effect of local geologic structures. Exposures of rock in road cuts and stream beds in the area indicate that local changes in the direction and magnitude of dip in bedrock are common in the area.

5.1.6 Fractures, Jointing, and Weathering

Fracturing, jointing, and weathering significantly influence groundwater flow in fractured bedrock aquifers. Joints are common in Cotter-Jefferson City outcrops in the vicinity of New Haven. The joints are generally vertical and have an orthogonal (lying at right angles) pattern. The joints set strike southeast-northwest and southwest-northeast.

5.1.7 Groundwater Flow

Groundwater in the Ozark aquifer is unconfined throughout most of southern Missouri. In the New Haven area there are two general flow systems within the Ozark aquifer—a deep "regional" flow system controlled by regional topography within southern Missouri and a "local" or shallow (less than 300 to 400 feet deep) flow system controlled by the topography within the New Haven area (Figure 5-5).

Regional groundwater movement generally is from upland areas between major rivers and streams toward valleys where it discharges as base flow into the streams. From New Haven, the regional flow system extends for tens of miles and generally is from upland areas more than 90 miles south of New Haven northward toward the Missouri River. The Missouri River and associated alluvial aquifer are regional groundwater discharge areas for the Ozark aquifer. The regional flow system generally occurs in the deeper parts of the aquifer (Roubidoux Formation and deeper units) except near regional recharge or discharge areas where flow enters or leaves the aquifer.

Superimposed on the regional flow system is a shallower flow system controlled by the topography in the New Haven area. During the 2001 ESI/RI, direction of groundwater flow in the New Haven area was determined by mapping the shallow potentiometric surface within the upper Ozark aquifer using measured water levels in area domestic and public supply wells. The shallow flow system in New Haven exists primarily within the Cotter and Jefferson City Dolomites. In New Haven, a shallow groundwater divide is centered along State Highway 100 immediately south of the topographic divide and just north of OU2/OU6.

Shallow groundwater south of this divide flows south, opposite the regional flow and toward Boeuf Creek. Shallow groundwater north of the divide flows north in the direction of regional flow toward the Missouri River. Along the shallow groundwater

divide near State Highway 100, a downward gradient exists between the shallow and deeper flow systems. The measure of the downward gradient decreases with increasing distance (north or south) away from the shallow groundwater divide. Further to the north, the vertical gradient reverses and moves upward near the Missouri River where regional flow dominates. This is substantiated by upward flow under ambient conditions in public supply well W2 and upward gradients in bedrock well clusters BW-00 and BW-01 located in OU1. To the south, the direction of the gradient between the shallow and deep flow systems is unknown. At the Missouri River, flow paths from the regional flow system and the shallow flow system converge and move upward into the alluvial valley.

5.2 Nature and Extent of Contamination

The following sections focus on the nature and extent of PCE, TCE, cis-DCE, and vinyl chloride (VC) in soils, groundwater, and as DNAPL at OU2 and OU6. A summary describing the results of the reconnaissance sampling of the sanitary sewer system and indoor air sampling is also presented.

5.2.1 Distribution of PCE and Other VOCs in Soils at OU2

The distribution of PCE; TCE; 1,2-DCE; and VC north and west of the former Kellwood facility and beneath the facility was evaluated by the 41 soil borings associated with Task 1 of the RI. Two samples were collected for analysis from each boring, with the exception of boring MC-1, located in the northeast corner of the former Kellwood facility and boring T-10 located on Industrial Drive north of the former Kellwood facility. Figure 5-6 presents the detected concentrations of PCE; TCE; 1,2-DCE (total); and VC in samples collected from the soil borings. Analytical results for compounds detected in the samples are presented in Tables 2.3, 3.2, 3.21, and 3.23 in the RI.

Analytical results of soil samples collected as part of the RI, along with prior sampling by EPA, USGS, and others, indicate that the extent of the PCE; TCE; and 1,2-DCE soil contamination is limited to the land-farm area north of the former Kellwood facility, beneath the former Kellwood facility, beneath Industrial Drive, and at the vacant lot northwest of the former Kellwood facility across Industrial Drive (Figure 5.6).

The central portion and southern margin of the land-farm area exhibits concentrations of PCE that are above the 141 µg/kg screening level. PCE was detected in these samples at concentrations up to 23,000 µg/kg. TCE and 1,2,-DCE were detected at concentrations below the screening level in the shallower sample from boring P16. Because of the shallow depth to refusal in this area (approximately 28 inches), variation of concentration with depth is not very significant. Of the eight boring locations in the land-farm area with PCE detections, four of the locations had higher concentrations detected in the shallower sample (P14, P16, Q13, and S13). Four locations had higher concentrations detected in the deeper sample (P15, Q16, R13, and S15). Samples collected from the northern end and eastern portions of the land-farm area did not contain PCE; TCE; 1,2-DCE; or VC.

On the west side of Industrial Drive, eight borings were advanced in the gravel parking lot to evaluate the potential for the release of PCE in this area. None of the 16 samples analyzed from these borings were found to contain PCE; TCE; 1,2,-DCE; or VC.

Eleven borings were advanced along Industrial Drive, one in the truck loading area on the northwest corner of the former facility (N12) and one north of the ramp at the north end of the former facility (P12), to evaluate potential westward migration of PCE from the land-farm area. PCE was detected in 12 of the 20 samples, with the screening criteria exceeded in five samples. The maximum concentration of PCE in these samples was 380 µg/kg collected at a depth of 3.5 feet from sample location R10. PCE was not found in either sample from the two southernmost borings and the northernmost boring. PCE concentrations were generally higher in the deeper samples of a given boring. TCE and/or 1,2-DCE were detected at concentrations below the screening level in eight samples.

Five borings were advanced through the concrete floor of the former Kellwood facility to evaluate the soils for potential contamination from PCE disposal. Only one depth was sampled at boring MC1. PCE was detected in each of the nine samples from these borings. The highest concentration detected was 290,000 µg/kg from a deep sample at boring MC4. This boring was placed near an abandoned floor drain. This sample and the deeper sample from boring MC05 both exceeded the screening criteria. The remaining samples, although indicating detections, had concentrations below the screening level. TCE and/or 1,2,-DCE were detected at concentrations below the screening criteria in two samples.

Soil samples identified five defects in the sewer lines between the manhole in front of the former Kellwood facility (MH-407) and lift station (LS-4); however, these samples did not indicate the presence of detectable concentrations of PCE; TCE; 1,2-DCE; or VC in these areas. Samples collected from eleven direct-push borings alongside the sewer in three segments north of Highway 100 did not indicate the presence of detectable levels of PCE; TCE; 1,2-DCE; or VC.

5.2.2 Distribution of PCE as DNAPL at OU2

The DNAPL investigation at OU2 consisted of installing core holes into the upper portion of the bedrock in the area where the disposal of PCE occurred. Core locations were drilled at selected nodes of a survey grid (see Figure 2-12 for locations). After the core holes were completed, FLUTe™ liners were placed in the borehole in accordance with the FSP. The FLUTe™ liners have a treated surface that produces a stain when it comes in contact with free-phase hydrocarbons. The FLUTe™ liners only indicate the presence of DNAPL at the point in time that the liner is actually in the borehole. Areas where DNAPLs may have been present, but no longer present, would not leave an indicator stain on the liner.

A total of 22 core holes were drilled as part of the DNAPL investigation. These core holes surround the former Kellwood facility to the north, west, and south. The land-farm area contained 14 of the core holes. DNAPL was positively identified on the FLUTe™ liners of five of the core holes as indicated on Figure 5-7. DNAPL detections were located primarily adjacent to the northern and northwestern portions of the former Kellwood facility. The core logs are presented in Appendix C of the RI. Photographs of the liners alongside the cores are presented in Appendix F of the RI.

Three of the core holes where DNAPL was detected (P-14, P-15, and Q15-5) were located at the southern portion of the land-farm area (north end of the former Kellwood facility). DNAPL was detected in these holes at depths ranging from 4.4 feet to 18.1 feet. DNAPL was also detected on the liners from 22.7 to 22.9 feet in P-14 and from 18.9 to 20.8 feet in P-15; however, these detections appeared to result from accumulation of DNAPL in the borehole prior to liner installation rather than the presence of DNAPL in fractures in these intervals.

Two core holes near the northwest corner of the former Kellwood facility (L-12 and N-12) had DNAPL detected by the liner. DNAPL was indicated over a longer interval in these holes compared to the holes on the land-farm area.

Core hole L-12 as well as USGS monitoring well BW-20 were sampled quarterly to identify whether DNAPL had accumulated in the borehole. When greater than 0.03 foot of DNAPL was detected in the borehole, a peristaltic pump was used to remove the DNAPL. Approximately six liters of DNAPL have been removed. The sampling and recovery effort in core hole N-12 was discontinued in April 2008 due to the lack of DNAPL.

5.2.3 Distribution of PCE and Other VOCs in Groundwater at OU2 and OU6

PCE; TCE; and 1,2-DCE have been detected in four laterally transmissive intervals—the unconsolidated deposits above the bedrock, the upper sandstone marker bed of the Cotter Dolomite, the Swan Creek sandstone member of the Cotter Dolomite, and the Lower Jefferson City Dolomite/Roubidoux Formation. VOCs have also been detected in other undifferentiated intervals in the Cotter Dolomite.

The distribution of PCE is widest in the upper sandstone marker bed/uppermost bedrock permeable zone (Figure 5-8) with PCE present above the 5 µg/L screening criterion to the west of MW-7US and to the south at MW-04A. Samples collected from the unconsolidated deposits at MW-1US and at MW-04A did not contain PCE. PCE is present at concentrations in the hundreds to low thousands of µg/L in the unconsolidated deposits throughout the southern portion of the industrial park, south and southwest of the former Kellwood facility as seen in the direct-push borings BW-21A and MW-1S (Table 5-2). The distribution of PCE in the Swan Creek sandstone member is limited with concentrations generally lower. PCE in the Lower Jefferson City/Roubidoux is limited to small, isolated occurrences. The following sections provide details about the distribution in each of these intervals.

Unconsolidated Deposits

Sampling of groundwater in the unconsolidated deposits was performed as part of the direct-push, cross-section holes north of Boeuf Lutheran Road, the initial direct push borings at proposed monitoring well locations and in monitoring wells MW-1S and MW-2S. PCE; TCE; and 1,2-DCE were identified in a number of the direct-push borings for the cross-section. The highest concentrations of PCE detected in these borings were along the eastern side of the bedrock low, just west of Industrial Drive, near its intersection with Helman Drive (1,500 and 2,800 µg/L in borings CSE4 and CSE5, respectively). Water was not encountered in the direct-push borings to the east of Industrial Drive despite the borings being left open at least 24 hours to allow water to collect. The area of the higher bedrock west of the industrial park detention basin had two samples that did not contain detectable concentrations of PCE.

Groundwater samples were collected from the unconsolidated deposits at MW-1UB, MW-5UB, the MW-6 cluster, MW-8US, the MW-9 cluster, MW-10UB, the originally planned location of MW-14US (termed MW-14X), and the final location of MW-14US. PCE was present in the samples from MW-1UB and the final location of MW14US. The sample of water from the unconsolidated deposits at relocated MW14US did not contain PCE.

Unconsolidated Deposits/Bedrock Interface

Monitoring wells MW-1S and MW-2S (which straddles the unconsolidated deposits/bedrock interface) were installed in 2004 and have been sampled on several occasions. Samples from these wells, collected as part of the Round-1 sitewide sampling event in March 2009, contained PCE at 2,100 µg/L and 22 µg/L, respectively. Sampling of MW-1S following the initial installation indicated PCE present at 1,800 µg/L in December 2004 and 1,400 µg/L in February 2005. MW-2S had PCE present at 9.8 µg/L in December 2004 and 11 µg/L in February 2005. Thus, the concentration of PCE has risen between 2005 and 2009 in these wells.

Figure 5-8 shows the distribution of PCE in groundwater in the unconsolidated deposits/bedrock interval.

Upper Sandstone Marker Bed/Uppermost Bedrock

PCE; TCE; and 1,2-DCE were detected in a number of monitoring wells that are open to the upper sandstone marker bed and/or uppermost bedrock. PCE was detected in the shallow bedrock in each of the samples collected from the 21 DNAPL boreholes sampled (Figure 5-7).

The distribution of PCE in this unit is shown in Figure 5-8. Detections were primarily to the south and the southwest in a downgradient direction. However, PCE was detected in MW-9US to the north of the former Kellwood facility at 3.4 µg/L. Three monitoring

wells are completed in the upper sandstone marker bed in the vicinity of the land-farm area north of the former Kellwood facility at depths ranging from 35 to 61 feet. The well hydraulically downgradient (MW-101 to the southwest) had PCE detected at a concentration of 16 µg/L. The monitoring wells to the north (MW-102) and to the southeast (MW-103) did not contain PCE.

Monitoring well MW-1UB was completed in the uppermost bedrock at the MW-1 cluster (open interval 34 to 43.6 feet bgs). PCE was detected in the well at a concentration of 1,700 µg/L. Well MW-1T1, located immediately adjacent to MW-1UB and open from 49 to 75.3 feet bgs, contained PCE at 1.6 µg/L in March 2009. Figure 5-8 shows the results for MW-1UB rather than MW-1T1 due to higher concentration at MW-1UB and the fact that it is the shallowest of the wells in the bedrock.

PCE was detected in a surface water sample collected at the 500 tributary at a concentration of 100 µg/L. Although this sample was not from a well, it represents a discharge from the upper sandstone marker bed. PCE was detected at a concentration of 460 µg/L in MW-4A at a depth between 20 and 28 feet, approximately 12 feet into rock, and the most southerly detection. To the west, MW-10UB did not contain PCE. MW-2S is located to the east of MW-04A and is open to the same elevation of rock and unconsolidated deposits. MW-2S contained PCE at 22 µg/L in March 2009. PCE concentrations in the well in December 2004 and February 2005 were 9.8 µg/L and 11 µg/L, respectively. It is possible that there is some preferential pathway controlling the distribution of PCE in the vicinity of MW-04A since the distribution pattern is long compared to its limited width.

Swan Creek Sandstone

Three of the seven monitoring wells open to the Swan Creek sandstone member contained PCE (Figure 5-8) detected in the 2009 sitewide groundwater sampling (Task E). Two of the wells (MW-1SW and MW-04BS) with detections of PCE are located to the south, downgradient of the former Kellwood facility. The concentration of PCE in both wells was below the screening level. The concentration in the Swan Creek in MW-04BS (open from 40 to 56 feet bgs) was 4.1 µg/L compared to the 46 µg/L concentration detected from 20 to 28 feet bgs in well MW-04A immediately adjacent to it. In 2009, the cluster of wells at the MW-1 cluster, PCE was detected in MW-1SW (open from 95 to 111 feet bgs) at 2.3 µg/L. The uppermost bedrock well at the cluster, MW-1UB, open from 34 to 44 feet bgs, had PCE present at 1,700 µg/L. Well MW-1T1 is open in the interval between these two wells (49 to 75.3 feet bgs) and contained PCE at 1.6 µg/L. Both MW1T1 and MW-1SW were installed in 2004. Sampling at the time of installation (December 2004) indicated that PCE was not present although PCE was present at 1 µg/L in MW-1T1 in the February 2005 sampling event.

PCE was detected in MW-9SW at a concentration of 2.4 µg/L in 2009. This well is hydraulically upgradient from the land-farm area. This concentration is approximately the same magnitude as the PCE in MW-9US. The lack of PCE in MW-7SW (open from 75 to 94 feet bgs) is noteworthy in that the upper sandstone marker bed well (MW-7US,

open from 15 to 25 feet bgs) contained PCE at a concentration of 750 µg/L in 2009. The similar concentrations in the Swan Creek and upper sandstone marker bed at the MW-9 cluster are in sharp contrast at the MW-1, MW-4, and MW-7 well clusters.

The detections of PCE in MW-9US and MW-9SW are contrary to the hydraulic gradient and bedrock dip. An intermediate sample collected from a depth of 31 feet in the borehole for MW-9SW did not contain detectable concentrations of PCE. Thus, it is that at the MW-9 cluster, PCE was detected at concentrations below the screening criteria in the upper sandstone marker bed (41 to 53 feet bgs) and in the Swan Creek member (114 to 121 feet bgs) but not at a shallower depth. The mechanism for VOCs to migrate from the land-farm area to the location of the MW-9 cluster is unclear. There is a relatively steep hydraulic gradient in the opposite direction indicating that groundwater flow is to the southwest rather than to the north. In addition, MW-102, which is located directly between the former Kellwood facility and the MW-9 cluster and is screened in the same interval as MW-9US, did not contain PCE. The lack of PCE in MW-102 indicates that the dispersion or diffusion of PCE is not contributing PCE to MW-9US. Several core holes from DNAPL investigation were placed between the identified DNAPL and the MW-9 cluster without detecting DNAPL. In addition, evaluation of the borehole logs of MW-9US, MW-101, MW-6US, and MW-7US indicates that the upper surface of the upper sandstone marker bed dips to the southwest, away from the MW-9 cluster.

Roubidoux Formation/Lower Jefferson City Dolomite

The distribution of PCE in wells open to the Roubidoux Formation or the lower portion of the Jefferson City Dolomite is indicated on Figure 5-8. PCE has been detected in six wells as part of Tasks 2c and 2e. Well JS-37 historically has contained PCE at approximately 69 µg/L with discrete samples from the interval sampling task containing PCE up to 340 µg/L. This well was reconfigured in April 2008. An attempt to sample the reconfigured well in April 2009 was unsuccessful due to the water level in the well not recovering after the initial pumping. PCE concentrations in the six Roubidoux/Lower Jefferson City wells had positive detections that ranged from 0.8 µg/L at JS-27 to 290 µg/L at JS-36. Four of the six wells with positive detections are located to the south and the southwest of the former Kellwood facility. This is the apparent direction of groundwater flow in the unconsolidated deposits (overburden), upper sandstone marker bed/upper most bedrock, and Swan Creek intervals.

Several lines of evidence suggest that the Roubidoux/Lower Jefferson City permeable zone has a limited natural hydraulic connection to the overlying Swan Creek and the upper sandstone marker bed/upper most bedrock intervals. The aquifer test did not identify a discernable response in the Swan Creek or upper sandstone marker bed to the pumping of the city wells. In addition, the high vertical hydraulic gradient could not exist if a moderately direct hydraulic connection between these intervals existed. Borehole flowmeter measurements identified downward flows in JS-14, JS-36, JS-37, and JS-38 ranging from approximately 0.14 gpm to approximately 0.50 gpm at JS-36.

The wells south of the former Kellwood facility that have had confirmed detections of PCE had downward flow of water containing PCE either in the specific well or in a well immediately adjacent. The fact that PCE concentrations declined following installation of liners is strong evidence that the open well intervals that extend upward to an interval with PCE present or ineffective sealing of the well casing are the main mechanisms for downward migration of PCE into the Roubidoux/Lower Jefferson City Formations, overcoming the intervening layers natural resistance to vertical migration.

The casing of JS-38 did not have an effective seal. Therefore, water was reaching the backside of the well casing flowing downward until the water reached the end of the casing and entered the borehole. The water then flowed down the borehole and into the Roubidoux/Lower Jefferson City Formations. The water flowing into these formations would then be drawn into JS-52. The presence of elevated levels of PCE in the upper bedrock at MW-04A and lower concentrations of PCE in MW-2S indicates that there is a source of PCE in the shallow bedrock in the vicinity of JS-38.

Migration of PCE along the long open well interval appears to be influencing the presence of PCE in JS-36, JS-14, and JS-37.

Quarterly sampling of JS-36 and JS-38 has been performed since 2002. Quarterly sampling of JS-14 and JS-52 has been performed since 2004. A liner was installed in JS-38 in July 2005. Liners were installed in JS-14 and JS-36 in April 2008. JS-52 has had a liner in place since shortly after the well was drilled in 2003.

Over the period of quarterly sampling, the concentrations of PCE in JS-38 ranged from a high of 19 µg/L in November 2003 to a low of 4.6 µg/L in May 2009. The PCE concentration in the four quarters prior to the installation of the liner in July 2005 averaged approximately 11 µg/L. Following installation of the liner, the concentration has slowly declined to the point that it is approximately equal to the 5 µg/L screening level with some samples below the screening level and some above. An estimation of the mass of PCE that flowed down the well prior to installation of the liner in the wells can be calculated assuming water containing an average of 30 µg/L (the maximum concentration detected during the interval screening) flowed downward at a rate of approximately 0.45 gpm for a period of at least three years (based on the earliest sampling date). Approximately 0.1 kg of PCE may have migrated down the well in this three-year period using these assumptions.

The concentrations of PCE in JS-52 averaged 3.2 µg/L in the four quarters leading up to the liner installation in JS-38 (located less than 100 feet away). In the four quarters after the liner installation, the PCE concentrations rose to an average of 6.7 µg/L. However, the four samples in 2008 averaged 4.3 µg/L indicating a trend of lower concentrations. The four samples in 2009 had an average concentration of 5.1 µg/L. Although the flow of PCE down the borehole of JS-38 into the Lower Jefferson City/Roubidoux Formations impacted JS-52; well JS-40, located approximately 400 feet to the northeast; MW-2R

(converted to a domestic well and subject to routine pumping) approximately 550 feet north-northwest; and MW-4, approximately 650 feet northwest, all are nondetect for PCE. This indicates that the impact of the downward flow of PCE in JS-38 is localized.

The concentrations of PCE in JS-36 rose from 170 µg/L in January 2002 to 430 µg/L in December 2006. In the four quarters prior to the installation of the liner, the PCE concentration in JS-36 averaged approximately 260 µg/L. Following the installation of the liner, the average PCE concentration has been approximately 230 µg/L.

JS-14 had an average concentration of approximately 34 µg/L in the four samples prior to the installation of the liner. Following installation of the liner, the PCE concentration has averaged 19 µg/L with a steady decline over time.

Both J-25 (7.1 µg/L) and JS-27 (0.8 µg/L) had detections of PCE in spring 2009. The mechanism for PCE to migrate from the area of the former Kellwood facility to these wells is not clear. The hydraulic gradient of the upper sandstone marker bed and the Swan Creek intervals are from the northwest to the southeast, away from these wells rather than toward them. DNAPL, which was detected immediately north of the former Kellwood facility, could migrate along bedding planes toward these wells. However, several core holes from the DNAPL investigation were placed between the identified DNAPL and these well without detecting DNAPL. In addition, evaluation of the logs of MW-9US, MW-101, MW-6US, and MW-07US indicates that the upper surface of the upper sandstone marker bed dips to the southwest away from these wells.

Figure 5-9 presents the concentrations of PCE in groundwater at all locations regardless of the depth or transmissive zone. At locations that have clusters of wells or had intermediate screening samples in addition to the finished well samples, the highest value is indicated in the figure. For example, at BW-22 the completed well has not had PCE detected in groundwater samples. However, during drilling a sample from the interval of 66 to 126 feet contained PCE at 1,170 µg/L.

5.2.4 Distribution of PCE and Other VOCs in Sanitary Sewers and Adjacent Soils

Five soil borings were advanced adjacent to the sewer line that serves the former Kellwood facility. The boring locations were selected to be near defects in the line to evaluate the potential for leakage of water containing VOCs from the line. Two soil samples were collected from each boring. None of the ten samples contained PCE; TCE; 1,2-DCE; or VC. These data are included in the distribution of PCE in the soil figure (Figure 5-6). Eleven soil borings were advanced along three sewer segments north of Highway 100. None of the samples from these borings contained PCE; TCE; 1,2-DCE; or VC. The distribution of PCE in sediment from the sanitary sewers is presented in Figure 5-10. The distribution of VOCs in sewer water is shown in Figure 5-11. All locations with PCE detected in sewer water are downstream of the former Kellwood facility.

5.2.5 Distribution of PCE and Other VOCs in Sediment and Surface Water

PCE was detected in surface water in several stream segments in OU6 south and west of the former Kellwood facility (Figure 5-12). PCE was detected at concentrations above the screening level at two locations along the 600 tributary west of Wildcat Creek Estates. PCE was also detected at low levels (below the screening criterion) at the Boeuf Lutheran Road crossing of the 500 tributary. This creek receives runoff from the northwestern portion of the Industrial Park's retention basin as well as the area of the New Haven High School and the city park. Samples from the upper portion of the drainage basin (SW-01, SW-02, SW-03, and SW-04) did not contain detectable concentrations of PCE.

Historical samples collected by USGS indicated that PCE was present in a spring located on the stream between samples SW-04 and SW-08. Access to sample this spring as a part of the RI was not granted. The upper sandstone marker bed of the Cotter Dolomite is reported to crop out in the stream near this spring. Access to collect a sample downstream of SW-06 was also not granted.

PCE was found to be present only at low levels at the Boeuf Lutheran Road crossing of the stream that flows southward west of JS-14 and JS-36. Access was not granted to sample this drainage further downstream.

6.0 Current and Potential Future Site and Resource Use

The city of New Haven is located in Franklin County, Missouri, approximately 50 miles west of downtown St. Louis, Missouri. The 2006 population estimate was approximately 2,000 residents. The population is characterized as rural and occupies approximately 707 households with an average household size of 2.5 people. Land use of north of State Highway 100, the main road through New Haven, is primarily single-family residential with some multi-family dwellings, small businesses, churches, and small manufacturing facilities.

OU2 and OU6 are located south of State Highway 100. OU2 is located within 22 acres zoned for industrial, light industrial, and commercial use and consists primarily of the former Kellwood facility and parking lot, the land-farm area north of the facility, and the property owned by Kellwood on the west side of Industrial Drive. Currently, there are seven lots available for development which includes water, sewer, gas, and electric connections. The city of New Haven owns all available lots in the Industrial Park area and intends to maintain industrial/commercial zoning.

OU6 is the area south of Boeuf Lutheran Road and includes a residential subdivision (Wildcat Creek Estates) and other residences as well as farmed acreage. This area is largely unincorporated with no plans to become part of the city of New Haven.

7.0 Summary of Site Risks

This section summarizes the results of the risk assessment conducted for OU2 and OU6. This report is based primarily on the available information collected as part of the RI conducted for OU2 and OU6. Information concerning background data, site description, site history, previous investigations, and investigations conducted is provided in detail in the RI.

The purpose of the Human Health Risk Assessment (HHRA) is two-fold. First, the HHRA provides an evaluation of the potential threat to human health associated with the release or potential release of contaminants of potential concern (COPCs) from OU2 and OU6. The primary objective of this evaluation is to identify the final list of COPCs and their exposure pathways, conduct a toxicity assessment for each COPC, conduct an exposure assessment, and assess current and future adverse effects on humans under the no action alternatives.

The second purpose of the HHRA is to evaluate the need for remedial action. This evaluation focuses on a determination of whether or not a site presents risks greater than those deemed acceptable. This analysis will identify those COPCs and the affected media that drive the need for remedial action.

7.1 Summary of Human Health Risk Assessment

This section summarizes the results of the baseline HHRA for OU2 and OU6 including a summary of COPCs, the exposure assessment, the toxicity assessment, and the characterization of human health risks.

7.1.1 Identification of Contaminants of Potential Concern

Although the presence of many hazardous substances may be identified in the environmental samples collected during site investigative activities, the risk assessment is typically driven by a few contaminants and exposure pathways. In order to streamline the process and focus efforts on the important issues, several methods have been developed by the regulatory agencies and the scientific community for the identification of chemicals and pathways that contribute significantly to the total risk posed by a site. A risk-based screening approach was used for the selection of COPCs to be further evaluated in the detailed risk assessment. This approach is based on EPA-developed methodology and follows standard risk assessment procedures.

The maximum concentration of a chemical was compared with chemical- and medium-specific, risk-based screening concentrations (RBSCs). RBSCs are defined as concentrations that are not expected to result in any adverse impact based on exposure conditions that serve as the basis for the calculation. A chemical was selected as a COPC if its maximum concentration exceeded the RBSC. Regional Screening Levels (RSLs) were adopted as the RBSCs and used for the comparison. If the maximum concentration of a chemical detected for any specific media exceeds or is equal to the carcinogenic RSL

concentration that is equivalent to a 10^{-6} cancer risk or exceeds or is equal to the noncarcinogenic RSL concentration that is equivalent to a hazard index (HI) of 0.1, the chemical is considered a COPC. Noncancer RSLs were adjusted (i.e., divided by 10) to an HI of 0.1 to account for potential additive, noncancer health effects. National Ambient Water Quality Criteria (AWQC) or Missouri surface water criteria (10 CSR 20-7.031) for a nondrinking water human receptor were also used for RBSCs to further select COPCs when available for surface water. MCLs were not used as RBSCs to select further COPCs. MCLs will be used as the criteria to meet federal applicable or relevant and appropriate requirements (ARARs) for the groundwater pathway. However, many MCLs are technology based and not risk based which is why MCLs cannot be used as the sole basis for cleanup of groundwater. Background levels are not used for COPC screening because site-specific background levels are not available. Comparison to regional background information is discussed in the uncertainty section because it is important to determine site-related impacts. For chemicals without RSLs, surrogate compounds were used based on toxicological and structural similarities.

For the indoor air exposure pathways, VOCs were defined as all compounds with Henry's Law Constants greater than $1x10^{-5}$atmospheres per liter/mole per kilogram (atm-L/mol-K) and molecular weights less than 200 grams per mole (grams per mole). The maximum detected concentrations of the VOCs in the soil and groundwater were then put into the Johnson and Ettinger screening models (SL-SCREEN and GW-SCREEN, version 3.1; 02/04) to obtain indoor air concentrations. The estimated indoor air concentrations (infinite source building concentrations) were then compared to ambient air RSLs to select COPCs for the indoor air exposure pathways. The indoor air screening models are included in Appendix B of the risk assessment.

Listed below are the RBSCs that were used for the identification of the COPCs that were further evaluated in the risk assessment.

<u>For Contaminants in Soils</u>

- The RSLs calculated for soils under a residential scenario were adopted as RBSCs for selecting COPCs in surface (< 3 feet) and subsurface (3-10 feet) soil samples. A cutoff of three feet was chosen in accordance with the Missouri risk-based corrective action rule's definition of surface soil. If the maximum concentration of a chemical exceeds the RSLs, the chemical is considered to be a COPC. RSLs for a cancer endpoint of $1x10^{-6}$ and a noncancer endpoint of 0.1 were utilized for both surface and subsurface soils.

<u>For Contaminants in Groundwater</u>

- The RSLs calculated for tap water were adopted as RBSCs for selecting COPCs in groundwater samples. If the maximum concentration of a chemical detected exceeds the RSLs, the chemical is considered a COPC. RBSCs for a cancer endpoint of $1x10^{-6}$ and a noncancer endpoint of 0.1 were utilized.

For Contaminants in Surface Water and Sediments

- The RSLs calculated for soils and tap water under a residential scenario were adopted as RBSCs for selecting COPCs in surface water and sediment samples. If the maximum concentration of a chemical detected exceeds the RSLs, the chemical is considered a COPC. RBSCs for a cancer endpoint of $1x10^{-6}$ and a noncancer endpoint of 0.1 were utilized. In addition, AWQCs for Missouri surface water for a nondrinking water human receptor were used as additional screening criteria to determine surface water COPCs when they are more conservative or RSLs are not available. Chemicals were eliminated from further consideration if the maximum concentrations of these COPCs were below the surface water screening criteria.

Tables 1, 2, and 3 of the Risk Assessment summarize the chemicals detected in soil at OU2/OU6 and the rationale for selecting the COPCs. A total of seven VOCs, nine SVOCs, one PCB, seven pesticides, and eight metals was detected in soils at OU2 at a depth less than three feet. Using the risk-based screening approach, one VOC (PCE), one SVOC (benzo(a)pyrene), and one metal (arsenic) were selected as COPCs in soils at a depth less than three feet.

A total of seven VOCs, nine SVOCs, one PCB, seven pesticides, and nine metals were detected in soils at depths to 10 feet. Using the risk-based screening approach, one VOC (PCE), one SVOC (benzo(a)pyrene), and one metal (arsenic) were selected as COPCs in soils at depths to 10 feet. In addition, off-site subsurface soils, to 15 feet in depth, were evaluated adjacent to sewer lines near the former Kellwood facility. Three VOCs (acetone, carbon disulfide, and methyl ketone) were detected in the off-site soils near the sewer lines. Using risk-based screening levels, no COPCs were identified in these off-site soils.

For indoor air, COPCs in soils down to 10 feet were used as there were no detections below 10 feet. One VOC (PCE) was identified as a COC in soils for the indoor air exposure pathway. Indoor air exposure concentrations were estimated from soil concentrations using EPA's (2004c) version of the Johnson and Ettinger model. This model is a one-dimensional, analytical solution to passive diffusion and convective vapor-transport through the vadose zone and consists of the following two components: (1) diffusion through the unsaturated zone, and (2) convective and diffusive transport into a building.

Tables 4, 5, 6a, and 6b of the risk assessment summarize the chemicals detected in the groundwater and the rationale for selecting the COPCs. A total of five VOCs, five SVOCs, and three metals was detected in shallow (upper sand/upper bedrock) groundwater. Using the risk-based screening approach, four VOCs (1,2-DCE; methylene chloride; PCE; and TCE) and one SVOC (naphthalene) were selected as COPCs in shallow groundwater.

A total of six VOCs (acetone, methyl ethyl ketone, methylene chloride, PCE, TCE, and VC) was detected in deep (Swan Creek/Lower Jefferson City/Roubidoux) groundwater. Using the risk-based screening approach, four VOCs (methylene chloride, PCE, TCE, and VC were selected as COPCs in deep groundwater.

Note that a quantitative evaluation of the upper bedrock and upper sand aquifers was not conducted since these units are unlikely to produce potable water. The upper sandstone is less than 80 feet deep in the impacted area, and there is a minimum casing length of 80 feet specified for Sensitive Area A which includes OU2/OU6. In addition, while the aquifer may yield enough water, due to the short water column that a well would have, the well would not have enough storage capacity and thus would not produce sufficient yield on a "sustained basis." Likewise, although the Swan Creek Formation is deeper and would have a modest storage in the well bore, a typical domestic well pump would run dry within ten minutes of pumping and then require approximately one hour to recharge before pumping again. Thus, the "sustained basis" criteria would not be met; and these aquifers were not quantitatively evaluated in this risk assessment for a drinking water scenario.

Four VOCs (1,2-DCE-total; methylene chloride; PCE; and TCE) and two SVOCs (2-methylnapthalene and naphthalene) were evaluated as COPCs in shallow groundwater for the indoor air exposure pathway. Using the risk-based approach, one COPC (PCE) was identified for the groundwater to indoor air pathway using the Johnson and Ettinger model to estimate screening concentrations of VOCs in indoor air. The indoor pathway was also evaluated for the shallow groundwater for the residents in OU6. Using the maximum detected groundwater concentration in the wells south of OU2 and within OU6, an indoor air concentration was calculated using the Johnson and Ettinger model and one COPC (PCE) was identified for the groundwater to indoor air pathway for residents in OU6.

In addition, five soil gas vapor samples were collected near neighboring New Haven High School. One VOC (PCE) was detected in one soil gas sample, but the concentration was below applicable screening levels.

In addition to the previously described groundwater samples, residential wells were sampled as part of the investigation for OU6 and four selected residential wells were sampled as part of a quarterly monitoring program. A total of eight VOCs had been detected in the groundwater wells of nearby residents prior in 2008 and 2009. Using the risk-based screening approach, two VOCs (PCE and TCE) were identified as COPCs in the residential wells.

A total of eight VOCs (benzene; cis-1,2-DCE; trans-1,2-DCE; methylene chloride; PCE; TCE; trichlorofluoromethane; and VC); six SVOCs [4-bromophenyl phenyl ether, benzo(a)anthracene, benzo(b)fluoroanthene, chrysene, hexachlorobenzene, and pyrene]; one pesticide (Endosulfan II); and one metal (barium) were detected in surface water. The SVOCs were all detected near the detection limit and were not detected in the duplicate sample that was also collected. Using the risk-based screening approach,

methylene chloride, PCE, TCE, VC, 4-bromophenyl phenyl ether, benzo(a)anthracene, benzo(b)fluoroanthene, chrysene, and hexachlorobenzene were identified as COPCs in surface water.

A total of four VOCs (acetone, chloroethane, chloromethane, and PCE); eleven SVOCs [3,3'-dichlorobenzidine; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoroanthene; benzo(ghi)perylene; benzo(k)fluoroanthene; chrysene; dibenzo(ah)anthracene; fluoranthene; indeno(123-cd)pyrene; and pyrene]; six pesticides (4,4'-DDD; 4,4'-DDT; Endosulfan Sulfate; Endrin andehyde; Endrin ketone; and methoxychlor); and eight metals (arsenic, barium, cadmium, chromium, lead, selenium, silver, and zinc) were detected in sediment samples. Using the risk-based screening approach, one SVOC [benzo(a)pyrene] and one metal (arsenic) were selected as COPCs in sediments.

7.1.2 Physical and Chemical Properties of the COPCs

The physical and chemical properties of COPCs and the physical processes acting upon them influence their environmental fate and transport in association with the characteristics of the environment. The physical and chemical characteristics of the COPCs are presented in Table 7-1. For the chemical 4-bromophenyl phenyl ether, which was detected in one sediment sample, there are little data available; therefore, this compound was not evaluated quantitatively in the risk assessment.

7.1.3 Exposure Assessment

The exposure assessment uses the site description and constituent characterization to identify potentially exposed human receptor populations, identify potential exposure pathways, and calculate estimated daily intakes of COPCs. Behavioral and physiological factors influencing exposure frequency and levels are presented in a series of exposure scenarios as a basis for quantifying constituent intake levels by receptor populations for each identified pathway.

To predict the constituent levels to which receptors would be exposed, site-specific information such as climate, geology, soils, groundwater, surface water, population demographics, land use, water use, and agricultural practices are examined. Once these exposure levels are determined, they were compared with the appropriate health effects criteria to characterize human health risks.

7.1.4 Conceptual Site Model

The Conceptual Site Model (Figure 5-1) illustrates the exposure pathways that identify the focus of the risk assessment. Exposure pathways describe the movement of chemicals from sources (e.g., chemicals in soil or surface water) to exposure points where receptors (i.e., potentially exposed populations) may come in contact with the chemicals. An exposure pathway is typically defined by the following elements:

- A source and mechanism of contaminant release to the environment

- An environmental transport medium (e.g., soil, water) for the released contaminants

- A point of potential contact with the contaminated medium (i.e., point of exposure)

- An exposure route (e.g., inhalation, ingestion, dermal contact) at the point of exposure

An exposure pathway is considered complete only if all four components are present. In conducting the risk assessment, only complete exposure pathways were evaluated quantitatively.

7.1.5 Known and Suspected Source of COPCs and Release Mechanisms

Based on the history of the site and the results of the site investigation, the primary source of COPCs is the historical use and disposal of solvents in the area. Primary release mechanisms may include direct release, leaching, erosion, and runoff associated with precipitation. Surface and subsurface soils and groundwater that have been impacted may act as secondary sources of COPCs through mechanisms such as leaching of chemicals from soils, surface runoff, groundwater recharge to surface water, and wind and mechanical erosion of chemicals in soils. The secondary sources of COPCs are impacted soil and groundwater migration to surface water and sediments and residential drinking water wells.

7.1.6 Retention or Transport Media

The media directly impacted by the COPCs are soil and groundwater. Dust is considered a potential transport medium because COPCs in soil may become entrained in fugitive dust. Surface runoff is considered a transport medium because precipitation from storm events may have generated episodic overland flow and carried COPCs away from the impacted areas. Groundwater is a transport medium of concern for COPCs where groundwater discharges to surface water bodies that are adjacent to the Site.

7.1.7 Transport Pathways

Release mechanisms and transport pathways were evaluated on a media-by-media basis. Listed below are potential cross-media transfer mechanisms of COPCs:

- COPCs in subsurface soil leaching

- COPCs in surface soil migrating to surface water and sediment adjacent to the site through surface runoff

- COPCs in groundwater transport to surface water and sediment through groundwater recharge

- COPCs in soil and groundwater transport to the atmosphere via volatilization or fugitive dust emission

- COPCs in soil and groundwater transport to indoor air via vapor migration

7.1.8 Exposure Route and Exposure Point

The impacted media are soil, groundwater, surface water, and sediments. An exposure route is the means by which the contaminant actually contacts a receptor. Exposure routes include incidental ingestion and dermal contact with soils, inhalation of volatiles from soil and groundwater, inhalation of dust generated from soil, and dermal contact with sediments and surface water.

Exposure points are defined as the points at which a receptor is likely to come into contact with a COPC. For incidental ingestion and dermal contact, the exposure point is the impacted area. For inhalation, the exposure point is ambient air or air in an enclosed space.

7.1.9 Receptors and Exposure Scenarios

The potential for exposure is analyzed from two perspectives—examination of current land use and consideration of reasonably anticipated future land use. Commercial workers, construction workers, and site trespassers are the current on-site human receptors for OU2. The reasonably anticipated future land use for OU2 is expected to remain the same as the current land use based on the historical use and the zoning of the area and surrounding properties. However, a residential future use scenario for OU2 is also evaluated as a "no action" alternative when evaluating mitigation of potential exposures. OU6 is currently used for residential use, and that use is unlikely to change in the future; thus, residents were the only receptors evaluated for OU6.

Based on the current and potential future land-use conditions, the known or potential on-site human receptors may include the following:

Human Receptors	Current Use	Potential Future Use
Routine Commercial/Industrial Workers	Yes	Potential
Construction Workers	No	Potential
Trespassers	Potential	Potential
Residents	No - On-Site Yes - Off-site	Potential

The potential exposures to surface water and sediment were evaluated as part of the trespasser scenario.

Presented below is an overview of populations of potential concern selected for further evaluation in the HHRA:

- Current Land Use Scenario – Commercial/Industrial Worker

OU2 is currently a manufacturing facility with limited access. Commercial/industrial workers and potential trespassers are the receptors under the current scenario. Because the commercial/industrial worker and trespassers are the same for both current and potential future scenarios, the risk to future scenarios was quantified since more conservative assumptions were used in the calculations of the risk for future receptors. These conservative assumptions included accounting for soils beneath buildings which are currently inaccessible, higher exposure frequencies, and durations.

- Industrial/Commercial Future Land Use Scenario – Industrial and Construction Workers and Site Trespassers

Commercial and construction workers are potential future receptors because commercial land use is a potential future use and construction activities could take place. Additionally, trespassers are potential future receptors.

- Residential Future Land Use Scenario – Residents

Although the reasonable anticipated future use of OU2 is industrial, a potential future residential scenario for all of OU2/OU6 is also evaluated under a potential "no remedial action" alternative analysis. Under this scenario, residents (adults and children) are the potential future receptors. Residents were conservatively assumed to be exposed to subsurface soils in the event that future regrading of soils is conducted.

7.1.10 Exposure Point Concentrations and Chemical Intakes

The COPCs and the exposure point concentrations (EPCs) used in the risk assessment are summarized in Tables 7-2 through 7-8. For COPCs identified in surface water and sediments, the maximum concentrations were used as the EPCs due to limited surface water samples, except for PCE. A 95 percent upper confidence limit (UCL) was calculated using EPA's ProUCL Version 4.00.04 software for PCE since over 90 samples were collected from many tributaries within OU6. Only 60 samples were used to calculate the 95 percent UCL for PCE in surface water due to the lack of detection limits for 32 of the samples. For groundwater COPCs, the maximum detected concentration was used as the EPC. For PCE, a COPC in soil, a 95 percent UCL of the arithmetic mean was calculated using EPA's ProUCL Version 4.00.04 software. ProUCL recommendations regarding the most appropriate UCL to estimate the EPC was followed based on the dataset. The maximum detected concentration of any duplicates was used to

calculate the 95 percent UCL. The 95 percent UCLs were not calculated for the other identified COPCs in soil due to the limited number of samples. The 95 percent UCL calculation sheets are included in Appendix K of the RI.

The soil data were separated into near surface soil (<3 feet) and mixed soil (3 -10 feet) for the direct contact exposure pathways. Surface soil EPCs (0-3 feet) were used for the commercial worker and trespasser scenarios. Ten feet bgs was utilized as the mixed soil range since no compounds were detected above detection limits in soil samples collected below 10 feet. Table 7-8 summarizes the exposure point concentrations associated with the two soil intervals. Typically, surface soil is defined as the top two centimeters of soil; however, since soil samples were collected in one-foot intervals in accordance with the approved work plans, the state of Missouri's definition of surface soils (Missouri defines surficial soils as being between 0 and 3 feet) was followed to complete the risk assessment in order to have a more robust data set. For COPCs identified in sediments and surface water, the maximum COPC concentrations detected are used due to the limited number of data points.

In order to calculate a quantitative risk, exposures are evaluated via a quantitative expression of chemical-specific intakes for each potentially completed exposure pathway by integration of data gathered in the exposure assessment (i.e., the extent, frequency, and duration of exposure for the population and pathways of concern).

The potential for human receptors to be exposed to the contaminated media through relevant routes of exposure (e.g., inhalation, ingestion, and dermal contact) was evaluated. Exposure pathways considered not to be applicable, based on site-specific information, were excluded from quantitative evaluation in the baseline risk assessment. The rationale for the elimination of certain exposure pathways was provided in previous sections.

7.1.11 Toxicity Assessment

The purpose of the toxicity assessment is to identify the types of adverse health effects that a COPC may cause and to define the relationship between the exposure to a COPC and the likelihood and magnitude of an adverse effect (response). Adverse effects are characterized as carcinogenic or noncarcinogenic. Dose-response relationships are defined by EPA for oral and inhalation exposures. Oral dose-response values were used to derive appropriate dermal toxicity values.

The dose-response assessment evaluates the available toxicity information and quantitatively describes the relationship between the level of exposure (either from animal or human epidemiological studies) and the occurrence of an adverse health effect. This relationship is described by a cancer slope factor or unit risk factor for carcinogens and a reference dose (RfD) or reference concentration (RfC) for systemic toxicants, collectively called toxicity values.

Toxicity values were obtained from the following hierarchy of sources:

- Tier 1 – Integrated Risk Information System (IRIS)

  IRIS is an EPA electronic database containing up-to-date risk and regulatory information for numerous chemicals. IRIS contains only toxicity criteria that have been verified by EPA work groups and, consequently, is considered to be the preferred source of toxicity information. Information on IRIS always supersedes all other sources.

- Tier 2 – Provisional Peer-Reviewed Toxicity Values (PPRTVs)

  EPA's Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center develops PPRTVs on a chemical-specific basis when requested by EPA's Superfund program.

- Tier 3 – Other (Peer-Reviewed) Toxicity

  Priority is given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed. The additional sources used in the risk assessment include the following:

- The Agency for Toxic Substances and Disease Registry's Minimal Risk Levels

- The California Environmental Protection Agency's toxicity values

- Health Effects Assessment Summary Tables' toxicity values

The toxicity values for the COCs are summarized in Tables 7.9 and 7.10. Information presented in Tables 7.9 and 7.10 includes EPA weight of evidence classification, route-specific slope factors for carcinogenic effects, and chronic and subchronic RfD/RfC for noncarcinogenic effects.

7.1.12 Risk Characterization

Risk characterization integrates the results of the exposure and toxicity assessments to derive quantitative and qualitative estimates of the potential cancer risk and noncancer hazards that may occur due to exposure to site-related contaminants. This section presents the methods and results of the risk characterization. The results of the risk characterization are presented in Tables 17.1 through 17.7 of the HHRA.

Method for Noncancer Hazard Estimation

The potential for chronic noncarcinogenic health effects due to chemical exposure was

evaluated by comparing intake (expressed as milligrams per kilogram per day [mg/kg/day]) with an RfD (expressed in mg/kg/day). This comparison, or unitless ratio, is called the Hazard Quotient (HQ) and is expressed by the following equation:

Noncancer HQ = CDI/RfD

Where: CDI = Chronic Daily Intake (mg/kg/day)/RfD = Reference Dose (mg/kg/day)

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short term). The central tendency exposures (CTE) HQs were quantified using the average CTE exposure intake values. The reasonable maximum exposures (RME) HQs were quantified using the RME exposure intake values. HQs were summed for each chemical across multiple exposure pathways to produce a total HI for a receptor for a given chemical. HIs were summed across multiple chemicals and multiple pathways to provide a total HI of noncancer risks under an assumption of additivity of toxic effects. The assumption of additivity is applicable to COCs that induce the same type of effect. If the total HI was greater than one (1), COCs were reevaluated by critical effect. Separate HIs were calculated by type of effect (target organ-specific HI) because health effects from exposure to different chemicals are only additive if they have the same toxic affect (affect the same target organ system).

Method for Cancer Risk Estimation

For chemicals that are potential carcinogens, risk was estimated as the incremental probability of a receptor developing cancer over a lifetime as a result of exposure via each identified exposure pathway. The slope factor converts estimated daily intakes to the incremental risk of a receptor developing cancer. The following equation (i.e., the linear low-dose cancer risk equation) was used to compute chemical-specific cancer risk:

Risk = CDI x SF

Where: Risk = Chronic Daily Intake (mg/kg/day) x Slope Factor ($mg/kg/day^{-1}$)

Above cancer risks of 1.0×10^{-2}, the model is no longer linear and the following equation (i.e., the one-hit equation) must be used:

Risk = 1 - exp (-CDI or Dose x Slope Factor)

The one-hit equation was used to calculate the RME and cancer risks for the future adult and child resident associated with ingestion, dermal absorption, and inhalation of PCE and TCE in groundwater.

Total incremental lifetime cancer risks for residential exposure scenarios were calculated by combining the estimated cancer risk for the adult and child.

The CTE risk estimate was quantified using the average CTE exposure intake parameters. The RME was quantified using the RME exposure intake parameters. The total cancer risk for each exposure pathway was quantified by summing the chemical-specific cancer risks.

To provide a perspective on the potential risks associated with OU2 and OU6, the magnitude of the potential risks associated with the known or suspected carcinogens detected was compared to the EPA acceptable cancer risk range of $1x10^{-4}$ to $1x10^{-6}$. A cancer risk of $1x10^{-4}$ is equivalent to one cancer case in 10,000 exposed people while a cancer risk of $1x10^{-6}$ is equivalent to one cancer case in one million exposed people. EPA considers acceptable exposure levels to be the residual concentration levels that represent an excess cancer risk to an individual between $1x10^{-4}$ to $1x10^{-6}$ based on dose and response information for the particular chemical.

7.1.13 Risk Characterization for Multiple COCs

For clarity, the methodology to be used for characterizing risk associated with exposures to multiple chemicals is briefly outlined as follows:

1. Organize outputs of exposure and toxicity assessments by the duration and route of exposure for each population.

   The total upper-bound excess lifetime cancer risks and the HQs are tabulated separately for each COC.

2. Quantify total carcinogenic and noncarcinogenic risks for each pathway by summing the risks estimated for each COC.

   The total upper-bound excess lifetime cancer risk for each pathway is obtained by summing the cancer risks calculated for individual COCs. For known or suspected carcinogens, exposure levels that represent an excess upper-bound lifetime cancer risk to an individual between 10^{-4} and 10^{-6} are considered to be acceptable by EPA.

   The sum of the HQs of all the COCs under consideration is termed the HI. The HI is a useful reference point for gauging the potential noncarcinogenic effects of multiple environmental exposures. In general, an HI that is less than or equal to one is regarded as not likely to be associated with any health risks and is, therefore, less likely to be of regulatory concern than HIs greater than one. However, a conclusion should not be categorically drawn that all HIs greater than one are "unacceptable" because of the following reasons:

   - There is perhaps one order of magnitude or greater uncertainty inherent in estimates of oral RfDs and inhalation RfCs due to the conservative approach used to derive these estimates.

- There are uncertainties related to the assumptions that individual HQs are additive.

Therefore, if the HI exceeds one, the sum of the HQs may be recalculated by segregating the chemicals into subgroups based on the target organs affected and the mechanism of action.

3. Estimate overall risks that affect each population over the same time period by combining risks across pathways.

   In order to address the possibility of a population that is likely to be exposed to more than one pathway, risks were combined across different pathways that are likely to affect the same population over the same time periods.

The HQ is the ratio of the estimated exposure dose to the noncarcinogenic toxicity value (RfD or RfC). This ratio is used to evaluate the risk of noncancer health effects due to exposure to a COC. Once the HQ values for each of the noncarcinogenic COCs have been calculated, they are summed to determine the HI. An HI greater than one indicates that the estimated exposure dose for that receptor exceeds acceptable levels for protection against noncancer affects. Although an HI of less than one suggests that noncancer health affects should not occur, an HI of slightly greater than one does not necessarily indicate that adverse affects will occur. This is because of the uncertainty inherent in the toxicity values used in the calculations. Uncertainties inherent in the risk assessment process are discussed in Section 7.1.16 and 7.1.17 and in more detail in Section 7.0 of the risk assessment.

Calculation of the total cancer risk and total HI for the current and future exposed populations are provided in Tables 7-11 through 7-16 and are summarized below:

- The total cancer risk and total HI resulting from exposure to COCs in soil and groundwater at OU2/OU6 for a current/future industrial worker (outdoor) were calculated to be 7.6×10^{-6} and 0.02, respectively.

- The total cancer risk and the total HI resulting from exposure to COCs in soil and groundwater at OU2/OU6 for a current/future industrial worker (indoor) are 1.9×10^{-3} and 0.1, respectively.

- The total cancer risk and total HI resulting from direct contact of the COCs in soil and groundwater for a future construction worker were calculated to be 6.6×10^{-7} and 0.02, respectively.

- The total cancer risk and total HI resulting from exposure to COCs in soil, shallow groundwater, sediment, and surface water at OU2/OU6 for a trespasser were calculated to be 2.6×10^{-5} and 0.04, respectively.

- The total cancer risk and total HI resulting from exposure to COCs in soil and groundwater volatilizing to indoor air for a future resident living anywhere within OU2 were calculated to be 9.4×10^{-3} and 6.9 (both adult and child), respectively, and 5.5×10^{-3} and 2.9, respectively, for a future drinking groundwater user in OU2.

- The total cancer risk and total HI resulting from exposure to COCs in deep groundwater used as tap water prior to treatment for a current/future residential groundwater user (adult and child) living in OU6 were calculated to be 3.3×10^{-3} and 1.9.

- The total cancer risk for a resident exposed to COCs in shallow groundwater via indoor air at OU2/OU6 ranged from 7.3×10^{-7} to 2.5×10^{-5}, depending on the depth of the concentration.

The total cancer risk and the total HI exceed the target cancer risk range of 1×10^{-4} and 1×10^{-6}, and the target hazard level of one for the following receptors: Industrial worker or future resident for OU2 and a current or future resident of OU6 if they drink untreated groundwater.

For the future resident of OU2, the pathways of concern are incidental ingestion, inhalation, and dermal contact with impacted soil, the inhalation of soil volatiles in indoor air, the inhalation of groundwater volatiles in indoor air, and the use of groundwater as tap water exposure pathways. The risk is primarily driven from the inhalation of PCE in indoor air and ingestion of groundwater as tap water. The total cancer risk and the total HI associated with soil to indoor air pathway are 5.6×10^{-3} and 3.7. The total cancer risk and the total HI associated with only groundwater to indoor air exposure pathway are 3.7×10^{-3} and 2.1. The primary COCs are PCE (soil and groundwater) and arsenic (soil). Locations where concentrations of PCE exceed target concentrations are underneath and immediately adjacent to (north and west of) the former Kellwood facility (soil) and south and southwest of the former Kellwood facility (groundwater).

For the industrial indoor worker, the risk is from PCE in soil and groundwater volatilizing to indoor air. This is the only COC identified for this pathway. Locations where concentrations of PCE exceed target concentrations are underneath and north of the former Kellwood facility (soil) and south and southwest of the former Kellwood facility (groundwater).

7.1.14 Uncertainty

All risk assessments involve the use of assumptions, professional judgments, and imperfect data to varying degrees which results in uncertainty in the final estimates of hazard and risk. Risk assessment in general is highly conservative and often is based on

conservative assumptions and scenarios. Uncertainty can be introduced into HHRAs at every step of the process. Uncertainties are present in a risk assessment because it requires the integration of the following:

- The release of pollutants into the environment
- The fate and transport of pollutants in a variety of different and variable environments by processes that are often poorly understood or too complex to quantify accurately
- The potential for adverse health effects in humans based on extrapolations from animal studies
- The probability of adverse effects in a human population that is highly variable with respect to genetics, age, activity level, and lifestyle

There are several categories of uncertainty associated with risk assessment. One is the initial selection of chemicals for analyses and, therefore, which chemicals are used to characterize risk from exposure. A second category is the selection of exposure scenarios that are conservative (i.e., protective of human health) and yet which are probable. Additional uncertainties are inherent in the exposure assessment for individual substances and individual exposures. Those uncertainties are driven by the degree of reliability of the chemical monitoring data, the models used to estimate EPCs in the absence of monitoring data, and the population intake parameters (e.g., exposure factors). A third category is the availability of toxicity information for the COCs to address all potential routes of exposure. Finally, additional uncertainties are incorporated into the risk assessment when exposures to several substances are summed.

7.1.15 Uncertainty Associated with Data Evaluation and Selection of Chemicals of Concern

The selection of site-related COCs was based upon the results of the sampling and analytical program established for OU2/OU6. The factors that contribute to the uncertainties associated with the identification of COCs are inherent in the data collection and data evaluation processes including appropriate sample locations, adequate sample quantities, laboratory analyses, data validation, and treatment of validated samples.

The predominant sources of uncertainty and potential bias associated with site characterization are based on the procedures used for site investigation (including sampling plan design and the methods used for sample collection, handling, and analysis) and the procedures used for data evaluation. In general, a very comprehensive sampling program was implemented to account for the chemicals most likely to be present as a result of past site history and activities. Although certain areas were not characterized due to limited access, it is reasonably expected that the impact from those areas is adequately represented by the data collected from nearby locations. An exception to this is that only one surface water and one sediment sample were analyzed for SVOCs and

metals in accordance with the approved work plan to determine the presence/absence of these compounds. Although neither class of compounds are expected to be present in the surface waters and sediments in OU2/OU6 as they are not site-related compounds and because they have not been detected at elevated concentrations in other media, a single sample from media is not adequate to characterize these media. Therefore, the estimated risk to receptors exposed to these compounds in these media may be underestimated.

Data with estimated qualifiers were considered as detected concentrations and used in the risk assessment which may result in the overestimation or underestimation of the actual risks/hazards. All nondetected compounds were eliminated as COCs which may result in underestimating the actual risk/hazards because some of the detection limits in soil and groundwater are more than one order of magnitude greater than risk-based screening levels.

Background information is not used for the selection of COCs because the Site and surrounding area have been an industrialized urban area since the 1800s. Some of the metals detected may be associated with native background instead of site-related. The maximum arsenic concentration of 5.1 mg/kg detected in surface soil (<3 feet) is within the background range for U.S. soils. The lack of site-specific background data means that the incremental risk due to site-related compounds could not be qualified.

In addition, some compounds that were below accepted screening levels were eliminated from further consideration in the risk assessment. Doing so may underestimate the total risk although the additional risk contributed by these eliminated compounds is thought to be minimal.

7.2 Ecological Risk Assessment

7.2.1 2002 Ecological Risk Assessment Summary

A Baseline Ecological Risk Assessment (BERA) was previously conducted for the Site by Black & Veatch for EPA in 2002. The evaluation included OUs 1 through 4 although the study area was defined as all watersheds potentially affected by the Site based on a review of surficial topography. Thus, the study area evaluated in the 2002 BERA included OU6 as shown in Figure 7-1 from the aforementioned report. Most terrestrial habitats within the study area were developed residentially or commercially; however, there were some undeveloped forest areas adjacent to streams or flood plains and some agricultural fields. Aquatic habitats in the study area consisted of the Missouri River (adjacent to OU1) and several small streams that originate within the study area.

Constituents evaluated in the BERA included PCE and related volatile compounds based on the history and the known discharges at the Site. Specifically, the constituents of potential ecological concern (COPECs) were: PCE, TCE, cis-DCE, trans-DCE, VC, and benzene. The exposure pathways that were evaluated included soil and contaminated

food ingestion for terrestrial receptors and groundwater discharging to surface waters for aquatic receptors. Media evaluated included flood plain surface soil, sediment, surface water, and plant tissue. None of the COPECs are considered bioaccummulative.

In the BERA, concentrations of COPECs in surface soil were compared to several sources of ecological toxicity including the EPA Region 4 ecological screening values, EPA Region 5 RCRA Ecological Data Quality Levels (EDQLs), Toxicological Benchmarks, and Canadian Environmental Quality Guidelines. Sediment and surface water concentrations were compared to EPA Region 5 EDQLs or Ecotox Thresholds. Calculated wildlife intakes via ingestion were compared to Toxicological Benchmarks for Wildlife.

Target compounds were not detected in the flood plain although reporting limits in soil for TCE and VC were higher than the screening levels. PCE and toluene were the only site-related compounds detected in sediments; however, the detections were below the screening values. Again, VC had a higher reporting limit than its screening level in sediment.

In surface water, PCE, cis-DCE, toluene, and VC were detected; however, most detections were below applicable screening levels. Two samples of surface water contained PCE at levels above its screening value. These samples were collected from a tributary of Boeuf Creek downgradient of OU2. The BERA concluded that given the high volatility of PCE in surface water, it was likely that the PCE would rapidly volatilize into the atmosphere. For herbivorous wildlife, none of the target compounds were present at levels that indicate a significant risk.

As a result of the BERA, no further ecological investigation or analyses were recommended for the Site. A Preliminary Remediation Goal (PRG) of 8.9 µg/L for PCE in surface water was recommended which would be more protective of aquatic receptors. The PRG was based on the EPA Region 5 EDQL.

7.2.2 Updates to the Ecological Risk Assessment Summary

After the BERA was prepared, additional samples were collected from the streams and tributaries in the study area. In addition, soil, surface water, and sediment samples were collected in association with the investigation of OU2 and OU6. Thus, the conclusions of the BERA were reassessed in light of this additional information. Surface soil (0-3 feet bgs) was compared to EPA Region 5 Ecological Screening Levels (ESLs), which replaced Region 5 EDQLs. Only one site-related compound (PCE) was detected in surface soils above the Region 5 ESLs. PCE was detected at two locations at depths of 0.5 feet and 2.5 feet bgs in an area north of the former Kellwood facility where there is little available habitat for wildlife. Since only 2 of 56 soil samples had concentrations of PCE above the screening level in a developed portion of the Site, these isolated detections are not expected to pose a risk to terrestrial ecological receptors. Three other

nonsite-related compounds were detected in four surface soil samples collected. Each compound (4,4-DDE; endrin aldehyde; and Arochlor-1254) was detected once in four samples. Since these compounds are not site related, they were not evaluated further.

In surface water samples collected from tributaries of Boeuf Creek, one site-related compound (PCE) was detected in several samples above the EPA Region 5 ESL. Four nonsite-related compounds were also detected; however, since these compounds (trichlorofluoromethane, benzo(a)anthracene, chrysene, and hexachlorobenzene) are not site related, they were not evaluated further. The highest concentrations of PCE were detected at a small spring on the 500 tributary located immediately upstream of 500TB-2 (Figure 2-12). The spring is in a pool in the bed of the 500 tributary and thus could not be directly sampled without the influence of the flow in the 500 tributary. The discharge of the spring was too low for it to be measured by taking the difference in the flow of the drainage upstream and downstream of the spring. Although it was not directly sampled, the maximum PCE concentration (100 µg/L in July 2002) measured immediately downstream of the spring indicates that impacts to wildlife are minimal.

For PCE, the maximum detected concentration was compared to the EPA Region 3 Biological Technical Assistance Group (BTAG) screening level for freshwater. Region 3 BTAG screening benchmarks have been updated more recently than Region 5 ESLs (2006 versus 2003). Region 3 BTAG has a screening value of 111 µg/L for PCE in freshwater, which is a chronic exposure screening value. Also, since PCE was only detected above EPA Region 5 ESL occasionally in 2002 and in localized areas, the risk to aquatic life due to the detections of PCE in surface waters is considered minimal.

In sediment samples collected from the tributaries of Boeuf Creek, no site-related compounds were detected above the EPA Region 5 ESLs; however, PCE was detected in one of eight sediment samples. Three nonsite-related volatile compounds (acetone, chloroethane, and chloromethane) were also detected in sediment samples collected from the tributaries. Acetone was detected twice at concentrations above its screening level while chloroethane and chloromethane do not have published screening levels available for comparison. In addition, five metals (arsenic, barium, lead, selenium, and zinc) were detected in a single sediment sample above their respective screening levels. Since there were no site-related compounds detected in sediments above applicable screening levels, the sediments in the tributaries of Boeuf Creek were not evaluated further.

Since no site-related COPECs were detected at frequencies or concentrations likely to pose a risk to ecological receptors, no further ecological investigations or assessments are recommended. In the BERA, a PRG of 8.9 µg/L for PCE was established in surface water. This concentration was based on the EPA Region 5 EDQL. However, in 2003 EPA Region 5 updated the EDQLs to ESLs and a new level of 45 µg/L was established for PCE. EPA Region 3 updated its surface water screening benchmarks in 2006 and established a level of 111 µg/L for PCE. This updated EPA Region 3 BTAG screening benchmark is now proposed as the new PRG for PCE in surface water.

7.3 Risk Assessment Summary and Conclusions

The risk assessment results are summarized as follows:

- The total cancer risk and total hazard index exceeds target ranges for potential future residents in OU2 where DNAPL is present and near the former Kellwood facility through incidental ingestion, inhalation, dermal contact with contaminated soil, inhalation of indoor air (volatilizing from either soil or groundwater), and ingestion of groundwater from a future drinking water well. Current zoning of this area, and the reasonably anticipated future land use for this area, is commercial/industrial.

- The total cancer risk and total hazard index exceeds target ranges for industrial workers through inhalation of indoor air in the area where DNAPL is present at the former Kellwood facility.

- The total cancer risk and total hazard index exceed the target ranges for residents in OU6 using groundwater as drinking water prior to any treatment. The risk is primarily driven from the ingestion of PCE in deep groundwater. Thus, treatment systems must be maintained at these homes.

- The total cancer risk is within the target risk range for residents living near the former Kellwood facility via inhalation of indoor air (volatilizing from groundwater), and the total hazard index is below target levels.

- The results of the comparison of soil gas samples collected near the high school show that PCE, the only detected constituent (and only detected at location SVI-5), exceeds EPA's residential air screening level but is below EPA's industrial air screening level and all specified Missouri target levels for both residential and nonresidential use. Given that the exposure assumptions for a teacher/ administrator/janitorial scenario would be similar to an industrial worker scenario, further evaluation of the teacher/administrator/janitorial receptor group is not warranted at this time. Further evaluation of a student scenario is also not warranted since a student's exposure would be even less than that of a teacher or a typical residential scenario.

A more complete discussion regarding the conclusions of the risk assessment can be found in Section 8 of the 2010 HHRA.

8.0 Remedial Action Objectives

Section 121(b) of CERCLA requires the selection of remedial actions that attain a degree of cleanup, ensure protection of human health and the environment, are cost effective, and use permanent solutions and alternative treatment technologies or resource recovery

technologies to the maximum extent practicable. RAOs provide a general description of what the response action is expected to accomplish at OU2 and OU6. The RAOs for OU2 and OU6 are summarized below.

- Protect human health by eliminating exposure (i.e., inhalation, incidental ingestion, dermal contact) to soil with concentrations of COCs in excess of risk-based standards (i.e., PCE at 550 µg/kg). This RAO applies to the area around the land-farm area at OU2 for a hypothetical residential scenario. The risk-based standards for soil were derived from residential soil RSLs (see Appendix A of the HHRA). The exposure factors used to derive the soil RSLs are consistent with the exposure factors used in the HHRA.

- Protect human health by eliminating exposure (i.e., inhalation) to indoor air containing concentrations of COCs (as vapors) due to the migration of vapors from contaminated soil or shallow groundwater in excess of risk-based standards (i.e., 272 µg/kg or 423 µg/L for industrial; 35.9 µg/kg or 44.1 µg/L for residential). This RAO applies to the area around the land-farm area for both the industrial and hypothetical residential scenario and at identified areas of impacted soil beneath the former Kellwood facility.

- Protect human health by preventing exposure (ingestion) to groundwater with chemical concentrations greater than their respective MCLs (i.e., PCE 5µg/L; TCE 5µg/L; cis-1,2,-DCE 70µg/L; and VC 2µg/L).

- Protect the environment by minimizing further migration of groundwater containing COCs.

- Protect the environment by reducing the soil COC concentrations by eliminating or mitigating the soil-to-groundwater pathway.

- Protect the environment by minimizing the movement of DNAPL from fractured bedrock into groundwater.

- Protect the environment by eliminating exposure of wildlife to surface water, sediment, and surface soils with concentrations of COCs in excess of ecological risk-based standards and achieve compliance with ARARs for ecological protection such as the EPA Region 3 BTAG freshwater benchmarks. Detected concentrations in surface water and sediment at OU2 and OU6 were below the risk-based standards listed in Table 8.1.

9.0 Description of Remedial Alternatives

The detailed analysis of alternatives consists of the analysis and presentation of the relevant information needed to allow decision makers to select a remedy. During the detailed analysis, each alternative is assessed against the evaluation criteria described below. The results of this assessment are arrayed in Table 5.1 of the FS Report. This

approach to analyzing alternatives is designed to provide decision makers with sufficient information to adequately compare the alternatives, select an appropriate remedy, and demonstrate satisfaction of the CERCLA remedy selection requirements in the ROD.

The remedial alternatives evaluated in the FS are:

1. No Action

2a. DNAPL recovery followed by in situ chemical oxidation, whole-house treatment units, institutional controls (ICs), and groundwater monitoring

2b. DNAPL recovery followed by in situ chemical oxidation, alternative water supply, whole-house treatment units (interim[7]), ICs, and groundwater monitoring

2c. DNAPL recovery followed by chemical oxidation, whole-house treatment units, ICs, in situ groundwater remediation, and groundwater monitoring

2d. DNAPL recovery followed by in situ chemical oxidation, alternate water supply, whole-house treatment units (interim), ICs, in situ groundwater remediation, and groundwater monitoring

3a. Thermal treatment of DNAPL, whole-house treatment units, ICs, groundwater monitoring

3b. Thermal treatment of DNAPL, whole-house treatment units (interim), alternate water supply, ICs, and groundwater monitoring

4a. Thermal treatment of DNAPL and soil at Area A-3, whole-house treatment units, ICs, and groundwater monitoring

4b. Thermal treatment of DNAPL and soil at Area A-3, bioremediation of groundwater, whole-house treatment units, ICs, and groundwater monitoring

4c. Thermal treatment of DNAPL and soil at Area A-3, in situ chemical oxidation of groundwater, whole-house treatment units, ICs, and groundwater monitoring

4d. Thermal treatment of DNAPL and soil at Area A-3, in situ chemical reduction of groundwater, whole-house treatment units, ICs, and groundwater monitoring

5. In situ chemical oxidation (DNAPL, Area -3, and groundwater); whole-house treatment units; ICs; and groundwater monitoring

6. In situ chemical reduction (DNAPL, Area A-3 and groundwater); whole-house treatment units; ICs; and groundwater monitoring

[7] The word "interim" indicates that whole-house treatment units would be used until a permanent source of potable water could be provided or until the COCs are consistently and reliably below the MCLs.

9.1 Description of Alternatives

9.1.1 Alternative 1: No Action

Estimated Capital Cost:	$0
Present Worth O&M[8] Cost:	$152,000
Total Present Worth Cost:	$152,000

Alternative 1 would not involve any remedial actions. This alternative, required by the NCP, is a baseline alternative against which the effectiveness of the other alternatives can be compared. Under the no action alternative, OU2 and OU6 would be left "as is" and no monitoring, containment, or cleanup of the contaminated groundwater and soils would occur. Five-year reviews of OUs 2 and 6 would be required under CERCLA so funds would have to be expended to conduct the OU2/6 portion of those reviews.

9.1.2 Alternative 2: DNAPL Recovery Followed by In situ Chemical Oxidation, Institutional Controls, Groundwater Monitoring, and

a) Whole-house Treatment Units
b) Alternate Water Supply, Whole-house Treatment Units (interim)
c) Whole-house Treatment Units, In situ Groundwater Remediation
d) Alternate Water Supply, Whole-house Treatment Units (interim), In situ Groundwater Remediation

The components of Alternative 2 consist of DNAPL recovery that would take place in the portion of the land-farm area identified as containing DNAPL in the bedrock. Once DNAPL recovery efforts have been exhausted, a pilot test evaluating the effectiveness of further treatment using in situ chemical oxidation would be conducted. If the pilot test indicates the treatment to be effective, the residual DNAPL would be treated with chemical oxidation using the DNAPL recovery wells and additional injection wells north of the DNAPL recovery wells. ICs to limit Area A-1 to nonresidential use will be implemented. An IC in the form of the State Well Construction Regulations [10 CSR 23-3.100(7)] currently exists to control well placement in the OU2/6 area. An environmental covenant or other appropriate proprietary control may also be imposed on the OU2 area to create activity and use limitations to help prevent exposures to hazardous substances. Community information on the contamination and the State Well Regulations would also be provided through public meetings, public notices, and/or public meetings. Groundwater monitoring would occur to monitor any changes in concentrations of COCs over time.

Alternative 2a

Estimated Capital Cost:	$ 990,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$3,480,000

[8] Operation and maintenance.

Alternative 2a remedy consists of the basic Alternative 2 remedy components (described above) and the following remedy components: residences with groundwater impacted with a COC above the MCL would be provided with whole-house water treatment units and those units will be operated and maintained until the groundwater contamination at that location no longer exceeds the MCL.

Alternative 2b

Estimated Capital Cost:	$2,610,000
Present Worth O&M Cost:	$2,000,000
Total Present Worth Cost:	$4,610,000

Alternative 2b consists of the basic Alternative 2 remedy components (described above) and the following remedy components: residences with groundwater impacted with a COC above the MCL would be provided with whole-house water treatment units and those units will be operated and maintained until new potable water lines are installed and activated and the affected well is properly abandoned. Potable water lines would be installed to provide potable water from an alternate water supply to residences. The land-farm area and potable water wells would be monitored for impacts of DNAPL into the potable water wells. The existing residential water supply wells will be abandoned in accordance with applicable regulations at residences connected to the alternate water system.

Alternative 2c

Estimated Capital Cost:	$3,430,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$5,920,000

Alternative 2c consists of the basic Alternative 2 remedy components (described above) and the following remedy components: treatability testing would be conducted to select the most effective in situ groundwater treatment technology for a line of groundwater treatment wells to be placed downgradient of the source area. Technologies that would be evaluated would include bioremediation, chemical oxidation, and chemical reduction.

Alternative 2d

Estimated Capital Cost:	$5,050,000
Present Worth O&M Cost:	$2,000,000
Total Present Worth Cost:	$7,050,000

Alternative 2d consists of the basic Alternative 2b remedy components (described above) and the following remedy components: treatability testing would be conducted to select a

groundwater treatment technology for a line of groundwater treatment wells to be placed downgradient of the source area and the selected treatment technology implemented at a pilot scale and then full scale.

9.1.3 Alternative 3: Thermally Enhanced Vapor Extraction for DNAPL, Institutional Controls, Groundwater Monitoring, and a) Whole-house Treatment Units b) Alternate Water Supply, Whole-house Treatment Units (interim)

The impacted soil in the land-farm area (A-1) would be left in place and ICs, consistent with Alternative 2, implemented. Thermally enhanced vapor extraction would be conducted in the land-farm area to remediate the DNAPL in A-1. Community information on the contamination and the State Well Regulations would also be provided through public meetings, public notices, and/or public meetings. Groundwater monitoring would occur to monitor any changes in contaminant concentrations over time.

Alternative 3a

Estimated Capital Cost:	$2,120,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$4,610,000

Alternative 3a consists of remedy components in Alternative 3 plus the following remedy components: residences with groundwater impacted with a COC above the MCL would be provided with whole-house water treatment units, and those units would be operated and maintained until the groundwater at the location no longer exceeds the MCL.

Alternative 3b:

Estimated Capital Cost:	$3,740,000
Present Worth O&M Cost:	$2,000,000
Total Present Worth Cost:	$5,740,000

Alternative 3b consists of remedy components in Alternative 3 plus the following remedy components: residences with groundwater impacted with a COC above the MCL would be provided with whole-house water treatment units, and those units would be operated and maintained until new potable water lines are installed and activated and the affected well is properly abandoned. Potable water lines would be installed to provide potable water from an alternative water supply to residences. The land-farm area and potable water wells would be monitored for impacts of DNAPL into the potable water wells. The existing residential water supply wells will be abandoned at residences connected to the alternate water system.

9.1.4 Alternative 4: Thermally Enhanced Vapor Extraction for Soils and DNAPL, Whole-house Treatment Units, Institutional Controls, Groundwater Monitoring, and
a) No Groundwater Treatment
b) Bioremediation for Groundwater
c) In situ Chemical Oxidation for Groundwater
d) In situ Chemical Reduction for Groundwater

The impacted soil in the land-farm area (A-1) would be left in place and ICs, as described in Alternative 2 above, would be used to prevent exposures. Community information on the contamination and the State Well Regulations would also be provided through public meetings, public notices, and/or public meetings. Residences with groundwater impacted with a COC above the MCL would be provided with whole-house water treatment units, and those units would be operated and maintained until the groundwater at the location no longer exceeds the MCL. Groundwater monitoring would occur to monitor for any changes in concentrations over time. Thermally enhanced vapor extraction would be conducted in the land-farm area to remediate DNAPL.

Alternative 4a

Estimated Capital Cost:	$2,310,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$4,800,000

Alternative 4a remedy components are described above with no additional remedy components.

Alternative 4b

Estimated Capital Cost:	$4,030,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$6,520,000

Alternative 4b consists of the remedy components of Alternative 4a plus the following remedy components: a line of treatment wells would be installed at the southern end of Industrial Drive (Area A-4). Treatment of the groundwater in the unconsolidated deposits and the top of the bedrock would be conducted by in situ bioremediation.

Alternative 4c

Estimated Capital Cost:	$4,720,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$7,210,000

Alternative 4c consists of the remedy components of Alternative 4a plus the following

remedy components: a line of treatment wells would be installed at the southern end of Industrial Drive (Area A-4). Treatment of groundwater in the unconsolidated deposits and the top of the bedrock would be conducted by in situ chemical oxidation.

Alternative 4d

Estimated Capital Cost:	$3,550,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$6,040,000

Alternative 4d consists of the remedy components of Alternative 4a plus the following remedy components: a line of treatment wells would be installed at the southern end of Industrial Drive (Area A-4). Treatment of groundwater in the unconsolidated deposits and the top of the bedrock would be conducted by in situ chemical reduction.

9.1.5 Alternative 5: In situ Chemical Oxidation (DNAPL, Area A-3, Groundwater); Whole-house Treatment Units; Institutional Controls; Groundwater Monitoring

Alternative 5

Estimated Capital Cost:	$3,680,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$6,170,000

The impacted soil in the land-farm area (A-1) would be left in place and ICs, as described in Alternative 2 above, would be used to prevent exposures. The impacted soil from the areas under the former Kellwood facility (A-3) would be treated by in situ chemical oxidation. Community information on the contamination and the State Well Regulations would also be provided through public meetings, public notices, and/or public meetings. Residences with groundwater impacted with a COC above the MCL would be provided with whole-house water treatment units. Groundwater monitoring would occur to monitor plume movement and any changes in concentration over time. The land-farm area would be treated using chemical oxidation to reduce the concentrations in the groundwater and to reduce the DNAPL mass. The land-farm area and the potable water wells would be monitored for impacts of DNAPL into the potable water wells.

9.1.6 Alternative 6: In situ Chemical Reduction (DNAPL, Area A-3, Groundwater); Whole-house Treatment Units; Institutional Controls; Groundwater Monitoring

Alternative 6

Estimated Capital Cost:	$2,230,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$4,720,000

The impacted soil in the land-farm area (A-1) would be left in place and ICs, as described in Alternative 2 above, will be implemented to prevent residential use of the property. The impacted soil from the areas under the former Kellwood facility (A-3) would be treated by in situ chemical reduction. Community information on the contamination and the State Well Regulations would also be provided through public meetings, public notices, and/or public meetings. Residences with groundwater impacted with a COC above the MCL would be provided with whole-house water treatment units. Groundwater monitoring would occur to monitor any changes in concentration over time. The land-farm area would be treated using chemical reduction to reduce the concentrations in the groundwater and to reduce the DNAPL mass. The land-farm area and the potable water wells would be monitored for impacts of DNAPL.

10.0 Comparative Analysis of Alternatives

The NCP sets forth nine criteria that EPA must use in evaluating remedial alternatives individually and against each other in order to select a remedy. A summary comparative analysis of alternatives for OU2 and OU6 is presented in Table 5-1 of the FS Report.

The first two criteria are identified in the NCP as "threshold criteria." Overall protection of human health and the environment and compliance with ARARs (unless a specific ARAR is waived) are threshold requirements that each alternative must meet in order to be eligible for selection. The next five criteria are indentified in the NCP as "primary balancing criteria." The overall effectiveness of a remedial alternative is evaluated by considering the remedy's long-term effectiveness and permanence; how it reduces the contamination's toxicity, mobility, or volume through treatment; its short-term effectiveness; its implementability; and its cost. The final two criteria identified in the NCP are referred to as "modifying criteria" and provide further balancing of the alternatives with regard to state and community acceptance.

The evaluation criteria are:

Threshold Criteria

1. Overall Protection of Human Health and the Environment – The assessment against this criterion describes how the alternative as a whole achieves and maintains protection of human health and the environment.

2. Compliance with Applicable or Relevant and Appropriate Requirements – The assessment against this criterion describes how the alternative complies with ARARs and may provide analysis as to whether an ARAR waiver is required and its justification. The assessment also considers other information from advisories, criteria, and guidance that the lead and support agencies have agreed are not ARARs but are "to be considered."

Primary Balancing Criteria

3. Long-term Effectiveness and Permanence – The criterion requires the assessment of the long-term effectiveness and permanence that a remedial alternative affords, along with the degree of certainty that the alternative will prove successful.

4. Reduction of Toxicity, Mobility, and Volume – The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume is assessed including how treatment is used to address the principal threats posed by a site.

5. Short-term Effectiveness – The assessment against this criterion examines the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until RAOs have been met.

6. Implementability – This assessment evaluates the technical and administrative feasibility of alternatives and the availability of required goods and services.

7. Cost – This assessment evaluates the capital and operation and maintenance (O&M) costs of each alternative.

A complete breakdown and discussion of cost estimates for the alternatives are presented in Appendix B of the FS Report. The present worth value of O&M costs are developed based on a standard discount rate of 7 percent interest rate and the 30-year term.

The final two criteria, State (or support agency) Acceptance and Community Acceptance, are evaluated after the RI and FS reports and the Proposed Plan have been released to the general public for review and comment.

The criteria are as follows:

Modifying Criteria

8. State Acceptance – This assessment reflects the state's expressed preferences among, and concerns about, the remedial alternatives.

9. Community Acceptance – This assessment reflects the community's expressed preferences among, and concerns about, the remedial alternatives. To collect the community's input, a public comment period and public meeting were provided.

The public comment period on the Proposed Plan began on August 4, 2010, and was to run through September 3, 2010. On August 4, 2010, EPA had an announcement of the public meeting and comment period published in the *New Haven Leader*—a local newspaper of general circulation in the New Haven area.

At the same time with the release of the Proposed Plan for public comment, a local resident requested that EPA extend the public comment period for an additional 30 days. On August 5, 2010, EPA mailed a notice to interested parties that the public comment period had been extended through October 4, 2010; and on August 12, 2010, EPA had an announcement of the extension of the public comment period published in the *New Haven Leader*.

A public meeting on the Proposed Plan was held on Tuesday, August 10, 2010, from 7:00 to 9:00 p.m. at the Trinity Lutheran Church located at 9521 Highway 100, in New Haven, Missouri. A number of comments were received and discussed during the public meeting. A transcript of that meeting is included in the Administrative Record for OU2/6. Public comments were also submitted to EPA by e-mail. The Responsiveness Summary portion of this ROD (Part III) addresses the oral and written comments provided to EPA on the remedial alternatives presented in the FS as well as on EPA's preferred alternative as presented in the Proposed Plan.

10.1 Overall Protection of Human Health and the Environment

This criterion determines whether an alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through engineering controls and/or ICs.

Alternative 1 is not discussed in the following analysis as it does not satisfy the threshold criteria of providing overall protection of human health and the environment, and it does not comply with ARARs.

Alternatives 2 through 6 are all protective of human health and the environment. DNAPL recovery and/or treatment are provided with Alternatives 2 through 6. The soil direct contact exposure pathway applies only to hypothetical future residences for Area A-1 and is addressed with ICs. The exposure pathway of indoor air from soil or groundwater is applicable only to Area A-3 (and A-1 if the former Kellwood facility is expanded over this area).

The groundwater in the Lower Jefferson City/Roubidoux Formations, which is the drinking water source for OU2 and OU6, has only localized areas where the RAOs are not achieved. These are associated with improperly installed wells which provided conduits from the shallower impacted zone to the Lower Jefferson City/Roubidoux Formations. These localized areas have already been addressed by the installation of liners in the wells with impacted groundwater and by the provision of whole-house water treatment systems. This drinking water zone has no discernable hydraulic connectivity with the upper nondrinking water zones. The upper nondrinking water zones have contamination at levels exceeding MCLs over an extensive area. The impacted water from the upper sandstone/upper bedrock and then unconsolidated deposits discharges to unnamed creeks (named by EPA as stream segments 500, 510, 512, 600) running behind the homes of the Wildcat Creek subdivision and west of wells JS-14 and JS-36. The

COCs in the impacted water rapidly volatilizes when discharged to these creeks and as a result is reduced below the Missouri surface water standards. The proposed DNAPL recovery/treatment minimizes the dispersion of DNAPLs into the groundwater. The risk-based ecological standards for sediment and surface water are not being exceeded. The risk-based ecological standards for surface soil are exceeded at only one isolated location.

The alternatives that include a line of groundwater treatment wells in the unconsolidated material at the southern end of Industrial Drive (A-4) (Alternatives 2c, 2d, 4b, 4d, 5, and 6) shorten the time period that potentially impacted water is present in this shallow groundwater zone that could potentially discharge to surface waters above the Missouri surface water standards (but below the risk-based criteria) by approximately 10 years.

10.2 Compliance with ARARs

This criterion evaluates whether the alternatives meet applicable and relevant and appropriate federal and state environmental statutes, regulations, and other requirements that pertain to the Site. Section 121(d) of CERCLA and the NCP at 40 CFR § 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations (collectively referred to as ARARs) unless such ARARs are waived as provided for in section 121(d)(4) of CERCLA.

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

The evaluation of ARARs for Alternatives 2 through 6 is presented in Table 10.1.

Alternatives 2 through 6 all provide DNAPL source removal and/or treatment. Alternatives 2 through 6 all provide drinking water meeting MCLs to the residences in OU2 and OU6 through either treatment or an alternative water supply. The isolated locations in the Lower Jefferson City/Roubidoux Formations used as a drinking water supply would be cleaned up over time as the water is extracted through the domestic

water wells and treated, or for the alternatives with an alternate water supply, the wells would be abandoned and the water would disperse to below the MCLs before it reaches another potential receptor. No additional impacted water is reaching the Lower Jefferson City/Roubidoux through these wells since the wells were lined. Total abandonment after installation of an alternate water supply is provided to eliminate a potential future pathway. Alternatives 2 through 6 would improve the groundwater quality in the upper nondrinking water zones sooner due to the treatment of the DNAPL source and for Alternatives 2c, 2d, 4b, 4c, 4d, 5, and 6, due to the accompanying treatment of groundwater in the unconsolidated deposits at Area A-4 located at the southern end of Industrial Drive.

None of the alternatives, however, are expected to reduce groundwater concentrations in the upper zones (which are not drinking water sources) to drinking water standards throughout every portion of the Site because none of the treatment alternatives will be able to eliminate all of the DNAPL located in the fractured bedrock. The addition of the groundwater treatment wall would lower the concentrations in the upper aquifer approximately 10 years earlier that it would be lowered due to providing only DNAPL recovery and treatment.

10.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain on-site following remediation and the adequacy and reliability of controls.

Alternatives 2 through 6 would provide similar long-term effectiveness as they all include DNAPL recovery and/or treatment. Future monitoring will be used to assess whether the selected alternative is able to achieve the RAOs throughout the Site. Regardless of the alternative selected, achieving the RAOs sitewide will present a near- and long-term technical challenge due to the nature of DNAPL and its presence in fractured bedrock.

Alternatives 2b, 2d, and 3b would require the provision of a permanent alternative water supply. However, the absence of an agreement to extend the city of New Haven's water supply to the area south of New Haven renders these options unavailable.

Alternatives 2a, 2c, 3a, 4a through d, 5, and 6 require ongoing O&M of the whole-house water treatment units at residences with well water concentrations of COCs exceeding MCLs. Such systems have been operated successfully in four residences for almost eight years. The impacted groundwater is in an upper water-bearing zone that is not used as a source of potable water and has no discernable hydraulic connectivity with the Lower Jefferson City/Roubidoux Formation that is used as a potable water source.

ICs regulating the construction of new wells, or the modification of existing wells, are provided through the well construction requirements promulgated by the state at 10 CSR

23-3.100 (7). Community information on the contamination and the State Well Regulations will also be provided through public meetings, fact sheets, and other such informational devices.

As the DNAPL remaining in the land-farm area after treatment will continue to dissolve into the groundwater, these COCs will migrate into the upper water-bearing zone until they discharge into the surface water in the unnamed streams or Wildcat Creek. After discharge into the surface water, the COCs will rapidly volatize. Alternatives 2c, 2d, 4b, 4d, 5, and 6 include the implementation of a groundwater treatment wall in an area of the upper water-bearing zone where the highest concentrations of COCs have been detected outside of the land-farm area. The addition of the groundwater treatment wall is anticipated to lower the concentrations in the upper aquifer, but the concentrations of COCs in the unnamed streams are already below human health and ecological risk levels.

10.4 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

This criterion evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contaminants present. Reduction of toxicity, mobility, or volume of contaminants through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternatives 2 through 6 provide a reduction but not a total elimination of the volume of DNAPL in the land-farm area and therefore a reduction but not total elimination of mobility and toxicity of the COCs as they dissolve into the groundwater. Alternatives 4a, 4b, 4c, 5, and 6 also provide a reduction in the toxicity and volume of the contaminated soil beneath the former Kellwood facility. Alternatives 2c, 2d, 4b, 4c, 4d, 5, and 6 provide a reduction in the toxicity and volume of contaminants in the upper groundwater at the treatment zone located at the southern end of Industrial Drive. This reduction in the toxicity and volume in the upper groundwater at the treatment zone is expected to be observed within approximately 10 years of the initiation of the treatment due to the recovery and/or treatment of DNAPL at the land-farm area without the additional groundwater treatment provided in Alternatives 2c, 2d, 4c, 4d, 5, and 6.

Thermal treatment of the DNAPL area could potentially result in DNAPL that cannot be intercepted by the vapor recovery system moving deeper into the bedrock. The chemical oxidation process (Alternative 5) would require a large quantity of oxidant to convert the PCE to the nontoxic compound ethane. This volume of chemicals would be reduced with DNAPL recovery efforts proposed as part of Alternatives 2a, 2b, 2c, and 2d. The chemical reduction process (Alternative 6) would require a large volume of zero valence iron (eZVI).

The bioremediation process could be used in Alternatives 2c, 2d, or 4b for the groundwater treatment wall at Area A-4. Evaluation of the need for dechlorinating bacteria and the addition of these bacteria as part of the injection process would need to

be evaluated during the treatability testing and the pilot testing of the bioremediation process to mitigate any potential that this process could stall resulting in increased concentrations of intermediate degradation products.

The chemical oxidation process could be used in Alternatives 2c, 2d, or 4b for the groundwater treatment wall at Area A-4. The treated groundwater would convert the PCE to nontoxic compounds through decomposition reactions that would vary with persulfate concentration, pH, and oxygen concentration. If an insufficient amount of persulfate is injected or the injection does not blanket the entire treatment zone, then the technology will not be effective in reducing the concentrations of COCs. Evaluation of these processes would take place during the treatability testing and pilot testing of the chemical oxidation process.

The chemical reduction process could be used in Alternatives 2c, 2d, 4d, or 6 for the groundwater treatment well at Area A-4. The groundwater that is treated would convert the PCE to nontoxic compounds through reductive dechlorination. If an insufficient amount of eZVI is injected or the injection does not blanket the entire treatment zone, then the technology will not be effective in reducing the concentrations of COCs and additional injections may be required. Evaluation of the volume of material to be injected and the spacing of the injection points would take place during the treatability testing and the pilot testing of the chemical reduction process.

10.5 Short-term Effectiveness

This criterion considers the length of time needed to implement a remedial alternative. It also evaluates the risks the alternative poses to residents, workers, and the environment during implementation.

DNAPL recovery would begin within three to six months with Alternatives 2a, 2b, 2c, or 2d. The full-scale in situ chemical oxidation component of these alternatives would start in year five. In Alternatives 5 and 6, DNAPL treatment would start midway through year two. The shortest estimated time frame for completion of DNAPL recovery/treatment would be 27 months with Alternatives 3 and 4 utilizing thermal treatment in the land-farm area.

Alternatives 2 through 6 provide immediate effectiveness for the groundwater users as there are already whole-house water treatment units in place at the residences with groundwater sources with COCs above MCLs. Alternative 2a has the shortest predesign investigation, design, and implementation time. Implementation of providing an alternative water supply (Alternatives 2b, 2d, and 3b) is dependent on reaching agreement with a local water supplier for connection to the system and for agreement of the residents to allow connection. The predesign investigation, design, and construction period for this technology is much longer than providing the whole-house treatment units. However, given the inability to obtain the legal right to access an alternative public water supply for OU6, the alternative water supply option in Alternatives 2b, 2d, and 3b are not implementable and should be dropped from further consideration in the ROD.

Alternatives 2c, 2d, 4b, 4c, 4d, 5, and 6 require the installation of treatment wells on 10-foot centers, which would require up to three and one-half years for the predesign investigation, treatability testing, pilot testing, design, and installation of the injection wells and an estimated five years for full-scale operation of the system.

Thermal treatment (Alternatives 3a, 3b, 4a, 4b, 4c, and 4d) would require a 480 volt power supply, but the individual voltage of the electrodes is low to provide a "step and touch" voltage of less than 15 volts, well below the Occupational Safety and Health Administration standard. Typically, the area to be treated is fenced off to prevent trespassers from entering the treatment area. The treatment area is approximately 8 to 20 feet bgs. Therefore, the heat should dissipate before reaching the surface. As a security measure, the system is designed to shut down if unauthorized personnel enter the area. The system is operated under a vacuum so the release of vapors to the atmosphere is not a concern.

Alternative 4b includes the use of hydrogen (as a gas) as part of a liquid mixture that would release hydrogen in situ. If containerized hydrogen gas is utilized, there are safety concerns due to the presence of pressurized gas cylinders.

The oxidizing chemical—sodium persulfate—and the associated activation compound that would be used in Alternatives 4c and 5 require careful attention to various aspects of handling and use.

The eZVI material (Alternatives 4d and 6) requires careful handling because it can stain surfaces it comes in contact with, but it is not toxic.

10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Alternative 2a is the easiest and fastest to implement. Some elements of this alternative are already in place (whole-house water treatment systems in the residential wells known to contain COCs above the MCLs, well construction regulations on new wells, monitoring program). DNAPL recovery well installation and operation could begin as soon as a work plan is approved. After DNAPL recovery is complete, a pilot test for in situ chemical oxidation would be conducted to aid in the design of the injection wells, chemical selection, and chemical injection rate for the full-scale operation. This alternative would be the least intrusive and would be the easiest to obtain access agreements to conduct.

Alternative 2b would in addition to the Alternative 2a remedy components also require the design and installation of a water distribution system. Water distribution systems are

also part of Alternatives 2d and 3b. However, given Kellwood's inability to obtain the legal right to access an alternative public water supply for OU6, the alternative water supply option in Alternatives 2b and 2d are not implementable and are, therefore, dropped from further consideration.

Alternatives 2c and 2d are similar to Alternatives 2a and 2b respectively with the addition of a groundwater treatment wall. Alternatives 4b, 4c, and 4d include a groundwater treatment wall and would be subject to the same procedures for selection, design, installation, and operation. The injection wells for the wall would not be installed until after a predesign investigation and treatability testing is conducted to select a preferred treatment method. A pilot test would then be conducted using this treatment technology prior to proceeding with full-scale installation and operation. The proposed location for a groundwater treatment wall crosses Industrial Drive and multiple injection wells are anticipated to be required to be installed within the roadway. This would require some coordination of traffic, but the injection wells would be installed flush to grade and would not interfere with traffic except during construction and at the time of the injection of the chemicals.

Alternatives 3a, 3b 4a, 4b, 4c, and 4d require installation of thermal treatment wells for treatment of DNAPL in the land-farm area, which would be installed on 15- to 20-foot centers for the co-located electrodes and vapor recovery wells. The time for installation of these wells is estimated to be approximately 180 days. The system could be installed with the wells completed above grade except where it would interfere with vehicular traffic just west of the north end of the former Kellwood facility.

Alternatives 5 and 6 include DNAPL treatment. Alternative 5 uses chemical oxidation, while Alternative 6 uses chemical reduction, wells in the land-farm area and at Area A-3 within the former Kellwood facility on approximately 10-foot centers. The time for installation of these wells is estimated to take 180 days. These alternatives also include installation of wells for a groundwater treatment wall. The installation of these wells (following a pilot test) is estimated to take 180 days. The road where the wells would be installed would need to be open to traffic during the operation of the treatment system. The below-grade work would take longer to complete and would require the temporary shutdown or limiting traffic on Industrial Drive. The installation of treatment systems within the former Kellwood facility would need to be coordinated with the facility operation and may require installation over weekends. This work is estimated to take 10 days for well installation.

The alternatives with treatability testing for a groundwater treatment technology (Alternatives 2c, 2d, 4a, 4b, 4c, and 4d) involve the most extensive and longest remedial activity. Alternatives 5 and 6 would take almost as much time to implement except treatability testing is not included. These alternatives that include groundwater treatment will require landowner approval to implement.

10.7 Cost

This criterion evaluates the estimated capital and O&M costs as well as present worth costs. Present worth costs are the total cost of an alternative over time in terms of today's dollars (i.e., present worth costs corrected for expected inflation). The cost estimates are order-of-magnitude estimates which are expected to be accurate within a range of +50 to -30 percent.

The costs associated with each alternative were calculated with the discount rate of seven percent and can be seen with their description in Section 9.0, Description of Alternatives.

10.8 State/Support Agency Acceptance

This criterion considers whether the state agrees with EPA's analyses and preferred alternative as contained in the RI/FS and the Proposed Plan.

As indicated by MDNR, the state of Missouri supports the preferred alternative—Alternative 2c—selected by EPA.

10.9 Community Support

This criterion considers whether the affected community agrees with EPA's analyses and preferred alternative as contained in the RI/FS and the Proposed Plan. Comments received on the Proposed Plan are important indicators of community acceptance.

During the Proposed Plan public comment period (August 4, 2010, through October 4, 2010), several written comments were received by EPA via e-mail requesting clarification or elaboration on specific components of alternatives presented in the FS. In addition, several comments were received by EPA during the public meeting on the Proposed Plan that was held in New Haven on August 10, 2010. These comments were considered by EPA and are addressed in the Responsiveness Summary Section (Part III) of this ROD.

11.0 Principal Threat Wastes

The NCP establishes an expectation that EPA will use treatment to address principal threats posed by a site whenever practicable [NCP § 300.430(a)(1)(iii)(A)]. The principal threat concept is applied to the characterization of source materials at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that acts as a reservoir for migration of contamination to groundwater, surface water, and air or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material; however, nonaqueous phase liquids (NAPLs) in groundwater may be viewed as source materials. Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or which could present a significant risk to

human health or the environment should exposure occur. Conversely, nonprincipal threat wastes are those source materials that generally can be reliably contained and would present only a low risk in the event of exposure. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied.

Wastes that generally will be considered to constitute principal threats include but are not limited to the following:

- Liquid source material – Waste contained in drums, lagoons, or tanks, free product in the subsurface (i.e., NAPLs) groundwater containing COCs

- Mobile source material – Surface soil or subsurface soil containing high concentrations of COCs that are, or potentially are, mobile due to wind entrainment, volatilization (e.g., VOCs), surface runoff, or subsurface transport

- Highly toxic source material – Buried drummed nonliquid wastes, buried tanks containing nonliquid wastes, or soils containing significant concentrations of highly toxic materials

Wastes that generally will not constitute principal threats include but are not limited to the following:

- Nonmobile contaminated source material of low to moderate toxicity – Surface soil containing COCs that generally are relatively immobile in or near groundwater (i.e., nonliquid, low volatility, low-leachability contaminants such as high molecular weight compounds) in the specific environmental setting

- Low-toxicity source material – Soil and subsurface soil concentrations not greatly above reference dose levels or that present an excess cancer risk near the acceptable range were exposure to occur

DNAPL in the fractured bedrock under the land-farm area (source area) at OU2 is considered to be a principal threat waste because the COCs are considered to be mobile source materials. Therefore, the selected alternative will need to reduce toxicity, volume, and mobility of COCs in the source area. Although contaminated groundwater also poses a risk, it is not considered a principal threat as defined by EPA guidance.[9] The components of Alternative 2c are designed to complement each other to mitigate contamination in the source area at OU2.

[9] *A Guide to Principal Threat and Low Level Threat Wastes*, OSWER 9380.3-06FS, November 1991.

12.0 Selected Remedy

EPA's preferred remedial alternative for addressing OUs 2/6 is Alternative 2c which includes DNAPL recovery followed by in situ chemical oxidation to address the land-farm source area, whole-house water treatment units, ICs, in situ groundwater remediation, and groundwater monitoring.

12.1 Summary of the Rationale for the Selected Remedy

Alternative 2c was selected over the other alternatives as it meets the requirements for protecting human health and the environment and provides a safe, reliable, and cost-effective drinking water source for affected groundwater users. This alternative includes DNAPL recovery followed by in situ chemical oxidation to address the source area COCs. It also addresses dissolved phase COCs downgradient from the source by the implementation of in situ groundwater remediation. The specific groundwater treatment technology would be selected following treatability testing. Implementation of the line of treatment wells would be a second phase to Alternative 2c, implemented upon selection of a treatment technology that would be effective in achieving RAOs.

Alternative 2c provides overall protection of human health and the environment. The contaminated soil in the land-farm area (A-1) (Figure 12-1) would remain in place and ICs in the form of an environmental covenant or similar control would be implemented to prevent residential use of the property. The soil in this area does not pose a risk except for a hypothetical future resident exposure which would require a change in zoning for the land-farm area, which is highly unlikely. After remedial activities are completed in the land-farm area and the recovery and treatment wells are abandoned, the area will be regraded with top soil and reseeded.

Groundwater samples obtained from the Lower Jefferson City/Roubidoux zone, which is the drinking water source for OUs 2/6, have shown the existence of isolated locations of COCs. These localized areas correlate to existing wells which presumably provided the vertical conduit for the downward migration of the dissolved phase contaminants. However, these isolated areas of contamination are being addressed through the installation of liners in the affected wells and the provision of whole-house water treatment systems at these locations. This drinking water zone has no discernable hydraulic connectivity with the upper nondrinking water zones. The upper nondrinking water zones contain COCs at levels in excess of the MCLs. DNAPL recovery/treatment will minimize the dispersion of DNAPL compounds into the groundwater.

Alternative 2c also includes a line of groundwater treatment wells in the unconsolidated material at the southern end of Industrial Drive (Area A-4) (Figure 12-2) that will shorten the time period that contaminated water remains in this shallow groundwater that could potentially discharge to surface waters above the Missouri surface water standards (but below the risk-based criteria) by approximately 10 years.

Alternative 2c also complies with ARARs. Alternative 2c provides DNAPL source removal and/or treatment. It also provides drinking water meeting the MCLs to the affected residences in OU6 through whole-house treatment units. The isolated locations of contaminated groundwater in the Lower Jefferson City/Roubidoux Formations will be cleaned up over time as the water is extracted through domestic water wells and treated by the whole-house water treatment units.

Alternative 2c will accelerate the improvement of groundwater quality in the upper nondrinking water zones due to the treatment of the DNAPL source and due to accompanying treatment of groundwater in the unconsolidated material in Area A-4 located at the southern end of Industrial Drive. It is unknown whether any of the alternatives, however, will be effective in reducing groundwater contaminant concentrations in the upper nondrinking water zones to levels below the MCLs throughout all areas of OUs 2/6 because none of the treatment alternatives are expected to eliminate all DNAPL located in the fractured bedrock which provides a continuing source of contaminants to this water-bearing zone. The addition of the groundwater treatment wells would lower the concentrations in the upper aquifer sooner than what would occur through DNAPL recovery/treatment alone.

The selected remedy reduces toxicity, mobility, and volume through treatment in the land-farm area by DNAPL recovery and by using in situ chemical oxidation—an innovative but proven technology. Short-term risk will be reduced given that oxidant injection activities are generally short-duration events (three to five days per event). Workers and residents will be protected as the workers will follow appropriate health and safety protocol. No air emissions or treatment system discharges are anticipated to be generated as a result of the operation of this remedy. Noise levels and any emissions from well/injection point installation can be mitigated through appropriate health and safety measures. The implementability of the remedy for source area soils is technically and administratively feasible from design through construction and operation. The material and supplies required to implement this alternative are readily available.

EPA expects the selected remedy to satisfy the requirements of CERCLA section 121(b) as it is protective of human health and the environment, is cost effective, and utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Unacceptable short-term or cross-media impacts are not expected to occur.

The preferred alternative presented in EPA's Proposed Plan is the selected remedy and did not change in response to public comment or new information.

12.2 Description of the Selected Remedy

EPA's preferred remedial alternative for addressing the contamination at OU2 and OU6 is Alternative 2c which is made up of the following components:

- Physical DNAPL recovery would be conducted in existing wells in the land-farm area with additional DNAPL recovery wells to be installed in the area north and west of the former Kellwood facility where DNAPL was detected during the RI. DNAPL recovery would continue until it becomes technically and physically impractical to continue. Enhanced recovery methods (e.g., applying a vacuum) may be utilized and will be evaluated during the remedial design.

- Once physical DNAPL recovery efforts are complete, the recovery wells may be utilized for in situ chemical oxidation treatment of any residual contamination. Additional (smaller diameter) wells may be installed as part of the chemical oxidation treatment phase. DNAPL detected during the installation of these additional wells will be physically removed prior to the injection of oxidants. Prior to implementing the chemical oxidation phase of the work, a pilot test will be conducted in a limited portion of the area to evaluate the potential effectiveness. Results of the pilot test would then be utilized to plan future remedial activities.

- Monitoring wells will be installed in the vicinity of the treatment area to evaluate the effectiveness of the treatment. Existing wells BW-20 and L-12 will also be used for monitoring the effectiveness of the treatment.

- Chemical oxidation treatment will be repeated periodically as needed in the land-farm area until nearby and downgradient monitoring wells indicate groundwater concentrations of COCs are below MCLs or monitoring indicates that further treatment will not effectively reduce the concentrations of COCs.

- The state has promulgated well construction regulations (10 CSR 23-3.100, the Special Area 3 designation) for new wells constructed within OU2/OU6 to prevent the installation of new vertical conduits which could allow contamination from shallow aquifers to migrate to the deeper aquifers via improperly installed new water or heat pump wells.

- Community information on the contamination and the State Well Regulations would also be provided through public meetings, public notices, five-year review process, and other appropriate opportunities.

- Any contaminated soil in the land-farm area (Area A-1) would remain in place and ICs in the form of an environmental covenant, or other appropriate mechanism, would be implemented to prevent residential use of the property. This soil was not shown to be a risk except for a hypothetical future residential scenario which would require a change in zoning for the land-farm area in order to be applicable. After remedial activities are completed in the land-farm area and recovery and treatment wells are properly abandoned, the area will be regraded and reseeded.

- Groundwater monitoring will be conducted to monitor the changes in contaminant concentrations over time within OU2 and OU6. This will include the monitoring of residential wells.

- Residences with groundwater contaminated with COCs above MCLs (current or future residents) would have the option of receiving whole-house water treatment units. If a treatment unit is required at a new residence based on groundwater monitoring, the well would also be inspected to determine if repairs are required to stop migration of contaminated groundwater from the transmissive zone (upper sand) to the Lower Jefferson City/Roubidoux Formations. If such repairs are required, they would be implemented.

- Treatability testing would be performed to determine the most effective in situ groundwater treatment technology for a line of treatment wells that would be installed approximately at the southern end of Industrial Drive. Technologies that would be evaluated would potentially include bioremediation, chemical oxidation, and chemical reduction.

- Following the selection of the most effective in situ groundwater treatment technology, Phase 2 of the alternative would be implemented. Phase 2 would include a pilot test for the recommended alternative followed by the design and implementation of the full-scale treatment.

12.3 Summary of the Estimated Costs

Estimated Capital Cost:	$3,430,000
Present Worth O&M Cost:	$2,490,000
Total Present Worth Cost:	$5,920,000

A complete breakdown of the costs related to Alternative 2c can be found in Appendix B of the FS Report.

The values in this cost estimate are based on the best available information regarding the expected scope of the remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the selected remedy. Any major changes will be, as appropriate, in the form of a memorandum in the Administrative Record file, an Explanation of Significant Differences, or an amendment to this ROD. This cost estimate is an order-of-magnitude engineering cost estimate. It is expected to be within +50 to -30 percent of the actual costs of the remedy.

12.4 Expected Outcomes of the Selected Remedy

Alternative 2c is the selected alternative as it meets the requirements for protecting human health and the environment, provides a safe and acceptable drinking water source to affected groundwater users, includes DNAPL recovery/treatment in the land-farm area, and the installation of groundwater treatment wells downgradient of the source area to

allow for the treatment of any dissolved phase COCs. The groundwater treatment technology would be selected following treatability testing. Implementation of the line of treatment wells would be a second phase to Alternative 2c, implemented upon selection of a treatment technology that would be most effective in achieving the remediation goals.

DNAPL recovery is anticipated to reduce the volume of chemicals to be injected for the treatment phase that follows. The effectiveness of these treatment technologies is limited by the nature of DNAPL and its presence in a fractured bedrock geologic setting. DNAPL is located in fractured bedrock beneath the land-farm area. The in situ treatment (oxidation or reduction) may have difficulty in reaching the DNAPL in fractures, which may require relatively large volumes of oxidants to be injected. None of these alternatives are expected to be able to achieve regulatory groundwater levels for PCE and its byproducts within the entire area of impacted groundwater in the foreseeable future. Reductions will occur and could reach acceptable levels in certain locations. However, at some point it may become technically impracticable, from the engineering perspective, to continue to remediate DNAPL in the fractured bedrock. Thus, a reevaluation for waiver for chemical-specific ARARs may be applicable.

Alternative 2c includes the continued operation, maintenance, and monitoring of the whole-house treatment units currently located at a number of affected residences. The 2002 Administrative Order on Consent (discussed in section 2.1 above) provided for the installation, maintenance, and monitoring of these treatment units and that continuing requirement will be carried forward as part of the selected alternative.

The installation and operation of a line of groundwater treatment wells downgradient of the land-farm is expected to reduce concentrations of dissolved phase PCE in the nondrinking zone of the unconsolidated deposits. This zone of water has no discernible hydraulic connectivity with the drinking water in the Lower Jefferson City/Roubidoux Formations. This water discharges to the unnamed creeks running behind the homes in the Wildcat Creek subdivision and west of JS-14 and JS-36. The COCs in the water that discharges to these creeks are below the established human health and ecological risk-based criteria in surface water in the creeks as they rapidly volatilize and are quickly reduced to levels below the Missouri surface water standards. The addition of the groundwater treatment wells is expected to lower the concentrations in the upper aquifer approximately 10 years (shortening from 30 to 20 years) earlier than would be the case without it.

13.0 Statutory Determinations

Pursuant to section 121 of CERCLA and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The selected remedy is designed and expected to be a final cleanup action at OU2 and OU6 and represents the balance of trade-offs among alternatives with

respect to pertinent criteria given the scope of the action. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. This preference is addressed in the selected remedy. The following sections discuss how the selected remedy meets these statutory requirements.

13.1 Protection of Human Health and the Environment

Alternative 2c is protective of human health and the environment. DNAPL recovery and treatment are provided for in this alternative. The soil direct contact exposure pathway applies only to hypothetical future residences for Area A-1 and is addressed with ICs. The exposure pathway of indoor air from soil or groundwater is applicable only to Area A-3 (and A-1 if the former Kellwood facility is expanded over this area).

The groundwater in the Lower Jefferson City/Roubidoux Formations, which is the drinking water source for OU2 and OU6, has only localized areas with exceedences of COCs above MCLs. These are associated with improperly installed wells which provided conduits for DNAPL to migrate from the shallower zone to the Lower Jefferson City/Roubidoux Formations. These localized areas have already been addressed by the installation of liners in the wells; this has been effective in eliminating this conduit. In addition, all affected residences with wells contaminated by COCs at levels in excess of MCLs have been provided whole-house water treatment systems which have been installed and maintained by Kellwood. This drinking water zone now has no discernable hydraulic connectivity with the upper nondrinking water zones. The upper nondrinking water zones are contaminated with COCs at levels in excess of MCLs over an extensive area. This contaminated water from the upper sandstone/upper bedrock and then unconsolidated deposits discharges to unnamed creeks (named by EPA as stream segments 500, 510, 512, and 600) running behind the homes of the Wildcat Creek subdivision and west of JS-14 and JS-36. COCs in the impacted water rapidly volatilize when discharged to these creeks and as a result are reduced below the Missouri surface water standards. DNAPL recovery/treatment minimizes the continued transport of DNAPL into the groundwater system. The risk-based ecological standards for sediment and surface water are not being exceeded. The risk-based ecological standards for surface soil are exceeded at only one isolated location, and this is being/will be addressed by ICs.

Alternative 2c includes a line of groundwater treatment wells in the unconsolidated material at the southern end of Industrial Drive (A-4). This alternative shortens the time period that potentially impacted water is present in this shallow groundwater zone and could potentially discharge to surface waters above the Missouri surface water standards (but below the risk-based criteria) by approximately 10 years.

13.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 2c complies with all ARARs. This alternative provides DNAPL source removal and/or treatment. Alternative 2c provides drinking water meeting MCLs to the residences in OU2 and OU6 through either treatment or an alternative water supply. The isolated locations in the Lower Jefferson City/Roubidoux Formations used as a drinking water supply would be cleaned up over time as the water is extracted through the domestic water wells and treated; or for the alternatives with an alternate water supply, the wells would be abandoned and the contaminants in the water would disperse to below MCLs before reaching another potential receptor. No additional impacted water is reaching the Lower Jefferson City/Roubidoux Formations through existing wells since the wells were lined. Total abandonment after installation of an alternate water supply is provided to eliminate a potential future pathway. Alternative 2c would improve the groundwater quality in the upper nondrinking water zones sooner due to the treatment of the DNAPL source and the accompanying treatment of groundwater in the unconsolidated deposits at Area A-4 located at the southern end of Industrial Drive.

None of the alternatives, however, are expected to reduce groundwater concentrations in the upper zones (which are not drinking water sources) to drinking water standards throughout every portion of the Site because none of the treatment alternatives will be able to eliminate all DNAPL located in the fractured bedrock. The addition of the groundwater treatment wall would lower the concentrations in the upper aquifer approximately 10 years earlier that it would be lowered due to providing only DNAPL recovery and treatment.

13.3 Cost Effectiveness

The selected remedy, Alternative 2c, is cost effective and represents a reasonable value for the money. In making this determination, EPA refers to the following definition of cost effectiveness contained in the NCP: "[a] remedy shall be cost-effective if its costs are proportional to its overall effectiveness." 40 CFR § 300.430(f)(1)(ii)(D). This determination was made by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs; hence, this alternative represents a reasonable value for the money to be spent. The estimated present-worth cost of the selected remedy is $5,920,000.

The information in this cost estimate is based on the best available information regarding the anticipated remedial alternative. Changes in the cost elements may occur as a result of new information and data collected during the remedial design and/or during the implementation of the remedial alternative. Major changes may be documented, as

appropriate, in the form of a memorandum to the Administrative Record file, an Explanation of Significant Differences, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project costs.

13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at OU2 and OU6. The selected remedy is the final remedy decision currently planned at OU2 and OU6. EPA has determined that the selected remedy is the best balance of trade-offs in terms of the balancing criteria given the scope of this action while also considering the statutory preference for treatment as a principal element, preference against off-site treatment and disposal, and considering state and community acceptance.

For Alternative 2c, DNAPL recovery wells would permanently remove a portion of the DNAPL from the bedrock in the land-farm area and would be effective in shortening the period of time for the groundwater to achieve RAOs. However, removal of all DNAPL located in the fractured bedrock may be technically impracticable from an engineering perspective. The effectiveness and permanence of this remedy would be further enhanced by the in situ chemical oxidation if the pilot test shows that full-scale implementation in the land-farm area would effectively further reduce the concentrations of PCE in groundwater.

Provision of whole-house water treatment units for Alternative 2c would provide a reliable and cost-effective, clean potable water supply to the residences in the affected area of OU2 and OU6.

13.5 Preference for Treatment Which Reduces Toxicity, Mobility, or Volume

The preference for treatment is addressed in this ROD. The treatment components that support the OU2 and OU6 remedy include recovery/treatment for DNAPL in the land-farm area and the installation of groundwater treatment wells for in situ chemical oxidation of dissolved phase PCE downgradient of the land-farm area. Treatment is the principal element for the OU2 and OU6 final remedy as COCs will be removed from the source area and the dissolved phase PCE will be oxidized and destroyed by in situ chemical oxidants.

13.6 Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above health-based levels, a statutory review as required by section 121(c) of CERCLA will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within five years after the initiation of the remedial actions. The schedule of the five-year reviews will be triggered

by the remedial action implemented at OU1 and will include all OUs at the Site. The five-year reviews will continue until it has been determined that no hazardous substances, pollutants, or contaminants remain on-site above levels that allow for unlimited use and unrestricted exposure. The basis for this finding will be documented in the final Five-Year Review Report.

14.0 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

The Proposed Plan was released for public comment on August 4, 2010. The Proposed Plan identified Alternative 2c: DNAPL Recovery followed by in situ Chemical Oxidation, Whole-house Water Treatment Units, ICs, Long-Term Groundwater Monitoring, and in situ Groundwater Remediation as the preferred alternative. EPA has determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

PART III RESPONSIVENESS SUMMARY

1.0 Introduction

This Responsiveness Summary section of the ROD summarizes public comments and concerns on the FS and EPA's Proposed Plan for the Site, OU2 and OU6, and provides EPA's responses to those comments and concerns.

A Responsiveness Summary serves two functions:

1. It provides decision makers with information about the views of the public, government agencies, the support agency, and potentially responsible parties regarding the proposed remedial action and other alternatives.

2. It documents how comments were considered during the decision-making process and provides answers to all significant comments.

The public comment period on the Proposed Plan began on August 4, 2010, and was to run through September 3, 2010. On August 4, 2010, EPA had an announcement of the public meeting and comment period published in the *New Haven Leader*—a local newspaper of general circulation in the New Haven area.

Contemporaneous with the release of the Proposed Plan for public comment, a local resident requested that EPA extend the public comment period for an additional 30 days. On August 5, 2010, EPA mailed a notice to interested parties that the public comment period had been extended through October 4, 2010; and on August 12, 2010, EPA had an announcement of the extension of the public comment period published in the *New Haven Leader*.

A public meeting on the Proposed Plan was held on Tuesday, August 10, 2010, from 7:00 to 9:00 p.m. at the Trinity Lutheran Church located at 9521 Highway 100 in New Haven, Missouri. A number of comments were received and discussed during the public meeting. A transcript of that meeting is included in the Administrative Record for OU2/6. Public comments were also submitted to EPA by e-mail. This Responsiveness

Summary addresses the oral and written comments provided to EPA on the remedial alternatives presented in the FS as well as on EPA's preferred alternative as presented in the Proposed Plan.

2.0 Summary of Commentators' Major Issues and Concerns and EPA's Responses

Many of the comments received by EPA were similar. Where it was possible and appropriate, such comments were combined and one comprehensive response provided.

Comment No. 1 – A number of comments pertain to the continuation in the Proposed Plan of whole-house filtration as a component of EPA's preferred alternative. These comments generally state that whole-house filtration should not be considered a long-term, permanent solution to address groundwater contamination. In addition, a number of these comments were directed at other groundwater alternatives—specifically, replacing existing impacted wells, the formation of a public water supply district, and extension of New Haven water service—and it was requested that these alternatives be more fully presented for public consideration.

Response - On March 25, 2002, EPA and Kellwood entered into an AOC (on file with EPA's Regional Hearing Clerk under Docket No. CERCLA-07-2002-0091) which required Kellwood to provide whole-house filtration units for any properties served by wells that had been contaminated with hazardous substances resulting from Kellwood's operations at its former facility located on Industrial Drive. Pursuant to this AOC, Kellwood installed whole-house filtration units at four residences in the OU6 area. Kellwood has monitored and maintained these units, has ensured that these units are working as intended, and has sampled the groundwater in these wells on a quarterly basis. The requirement that these units (and additional units at newly affected locations if applicable) continue to be provided and maintained was a component of EPA's preferred alternative as presented in the Proposed Plan and is a component of the selected remedy in the ROD. This component is deemed necessary to provide a mechanism to respond quickly in the event that any wells become contaminated in the future. As to the inclusion of this component as part of the selected remedy for more "permanent" application, that is addressed below.

As a result of public comment on the continued inclusion of whole-house filtration as a permanent component of the selected remedy, in September 2010 EPA directed Kellwood to more thoroughly present these options for EPA and public consideration. In November 2010 Kellwood submitted to EPA for review and approval a Supplemental FS Report, which will be placed in the Administrative Record and Site Repository,

Response – In the absence of an alternative water source for affected residents, which currently does not exist, this suggestion would deprive residents of water. The plugging of every well is also not desirable from the sense that long-term groundwater monitoring is a component of the selected remedy and as such is critical in determining the effectiveness of the other components of the remedy, particularly, DNAPL recovery in the land-farm area and in situ chemical oxidation of the dissolved phase PCE downgradient of the land-farm area. The long-term groundwater monitoring also allows for the continued observation of contaminant levels and the ability to foresee any potential impacts to other receptors due to plume movement. In addition, some of the existing wells provided the vertical conduit through which DNAPL moved from the shallower groundwater zone into the deeper zone. These wells have had liners installed so continued movement of contamination down the well is no longer occurring. As discussed in response to Comment No. 4 below, the continued operation of these wells is desirable as they allow for contamination to be captured and treated through the whole-house filtration systems currently in use.

Comment No. 4 – A comment was received asking whether existing wells within OU6 should continue to be pumped to remove contamination from the groundwater.

Response – There are currently four residences within OU6 with private wells that are actively pumping water for domestic use. The water from each of these wells is treated by a whole-house filtration unit prior to use. Data collected from these wells, as a result of quarterly sampling, indicate that contaminant levels in each of these wells have steadily declined. For two of the private wells, the decline in contaminant levels has occurred over a relatively short time and that is likely attributable to the installation of well liners and the short time between the completion of the well and installation of the well liner. The relatively short duration between when the well was installed and when the liner was put into place limited the opportunity for dissolved phase PCE to migrate through the well into the deeper aquifer from the shallower, contaminated aquifer. The other two residences also have had liners installed in their wells, but the duration between well installation and liner installation was much longer resulting in a larger amount of contamination that was able to move through the borehole and contaminate the aquifer that the well draws water from. This greater quantity of contamination will require a much longer period of pumping to show any decline in contaminant levels. So the continued use of these wells is expected to capture additional dissolved phase PCE which will then be filtered out by the whole-house filtration units. This will result in the desirable outcome of contamination being removed from the aquifer with no exposures occurring.

Comment No. 5 – A comment was received asking whether there would be any "harm or hazard" from the chemical oxidation treatments included as part of EPA's selected remedy for treating the contaminant source area and groundwater.

Response – The remediation of groundwater contamination using in situ chemical oxidation involves injecting oxidants (e.g., sodium permanganate, potassium permanganate) directly into the source area and downgradient plume. The oxidant

Response – In the absence of an alternative water source for affected residents, which currently does not exist, this suggestion would deprive residents of water. The plugging of every well is also not desirable from the sense that long-term groundwater monitoring is a component of the selected remedy and as such is critical in determining the effectiveness of the other components of the remedy, particularly, DNAPL recovery in the land-farm area and in situ chemical oxidation of the dissolved phase PCE downgradient of the land-farm area. The long-term groundwater monitoring also allows for the continued observation of contaminant levels and the ability to foresee any potential impacts to other receptors due to plume movement. In addition, some of the existing wells provided the vertical conduit through which DNAPL moved from the shallower groundwater zone into the deeper zone. These wells have had liners installed so continued movement of contamination down the well is no longer occurring. As discussed in response to Comment No. 4 below, the continued operation of these wells is desirable as they allow for contamination to be captured and treated through the whole-house filtration systems currently in use.

Comment No. 4 – A comment was received asking whether existing wells within OU6 should continue to be pumped to remove contamination from the groundwater.

Response – There are currently four residences within OU6 with private wells that are actively pumping water for domestic use. The water from each of these wells is treated by a whole-house filtration unit prior to use. Data collected from these wells, as a result of quarterly sampling, indicate that contaminant levels in each of these wells have steadily declined. For two of the private wells, the decline in contaminant levels has occurred over a relatively short time and that is likely attributable to the installation of well liners and the short time between the completion of the well and installation of the well liner. The relatively short duration between when the well was installed and when the liner was put into place limited the opportunity for dissolved phase PCE to migrate through the well into the deeper aquifer from the shallower, contaminated aquifer. The other two residences also have had liners installed in their wells, but the duration between well installation and liner installation was much longer resulting in a larger amount of contamination that was able to move through the borehole and contaminate the aquifer that the well draws water from. This greater quantity of contamination will require a much longer period of pumping to show any decline in contaminant levels. So the continued use of these wells is expected to capture additional dissolved phase PCE which will then be filtered out by the whole-house filtration units. This will result in the desirable outcome of contamination being removed from the aquifer with no exposures occurring.

Comment No. 5 – A comment was received asking whether there would be any "harm or hazard" from the chemical oxidation treatments included as part of EPA's selected remedy for treating the contaminant source area and groundwater.

Response – The remediation of groundwater contamination using in situ chemical oxidation involves injecting oxidants (e.g., sodium permanganate, potassium permanganate) directly into the source area and downgradient plume. The oxidant

chemical reacts with the contaminants producing harmless substances such as carbon dioxide; water; and in the case of chlorinated compounds (PCE and TCE), inorganic compounds which are harmless at the levels where exposure may occur.

Comment No. 6 – A comment was received requesting the types of "institutional controls" that may be imposed on properties within the New Haven Industrial Park area.

Response – As discussed above, all of OU2 and OU6 are within Special Area 3 which is an area designated by MDNR where well installation requirements intended to eliminate the possibility of cross-contamination of aquifers currently exist. These requirements are considered ICs. Also, zoning is considered an IC. Currently, OU2 is zoned for commercial uses but not residential. There would be an exposure concern in the land-farm area if that area were ever to be developed for residential use. Such an occurrence is highly unlikely as such a use would be inconsistent with current, and reasonably anticipated future, land use in the area but it is not inconceivable. The ROD does provide for an additional "layer" of protection with regard to this parcel. This protection is expected to be provided by an environmental covenant, imposed pursuant to Missouri's Environmental Covenants Act (Sections 260.1000 - .1039 RSMo). An environmental covenant is similar to a restrictive covenant and typically requires the owner of the property to agree, through a recorded instrument, to use or not use property in a certain way. The land-farm area where the environmental covenant would be imposed would still be available for commercial development as long as certain precautions are taken.

Comment No. 7 – A comment was received asking if the Kellwood Company would be responsible for implementing the remedial alternative selected in the ROD.

Response – EPA considers Kellwood to be a liable party pursuant to section 107(a) of CERCLA with regard to the contamination at OU2 and OU6. While Kellwood had previously entered into agreements with EPA for the performance of work at these OUs, there is no current commitment in place to ensure that Kellwood will perform the work required by the ROD. EPA generally follows an "enforcement first" policy which requires engagement of responsible parties before Superfund monies may be spent. Following the issuance of the ROD, EPA expects to engage Kellwood in negotiations on a settlement which would include the implementation of the selected remedy presented in the ROD.

Comment No. 8 – A comment was received asking who would be responsible for replacing broken well pumps for residents with whole-house filtration systems.

Response – In the first response to Comment No. 1 above, EPA describes an AOC entered into by and between EPA and Kellwood which requires the provision of whole-house filtration units, or other appropriate responses, to users of wells that become impacted by contamination resulting from Kellwood's activities in the area. Pursuant to this AOC, Kellwood has installed and continues to maintain and monitor whole-house filtration units at four affected residences at OU6. The obligation imposed by this AOC

continues until the contamination in those wells is reliably below MCLs for COCs. Since whole-house filtration units will be carried forward as a component of the selected remedy in the ROD, these units will continue to be maintained and sampled on a regular basis; and new whole-house filtration units (or other appropriate responses) will be provided for newly affected wells.

Comment No. 9 – A comment was received stating that whole-house filtration systems are susceptible to mechanical problems and should not be considered as a long-term solution.

Response – As with any mechanical device that is constantly in use, there is always the potential for problems and failures to occur as has on occasion happened with the existing units. When problems have occurred, Kellwood has acted to address the problems; and it is expected that for it to perform in a manner consistent with its obligations under the AOC, it will continue to do so.

Comment No. 10 – A comment was received stating that due to the large amount of information collected as part of the RI and the time required for the public to review this information, the public comment should be extended from the required 30 days to 60 days.

Response – The request was granted and the public comment period ran from August 4, 2010, through October 4, 2010.

Comment No. 11 – A comment was received requesting that the Responsiveness Summary be made available to the public with any additional comments made after the closing of the public comment period prior to the ROD be released.

Response – The NCP, at 40 CFR § 300.430(f)(3), sets forth the community involvement process as it pertains to remedy selection at Superfund sites. EPA has followed that process with regard to remedy selection at OU2 and OU6. While additional process may be sought, in the absence of new information, it does not appear that the remedy selection would change. EPA, and the state concurs, that it is desirable to conclude the formal community involvement process and proceed with implementing a final remedy for OU2/6. It is always EPA's intent to select the best available remedy in accordance with the requirements of the Superfund law and the NCP. The community is encouraged to provide information at any time to EPA that may inform EPA's remedy consideration. EPA may change the requirements of this ROD upon receipt of new information indicating that such a change is appropriate.

Comment No. 12 – A comment was received stating that the Special Area 3 designation covering OU6 makes it extremely difficult to develop any property or sell property.

Response – (This response is based on information provided by MDNR.) The Special Area 3 designation was made to ensure that newly constructed and reconstructed wells within the area did not produce contaminated water that could make people sick. It was

also made to ensure that newly constructed wells did not act to spread contamination from shallow formations where it is known to be present into the deeper formations that serve as regional drinking water supplies and that are currently known to be clean. The requirements imposed by the Special Area 3 designation, although perceived by some to be burdensome, help to ensure that existing water supplies serving the New Haven area and the region continue to be free of contamination and thus be able to serve future development in the New Haven area.

3.0 Technical and Legal Issues

3.1 Technical Issues

There are no technical issues associated with OU2 or OU6.

3.2 Legal Issues

There are no legal issues associated with OU2 or OU6.

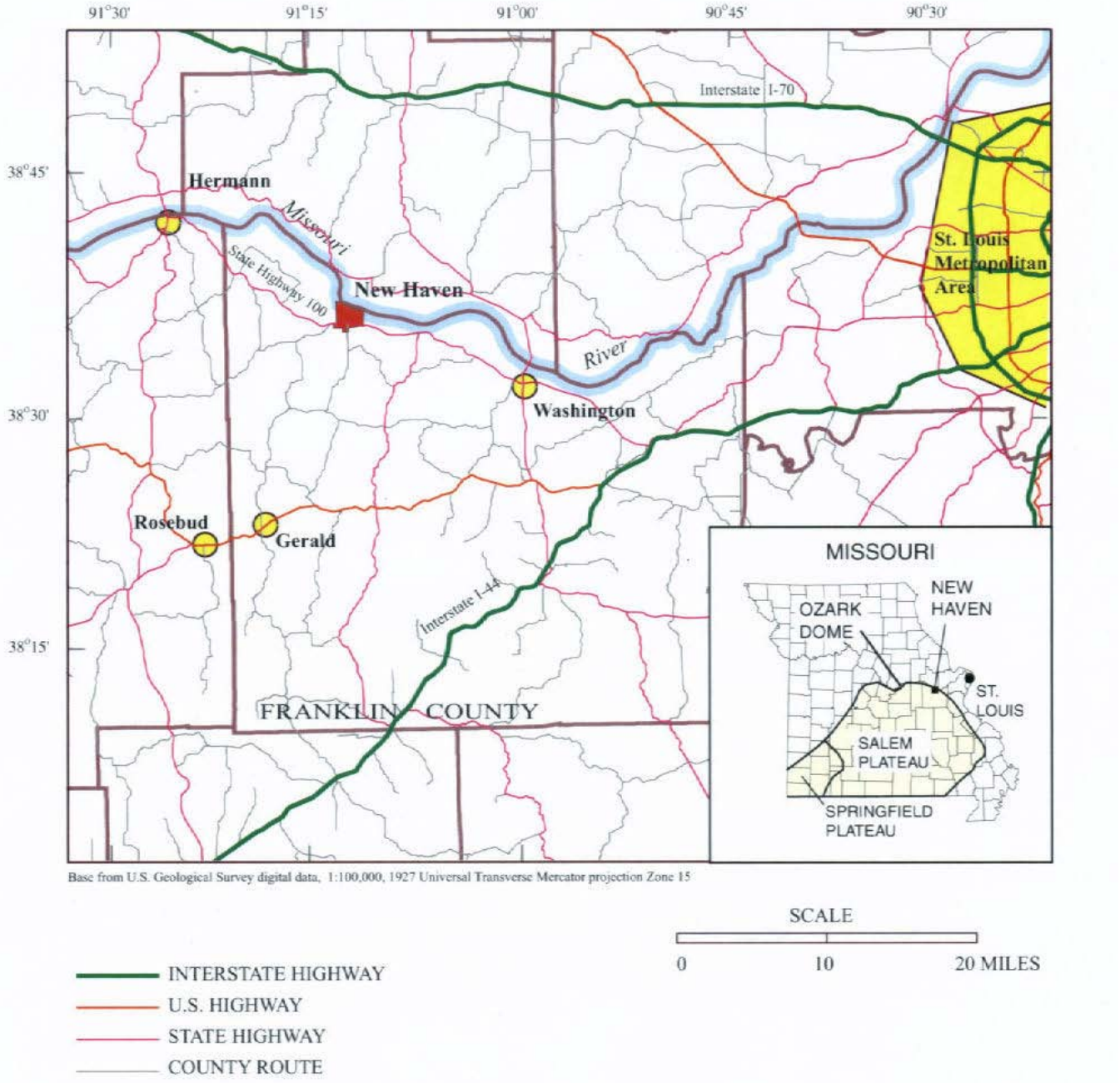


Figure 1-1: Location of New Haven, Missouri.

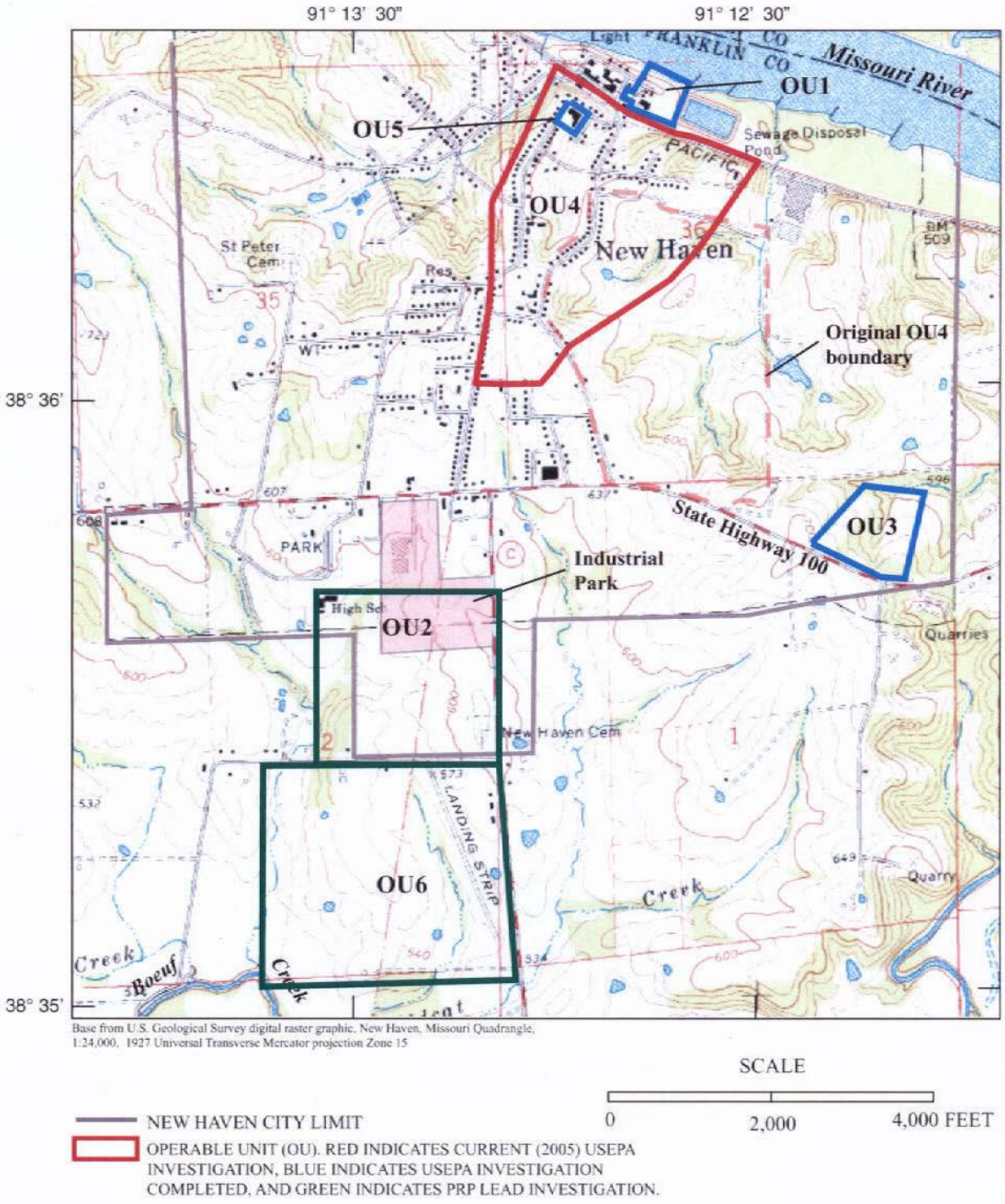


Figure 1-2 Topography in the New Haven Remedial Investigation (RI) study area and location of RI Operable Units (OUs).

Figure 2-1: Location of former Kellwood facility and the landfarm area.

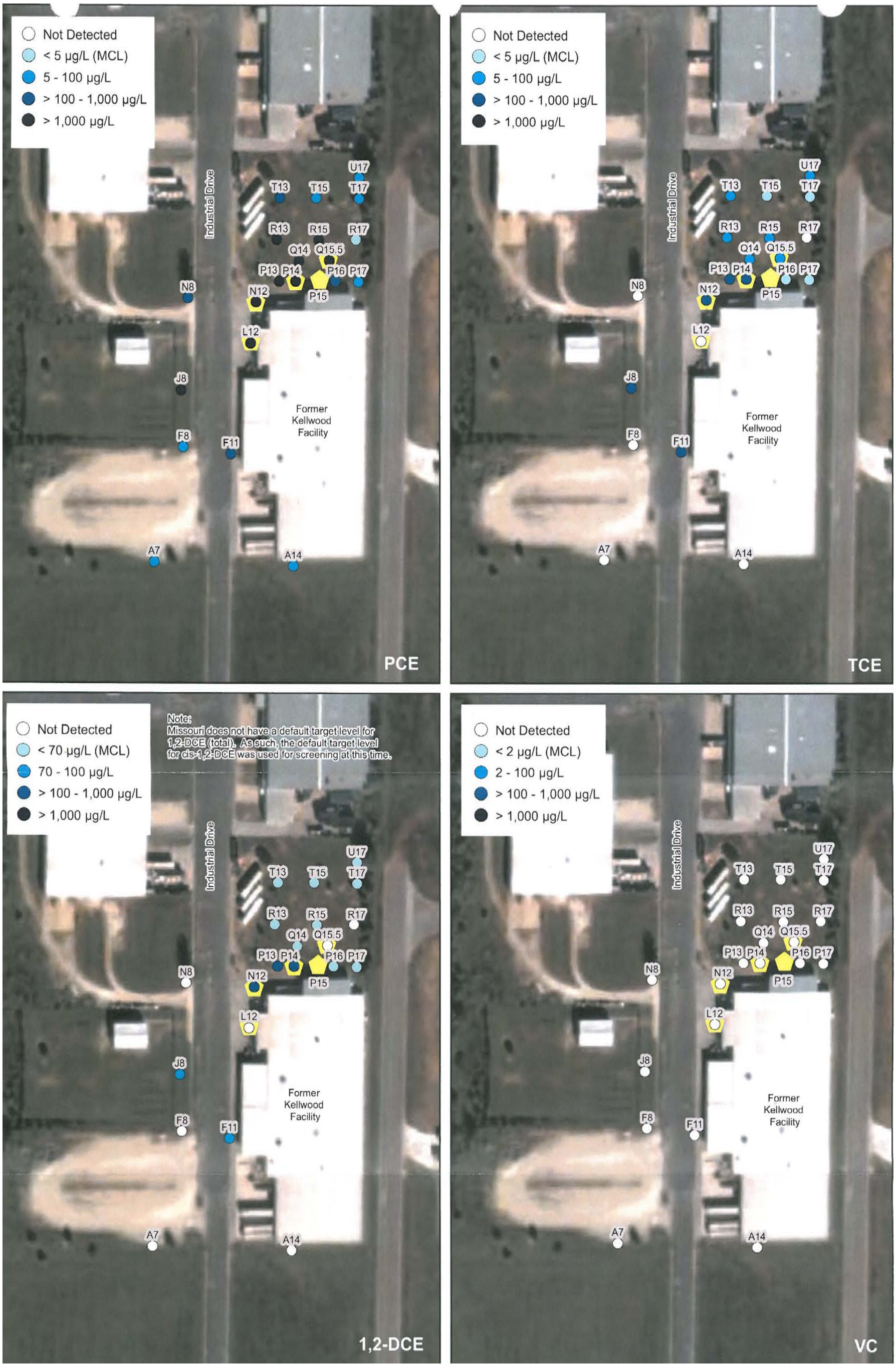


Figure 2.2: Locations of sampling points on OU2.

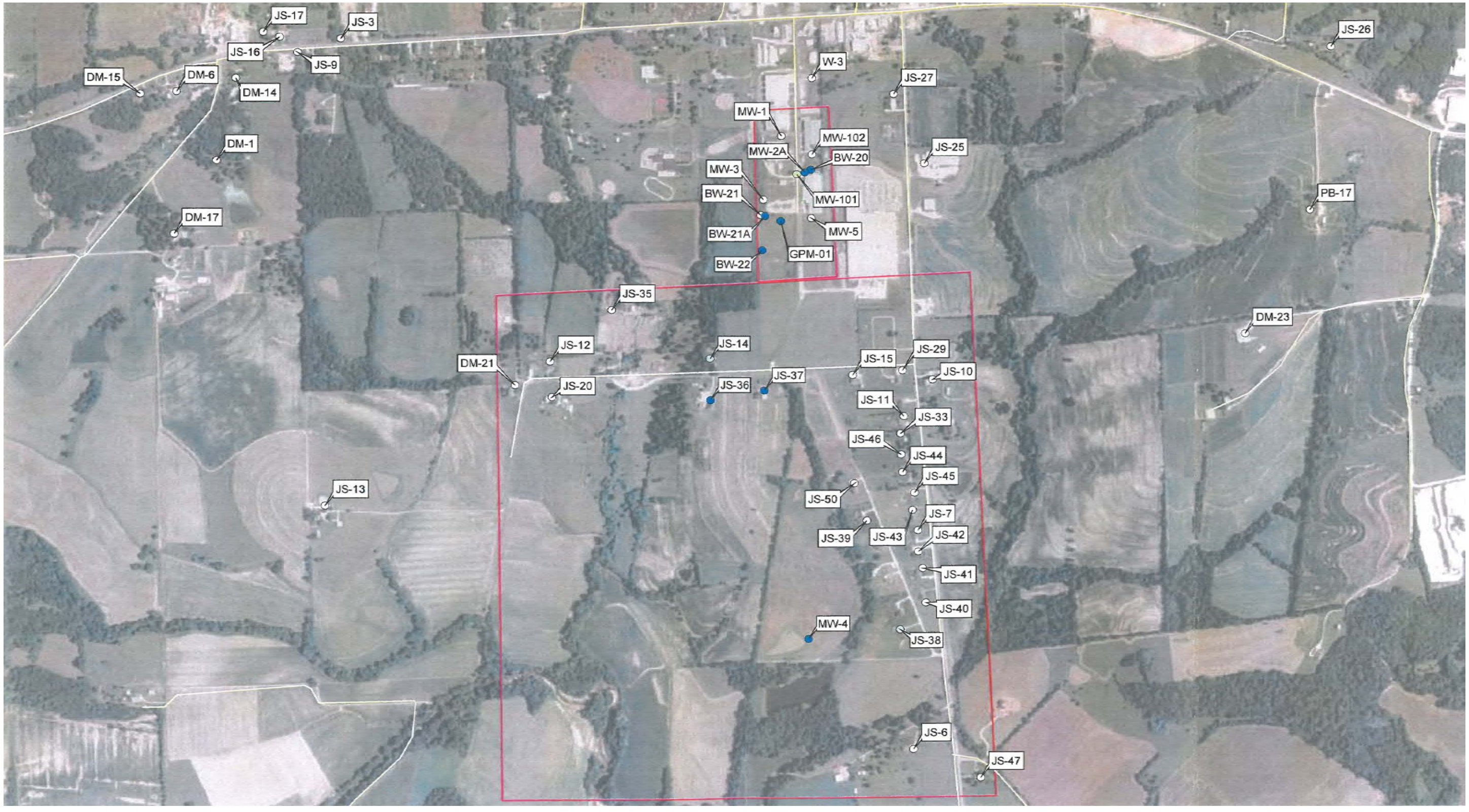


Figure 2-3: Pre-RI groundwater sample locations OU2/6.

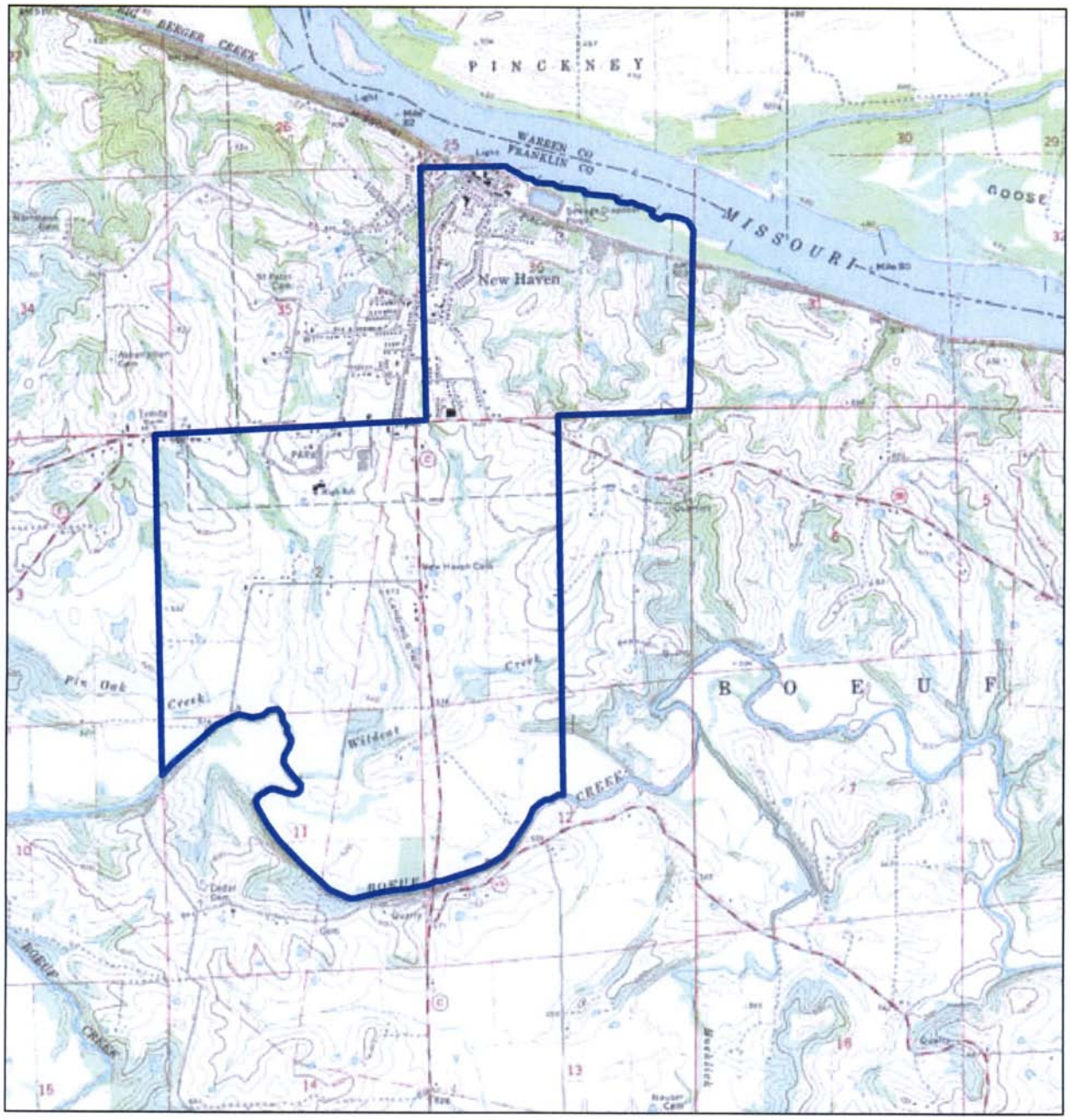


Figure 2-4: Special Area 3 boundary

Figure 2-5: Pre-RI surface water sample locations OU2/6.

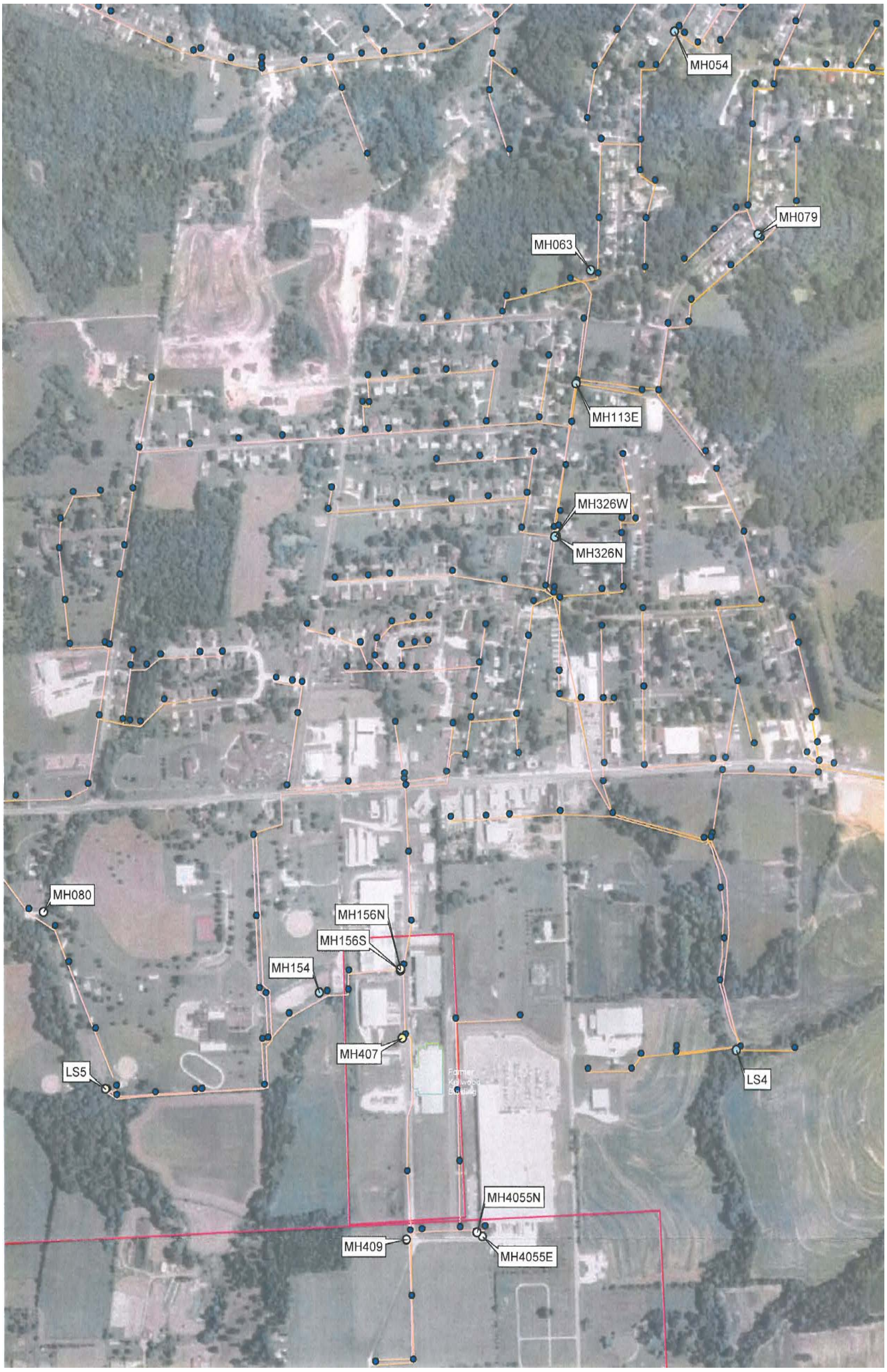


Figure 2-6: USGS sanitary sewer sample locations in New Haven Missouri.

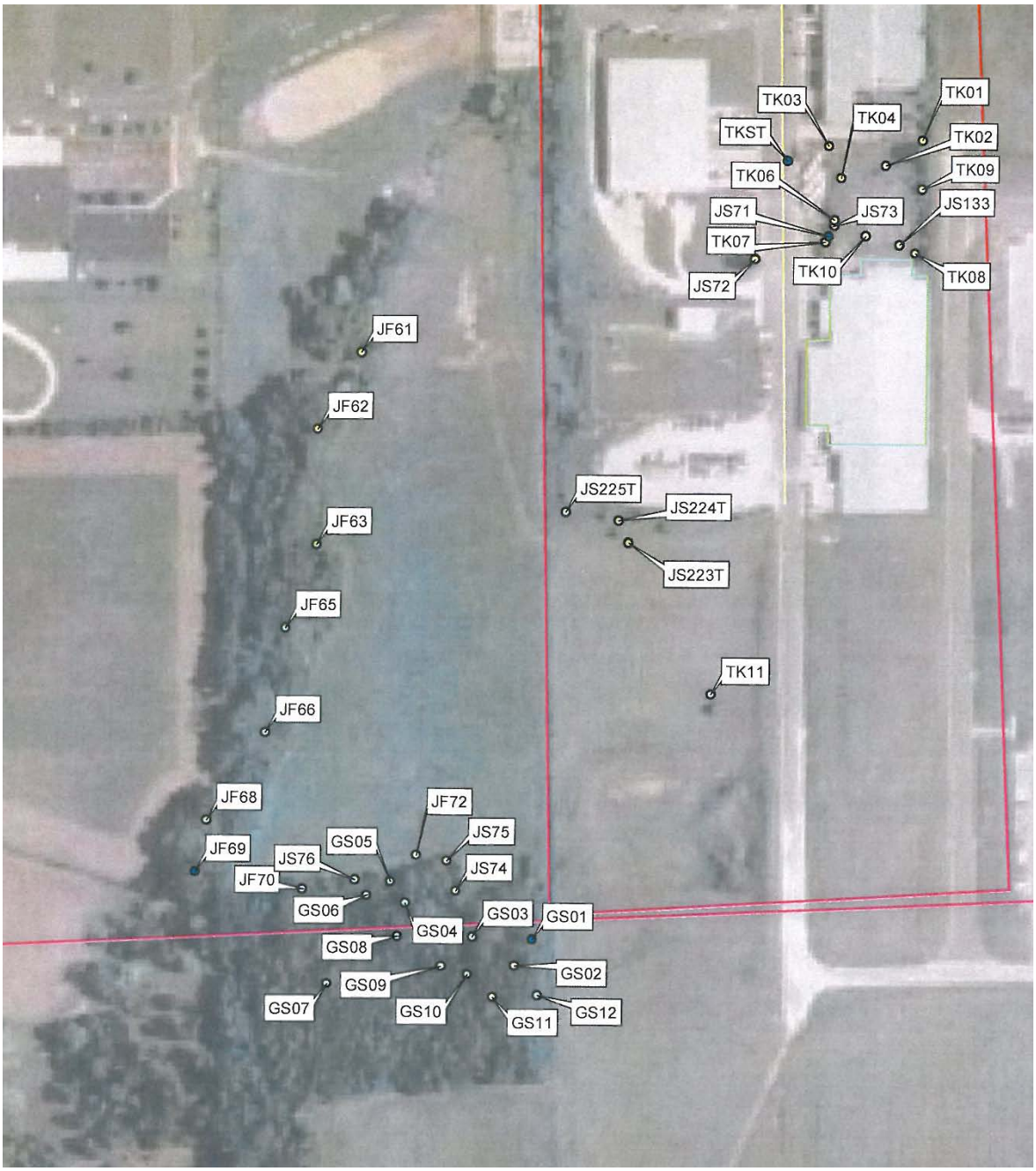


Figure 2-7: USGS tree core sample locations in OU2/6.

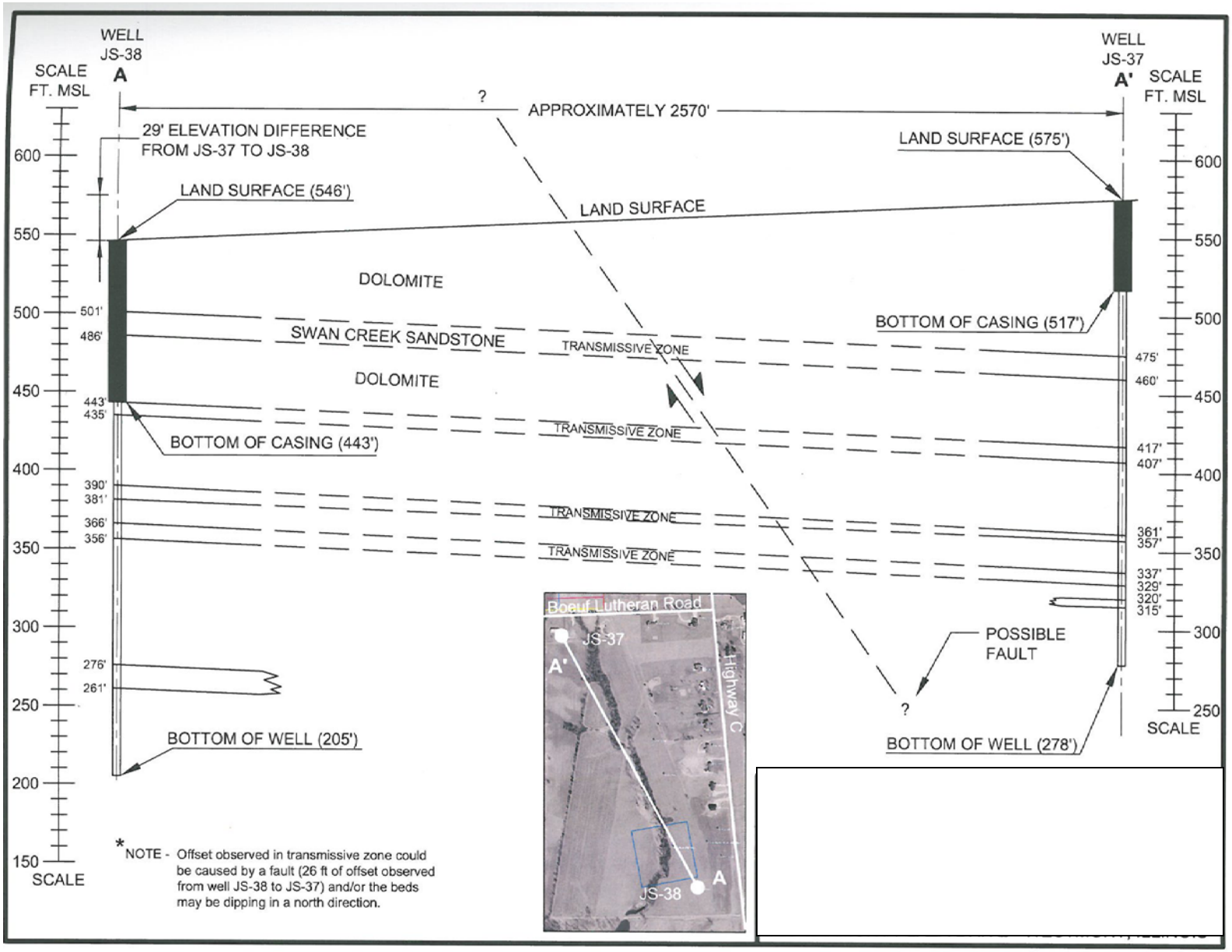


Figure 2-8: Interval Screening Report's transmissive zones.

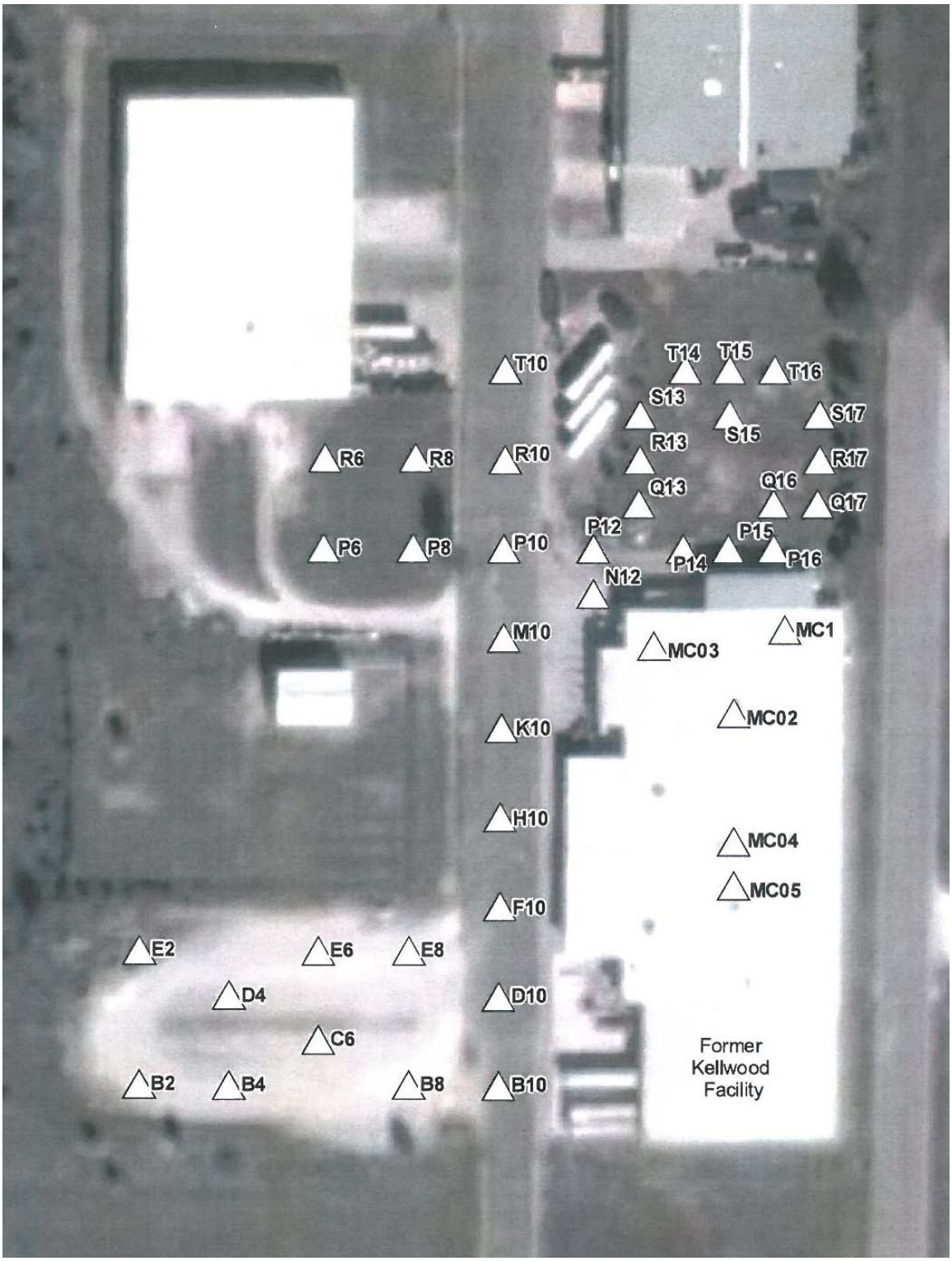


Figure 2-9: Soil Investigation sampling locations at OU2.

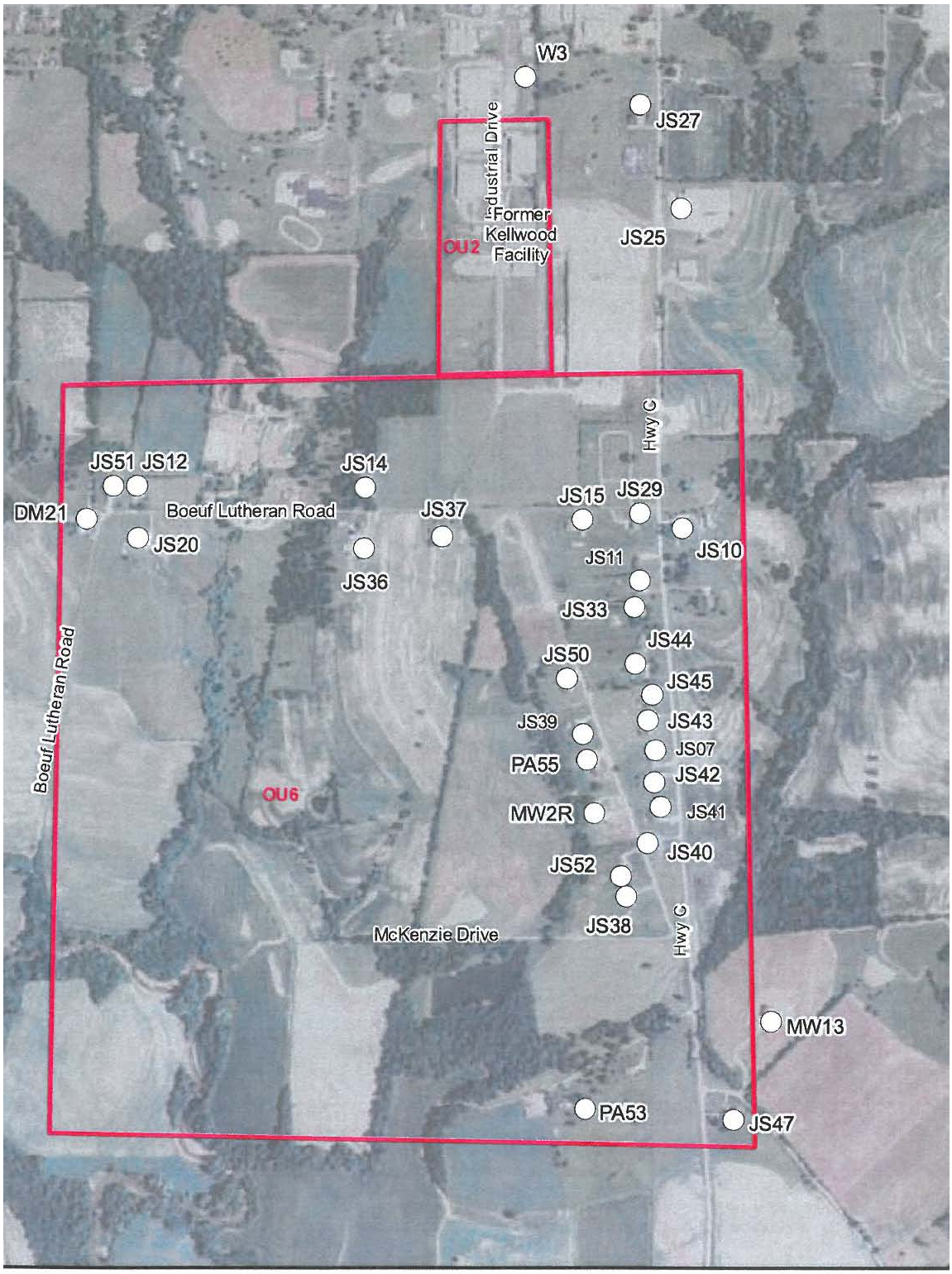


Figure 2-10: Residential well sampling locations.

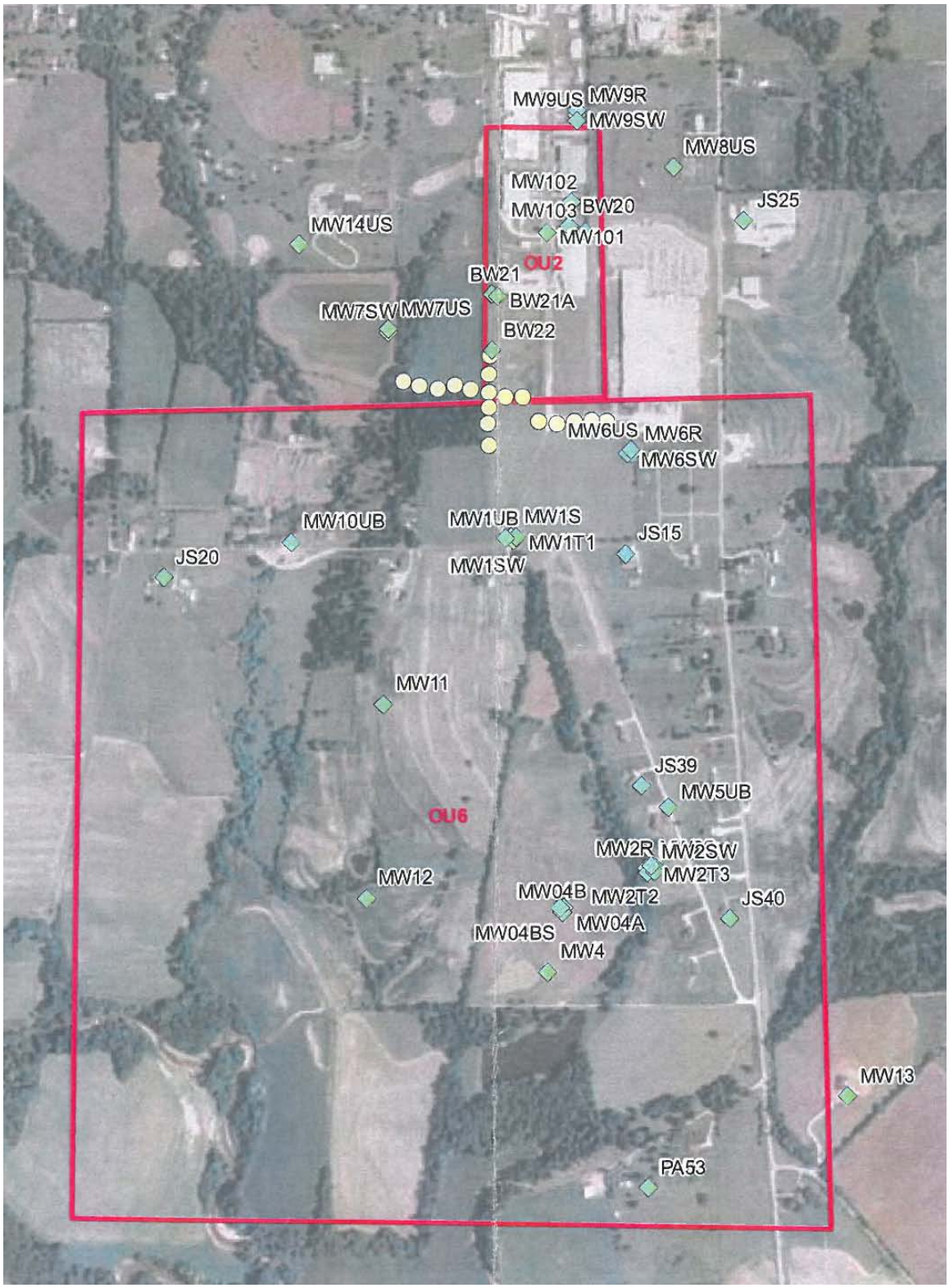


Figure 2-11: Site-wide groundwater sampling locations.

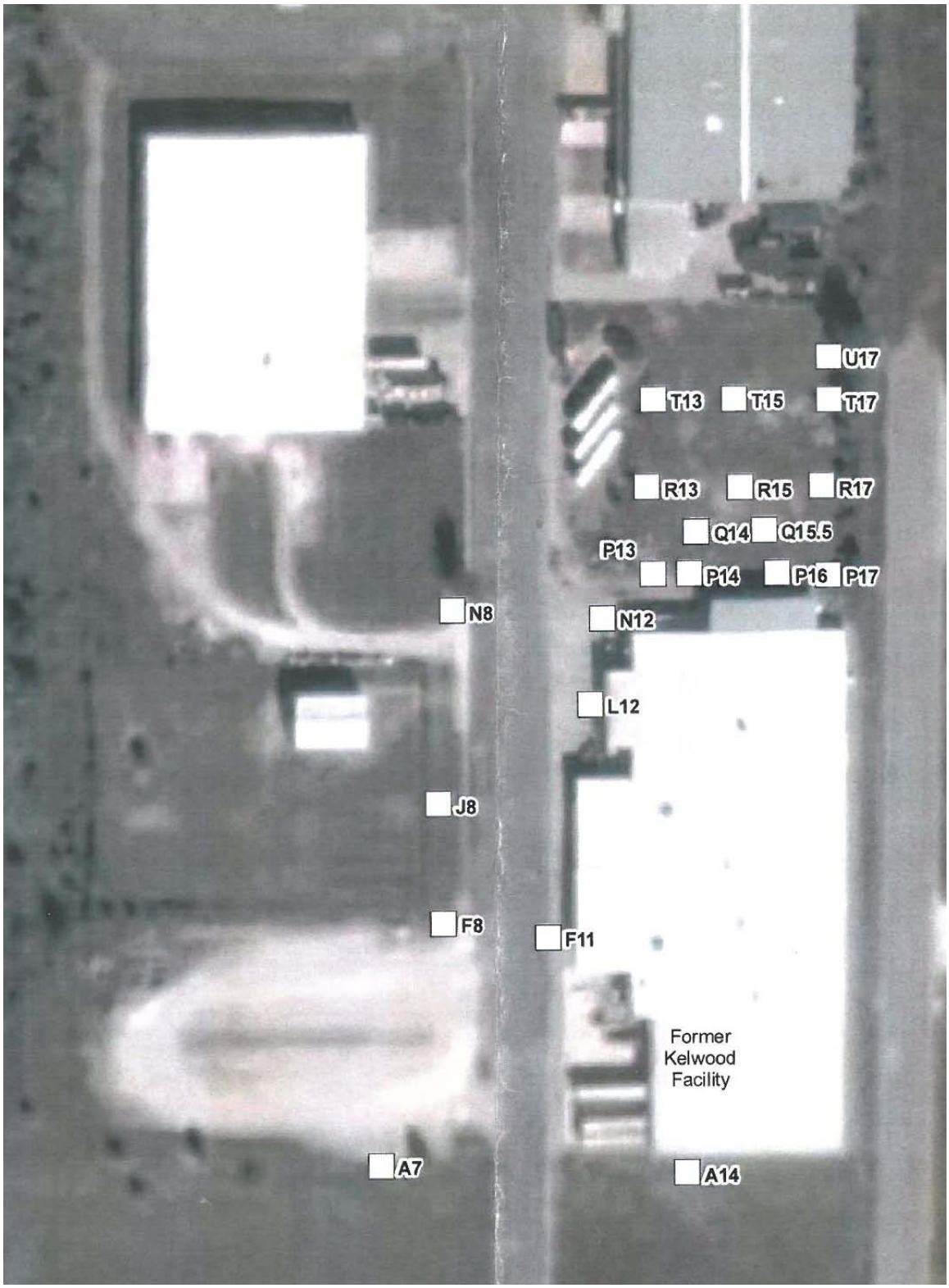


Figure 2-12: DNAPL investigation sampling locations.

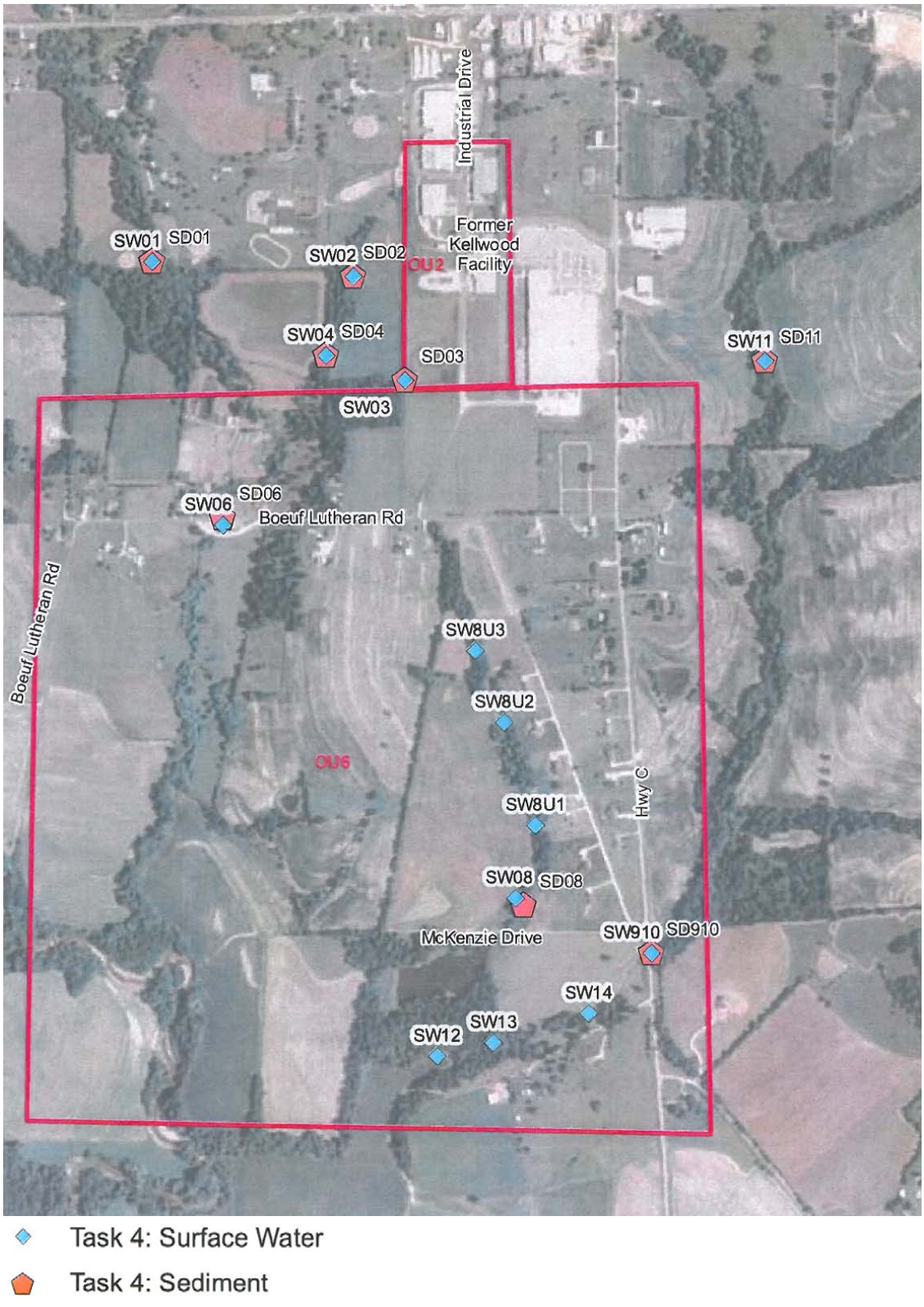


Figure 2-13: Sediment and surface water sampling locations.

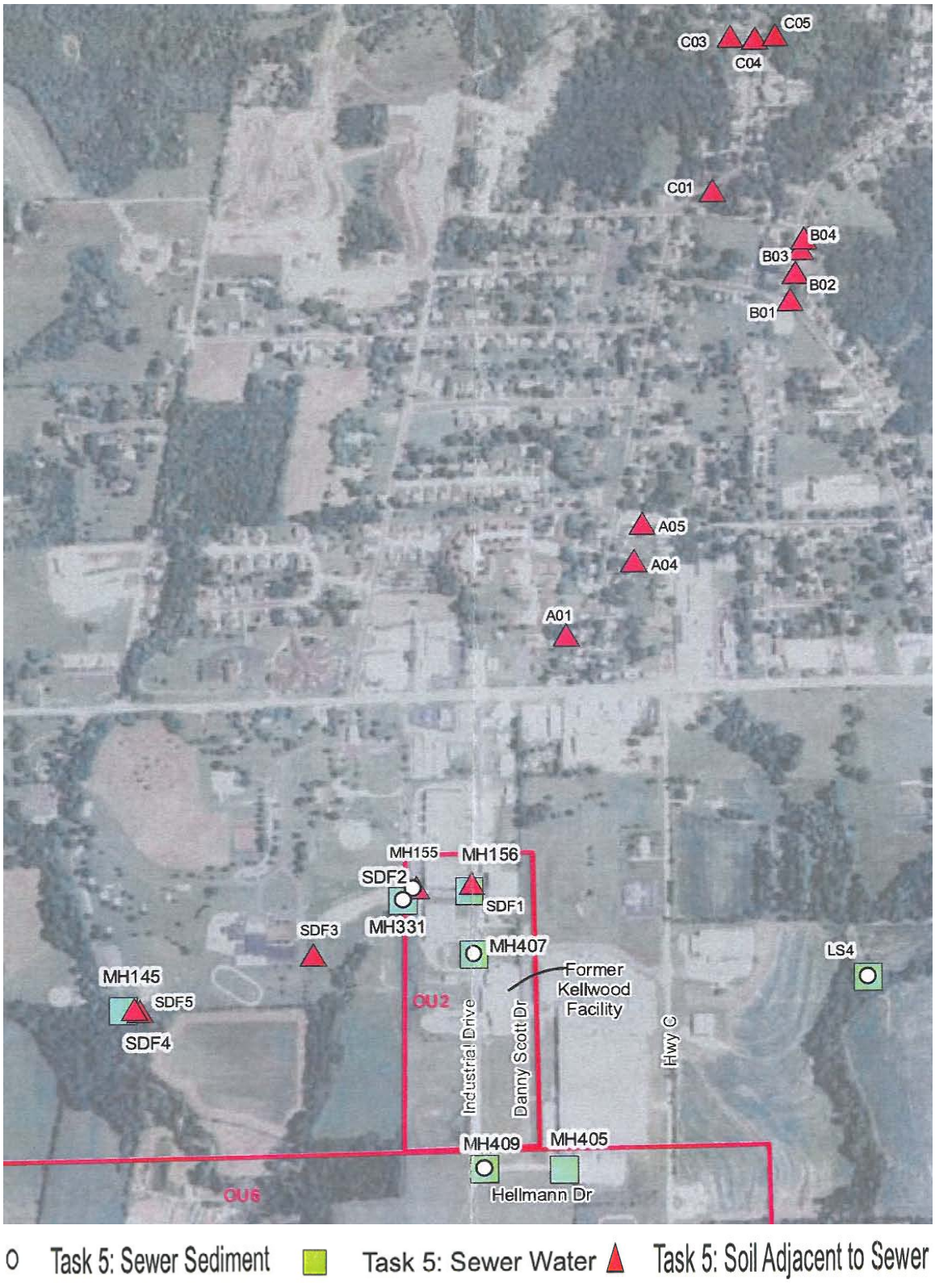


Figure 2-14: Sewer sediment, water, and soil sampling locations.

Figure 2-15: Soil gas sampling locations around high school.

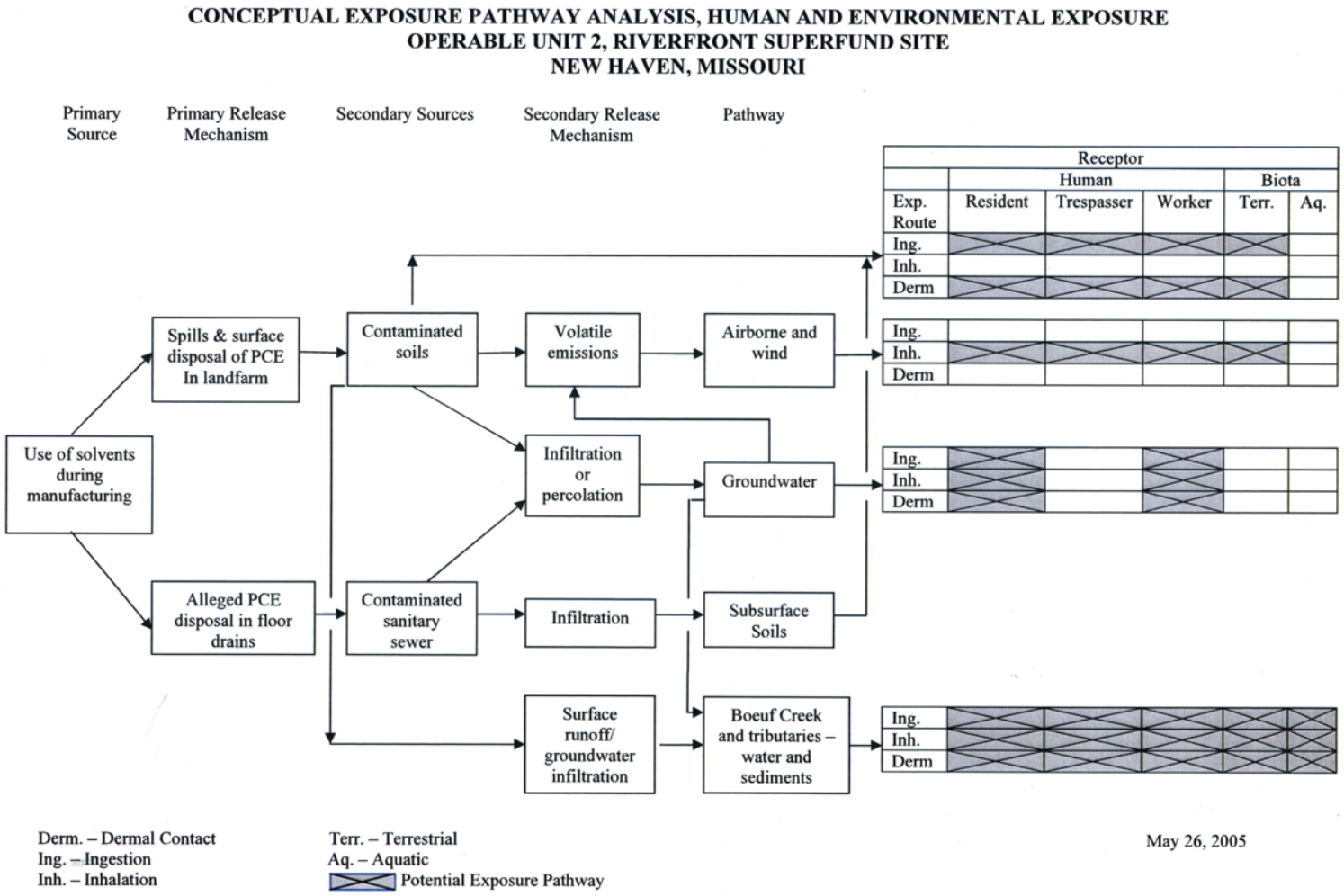


Figure 5-1: Conceptual site model.

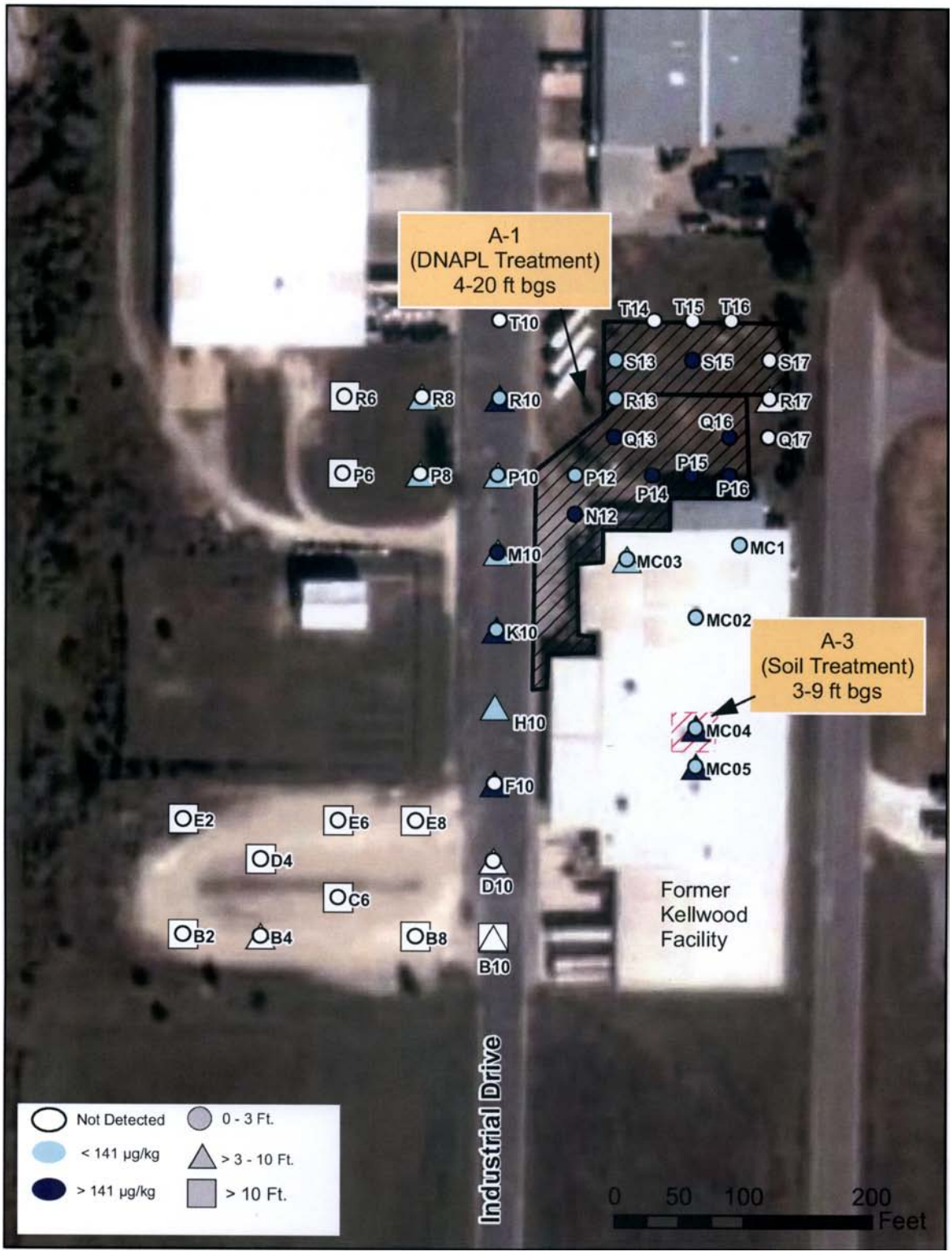
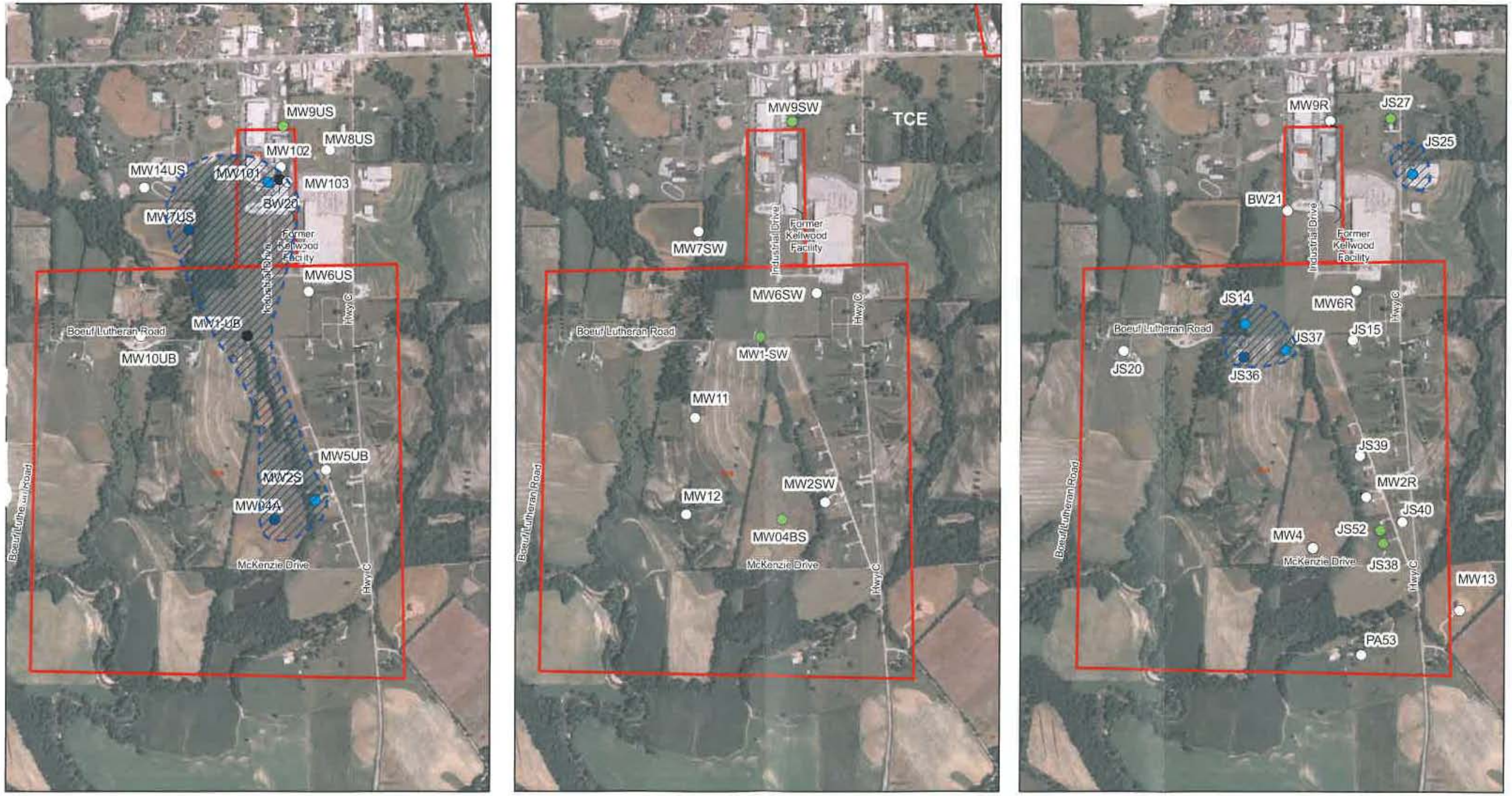


Figure 5-2: DNAPL Treatment Area (A-1) and Soil Treatment Area (A-3) under the former Kellwood facility.



Upper Sandstone Marker Bed/Upper Bedrock Permeable Zone

Swan Creek

Lower Jefferson City/Roubidoux Formation

Figure 5-3: Estimated extent of groundwater above Remedial Action Objective.

Not Detected

PCE Concentration

<5 µg/L (MCL)

5-100 µg/L

> 100 – 1,000 µg/L

> 1,000 µg/L

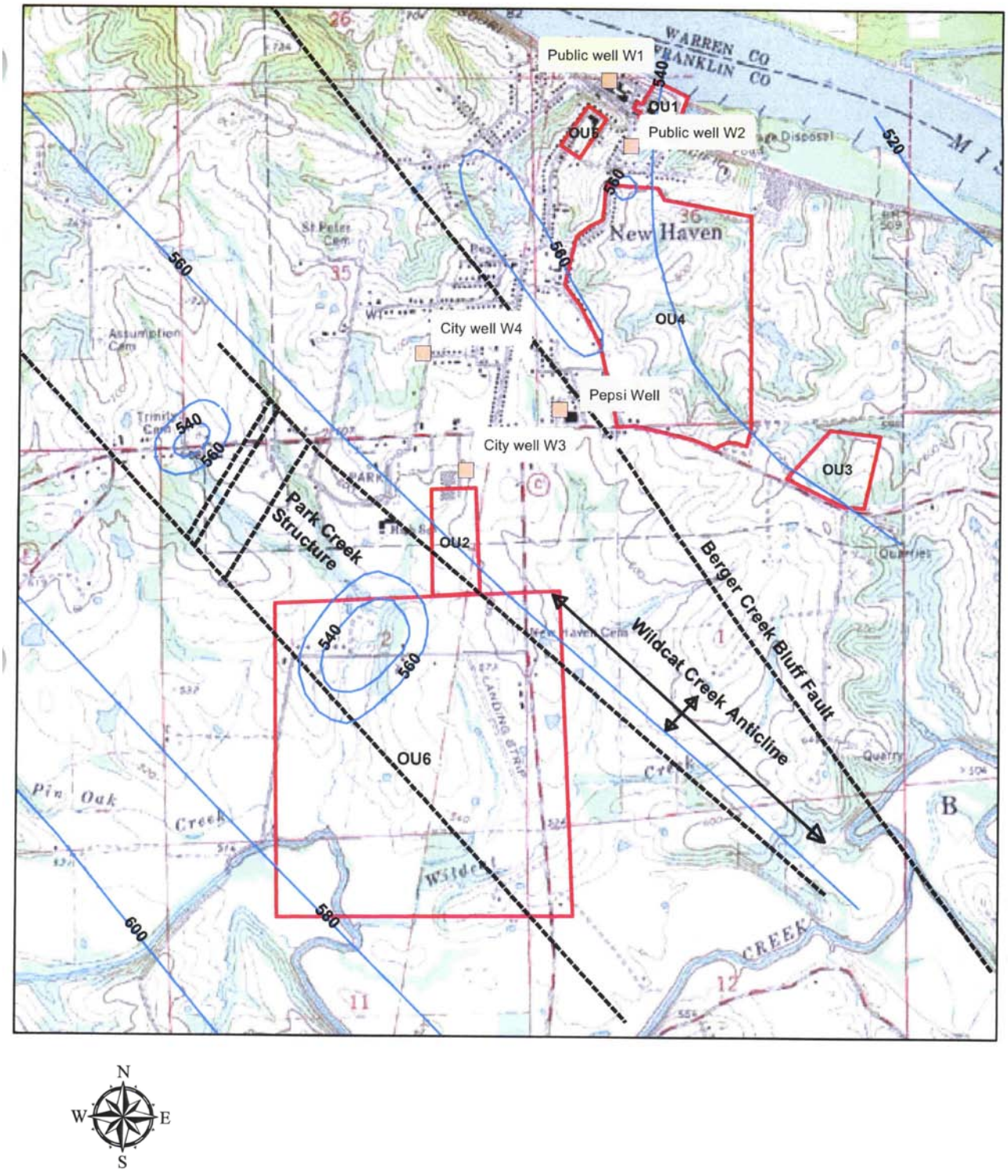


Figure 5-4: Geologic structure beneath New Haven, Missouri.

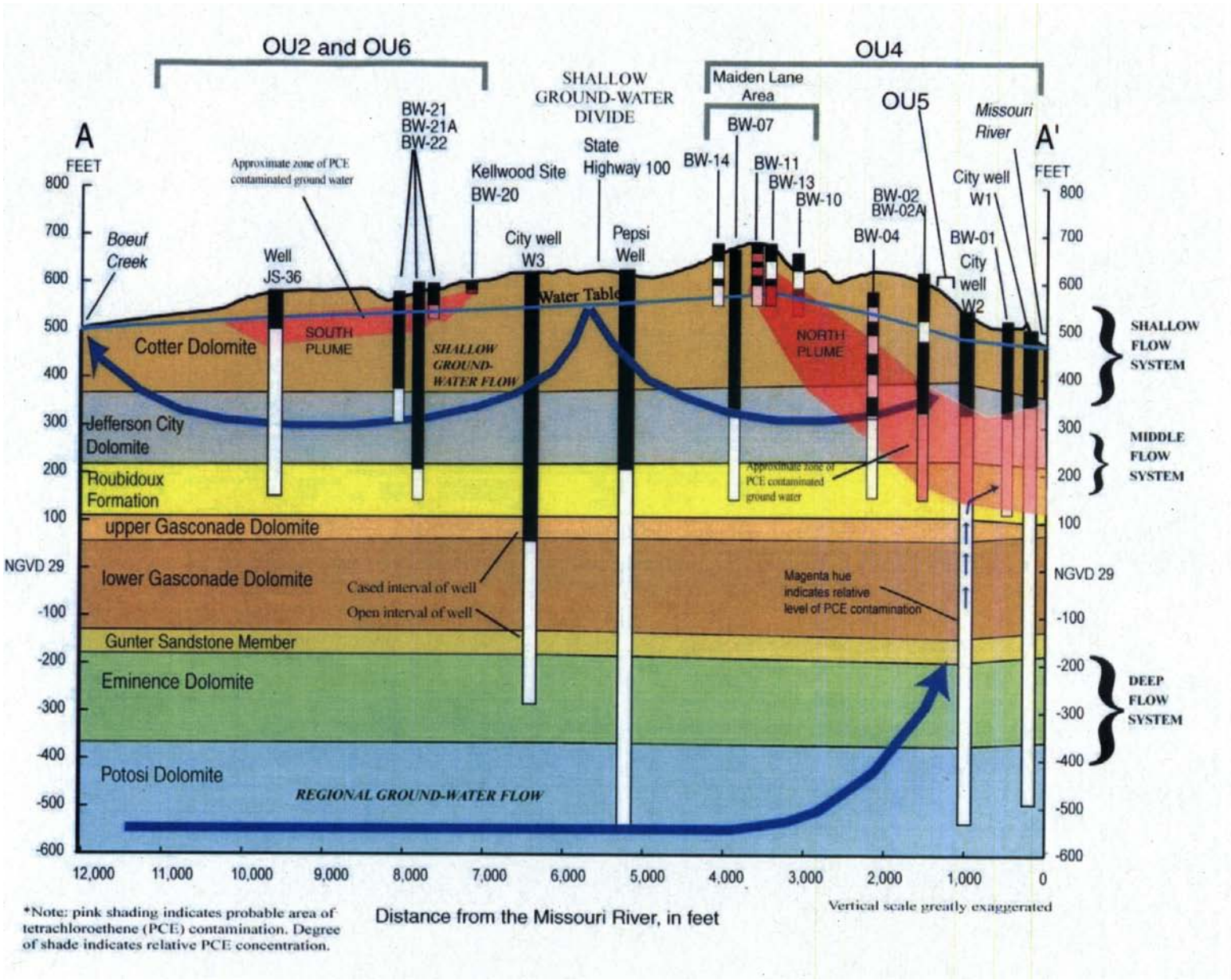


Figure 5-5: Groundwater Divide.

Figure 5-6: Location of contamination in soils at OU2 and OU6.

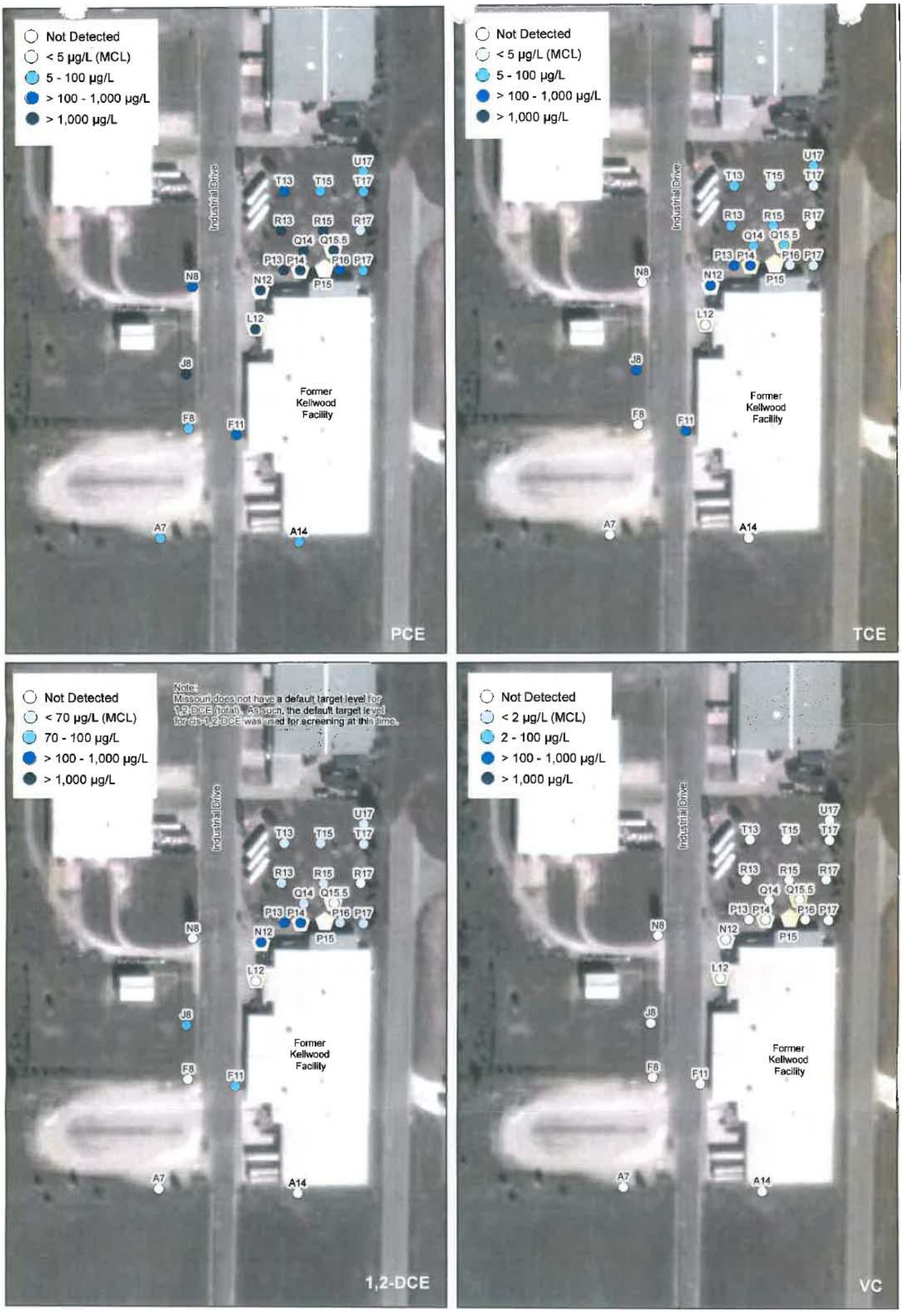


Figure 5-7: Extent of detections of DNAPL in OU2 and OU6.

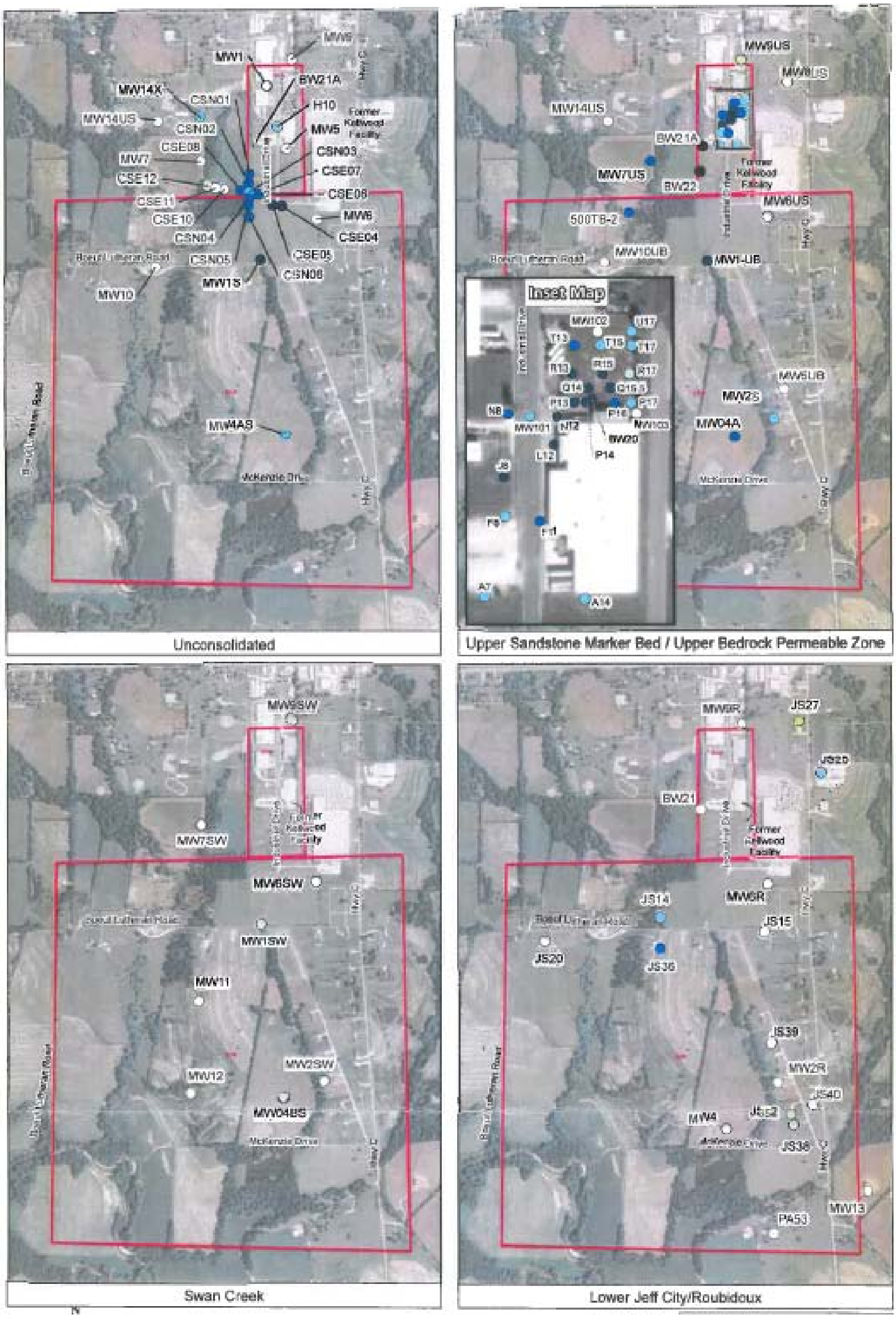


Figure 5-8: PCE detections in primary transmissive zones.

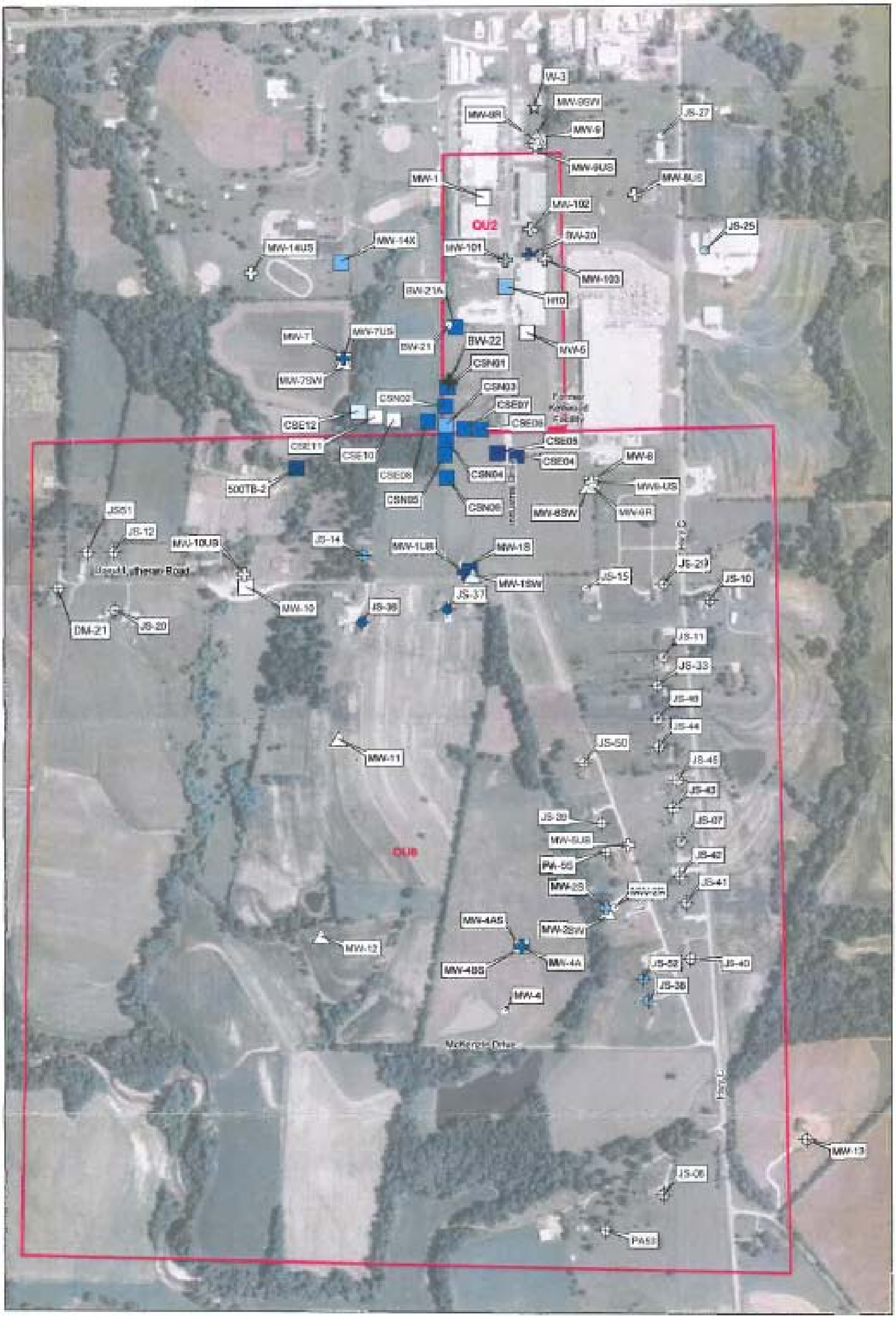


Figure 5-9: PCE detections in all groundwater zones.

Figure 5-10: PCE detection in sanitary sewer sediment and in soils adjacent to sewers at OU2 and OU6.

Figure 5-11: PCE detections in sanitary sewer water in OU2 and OU6.

Figure 5-12: PCE detections in surface water in OU2 and OU6.

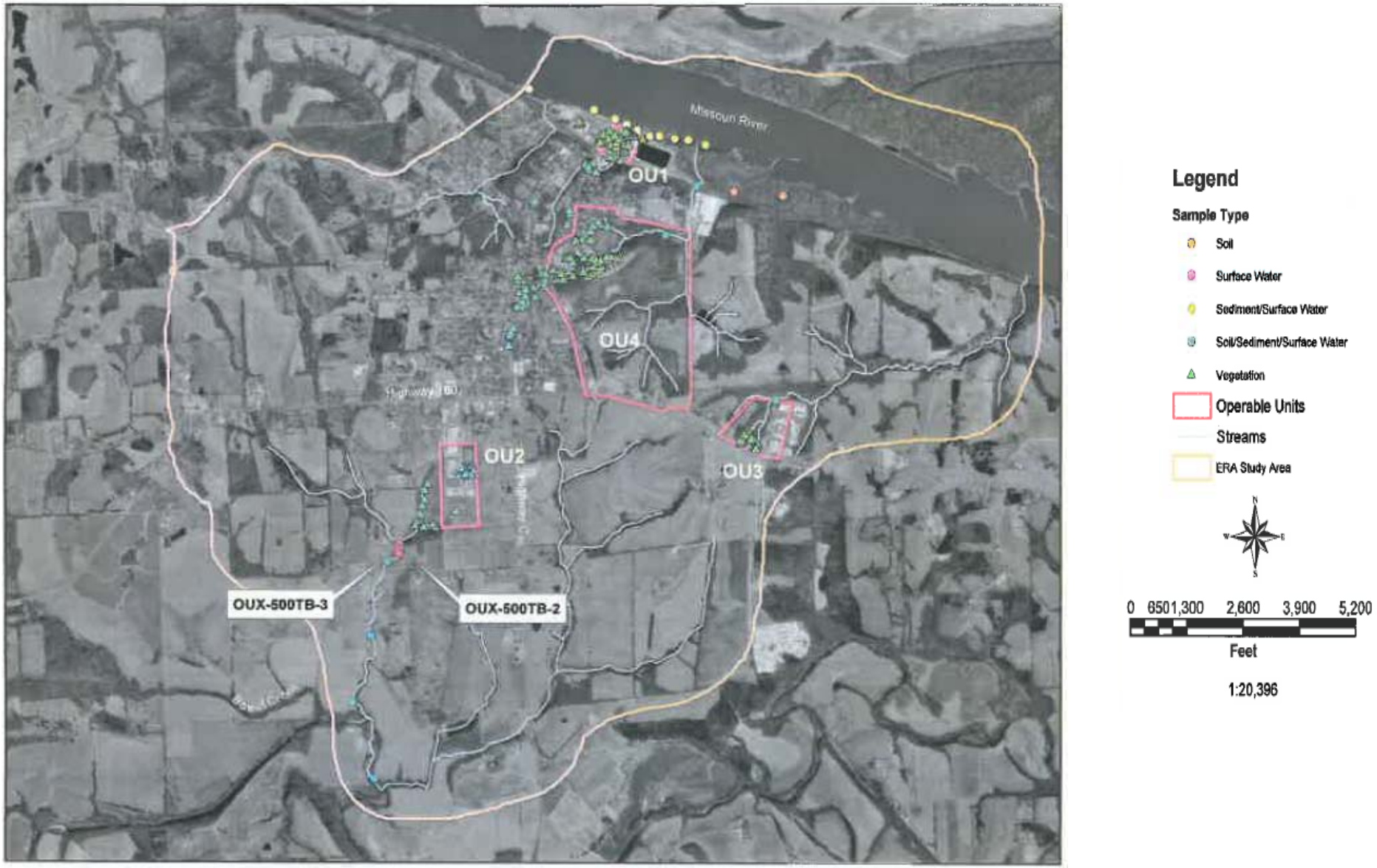


Figure 7-1: Ecological Risk Assessment Study Area.

Figure 12-1: DNAPL and chemical oxidation treatment areas in OU2.

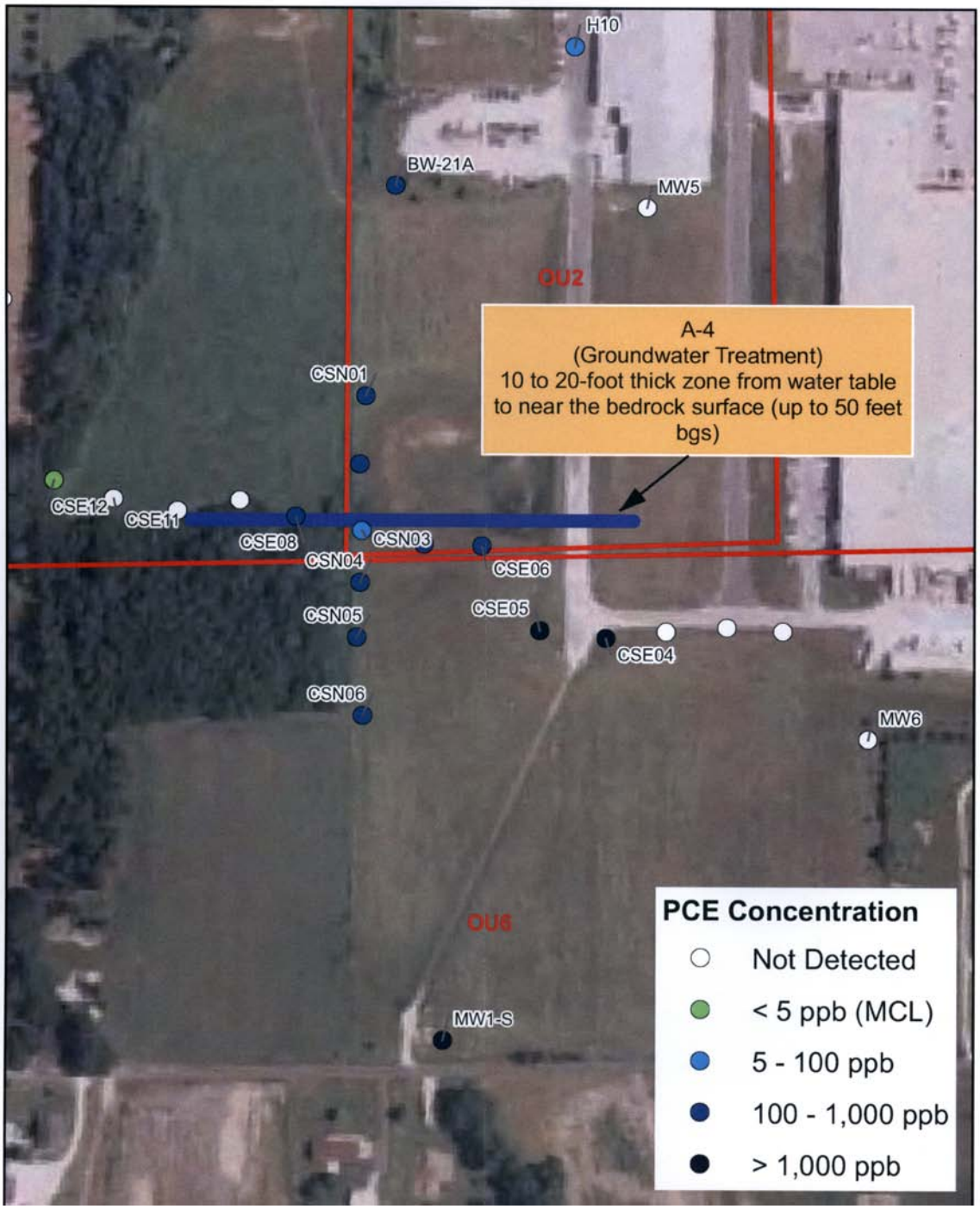


Figure 12-2: Area A-4 groundwater treatment wells.

Tables

TABLE 2.2
CHRONOLOGICAL HISTORY OF INVESTIGATIONS AT OU2 AND OU6
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Date	Activity
Mid -1970	*Former Kellwood Facility developed*
1973	*Kellwood company began operating tube mill*
September, 1985	*Kellwood operations ceased*
September, 1989	*MDNR performed an investigation of the New Haven Public Water Supply Site*
June 12, 1990	*State of Missouri informed American Recreation Products (ARP) and Kellwood Company of former employees statement of cleaning solvent dumping*
1988-1993	*MDNR performed groundwater investigation of Municipal Well 3 and Pepsi Well*
1991-1998	*Geotechnology submitted a Final Contamination Delineation Plan for Metalcraft Enterprises Facility to MDNR*
April 1, 1994	*Kellwood and MDNR entered into agreement to remediate soils*
1994-1996	*Geotechnology excavated highly contaminated soil, initiated and performed landfarming*
1999	*Environmental Management Associates performed Phase I and Phase II environmental site assessment*
1999-2002	*United State Geological Survey (USGS) installed groundwater monitoring wells, and collected soil, groundwater, residential well, sediment, surface water, and tree core samples in the vicinity of the Former Kellwood Facility*
October 19, 2000	*Riverfront Site listed as a Federal NPL or Superfund site*
2000 - 2007	*USGS and Black and Veatch performed Soil, Residential well and Groundwater Investigation throughout all Operable Units*
May 17, 2004	Draft RI/FS Work Plan submitted to USEPA
June 3, 2004	Draft Residential Well Investigation Work Plan submitted to USEPA
July 21, 2004	Final Expedited Residential Well Investigation Work Plan submitted to USEPA
Week of July 12, 2004	Surface geophysics portion of the Expedited Residential Well Investigation was completed
July 26 and August 16, 2004	Residential sampling portion of the Expedited Residential Well Investigation was performed
Week of July 16, 2004	Interval Screening portion of the Expedited Residential Well Investigation (consisting of borehole geophysics and groundwater sampling at several discrete intervals at the Vedder and Laune wells) was performed
August 30, 2004	Letter responding to EPA's comments on the draft RI/FS Work Plan was submitted
September - November 2004	Monitoring well installation portion of the Expedited Residential Well Investigation was completed
September 14, 2004	Submitted the Interval Screening Report for JS-37 and JS-38
September 30, 2004	Revisions to Standard Operating Procedure No. 9, the SOP describing Volatile Organics Analysis in Groundwater using a Portable Gas Chromatograph with Photoionization Detector, were submitted
October 14, 2004	Residential Well Sampling Memo submitted to USEPA
week of November 29th-December 13th, 2004	Monitoring well development (MW1 and 2 clusters) and sampling were conducted
January - July 2005	Amanda Farms pilot well installation and sampling were conducted
Week of January 31, 2005	Second round of monitoring well sampling at MW-1 and MW-2 clusters was conducted
February 10, 2005	Monitoring Well Sampling Memo submitted
February 23, 2005	Revised RI/FS Work Plan for OU2 was submitted
February 1, 2005	Video inspection of MW2-T3 was performed
February 1, 2005	Surface water in the vicinity of MW-1 was sampled at MDNR's request
February 4, 2005	During the second round of groundwater monitoring, well MW2-T3 was sampled for selected inorganic parameters on February 4, 2005, to evaluate the high turbidity noted in this well and to determine the viability of the well.

TABLE 2.2
CHRONOLOGICAL HISTORY OF INVESTIGATIONS AT OU2 AND OU6
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Date	Activity
April 27, 2005	Revised Final Residential Well Investigation (RWI) Work Plan was submitted
April 29, 2005	Draft RWI Report was submitted to USEPA
May 26, 2005	Final OU2 RI/FS Work Plan was submitted
July 7 - July 27, 2005	Amanda Farms Well Investigation Memorandum Report , response to comments, and revised report were submitted
July 25, 2005	A variance request was submitted to the MDNR to enable Mr. Tom Barkley to convert the Amanda Farms pilot monitoring well (AF01) into a permanent residential (domestic) water well (MW-13)
September 23, 2005	Submitted a workplan outlining the voluntary installation of the proposed domestic wells to be installed at 539 Wildcat Creek Lane and 559 Wildcat Creek Lane to the MDNR. The work plan, entitled Wildcat Creek Domestic Well Installation Work Plan, presents the activities that Kellwood is proposing to perform to facilitate the voluntary installation of the requested domestic water wells
October 28, 2005	Submitted Response to Comments and Redline text of the Final Remedial Investigation/Feasibility Study Work Plan to USEPA
November 29, 2005	Submitted a redline version of the revised Wildcat Creek Domestic Well Installation Work Plan detailing the proposed confirmation sampling of the MW2 monitoring well cluster, including interconnectivity evaluation
November 30, 2005	*USEPA/MDNR representatives informed Parsons, for the first time, that the Benson and Carlin wells would not be approved for installation.*
December 12, 2005	Received final comments on the RI work plan via e-mail
January 18, 2006	Submitted the Final RI/FS Work Plan and response to USEPA's comments
January 24, 2006	Submitted the PA-54 Residential Well Investigation Report (Burt Well Report)
February 2, 2006	*USEPA approved Revised Final RI/FS Work Plan and Revised Final Conceptual Exposure Pathway Analysis*
February 22, 2006	Task 2a - Submitted a technical memorandum summarizing the proposed approach to conduct interval screening of two existing residential wells, JS-14 and JS-36 as a part of the proposed RI/FS at OU2 of the Riverfront Superfund site.
February 28, 2006	Collected the final groundwater sample from AF-01, converted to a domestic well (MW-13), in accordance with the requirements stated in the Final Amanda Farms Well Investigation Memorandum Report, dated July 27, 2005.
March 6, 2006	Submitted draft Sampling Analysis Plan (SAP) consisting of the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) for the OU2/OU6 RI/FS
March 14, 2006	Submitted a response to comments letter to address questions/comments on the Draft QAPP raised by Ms. Diane Harris, Regional Quality Assurance Manager, USEPA Region 7, in a conference call on March 13, 2006
March 22, 2006	Task 2a - Submitted via email, a revised interval screening study (Study) memorandum, incorporating comments from USEPA, and summarizing the proposed approach to conduct this Study
April 3 through 7, 2006	Task 2a - Performed Interval Screening Activities at JS-14 and JS-36 as a part of expedited RI/FS activities
July 10, 2006	Submitted Final SAP
July 11, 2006	*USEPA provided additional comments on Final SAP*
July 14, 2006	Parsons provides responses on USEPA's comments on the Final SAP
July 18, 2006	*USEPA approved Final SAP*
August 14, 2006	Task 2a - Parsons submitted draft interval screening report summarizing the methodology and findings of the April 2006 interval screening study of JS-14 and JS-36
September 1, 2006	USEPA, Kellwood, and Parsons discussed the possible installation of domestic wells in Wildcat Creek Estates

TABLE 2.2
CHRONOLOGICAL HISTORY OF INVESTIGATIONS AT OU2 AND OU6
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Date	Activity
September 2006	Parsons discussed the modeling goals with MDNR and ran AQTESOLV modeling scenarios. The modeling effort was not meaningful and Parsons determined AQTESOLV is not a proper modeling technique. Parsons evaluated other modeling options and suggested the use of MODFLOW to the USGS.
	Began the pre-field (intrusive) investigation of the sewers on September 25, 2006, meeting with the City of New Haven Public Works Director, Mr. Julius Gatzemeyer, to review engineering drawings and discussing the sewer flow patterns.
October 12, 2006	Submitted a letter summarizing the discussion with Mr. Julius Gatzemeyer (City of New Haven Utilities Department) regarding the portions of the City sewer system covered by the Final RI/FS Work Plan, approved February 2, 2006 (RI/FS Work Plan)
Week of November 6, 2006	Conducted an aquifer test and re-sampling event for the MW2 cluster
December 12, 2006	Submitted a draft letter report summarizing (1) the results of an aquifer test and groundwater sampling performed at the Wildcat Creek subdivision on the MW-2 cluster on November 6 through 8, 2006, (2) Modeling results obtained from WATQ, an aquifer simulation and pumping test interpretation program described in the USGS Water Resources Investigation Report 99-4225, and (3) Methodology to conduct an aquifer test at MW2 to evaluate the potential for vertical connectivity between the Roubidoux Formation and overlying transmissive zones in the Jefferson City Dolomite
January 2, 2007	Requested approval of the installation of domestic wells in Wildcat Creek Estates from MDNR with concurrence from the City of New Haven and the USEPA
January 10, 2007	Provided USEPA with the Final Wildcat Creek Well Installation Work Plan, addressing comments from USEPA, MDNR, and USGS
January 16, 2007	*MDNR approves plan to convert monitoring well MW2R to a domestic supply well for the residence at 559 Wildcat Creek Lane*
January 18, 2007	Task 5 - Submitted a letter to the USEPA to document modifications to the sewer investigation discussed in the January 4, 2007 teleconference
January 18, 2007	*Task 2a - Received comments on the August 2006 Interval Sampling Report for JS-14/JS-36*
January 22, 2007	*Received approval from the USEPA on the January 10, 2007 Final Wildcat Creek Well Installation Work Plan*
January 25, 2007	*Received an approval letter from the USEPA on the January 18, 2007 Sewer Investigation letter*
January 29, 2007	MW2R was converted to a domestic supply well
January 29, 2007	Parsons, USEPA, MDNR, and USGS participated in a meeting with the property owners to discuss the proposed monitoring wells locations (for the remedial investigation) and associated access issues
February 6, 2007	Kellwood, Bryan Cave (legal counsel for Kellwood on the Riverfront Superfund Site, OU 2/6), Parsons, and USEPA participated in a meeting with the City of New Haven to discuss the specifics of the potential water main extension and access issues for the RI
February 26, 2007	Second (and final) round of sampling was performed at MW2R
March 5, 2007	To expedite resolving access issues associated with OU6, Kellwood submitted a written proposal to the City of New Haven regarding the extension of public water to the affected residences
April 3, 2007	*Received approval from Mrs. Benson's attorney to proceed with the proposed domestic well installation at 539 Wildcat Creek Lane*

TABLE 2.2
CHRONOLOGICAL HISTORY OF INVESTIGATIONS AT OU2 AND OU6
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Date	Activity
April 16, 2007	*Received comments from the USEPA on the March 2007 monthly progress report. The letter requested that an attempt be made to pursue selected tasks (Soil Investigation, Dense Non-Aqueous Phase Liquid [DNAPL] Investigation, Surface water and Sediment Sampling, and Sanitary Sewer Inspection and Sampling) of the remedial investigation at OU 2/6*
April 25, 2007	*Bryan Cave received an approval on the access request from the City of New Haven to proceed with the proposed Soil and DNAPL Investigation on the City of New Haven property (in the vicinity of the Former Kellwood Facility). According to the City of New Haven, the City's property was not implicated in the Surface Water and Sediment Sampling. Based on additional correspondence on April 25, 2007 between Bryan Cave and the City of New Haven, it was determined that further discussions between the City and Parsons are warranted for an approval on the proposed Sanitary Sewer Inspection and Sampling.*
April 25, 2007	Submitted an access request to Tubular Steel Inc. (TSI)/Metalcraft, current owner of the Former Kellwood Facility, to proceed with select aspects of the Soil Investigation and DNAPL Investigation at the Former Kellwood Facility
May 3, 2007	Parsons met with Steve Roth and Julius Gatzemeyer, City of New Haven, to further discuss the specifics of the proposed Sanitary Sewer Inspection and Sampling. Parsons was informed that additional review and discussions in the City Council meeting (scheduled for the second week of June 2007) were warranted before access is approved.
May 1, 2007	Contacted selected residents to seek access for the Surface water and Sediment Sampling at OU 2/6.
May 27 - July 9, 2007	Completed the domestic well installation (PA-55)
July 2007 to May 2008	Task 3 - Completed DNAPL Investigation including 22 core holes and core hole abandonment
August 23, 2007	Conducted second round of post-installation sampling at PA-55
September 2007 - June 2008	Task 1- Completed soil investigation including advancing 42 direct push borings
September 2007 - May 2008	Task 5 - Completed sewer investigation including: a video survey of the sewer segment immediately downstream of the former Kellwood facility, advancing 11 DPT borings along sewer segments north of Highway 100, advancing 5 DPT borings adjacent to potential sewer defects, collection of 7 sewer water samples, and collection of 5 sewer sediment samples
October 18, 2007	Submitted the Second Round of Domestic Well Sampling Report (conducted at PA-55)
December 5, 2007	In light of access issues related to the Groundwater and Sediment and Surface Water Investigations, submitted to USEPA to pursue these investigations at alternate locations (where possible)
December 19, 2007	Submitted a response to USEPA's October 29, 2007 comments letter on the October 18, 2007 Second Round Domestic Well Sampling Report for PA-55 in the Wildcat Creek Estates.
January 2, 2008	*Received an approval letter from the USEPA on the Second Round Domestic Well Sampling Report for PA-55. USEPA suggested that in addition to the groundwater samples (at PA-55) proposed (in order to better understand the form and thereby fate of iron in groundwater at PA-55) in the December 19, 2007 letter, a minimum of two additional background samples be collected from wells near PA-55, which are screened at the same interval as PA-55.*
February 2008 - May 2008	Task 2c - Residential Well Sampling was conducted from 38 wells
February 28, 2008	Collected the groundwater samples proposed in the December 19, 2007 response to comments on the Second Round Domestic Well Sampling Report for PA-55.

TABLE 2.2
CHRONOLOGICAL HISTORY OF INVESTIGATIONS AT OU2 AND OU6
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Date	Activity
March 2008 - Present	Conducted quarterly DNAPL recovery efforts at BW-20 and L-12.
April - May 2008	Task 2a - Interval screening efforts at JS-36 and liner installation at JS-14 and JS-36
May 2008 - September 2009	Task 2d - Monitoring Well Installation; Parsons installed 13 new monitoring wells, 5 wells installed and sampled by USGS
May 2008 and April 2009	Task 2b - Direct Push Borings North of Boeuf Lutheran Road, advanced 18 DPT borings to refusal
June 9, 2008	Submitted to USEPA a report summarizing the findings of the Benson well iron issue investigation in response to January 2, 2008 request from EPA
July 21, 2008	Task 2a - Submitted (via email) a draft of the revised Interval Screening Report (JS-14 and JS-36) for USEPA's review
August 2008 - August 2009	Task 4 - Collected sediment and surface water samples where access was available
February - March, 2009	Task 2f - Slug testing was conducted at 16 Parsons' installed monitoring wells
March 2009 - September 30, 2009	Task 2e - Sitewide Groundwater Sampling Round 1; Note that selected wells were sampled by USGS
June 18, 2009	Conducted a video survey of JS-25 (Beaver Brand Hats, located east of Highway C) on June 18, 2009 to evaluate the length and condition of the well casing
July - August 2009	Task 2f - Aquifer testing was conducted at selected monitoring wells and the City Wells 3 and 4
August 4, 2009	Task 11 - Submitted the soil vapor sampling work plan (near the New Haven High School) to USEPA
September 2, 2009	Task 2g - Completed surveying of the final monitoring well locations
September 8 and September 14, 2009	Task 11 - Completed soil vapor sampling activities (in the August 25, 2009 revised work plan) at the New Haven High School

Notes:

Text in italics represents work performed by others (other than Parsons)

To accommodate the proposed RI/FS schedule, selected reports/memoranda (Task 6a – Preliminary Site Characterization Report, Task 6b – Fate and Transport Memorandum, Task 6d – Data Analysis Technical Memorandum, Task 6f – Candidate Technologies Technical Memorandum) were eliminated.

Instead, these components were included directly in the RI Report

TABLE 2.3
HISTORIC SOIL SAMPLING RESULTS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Sample Name	Date Collected	Depth Interval (feet bgs)	PCE	TCE	cis-DCE	trans-DCE	VC	Toluene	Benzene
Laboratory Analysis									
MW-2[1]	7/15/99	0-3	**339,000**	**2,100**	**5,620**	---	---	---	---
OU2-SO-G01	2/20/01	0-1	<6.0	<6.0	<3.0	<3.0	<12	<6.0	<6.0
OU2-SO-G02	2/20/01	0-1	<6.0	<6.0	<3.0	<3.0	<12	<6.0	<6.0
OU2-SO-G03	2/20/01	0-1.5	**3,300 Q**	<310	<150	<150	<620	<310	<310
OU2-SO-G04	2/20/01	0-2	<5.9	<5.9	<3.0	<3.0	<12	<5.9	<5.9
OU2-SO-G05	2/20/01	0-2	<6.0	<6.0	<3.0	<3.0	<12	<6.0	<6.0
OUX-SO-EC06	3/14/02	0-0.5	<6.3	<6.3	<3.2	<3.2	<13	<6.3	<6.3
OUX-SO-EC07	3/14/02	0-0.5	<6.2	<6.2	<3.1	<3.1	<13	<6.2	<6.2
OUX-SO-EC08	3/14/02	0-0.5	<6.4	<6.4	<3.2	<3.2	<13	<6.4	<6.4
OUX-SO-EC09	3/14/02	0-0.5	<6.5	<6.5	<3.2	<3.2	<13	<6.5	<6.5
Field GC Analysis									
OU2-G01	2/20/01	0-1.5	**0.31**	0	0	**0.07**	0	---	**0.49**
OU2-G02	2/20/01	0-1	**0.07**	0	0	**0.03**	0	---	**0.05**
OU2-G03	2/20/01	0-1.5	**14,226**	**12.68**	**21.46**	**0.12**	0	---	**9.74**
OU2-G03 (DUP)	2/20/01	0-1.5	**17,610**	**2.4**	**2.3**	0	0	---	**4.5**
OU2-G04	2/20/01	0-2	**2,223.6**	**10.74**	**8.05**	0	0	---	**1.81**
OU2-G04 (DUP)	2/20/01	0-2	**5,280**	**30.8**	**2**	0	0	---	0
OU2-G05	2/20/01	0-2	**21.3**	0	0	0	0	---	**0.6**
OU2-BW-21A	3/8/01	5	**0.2**	0	0	0	0	---	**2.73**
OU2-BW-21A	3/8/01	10	0.0	0	**17**	0	0	---	0
OU2-BW-21A (DUP)	3/8/01	10	0.0	0	**0.73**	0	0	---	**0.22**
OU2-BW-21A	3/23/01	30	**6.2**	**3.31**	**8.32**	**0.05**	0	---	**4.95**
OU2-GPM01	10/22/01	3	0.0	0	0	0	0	---	0
OU2-GPM01	10/22/01	5.5	0.0	0	0	0	0	---	0
OU2-GPM01 (DUP)	10/22/01	18.5	0.0	0	0	0	0	---	0
OU2-GPM01	10/23/01	23.5	0.0	0	0	0	0	---	0
OU2-GPM01 (DUP)	10/23/01	31	0.0	0	0	0	0	---	**17.24**
OU2-GPM01 (DUP)	10/23/01	39	**24.8**	0	0	0	0	---	0

Notes:
Data for USGS samples are from USGS Lab Sample Log and Field GC Log unless noted
[1] - Data for MW-2 are from Pre-Acquistion ESA, Phase I and Limited Phase II Investigation Report, EMA, December 1999.
Results in ug/kg
Dup-Duplicate Sample
"---" Sample was not analyzed for this compound, or results are unknown
DCE - Dichloroethene
PCE - Tetrachloroethene
TCE - Trichloroethene
VC - Vinyl Chloride
Q - Sample was diluted

TABLE 2.4
U.S. GEOLOGICAL SUVEY MONITORING WELL CONSTRUCTION
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Well Name	Completion Type	Altitude of Measuring Point (feet msl)	Top of Monitoring Interval (feet bls)	Bottom of Monitoring Interval (feet bls)	Uppermost Producing Formation	Lowermost Producing Formation
BW-04	Open Hole	575.5	242.5	425	Cotter	Jeff City
BW-07	Open Hole	674.05	338.5	530	JC	Rbdx
BW-20	Open Hole	603.5	10	20	Cotter	Cotter
BW-21	Open Hole	584.63	374.5	440	Rbdx	Rbdx
BW-21A	Screen	585.34	43	52.4	Overburden	Cotter
BW-22	Open Hole	579.12	160	260	Cotter	Jeff City

TABLE 2.5
HISTORICAL GROUNDWATER SAMPLING RESULTS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Sample Name	Collection Date	Screened Interval (feet bgs)	Laboratory or Field GC Analysis	PCE (µg/L)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	Vinyl Chloride (µg/L)	Toluene (µg/L)	Benzene (µg/L)
Public Supply Well										
OUX-W3	3/22/1999	525-885	Field GC	ND	ND	ND	ND	ND	–	ND
City Well #3*	5/31/2000	525-885	Laboratory	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	–
OUX-W3	5/31/2000	525-885	Field GC	ND	ND	ND	ND	ND	–	ND
City Well #3*	11/13/2000	525-885	Laboratory	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	–
City Well #3*	01/24/01	525-885	Laboratory	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	–
OUX-W3	1/24/2001	525-885	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-GW-W3	06/06/01	525-885	Laboratory	<1	<1	<1	<1	<1	<1	<1
OUX-GW-W3	09/05/01	525-885	Laboratory	<1	<1	<1	<1	<1	<1	<1
OUX-GW-W3	08/01/02	525-885	Laboratory	<1	<1	<1	<.5	<2	<1	<1
OUX-GW-W3	08/16/02	525-885	Laboratory	<0.03	<0.04	<0.04	<0.03	<0.11	<0.05	<0.04
OUX-GW-W3	07/16/99	525-885	Laboratory	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1
OUX-GW-W3	05/31/00	525-885	Laboratory	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1
OUX-GW-W3	11/13/00	525-885	Laboratory	<1	<1	<1	<1	<1	<1	<1
OUX-W3	6/6/2001	525-885	Field GC	ND	ND	**0.12**	ND	ND	–	ND
OUX-GW-W3**	12/16/03	525-885	Laboratory	<5	<5	<5	<5	<5	<5	<5
Monitoring Wells										
OU2-BW-20	4/9/2001	3-10	Field GC	**1.4**	ND	**8.62**	ND	ND	–	**5.33**
OU2-BW-20	4/13/2001	3-10	Field GC	**59,480**	**48.8**	**0.65**	ND	ND	–	**0.85**
OU2-GW-BW-20	04/17/01	10-20	Laboratory	**200,000**	<5,000	<5,000	<2,500	<10,000	<5,000	<5,000
OU2-BW-20	4/18/2001	10-20	Field GC	**44.5**	**0.3**	**1.2**	**0.07**	ND	–	ND
OU2-GW-BW-20***	05/22/01	10-20	Laboratory	**1,400,000**	<40,000	<40,000	<20,000	<80,000	<40,000	<40,000
OU2-BW-21	1/10/2001	0-59	Field GC	**77.3**	**11.4**	**1.97**	ND	ND	–	ND
OU2-BW-21	1/10/2001	59-100	Field GC	**1,187**	**136.8**	**18.82**	**1.39**	ND	–	**8.03**
OU2-BW-21	1/31/2001	59-100	Field GC	ND	ND	ND	ND	ND	–	**0.7**
OU2-BW-21	5/31/2001	374.5-440	Field GC	**0.02**	ND	**0.04**	**3.03**	ND	–	ND
OU2-BW-21	5/31/2001	374.5-440	Field GC	**0.01**	ND	**0.16**	**1.85**	ND	–	ND
OU2-BW-21	5/31/2001	374.5-440	Field GC	**0.02**	ND	ND	ND	ND	--	ND
OU2-BW-21	8/21/2001	374.5-440	Field GC	ND	ND	ND	ND	ND	–	ND
OU2-BW-21	7/30/2002	374.5-440	Field GC	ND	ND	ND	ND	ND	–	ND
OU2-GW-BW-21***	05/31/01	374.5-440	Laboratory	<1	<1	<1	<1	<1	<1	<1
OU2-GW-BW-21	08/21/01	374.5-440	Laboratory	<1	<1	<1	<1	<1	<1	<1
OU2-GW-BW-21	07/30/02	374.5-440	Laboratory	<1	<1	<1	<.5	<2	<1	<1
OU2-BW-21A	3/20/2001	0-8	Field GC	ND	ND	ND	ND	ND	–	ND
OU2-GW-BW-21A***	06/11/01	43-52.4	Laboratory	**1,000**	**160**	**28 J**	<25	<100	<50	<50
OU2-GW-BW-21A	08/21/01	43-52.4	Laboratory	**1,000**	**160**	**32J**	<25	<100	<50	<50

TABLE 2.5
HISTORICAL GROUNDWATER SAMPLING RESULTS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Sample Name	Collection Date	Screened Interval (feet bgs)	Laboratory or Field GC Analysis	PCE (µg/L)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	Vinyl Chloride (µg/L)	Toluene (µg/L)	Benzene (µg/L)
OU2-GW-BW-21A	07/30/02	43-52.4	Laboratory	**970**	**170**	**34**	<33	<33	<33	<33
OU2-BW-21A	7/30/2002	43-52.5	Field GC	**3,490**	**330**	**40**	**0.33**	ND	–	ND
OU2-BW-22	2/6/2001	66-105	Field GC	**808**	**53.6**	**13**	**0.72**	ND	–	**0.24**
OU2-BW-22	2/6/2001	66-126	Field GC	**1,170**	**70**	**50**	ND	ND	–	ND
OU2-BW-22	2/13/2001	60-160	Field GC	**389**	**11.4**	**10.25**	ND	ND	–	ND
OU2-BW-22	2/13/2001	80	Field GC	**256.95**	**5.54**	**3.39**	**0.02**	ND	–	**0.12**
OU2-BW-22	2/26/2001	160-260	Field GC	ND	ND	ND	ND	ND	–	**0.19**
OU2-BW-22	2/27/2001	160-260	Field GC	ND	ND	ND	ND	ND	–	ND
OU2-GW-BW-22***	05/29/01	180-260	Laboratory	<1	<1	<1	<1	<1	<1	<1
OU2-GW-BW-22	08/21/01	180-260	Laboratory	<1	<1	<1	<1	<1	<1	<1
OU2-GW-BW-22	07/30/02	180-260	Laboratory	<1	<1	<1	<.5	<2	**0.26 J**	<1
OU2-BW-22	7/30/2002	180-260	Field GC	ND	ND	ND	ND	ND	–	ND
OU2-GPM01	10/23/2001	0-41.75	Field GC	**2,989.5**	**353.1**	**144.75**	**16.45**	ND	–	ND
OU2-MW-101	1/15/2002	33.5-53.5	Field GC	**1.24**	ND	ND	ND	ND	–	ND
OU2-MW-101	1/15/2002	33.5-53.5	Field GC	**1.5**	ND	ND	ND	ND	–	ND
OU2-MW-101	7/31/2002	33.5-53.5	Field GC	**3.34**	ND	ND	ND	ND	–	ND
OU2-MW-102	1/15/2002	33-55	Field GC	ND	ND	ND	ND	ND	–	ND
OU2-MW-102	1/15/2002	33-55	Field GC	ND	ND	ND	ND	ND	–	ND
OU2-MW-102	1/15/2002	33-55	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-UNKNOWN WELL	11/14/2001	0-34.5	Field GC	ND	ND	ND	**0.02**	ND	–	ND
OU2-G05	2/22/2001	0-2	Field GC	**8.73**	**0.97**	**0.53**	ND	ND	–	**0.59**
OU2-G05	2/22/2001	0-2	Field GC	**7.76**	**3.47**	**8.26**	ND	ND	–	**2.05**
Residential Wells										
DM-01*	3/23/1999	123-250	Field GC	<0.1	<0.1	–	--	--	–	--
JS-03*	3/22/1999	52-330	Field GC	<0.1	**0.2**	--	–	--	–	–
JS-06*	3/22/1999	120-400	Field GC	<0.1	<0.1	–	--	--	–	--
DM-06*	3/23/1999	NA	Field GC	<0.1	**1.3**	--	–	--	–	–
JS-07*	3/22/1999	103-415	Field GC	<0.1	<0.1	–	--	--	–	--
JS-09*	3/24/1999	106-360	Field GC	<0.1	<0.1	–	--	--	–	--
JS-10*	3/24/1999	NA	Field GC	<0.1	<0.1	–	--	--	–	--
OUX-GW-JS-10	10/04/02	0	Laboratory	<1	<1	<1	<1	<1	<1	<1
JS-11*	03/24/99	NA	Field GC	<0.1	<0.1	–	--	--	–	--
JS-12*	3/24/1999	NA	Field GC	<0.1	<0.1	–	--	--	–	--
OUX-GW-JS-12	01/29/02	400	Laboratory	<1	<1	<1	<1	<1	<1	<1
JS-13*	3/24/1999	NA	Field GC	<0.1	<0.1	–	--	--	–	--
DM-14*	3/25/1999	NA	Field GC	<0.1	0.8	--	–	--	–	--

TABLE 2.5
HISTORICAL GROUNDWATER SAMPLING RESULTS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Sample Name	Collection Date	Screened Interval (feet bgs)	Laboratory or Field GC Analysis	PCE (µg/L)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	Vinyl Chloride (µg/L)	Toluene (µg/L)	Benzene (µg/L)
JS-14*	3/24/1999	NA	Field GC	**0.3**	<0.1	--	--	--	--	--
OUX-GW-JS-14	03/24/99	NA	Laboratory	**0.11 E**	<0.125	<0.125	<0.125	<0.25	<0.125	<0.125
OUX-GW-JS-14	01/16/02	NA	Laboratory	**1.4**	<1	<1	<1	<1	<1	<1
DM-15*	3/25/1999	109-290	Field GC	<0.1	<0.1	--	--	--	--	--
JS-15*	3/24/1999	120-425	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-15	01/29/02	120-425	Laboratory	<1	<1	<1	<1	<1	<1	<1
JS-16*	3/25/1999	50-395	Field GC	<0.1	**4**	--	--	--	--	--
JS-17*	3/25/1999	NA	Field GC	<0.1	<0.1	--	--	--	--	--
DM-17*	3/30/1999	273-520	Field GC	<0.1	<0.1	--	--	--	--	--
JS-20*	03/31/99	NA	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-20	01/29/02	400	Laboratory	<1	<1	<1	<1	<1	<1	<1
DM-21*	3/31/1999	NA	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-22***	12/5/2000	406-1155	Laboratory	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
DM-23*	04/01/99	100-490	Field GC	<0.1	<0.1	--	--	--	--	--
JS-25*	8/26/1999	--	Field GC	<0.1	<0.1	--	--	--	--	--
JS-26*	2/4/2000	NA	Field GC	<0.1	<0.1	--	--	--	--	--
JS-27*	7/11/2000	NA	Field GC	<0.1	<0.1				--	
JS-29*	01/24/01	NA	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-29	01/24/01	NA	Laboratory	<1	<1	<1	<1	<1	<1	<1
JS-33*	03/22/01	NA	Field GC	<0.1	<0.1	--	--	--	--	--
JS-35*	8/28/2001	NA	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-35	08/28/01	NA	Laboratory	<1	<1	<1	<1	<1	<1	<1
JS-36*	11/15/01	NA	Field GC	**200**	<15	--	--	--	--	--
OUX-GW-JS-36	11/16/01	468	Laboratory	**200**	<13	<13	<6.7	<27	<13	<13
JS-37*	01/16/02	61-297	Field GC	**69**	<4	--	--	--	--	--
OU2-GW-JS-37****	01/16/02	61-237	Laboratory	**62**	**1.0 J**	**1.0 J**	<4	<4	<4	<4
OU2-GW-JS-37	05/01/02	61-237	Laboratory	**69**	<4	<4	<4	<4	<4	<4
JS-38*	07/10/02	80-340	Field GC	**9.8**	0.36	--	--	--	--	--
OUX-GW-JS-38	07/10/02	105	Laboratory	**9.8**	**0.36 J**	<1	<0.5	<2	<1	<1
JS-39*	07/10/02	140-385	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-39	07/10/02	140-385	Laboratory	<1	<1	<1	<0.5	<2	<1	<1
JS-40*	07/25/02	NA	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-40	07/25/02	NA	Laboratory	<1	<1	<1	<1	<1	<1	<1
JS-41*	07/25/02	NA	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-41	07/25/02	NA	Laboratory	<1	<1	<1	<1	<1	<1	<1
JS-42*	08/01/02	NA	Field GC	<0.1	<0.1	--	--	--	--	--
OUX-GW-JS-42	08/01/02	NA	Laboratory	<1	<1	<1	<.5	<2	<1	<1

TABLE 2.5
HISTORICAL GROUNDWATER SAMPLING RESULTS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Sample Name	Collection Date	Screened Interval (feet bgs)	Laboratory or Field GC Analysis	PCE (µg/L)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	Vinyl Chloride (µg/L)	Toluene (µg/L)	Benzene (µg/L)
JS-43*	08/01/02	NA	Field GC	<0.1	<0.1	–	--	--	–	--
OUX-GW-JS-43	08/01/02	NA	Laboratory	<1	<1	<1	<.5	<2	<1	<1
JS-44*	8/1/2002	NA	Field GC	<0.1	<0.1	–	--	--	–	--
OUX-GW-JS-44	08/01/02	NA	Laboratory	<1	<1	<1	<.5	<2	<1	<1
JS-45*	08/01/02	NA	Field GC	<0.1	<0.1	–	--	--	–	--
OUX-GW-JS-45	08/01/02	NA	Laboratory	<1	<1	<1	<.5	<2	<1	<1
JS-46*	08/01/02	NA	Field GC	<0.1	<0.1	–	--	--	–	--
OUX-GW-JS-46	08/01/02	NA	Laboratory	<1	<1	<1	<.5	<2	<1	<1
JS-47*	08/16/02	90-390	Field GC	<0.1	<0.1	–	--	--	–	--
JS-50*	9/6/2002	200-400	Field GC	<0.1	<0.1	–	--	--	–	--
OU2-JS-37	1/16/2002	NA	Field GC	**43.67**	**2.36**	**3.67**	ND	ND	–	ND
OU2-JS-37	1/16/2002	NA	Field GC	**36.16**	**2.04**	**5.19**	ND	ND	--	ND
OU2-JS-37	4/30/2002	ND	Field GC	**95.4**	**4.06**	**1.03**	ND	ND	--	ND
OUX-JS-06	3/23/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-07	3/23/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-08	3/23/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-10	3/24/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-11	3/24/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-12	3/24/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-13	3/24/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-14	3/24/1999	ND	Field GC	**0.08**	ND	ND	ND	ND	--	ND
OUX-JS-14	3/24/1999	ND	Field GC	**0.33**	ND	ND	ND	ND	--	ND
OUX-JS-14	1/16/2002	ND	Field GC	**4.1**	ND	ND	ND	ND	--	ND
OUX-JS-15	3/24/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-15	1/29/2002	120-425	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-20	3/31/1999	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-20	1/29/2002	400	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-22	12/5/2000	406-1155	Field GC	ND	ND	ND	ND	ND	–	**0.01**
OUX-JS-22	12/5/2000	406-1155	Field GC	ND	ND	ND	**0.53**	ND	--	**0.06**
OUX-JS-22	12/5/2000	406-1155	Field GC	**0.58**	ND	ND	**0.51**	**4.02**	--	**0.44**
OUX-JS-22	12/5/2000	406-1155	Field GC	ND	ND	ND	**0.52**	**3.92**	--	**2.78**
OUX-JS-22	12/5/2000	406-1155	Field GC	ND	ND	ND	**0.03**	**10.54**	--	**0.17**
OUX-JS-22	12/5/2000	406-1155	Field GC	ND	ND	ND	ND	**4.93**	--	**0.01**
OUX-JS-26	2/7/2000	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-27	7/11/2000	ND	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-29	1/24/2001	ND	Field GC	ND	ND	ND	**0.02**	ND	--	ND
OUX-JS-33	3/22/2001	ND	Field GC	ND	ND	ND	ND	ND	–	ND

TABLE 2.5
HISTORICAL GROUNDWATER SAMPLING RESULTS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Sample Name	Collection Date	Screened Interval (feet bgs)	Laboratory or Field GC Analysis	PCE (µg/L)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	Vinyl Chloride (µg/L)	Toluene (µg/L)	Benzene (µg/L)
OUX-JS-35	8/28/2001	NA	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-36	11/15/2001	468	Field GC	**309.4**	**3.61**	**4.78**	ND	ND	–	ND
OUX-JS-36	11/15/2001	468	Field GC	**345.6**	**4.65**	**8.21**	ND	ND	–	ND
OUX-JS-36	11/15/2001	468	Field GC	**133**	**1.96**	**1.6**	**0.04**	ND	–	ND
OUX-JS-36	11/16/2001	468	Field GC	**432.8**	**6.07**	**11**	**0.09**	ND	–	**1.93**
OUX-JS-36	1/15/2002	NA	Field GC	**115.5**	**12.1**	ND	**5.39**	ND	–	ND
OUX-JS-40	7/25/2002	NA	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-41	7/25/2002	NA	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-42	8/1/2002	NA	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-43	8/1/2002	NA	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-44	8/1/2002	NA	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-45	8/1/2002	NA	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-46	8/1/2002	NA	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-47	8/16/2002	390	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-51	1/29/2002	400	Field GC	ND	ND	ND	ND	ND	–	ND
OUX-JS-51	1/29/2002	147-425	Field GC	ND	ND	ND	ND	ND	–	ND
PB-17*	3/31/1999	NA	Field GC	<0.1	<0.1	–	--	--	–	--

Notes:
Data are from USGS Lab Sample Log and Field GC Log unless otherwise noted.
* Data are from USEPA website (http://mo.water.usgs.gov/epa/nh/Datadocs_files/table00-01.pdf), downloaded May 3, 2004).
** Data are from quarterly monitoring performed by Parsons.
*** Data are from letters to Mayor of New Haven (August 6, 2001 and February 15, 2001) and residents (February 15, 2001).
**** Data are from USGS Contract Laboratory Results Summary.
NA - Not available
ND - Analyte was not detected, however, the detection limit was not specified.
-– Sample was not analyzed for this compound.
Dup - Duplicate sample
E - Result exceeded calibration range, secondary dilution required.
J - Result is an estimated value below the reporting limit or a tentatively identified compound (TIC).
Q - Sample was diluted.

JS-07	JS-27	JS-41	JS-51
JS-10	JS-29	JS-42	JS-52*
JS-11	JS-33	JS-43	DM-21
JS-12	JS-36*	JS-44	PA-53
JS-14*	JS-37	JS-45	PA-55*
JS-15	JS-38*	JS-47	MW-13
JS-20	JS-39	JS-50	MW-2R
JS-25	JS-40	W-3	

Table 2-6: Task 2c – Residential well sampling locations. Also see Figure 2-10.

Figure 5a: Sub-slab sampling results.

SUB-SLAB VAPOR SAMPLING RESULTS
METALCRAFT ENTERPRISES FACILITY
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

	Sub-slab Air Screening Level[1] (µg/m³)		Sample ID	SSVI-SV01-000.4-101204	SSVI-SV02-000.4-101204	SSV2-SV01-000.4-101204	SSV3-SV01-000.4-101204	SSV4-SV01-000.4-101204	SSV5-SV01-000.4-101204	SSV6-SV01-000.4-101204	SSV7-SV01-000.4-101204
	1.00E-06	Non-Cancer	Sample Date	4-Dec-10	4-Dec-10	4-Dec-10	4-Dec-10	4-Dec-10	4-Dec-10	4-Dec-10	4-Dec-10
	Cancer Risk	HI = 1	Units	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³
PCE	20.8	11,900		**7,900**	**7,400 D**	**3,400**	**940 D**	**110**	**6,100 D**	**530 D**	**14**
TCE[2]	61.3	440		**770**	**67**	**750**	**210**	**16**	**700**	**1.6**	**3.9**
cis-1,2-DCE[2]	-	2,630		**120**	**11**	**140**	**100**	**25**	**110**	<0.79	**2.4**
trans-1,2-DCE	-	2,630		**87**	**7.3**	<16	<2.5	<0.79	<16	<0.79	<0.79
Vinyl chloride	27.9	4,380		<16	<0.51	<10	<1.6	**3.0**	<10	<0.51	**<0.51**

1 Sub-slab Air Screening Level = Industrial Indoor Air Screening Level/Attenuation Factor (α), where α = 0.1 (USEPA, 2008).

2 TCE's non-cancer screening level derived using NYSDOH's reference concentration of 1E-02 mg/m³ (NYSDOH, 2006).

3 Inhalation toxicity values are not currently available for *cis*-1,2-DCE. *trans*-1,2-DCE is used as a surrogate.

Bold font indicates positive detection

D Indicates sample diluted to be within range of instrument

Results exceed the Sub-Slab Air Screening Level

Sample SVI-SV02-000.4-101204 is a replicate sample of SSVI-SV01-000.4-101204

Table 5b: Indoor air sampling results.

INDOOR AIR SAMPLING RESULTS
METALCRAFT ENTERPRISES FACILITY
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

	Industrial Indoor Air Screening Level (µg/m³)			Sample ID	ME05-IA01-110129	ME05-IA02-110129	ME03-IA01-110129	ME04-IA01-110129	ME06-IA01-110129	ME08-IA02-110129	ME09-IA01-110129	ME07-IA01-110129	ME03-IA01-110129	ME05-IA01-110129	ME01-AM01-110129
				Inlet Height (inches)	91	97	66.5	58	63	63	64.5	77	66.5	56	48
	1.00E-04	1.00E-06	Non-Cancer	Sample Date	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011	Jan 29-30, 2011
	High End Cancer Risk Range	Low End Cancer Risk Range	HI = 1	Units	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³	ug/m³
PCE	208	2.08	1,190		**19**	**13**	**16**	**11**	**17**	**14**	**21**	**16**	**20**	**24**	< 1.4
TCE[1]	613	6.13	44		**2.4**	**1.9**	**2.2**	**1.3**	**1.8**	**1.6**	**5.2**	**1.3**	**2.1**	**2.6**	< 1.1
cis-1,2-DCE[2]	-	-	283		**2.1**	**1.5**	**1.9**	**0.92**	**1.3**	**1.2**	**2.4**	**0.93**	**1.4**	**0.99**	< 0.79
trans-1,2-DCE	-	-	283		< 0.79	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79
Vinyl chloride	279	2.79	438		< 0.51	< 0.51	< 0.51	< 0.51	< 0.51	< 0.51	< 0.51	< 0.51	< 0.51	< 0.51	< 0.51

1 TCE's non-cancer screening level derived using NYSDOH's reference concentration of 1E-02 mg/m³ (NYSDOH, 2006).
2 Inhalation toxicity values are not currently available for *cis*-1,2-DCE. *trans*-1,2-DCE is used as a surrogate.
Bold font indicates positive detection
D Indicates sample diluted to be within range of instrument
Results within the low end and high end of the cancer Industrial Indoor Air Risk Range
Sample ME05-IA02-110129 is a duplicate sample of ME05-IA01-110129
Sample ME01-AM01-110129 is an ambient sample collected approximately 150 feet west of the Metalcraft Facility.

Table 5-1

GEOLOGIC UNITS OF THE OZARK AQUIFER
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

System	Formation	Approximate Thickness (Feet)	General Lithology	General Hydrologic Properties
Ordovician	St. Peter Sandstone	Less than 40	Fine-grained cemented quartz sandstone.	Yields of 10 to 50 gpm where moderately thick.
	Powell Dolomite	0 to 95	Difficult to differentiate. Crystalline cherty dolostone with abundant thin shale partings and occasional thin sandstone beds. Thicker (2 to 10 feet thick) sandstone beds in Cotter. Within the Cotter, the upper sandstone marker bed and the Swan Creek sandstone member are important marker horizons and are laterally persistent.	Adequate for small domestic supply. Yields of 5 to 15 gpm locally. Less permeable than surrounding units and impedes downward water movement. Within the Cotter, the upper sandstone marker bed and the Swan Creek sandstone member are laterally persistent permeable zones.
	Cotter Dolomite	85 to 300		
	Jefferson City Dolomite	150 to 165		
	Roubidoux Formation	110 to 120	Cherty, sandy dolostone. Middle 20 to 30 feet is clean sandstone.	Normal yields of 15 to 50 gpm. Target unit for newer domestic wells.
	Upper Gasconade Dolomite	35 to 50	Massively bedded, crystalline dolostone.	Lower permeability than surrounding units.
	Lower Gasconade Dolomite	200 to 240	Cherty dolostone with massive chert beds.	Combined yields of upper and lower units range from 50 to 75 gpm.
	Gunter Sandstone Member of Gasconade Dolomite	35 to 50	Dolostone with less than 10 percent sand.	Normal yield of 40 to 50 gpm, but 200 to 500 gpm locally.
Cambrian	Eminence Dolomite	145 to 180	Crystalline dolostone with less than 5 percent chert and sand.	Yields of 75 to 250 gpm.
	Potosi Dolomite	Greater than 170	Crystalline dolostone with abundant small solution cavities and quartz druse.	Target zone of most high capacity wells. Yields 200 to 1,000 gpm.

Notes:
Table reproduced from Focused Remedial Investigation of OU1 and OU3, January 2003.
gpm - gallons per minute

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS IN OVERBURDEN NORTH OF BOEUF LUTHERAN ROAD (TASK 2B)
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

	Screening Criteria	Lab ID	500-18318-1	500-18318-3	500-18318-4	500-18318-5	500-18318-6	500-18367-3	500-18367-2
		Sample Date	15-Apr-09	15-Apr-09	16-Apr-09	16-Apr-09	16-Apr-09	17-Apr-09	17-Apr-09
		Sample Depth (feet)	42	39.4	32.5	29.5	29.5	12.3	5.2
		Sample ID	CSE04-GW01-042.0-090415	CSE05-GW01-039.4-090415	CSE08-GW01-032.5-090416	CSE07-GW01-029.5-090416	CSE07-GW02-029.5-090416	CSE08-GW01-012.3-090417	CSE10-GW01-005.2-090417
VOCs		UNITS:							
Acetone	2,970	ug/L	R	R	5.4 J	R	R	R	R
Trichloroethene	5	ug/L	63	220	46	47	65	95	ND
Tetrachloroethene	5	ug/L	1500 +	2800 +	590 +	710 +	870 +	560 +	ND
1,2-Dichloroethene, Total	70	ug/L	32	64	8.4	9	11	27	ND

Notes:
Screening Criteria: The analytical data were compared to the Missouri Default Target Levels (Table B-1) or the USEPA MCLs (as applicable)
There is no screening criterion for 1,2-DCE(total). The MCL for cis-1,2-DCE was used
NA: Not Applicable
Blank Cells: Parameter Not Analyzed
ND: compound was not detected
J: estimated concentration
+: results reported from diluted samples
R: rejected data
Bolded values: detected
Shaded values: exceeded screening criteria
Shaded sample ID indicates duplicate sample

Table 5-2: Groundwater sampling results in unconsolidated deposits north of Boeuf Lutheran Road.

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS IN OVERBURDEN NORTH OF BOEUF LUTHERAN ROAD (TASK 2B)
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

	Screening Criteria	Lab ID	500-18318-7	500-18318-8	500-18367-5	500-11381-1	500-11379-6	500-11379-4	500-11381-2
		Sample Date	16-Apr-09	16-Apr-09	17-Apr-09	14-May-08	14-May-08	14-May-08	15-May-08
		Sample Depth (feet)	4.5	6	27.4	8	27.4	27.4	16
		Sample ID	CSE11-GW01-004.5-090416	CSE12-GW01-006.0-090416	CSN01-GW01-027.4-090417	CSN2-GW01-008.0-080514	CSN2-GW01-027.4-080515	CSN2-GW02-027.4-080514	CSN3-GW01-016.0-080515
VOCs		UNITS:							
Acetone	2,970	ug/L	R	10 J	R	11	35 J+	ND	ND
Trichloroethene	5	ug/L	ND	ND	**80**	ND	**17 +**	**15 +**	ND
Tetrachloroethene	5	ug/L	ND	**1.2**	**720 +**	ND	**170 +**	**300 +**	ND
1,2-Dichloroethene, Total	70	ug/L	ND	ND	**31**	ND	**4.2 +**	**3.1 +**	ND

Notes:
Screening Criteria: The analytical data were compared to the Missouri Default Target Levels (Table B-1) or the USEPA MCLs (as applicable)
There is no screening criterion for 1,2-DCE (total). The MCL for cis-1,2-DCE was used
NA: Not Applicable
Blank Cells: Parameter Not Analyzed
ND: compound was not detected
J: estimated concentration
+: results reported from diluted samples
R: rejected data
Bolded values: detected
Shaded values: exceeded screening criteria
Shaded sample ID indicates duplicate sample

Table 5-2: Groundwater sampling results in unconsolidated deposits north of Boeuf Lutheran Road.

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS IN OVERBURDEN NORTH OF BOEUF LUTHERAN ROAD (TASK 2B)
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

	Screening Criteria	Lab ID	500-11379-7	500-11379-5	500-11402-2	500-18367-4
		Sample Date	15-May-08	15-May-08	16-May-08	17-Apr-09
		Sample Depth (feet)	25.7	26.8	27	33.7
		Sample ID	CSN3-GW01-025.7-080515	CSN4-GW01-026.8-080515	CSN5-GW01-027.0-080516	CSN06-GW01-033.7-090417
VOCs		UNITS:				
Acetone	2,970	ug/L	ND	**5.6** +	**12**	R
Trichloroethene	5	ug/L	**4.4**	**34** +	**70**	**56**
Tetrachloroethene	5	ug/L	**52**	**260** +	**780** +	**770** +
1,2-Dichloroethene, Total	70	ug/L	ND	**8.1** +	**11**	**9.6**

Notes:
Screening Criteria: The analytical data were compared to the Missouri Default Target Levels (Table B-1) or the USEPA MCLs (as applicable)
There is no screening criterion for 1,2,-DCE(total). The MCL for cis-1,2-DCE was used
NA: Not Applicable
Blank Cells: Parameter Not Analyzed
ND: compound was not detected
J: estimated concentration
+: results reported from diluted samples
R: rejected data
Bolded values: detected
Shaded values: exceeded screening criteria
Shaded sample ID indicates duplicate sample

Table 5-2: Groundwater sampling results in unconsolidated deposits north of Boeuf Lutheran Road.

Table 7-1: Chemicals of Potential Concern.

PHYSICAL PROPERTIES FOR CHEMICALS OF POTENTIAL CONCERN

Riverfront Superfund Site - OU2/OU6

COPC[a]	CAS Number[a]	Parameter Value[a] H'	Ref[a]	D^{air} (cm^2/s)[a]	Ref	D^{wat} (cm^2/s)[a]	Ref	Koc (L/kg)[a]	Ref	Kd (cm^3/g)[a]	Ref	OAF	Ref	DAF	Ref
Volatile Organic Compounds															
Methylene Chloride	75-09-2	1.30E-01	RSL	1.00E-01	RSL	1.35E-05	RSL	2.37E+01	RSL	1.42E-01	CA	**	U	--	-
Naphthalene	91-20-3	1.80E-02	RSL	6.00E-02	RSL	8.40E-06	RSL	1.84E+03	RSL	1.10E+01	CA	**	U	0.13	U
Tetrachloroethylene (PCE)	127-18-4	7.20E-01	RSL	5.00E-02	RSL	9.50E-06	RSL	1.07E+02	RSL	6.42E-01	CA	**	U	--	-
Trichloroethylene (TCE)	79-01-6	4.00E-01	RSL	6.90E-02	RSL	1.00E-05	RSL	6.77E+01	RSL	4.06E-01	CA	**	U	--	-
1,2-Dichloroethene, total	540-59-0	1.70E-01	RSL	9.00E-02	RSL	1.10E-05	RSL	4.38E+01	RSL	2.63E-01	CA	**	U	--	-
Vinyl Chloride	75-01-4	1.10E+00	RSL	1.10E-01	RSL	1.20E-05	RSL	2.37E+01	RSL	1.42E-01	CA	**	U	--	-
Semivolatile Organic Compounds															
Benzo(a)anthracene	56-55-3	4.90E-04	RSL	5.10E-02	SSL	9.00E-06	SSL	2.31E+05	RSL	1.39E+03	CA	**	U	0.13	U
Benzo(a)pyrene	50-32-8	1.90E-05	RSL	4.30E-02	SSL	9.00E-06	SSL	7.87E+05	RSL	4.72E+03	CA	**	U	0.13	U
Chrysene	218-01-9	2.10E-04	RSL	2.48E-02	SSL	6.21E-06	SSL	2.36E+05	RSL	1.42E+03	CA	**	U	0.13	U
Hexachlorobenzene	118-74-1	7.00E-02	RSL	5.42E-02	SSL	5.91E-06	SSL	3.38E+03	RSL	2.03E+01	CA	**	U	0.1	U
4-bromophenyl phenyl ether	101-55-3	--	-	--	-	--	-	--	-	--	-	--	-	--	-
Inorganics															
Arsenic	7440-38-2	--	NU	--	NU	--	NU	--	NU	31	SSL	**	U	0.03	U

[a] Parameters defined as: H' = Henry's law constant (unitless); D^{air} = Diffusivity in air; D^{wat} = Diffusivity in water; Koc = Organic carbon partition coefficient; Kd = Soil-water partition coefficient; OAF = Oral absorption factor; DAF = Dermal absorption factor.

[b] COPC = Chemical of potential concern.

[c] CAS = Chemical abstracts service number.

[d] Ref = References, RSL = USEPA (2009, Inorganic K_d value based on a site specific pH of 8.0); U = USEPA (2004b); CA = Calculated per USEPA (1996a) guidance, NU = Not used.

[e] Units are defined as: cm^2/s = Square centimeters per second, L/kg = Liters per kilogram, and cm^3/g = Cubic centimeters per gram.

[f] "***" = Per USEPA (2001b) guidance, toxicity factors were not adjusted for chemicals with gastrointestinal absorption values greater than 50-percent.

[g] "--" = Data unavailable.

Table 7-2: Exposure Point Concentrations for OU2 and OU6.

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

Riverfront Superfund Site - OU2/OU6

Scenario Timeframe:	Current/Future
Medium:	Groundwater-shallow (on-site)
Exposure Medium:	Ambient Air

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
	Naphthalene	mg/l	NA	NA	2.90E-04	2.90E-04	mg/l	max.	Few samples
	1,2-Dichloroethene (total)	mg/l	NA	NA	7.80E-02	7.80E-02	mg/l	max.	Less than 20 samples
	Methylene chloride	mg/l	NA	NA	1.90E-02	1.90E-02	mg/l	max.	Less than 20 samples
	Tetrachloroethene	mg/l	NA	NA	1.90E+02	1.90E+02	mg/l	max.	Less than 20 samples
	Trichloroethene	mg/l	NA	NA	1.50E-01	1.50E-01	mg/l	max.	Less than 20 samples

NA - Not applicable max. - maximum concentration

See Table 4 for maximum concentrations of COPCs in shallow groundwater presented in this table.

Table 7-3: Exposure Point Concentrations for OU2 and OU6.

EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Riverfront Superfund Site - OU2/OU6

Scenario Timeframe:	Future
Medium:	Groundwater-Deep
Exposure Medium:	Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Tap Water	Methylene Chloride	mg/l	NA	NA	5.20E-03	5.20E-03	mg/l	max.	Standard Practice
	Tetrachloroethene	mg/l	NA	NA	4.91E+02	4.91E+02	mg/l	max.	Standard Practice

NA - Not applicable

max. - maximum concentration

See Table 5 for maximum concentrations of COPCs in deep groundwater presented in this table.

Table 7-4: Exposure Point Concentrations for OU2 and OU6.

EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Riverfront Superfund Site - OU2/OU6

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
Surface Soil (<3 feet)	Arsenic	mg/kg	NA	NA	5.10E+00	5.10E+00	mg/kg	Max	Few samples
	Benzo(a)pyrene	mg/kg	NA	NA	3.60E-02	3.60E-02	mg/kg	Max	Few samples
	Tetrachloroethene	mg/kg	2.29E+00	7.26E+00	2.30E+01	7.26E+00	mg/kg	99% KM (Chebyshev) UCL	representative
Residential Mixed Soil (0-10 feet)	Arsenic	mg/kg	5.06E+00	NA	1.50E+01	1.50E+01	mg/kg	Max	Few samples
	Benzo(a)pyrene	mg/kg	2.90E-02	NA	3.60E-02	3.60E-02	mg/kg	Max	Few samples
	Tetrachloroethene	mg/kg	8.94E+00	3.04E+01	2.90E+02	3.04E+01	mg/kg	97.5% KM (Chebyshev) UCL	representative

(1) recommended UCL values per ProUCL distributions. (2) ProUCL recommended distributions. max. = maximum concentration

EXPOSURE POINT CONCENTRATION SUMMARY

REASONABLE MAXIMUM EXPOSURE

Riverfront Superfund Site - OU2/OU6

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Indoor Air

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
On-property Building	Tetrachloroethene	ug/m^3	--	--	3.90E+04	3.90E+04	ug/m^3	max.	Standard Practice

(1) Recommended UCL values per ProUCL distributions. "--" not calculated.

(2) ProUCL recommended distributions. Max.- maximum concentration

Table 7-5: Exposure Point Concentrations for OU2 and OU6.

Table 7-6: Exposure Point Concentrations for OU2 and OU6.

EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Riverfront Superfund Site - OU2/OU6

Scenario Timeframe:	Current/Future
Medium:	Sediments
Exposure Medium:	Sediments

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
Boeuf Creek	Benzo(a)pyrene	mg/kg	--	--	3.52E-02	3.52E-02	mg/kg	max.	Only Sample
Tributaries	Arsenic	mg/kg	--	--	2.40E+01	2.40E+01	mg/kg	max.	Only Sample

(1) Recommended UCL values per ProUCL distributions. "--" not calculated. (2) ProUCL recommended distributior Max.- maximum concentration

Table 7-7: Exposure Point Concentrations for OU2 and OU6.

EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Riverfront Superfund Site - OU2/OU6

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Surface Water

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale
Boeuf Creek Tributaries	Methylene Chloride	mg/L	NA	NA	7.50E-03	7.50E-03	mg/L	max.	Standard practice
	Tetrachloroethene	mg/L	2.18E+01	3.02E+01	1.00E-01	3.02E+01	mg/L	95% KM (Chebyshev) UCL	Standard practice
	Trichloroethene	mg/L	NA	NA	1.26E-02	1.26E-02	mg/L	max.	Standard practice
	Vinyl chloride	mg/L	NA	NA	3.37E-02	3.37E-02	mg/L	max.	Standard practice
	Benzo(a)anthracene	mg/L	NA	NA	1.60E-04	1.60E-04	mg/L	max.	Only sample
	Benzo(b)fluoranthene	mg/L	NA	NA	4.20E-05	4.20E-05	mg/L	max.	Only sample
	Chrysene	mg/L	NA	NA	6.70E-05	6.70E-05	mg/L	max.	Only sample
	Hexachlorobenzene	mg/L	NA	NA	6.50E-05	6.50E-05	mg/L	max.	Only sample

(1) recommended UCL values per ProUCL distributions. NA-Not calculated.
(2) ProUCL recommended distributions. Max.- maximum concentration

EXPOSURE POINT CONCENTRATIONS ASSOCIATED WITH SOIL EXPOSURE

REASONABLE MAXIMUM EXPOSURE

Riverfront Superfund Site - OU2/OU6

Chemical of Potential Concern	Surface Soil (0-3') mg/kg	Mixed Soil (0-10') mg/kg
Tetrachloroethylene	7.26E+00	3.04E+01
Benzo(a)pyrene	3.60E-02	3.60E-02
Arsenic	5.10E+00	1.50E+01

Table 7-8: Exposure Point Concentrations for OU2 and OU6.

Table 7-9: COPCs for non-cancer toxicity data (oral/dermal) for OU2 and OU6.

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

Rivertront Superfund Site - OU2/OU6

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal	Absorbed RfD for Dermal		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units	(1)	Value (2)	Units			Source(s) (3)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	3.00E-04	mg/kg-day	1	3.00E-04	mg/kg-day	Skin	3	IRIS	04/01/09
	Subchronic	3.00E-04	mg/kg-day	1	3.00E-04	mg/kg-day	Skin	3	HEAST	1997
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chrysene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Naphthalene	Chronic	2.00E-02	mg/kg-day	1	2.00E-02	mg/kg-day	Body weight	3000	IRIS	04/01/09
	Subchronic	6.00E-01	mg/kg-day	1	6.00E-01	mg/kg-day	Body weight	3000	ATSDR	2009
Methylene chloride	Chronic	6.00E-02	mg/kg-day	1	6.00E-02	mg/kg-day	Liver	100	IRIS	04/01/09
	Subchronic	6.00E-02	mg/kg-day	1	6.00E-02	mg/kg-day	Liver	100	HEAST	1997
Tetrachloroethene	Chronic	1.00E-02	mg/kg-day	1	1.00E-02	mg/kg-day	Liver	1000	IRIS	04/01/09
	Subchronic	1.00E-01	mg/kg-day	1	1.00E-01	mg/kg-day	Liver	1000	HEAST	1997
Trichloroethylene	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A
1,2-Dichloroethylene, total	Chronic	9.00E-03	mg/kg/day	1	9.00E-03	mg/kg/day	Liver	1000	RSL	04/01/09
	Subchronic	1.00E-01	mg/kg-day	1	1.00E-01	mg/kg-day	Blood	1000	PPRTV	2009
Hexachlorobenzene	Chronic	8.00E-04	mg/kg/day	1	8.00E-04	mg/kg/day	Liver	100	IRIS	04/01/09
Vinyl chloride	Chronic	3.00E-03	mg/kg/day	1	3.00E-03	mg/kg/day	Liver	30	IRIS	08/07/00

(1) Source: see Table 10.

(2) RfDABS = RfDo X ABSGI

(3) For IRIS values, the date IRIS was searched is provided.
For HEAST values, a reference to the PRGs is provided.
For NCEA values, a reference to the PRGs is provided.

IRIS = Integrated Risk Information System
NCEA = National Center for Environmental Assessment
RSL = U.S. EPA Regional Screening Levels
HEAST= Health Effects Assessment Summary Tables

N/A = Not Applicable or Not Available

NON-CANCER TOXICITY DATA -- INHALATION

Riverfront Superfund Site - OU2/OU6

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units			Source(s) (2)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	3.00E-05	mg/m^3			CAL	
	Subchronic						
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chrysene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Naphthalene	Chronic	3.00E-03	mg/m^3	nasal	3000	IRIS	10/1/09
	Subchronic						
Methylene chloride	Chronic	1.10E+00	mg/m^3	Liver	100	ATSDR	2009
	Subchronic						
Tetrachloroethene	Chronic	2.70E-01	mg/m^3	N/A	N/A	ATSDR	2009
	Subchronic						
Trichloroethylene	Chronic	1.00E-02	mg/m^3	Lung	N/A	NY	2006
	Subchronic						
1,2-Dichloroethylene, total	Chronic	6.00E-02	mg/m3			USEPA	2009
	Subchronic						
Hexachlorobenzene	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vinyl Chloride	Chronic	1.00E-01	mg/m3	Liver	30	IRIS	08/07/00
	Subchronic						

N/A = Not Applicable or Not Available

(2) For IRIS values, the date IRIS was searched is provided.
For HEAST values, a reference to the RSLs is provided.
For NCEA values, a reference to the RSLs is provided.

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
RSL = U.S. EPA Regional Screening Levels Tables
Cal = California Toxicity Criteria Database

Table 7-10: COPCs for non-cancer toxicity data (inhalation) for OU2 and OU6.

Table 7-11: COPCs for cancer toxicity data (oral/dermal) for OU2 and OU6.

CANCER TOXICITY DATA – ORAL/DERMAL

Riverfront Superfund Site - OU2/OU6

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units	(1)	Value (2)	Units	(3)	Source(s) (4)	Date(s) (MM/DD/YYYY)
Arsenic	1.50E+00	(mg/kg-day)$^{-1}$	1	1.50E+00	(mg/kg-day)$^{-1}$	A	IRIS	10/2/09
Benzo(a)anthracene	7.30E-01	(mg/kg-day)$^{-1}$	1	7.30E-01	(mg/kg-day)$^{-1}$	B2	IRIS	10/2/09
Benzo(a)pyrene	7.30E+00	(mg/kg-day)$^{-1}$	1	7.30E+00	(mg/kg-day)$^{-1}$	B2	IRIS	10/2/09
Benzo(b)fluoranthene	7.30E-01	(mg/kg-day)$^{-1}$	1	7.30E-01	(mg/kg-day)$^{-1}$	B2	IRIS	10/2/09
Chrysene	7.30E-03	(mg/kg-day)$^{-1}$	1	7.30E-03	(mg/kg-day)$^{-1}$	B2	IRIS	10/2/09
Naphthalene	N/A	N/A	N/A	N/A	N/A	C	IRIS	10/2/09
Methylene chloride	7.50E-03	(mg/kg-day)$^{-1}$	1	7.50E-03	(mg/kg-day)$^{-1}$	B2	IRIS	10/2/09
Tetrachloroethene	5.40E-01	(mg/kg-day)$^{-1}$	1	5.40E-01	(mg/kg-day)$^{-1}$	N/A	IRIS	10/2/09
Trichloroethylene	1.30E-02	(mg/kg-day)$^{-1}$	1	1.30E-01	(mg/kg-day)$^{-1}$	B1	CALEPA	10/2/09
1,2-Dichloroethylene, total	N/A	N/A	1	N/A	N/A	D	IRIS	10/2/09
Hexachlorobenzene	1.60E+00	(mg/kg-day)-1	1	1.60E+00	(mg/kg-day)-1	B2	IRIS	10/2/09
Vinyl Chloride	7.20E-01	(mg/kg-day)-1	1	7.20E-01	(mg/kg-day)-1	A	IRSI	10/2/09

(1) Source: see Table 10.

(2) $SF_{ABS} = \frac{SF_O}{ABS_G}$

(3) Weight of Evidence/EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

(4) IRIS = Integrated Risk Information System

RSL = U.S. EPA Regional Screening Levels

CALEPA = California

N/A = Not Applicable or Not Available

Table 7-12: COPCs toxicity data (inhalation) for OU2 and OU6.

CANCER TOXICITY DATA – INHALATION
Riverfront Superfund Site - OU2/OU6

Chemical of Potential Concern	Unit Risk		Weight of Evidence/ Cancer Guideline Description (2)	Unit Risk : Inhalation CSF	
	Value	Units		Source(s) (3)	Date(s) (MM/DD/YYYY)
Arsenic	4.30E-03	$(\mu g/m^3)^{-1}$	A	IRIS	10/2/09
Benzo(a)anthracene	1.10E-04	$(\mu g/m^3)^{-1}$	B2	CAL	2009
Benzo(a)pyrene	1.10E-03	$(\mu g/m^3)^{-1}$	B2	CAL	2009
Benzo(b)fluoranthene	1.10E-04	$(\mu g/m^3)^{-1}$	B2	CAL	2009
Chrysene	1.10E-05	$(\mu g/m^3)^{-1}$	B2	CAL	2009
Naphthalene	3.40E-05	$(\mu g/m^3)^{-1}$	C	CAL	10/2/09
Methylene chloride	4.70E-07	$(\mu g/m^3)^{-1}$	B2	IRIS	10/2/09
Tetrachloroethene	5.90E-06	$(\mu g/m^3)^{-1}$	N/A	CAL	2004
Trichloroethylene	2.00E-06	$(\mu g/m^3)^{-1}$	B1	CAL	2004
1,2-Dichloroethylene, total	N/A	N/A	D	IRIS	10/2/09
Hexachlorobenzene	4.60E-04	$(\mu g/m^3)^{-1}$	B2	IRIS	N/A
Vinyl chloride	4.40E-06	$(\mu g/m^3)^{-1}$	A	IRIS	8/7/00

(1) SFi = Unit Risk x Adjustment Factor or Inhalation RfD

(2) Weight of Evidence/EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

(3) IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
RSL = U.S. EPA Regional Screening Levels
N/A = Not applicable or Not available
For IRIS values, the date IRIS was searched is provided.
For HEAST values, a reference of the PRGs is provided.

Applicable Compounds	Target Concentration (ug/kg)	Basis
SURFACE SOILS – Pathway: Prevent direct contact with impacted surface soils and consumption of impacted food		
PCE	9,920	Region 5 ESL
Applicable Compounds	**Target Level (ug/L)**	**Basis**
SURFACE WATER – Pathway: Prevent direct contact with impacted surface water		
PCE	111	Region 3 BTAG
(Note: detected concentrations of PCE at OU2 and OU6 were below the Region 3 BTAG target level.)		
Applicable Compounds	**Target Level (ug/kg)**	**Basis**
SEDIMENT – Pathway: Prevent direct contact with impacted sediment		
PCE	468	Region 3 BTAG
(Note: detected concentrations of PCE at OU2 and OU6 were below this target level.)		

PCE = Tetrachloroethylene
ESL = Ecological Screening Level

Table 8.1: RAOs for ecological receptors.

REGULATION	BRIEF SUMMARY	ALTERNATIVES [1]													COMMENTS ON APPLICABILITY
		1	2a	2b	2c	2d	3a	3b	4a	4b	4c	4d	5	6	
40 CFR 141	National primary drinking water standards: Establish maximum contaminant levels (MCLs), which are health based standards for public water systems and non-enforceable drinking water quality goals (MCLGs). The MCLGs are set to levels that produce no known or anticipated adverse health effect.	NC	C	C	C	C	C	C	C	C	C	C	C	C	The MCLs for organic constituents are relevant and appropriate to impacted groundwater in a potential or actual drinking water aquifer. This would apply to the isolated impacts in the lower Jefferson City / Roubidoux formation that is used as a potable water source. Alternative 1 would not include the continued operation of the whole house treatment units and would not provide any protection against use of impacted water in the isolated areas where the potable water aquifer is used as a residential potable water source. Alternatives 2a, 2c, 3a, 4a, 4b, 4c, 4d, 5, and 6 include whole house treatment systems to treat the extracted groundwater in the impacted areas of the potable water aquifer prior to use. Over time, the extracted groundwater would meet RAOs. Alternatives 2b, 2d, and 3b provide an alternate water source and seals off the impacted aquifer from use as a potable water source in the area of impacted water. The impacted groundwater is anticipated to disperse and dissipate before it would reach any other receptors.
40 CFR 143	National Secondary Drinking Water Standards: Establish secondary maximum contaminant levels (SMCLs), which are non-enforceable guidelines for public water systems to protect the aesthetic quality of the water.	C	C	C	C	C	C	C	C	C	C	C	C	C	SMCLs may be relevant and appropriate if treated groundwater is used as a source of drinking water. None of the SMCL parameters are affected by the isolated impacted groundwater in the lower Jefferson City / Roubidoux formation.
40 CFR 144 – 147	Underground Injection Control (UIC) Regulations: Provides for protection of underground sources of drinking water.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	If an alternative involves underground injection in a drinking water aquifer, this part would be applicable or relevant and appropriate. Alternatives 2c, 2d, 4b, 4c, 4d, 5, and 6 involve injection of remediation materials; however the injection will be in the unconsolidated material and upper bedrock containing non-potable drinking water, not in the lower Jefferson City / Roubidoux formation that is a drinking water aquifer. .
42 USC 4901	Noise Control Act: Activities must not result in noise that will jeopardize the health or welfare of the public.	C	C	C	C	C	C	C	C	C	C	C	C	C	Regulation is handled on a state and local level. All alternatives would mandate compliance with noise regulations.
10 CSR 25-3.260 (1)(H)2	Waste Characterization: Requires that wastes at the site be characterized to determine if the wastes meets the definition of hazardous waste in the citation.	C	C	C	C	C	C	C	C	C	C	C	C	C	This standard would apply to alternatives that require collection and disposal of material off-site. This would include drill cuttings, water from monitoring activities, DNAPL extraction, and extracted material from thermal process. For all alternatives, waste materials would be characterized prior to disposal.
10 CSR 25-4.261	Identification and Listing of Hazardous Waste: Defines those solid wastes which are subject to regulations as hazardous wastes under 10CFR25.	C	C	C	C	C	C	C	C	C	C	C	C	C	This standard would apply to alternatives that require collection and disposal of material off-site. This would include drill cuttings, water from monitoring activities, DNAPL extraction, and extracted material from thermal process. For all alternatives, waste materials would be characterized prior to disposal.

[1] C = Complies with ARAR NC = Does not comply with ARAR NA = ARAR is not applicable

Table 10.1: Evaluation of ARARs for Alternatives 2 through 6.

REGULATION	BRIEF SUMMARY	ALTERNATIVES[1]													COMMENTS ON APPLICABILITY
		1	2a	2b	2c	2d	3a	3b	4a	4b	4c	4d	5	6	
10 CSR 25-18.018	Missouri Risk Based Corrective Action (MRBCA): Outlines a risk based process for determining cleanup goals at sites with known or suspected hazardous substance contamination.	NC	C	C	C	C	C	C	C	C	C	C	C	C	This process was used for the risk assessment and determining the remedial action objectives. Compliance is relative to meeting remedial action objectives. See discussion above regarding MCLs.
10 CSR 20-7.031 (2)	Missouri Water Quality Standards: Outlines the antidegradation criteria for protection of waters of the state, surface water bodies and groundwater	NC	C	C	C	C	C	C	C	C	C	C	C	C	The requirements of the antidegradation policy tier 1 are met for Alternatives 2A through 6. Tier 2 and tier 3 do not apply as the existing water quality is not better than applicable water quality criteria (tier 2) and none of the receiving streams are listed in tables D and E of the regulation as outstanding resource waters (tier 3).
10 CSR 20-7.031 (3)	Missouri Water Quality Standards: Outlines the general water quality criteria for protection of waters of the state	C	C	C	C	C	C	C	C	C	C	C	C	C	The General Criteria water quality criteria are met for Alternatives 2A through 6.
10 CSR 20-7.031 (4)	Missouri Water Quality Standards: Outlines the specific criteria for protection of classified waters	NC	C[1]	C[1]	C[1]	C[1]	C[1]	C[1]	C[1]	C[1]	C[1]	C[1]	C[1]	C[1]	This standard would apply to alternatives that include discharges into the 500 tributary north of Boeuf Lutheran Road which is included as a classified stream in Table H of 10 CSR 20-7.031 (samples have exceeded criteria for human health – fish consumption in table A). The Human Health Risk Assessment determined that the segment of the stream impacted is too small to be considered fishable waters. A waiver of the regulations may be required. The 700 tributary is not a classified stream and does not fall under this standard. [1] The 500 tributary is too small to be considered fishable waters so the criteria are not applicable.
10 CSR 20-7.031 (5)	Missouri Water Quality Standards: Outlines the specific criteria for protection of groundwater	NC	C	C	C	C	C	C	C	C	C	C	C	C	This regulation is not applicable to the upper sandstone formation where the majority of the impacted groundwater is located as it does not fall under the definition of an aquifer. Alternatives 2b, 2d, and 3b would have isolated pockets of groundwater above MCLs to remain after wells are abandoned. These COPCs would disperse before reaching any receptors. Alternatives 2a, 2c, 3a, 4a, 4b, 4c, 4d, 5, and 6 have the impacted groundwater pumped and run through a treatment system controlling migration of the impacted groundwater.
10 CSR 10-6	Missouri Air Pollution Control Program: Ambient concentrations of VOCs should be less than their respective acceptable ambient air levels at the Site boundary.	NA	NA	NA	NA	NA	C	C	C	C	C	C	NA	NA	These requirements would be relevant and appropriate for alternatives 3a, 3b, 4a, 4b, and 4c which potentially involve discharge of contaminants to the air as the thermal treatment process includes removal using vapor extraction.
10 CSR 23	Well Construction Code: Regulates the construction and abandonment of domestic water wells (23-3) and monitoring wells (23-4).	NA	C	C	C	C	C	C	C	C	C	C	C	C	If an alternative includes installing new or abandoning wells, these requirements may be applicable or relevant and appropriate.

[1] C – Complies with ARAR NC – Does not comply with ARAR NA – ARAR is not applicable

Table 10.1: Evaluation of ARARs for Alternatives 2 through 6.