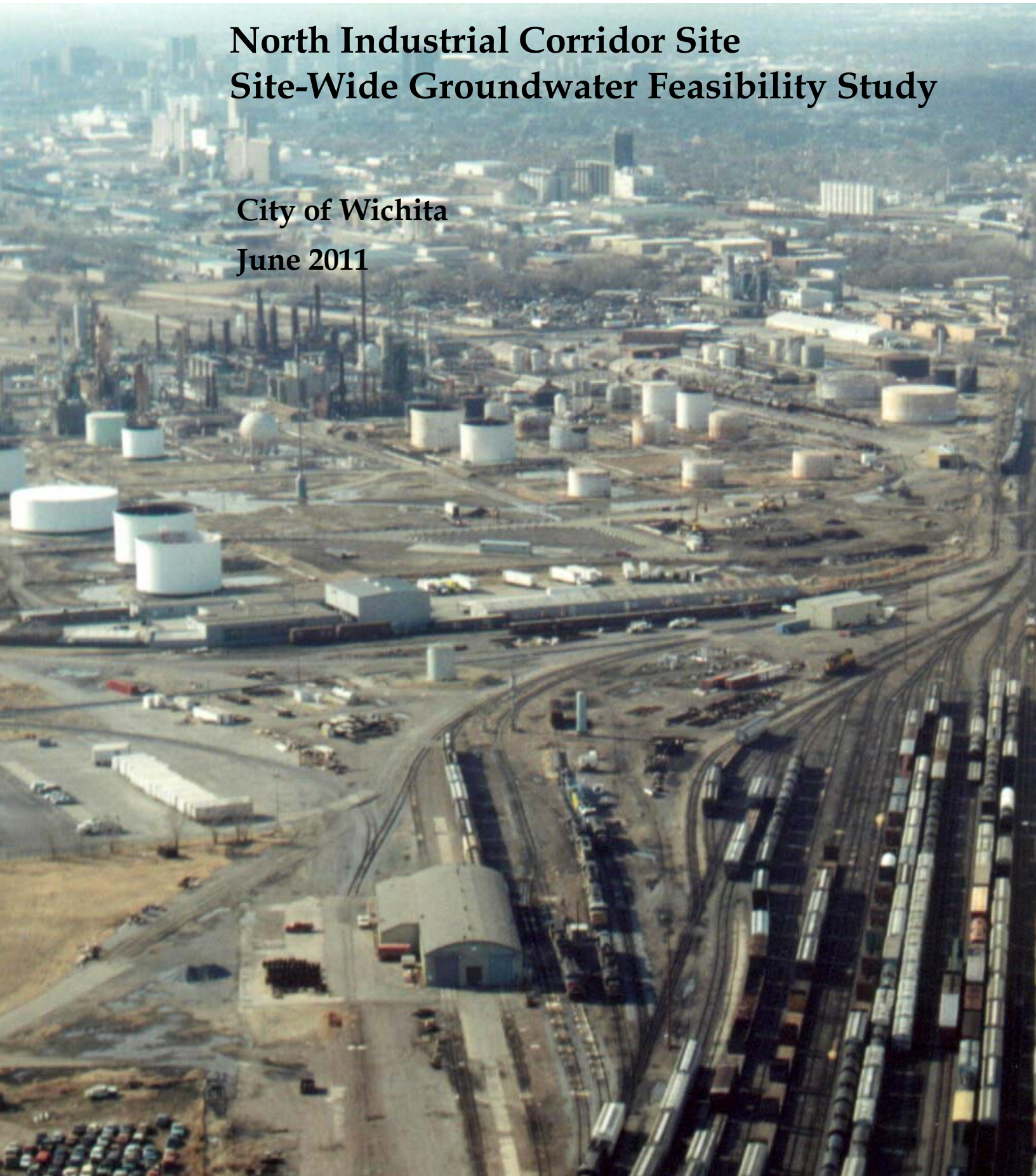
CDM

North Industrial Corridor Site
Site-Wide Groundwater Feasibility Study



City of Wichita

June 2011

City of Wichita

Site-Wide Groundwater Feasibility Study
North Industrial Corridor Site

June 2011

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Report

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Acronyms and Abbreviations

ACB	Altra Color Body Shop [facility]
ACE	Acetone
ACS	Aero Space Controls, Inc. [facility]
AOC	Area of concern
ARARs	Applicable or Relevant and Appropriate Requirements
AS	Air sparge
AST	Above ground storage tank
ATG	Alternate target goal
ATS	A&A Auto and Truck Salvage [facility]
BDCM	Bromodichloromethane
BEN	Benzene
BER	Bureau of Environmental Remediation
BFI	Browning-Ferris Industries [facility]
BFM	Bromofluoromethane
bgs	Below ground surface
BLRA	Baseline human health risk assessment
bmp	below measuring point
BRA	Baseline risk assessment
BRND	former Barnsdall Refinery [facility]
BTEX	Benzene, toluene, ethylbenzene, and xylenes
C12DCE	cis-1,2-Dichloroethene (*cis*-1,2-DCE)
CAD	Corrective action decision
CAH	Chlorinated aliphatic hydrocarbon
CAS	Corrective action study
CBN	Chlorobenzene
CBY	former Coastal Refining and Marketing, Inc. Boneyard [facility]
CDM	Camp Dresser & McKee Inc.
CDS	Carbon disulfide
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFM	Chloroform
CFR	Code of Federal Regulations
CGI	Compressed Gases, Inc. [facility]
CGL	Cargill Elevator [facility]
CH_4	Methane
CHEA	Chloroethane
CI	Comprehensive investigation
CIT	Copeland International Trucks, Inc. [facility]
CM	Chloromethane
CMS	Corrective Measures Study
CN	Coleman North/Evcon [facility]

CNE	Coleman Northeast [facility]
CO_2	Carbon dioxide
COCs	Chemicals of concern
COPCs	Chemicals of potential concern
COU	Coleman operable unit
CSI	Christopher Steel, Inc. [facility]
CT	Carbon tetrachloride
CTC	Continental Tank Car Corporation [facility]
11DCA	1,1-Dichloroethane (1,1-DCA)
12DCA	1,2-Dichloroethane
12DCB	1,2-Dichlorobenzene
14DCB	1,4-Dichlorobenzene
11DCE	1,1-Dichloroethene (1,1-DCE)
12DCE	1,2-Dichloroethene (1,2-DCE)
DCBM	Dibromochloromethane
DEC	Dow/Essex Chemical Company [facility]
DLDS	former Dold Foods Inc. [facility]
DNAPL	Dense non-aqueous phase liquid
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DRB	Coastal-Derby Refinery [facility]
DRO	Diesel-range organics (TPH)
EAB	Enhanced anaerobic biodegradation
EBN	Ethylbenzene
EC	Electroconductivity
EDB	Ethylene dibromide (= 1,2-dibromoethene)
EPA	United States Environmental Protection Agency
ERD	Enhanced reductive dechlorination
EUC	Environmental use control
EXC	Excel [facility]
EZVI	Emulsified zero-valent iron
Fe^{2+}	Ferrous iron
Fe^{3+}	Ferric iron
FLE	Farmland Elevator [facility]
FPH	Free phase petroleum hydrocarbon
FRTR	Federal Remediation Technologies Roundtable
FS	Feasibility study
ft	Feet or foot
GAC	Granular activated carbon
GC	Gas chromatograph
GilMo	Gilbert & Mosley
gpm	Gallons per minute
GRA	General response action

GRO	Gasoline-range organics (TPH)
GRR	former Golden Rule Refinery [facility]
GWTP	Groundwater treatment plant
GWU	Groundwater Unit (formerly OU)
GWU1	Groundwater Unit 1
GWU2	Groundwater Unit 2
GWU3	Groundwater Unit 3
GWU4	Groundwater Unit 4
GWU5	Groundwater Unit 5
GWU6	Groundwater Unit 6
HCI	HCI Advance Chemical (now Brenntag) [facility]
HDPE	High density polyethylene
HRC	Hydrogen release compound
HRI	Hydrocarbon Recyclers, Inc. [facility]
HSWA	Hazardous and Solid Waste Amendments
HUT	Huttig Distributors/Rock Island Millworks, Inc. [facility]
ICs	Institutional controls
IPB	Isopropylbenzene (cumene)
IRZ	*In situ* reactive zone
IRM	Interim remedial measure
ISL	Identified Sites List
JRF	former Johns' Refinery [facility]
KDHE	Kansas Department of Health and Environment
KPI	Kansas Plating, Inc. [facility]
KRE	Kreonite, Inc. – East [facility]
KRW	Kreonite, Inc. - West [facility]
LBC	Love Box, Inc. [facility]
LES	Laidlaw Environmental Services
LNAPL	Light non-aqueous phase liquid
LRF	Liability release form
LUST	Leaking underground storage tank
MCAWW	Methods for Chemical Analysis of Water and Wastes
MCL	Maximum contaminant level
MECL	Methylene chloride
MEE	Methane, ethene, ethane
MEK	Methyl ethyl ketone (= 2-Butanone)
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MNA	Monitored natural attenuation
msl	mean sea level
MS/MSD	Matrix spike/matrix spike duplicate
MTBE	Methyl tert-butyl ether
mV	Millivolts

NAP	Naphthalene
NAPL	Non-aqueous phase liquid
NBB	n-Butylbenzene
NCP	National Contingency Plan
NIC	North Industrial Corridor
NIM	Novick Iron and Metal Salvage Company [facility]
NPL	National Priorities List
NO_3	Nitrate
NO_2	Nitrite
NPC	Northern Pipeline Construction [facility]
NPDES	National Pollutant Discharge Elimination System
OA	Other area
OKGS	Oneok Kansas Gas Service [facility]
O&M	Operation and maintenance
ORP	Oxidation-reduction potential
OU	Operable Unit (in previous draft versions of FS, now identified as GWU)
PAHs	Polyaromatic hydrocarbons
1122PCA	1,1,2,2-Tetrachloroethane
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PE	Performance evaluation
PID	Photoionization detector
PIPT	p-Isopropyltoluene
PKB	Parker Boss Clay Traps [facility]
PPE	Personal protective equipment
PPL	Phillips Pipeline Wichita Bulk Terminal Facility
ppm	Parts per million
PRAO	Preliminary remedial action objective
PRG	Preliminary remediation goal
PRP	Potentially responsible party
PSM	Plume stability monitoring
PVC	Polyvinyl chloride
QA/QC	Quality assurance and quality control
RA	Remedial action
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RD	Remedial design
Redox	Reduction-oxidation
RI	Remedial investigation
ROD	Record of decision
ROI	Radius of influence

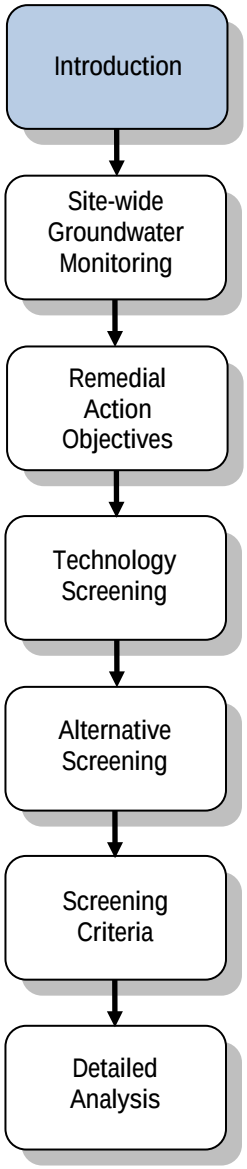
RPD	Relative percent difference
RSC	Reid Supply Company
S^{-2}	Sulfide
S2B	Stockyard Properties (Area 02B) [facility]
SBB	sec-Butylbenzene
SCI	Source control investigation
SCSC	Service Chemical Supply Company
SK	Safety-Kleen, Inc. (now Clean Harbors Kansas, LLC) [facility]
SO_4^{2-}	Sulfate
SOP	Standard operating procedure
SOW	Statement of work
SSL	Soil screening level
SVE	Soil vapor extraction
SW	Sherwin Williams Paint [facility]
SWMU	Solid Waste Management Unit
111TCA	1,1,1-Trichloroethane (1,1,1-TCA)
112TCA	1,1,2-Trichloroethane
124TMB	1,2,4-Trimethylbenzene
135TMB	1,3,5-Trimethylbenzene
T12DCE	*trans*-1,2-Dichloroethene
TAC	Technical Advisory Committee
TBB	tert-Butylbenzene
TBC	To be considered
TCE	Trichloroethene
TCFM	Trichlorofhuoromethane
TIF	Tax increment finance
TOC	Total organic carbon
TOL	Toluene
TPH	Total petroleum hydrocarbons
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
UCL	Unocal [facility]
USC	United States code
UPRF	Union Pacific Railroad Fueling Terminal [facility]
UPRR	Union Pacific Railroad
US	United Steel [facility]
USGS	United States Geological Survey
USPCI	U.S. Pollution Control, Inc. [facility]
UST	Underground storage tank
VC	Vinyl chloride
VCM	Via Christi Medical Center, St. Francis Campus [facility]
VFAs	Volatile fatty acids
VOC	Volatile organic compound

VWR	Van Waters & Rogers Company [facility]
VWRN	Van Waters & Rogers Company (northern facility)
VWRS	Van Waters & Rogers Company (southern facility)
WBA	Wichita Brass and Aluminum [facility]
WG	Wil-Gro Fertilizer Inc. [facility]
WHW	Waco Handi-Wash [facility]
WM	Weaver Manufacturing, Inc. [facility]
WMG	Wichita Mirror and Glass [facility]
WNID	Wichita North Industrial District
WP	Wilko Paints [facility]
WRG	WR Grace [facility]
WTE	Wichita Terminal Elevator [facility]
WU	Western Uniform and Towel Service, Inc. [facility]
XYL	Xylenes, total
XYLMP	m,p-Xylene
XYLO	o-Xylene
ZVI	Zero-valent iron

Section 1
Introduction

1.1 Purpose and Organization of Report

Camp Dresser & McKee Inc. (CDM) has been retained by the City of Wichita (City) to assist the City in conducting a Remedial Investigation (RI) and preparing a Feasibility Study (FS) for the North Industrial Corridor (NIC) Site (Site) in Wichita, Kansas.



Activities performed during the FS were accomplished in accordance with guidance developed by the United States Environmental Protection Agency (EPA) for conducting a FS under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA 1988). Cost estimates for each alternative were developed in accordance with *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000).

The objectives of this FS were identified in the *Settlement Agreement for Remedial Investigation and Feasibility Study for Certain Remedial Actions to be Determined Following Opportunity for Public Involvement* (Settlement Agreement) for the NIC Site with the Kansas Department of Health and Environment (KDHE). This Settlement Agreement was finalized on November 14, 1995. The objectives of the FS are:

- Define Groundwater Units (GWUs) within the NIC Site;
- Identify, evaluate, and screen remedial technologies;
- Develop, refine, and evaluate remedial alternatives;
- Conduct treatability studies (if necessary); and
- Recommend the most feasible and effective remedial alternative.

This document focuses on groundwater contamination issues for groundwater units GWU1 through GWU6. Soil remediation is not discussed because all identified soil contamination is attributable to source areas and contamination associated with source areas is being addressed on individual bases under a variety of KDHE regulatory mechanisms, including the following:

- KDHE consent order;
- Underground storage tank (UST) trust fund; and

- Dry-cleaning trust fund.

A few select source areas are under the purview of the EPA either as a CERCLA or Resource Conservation and Recovery Act (RCRA) site. Source areas with no identified responsible party will be addressed by the City under separate cover.

This report presents the results of the development, screening, and detailed evaluation of remedial alternatives to address Site-wide contaminated groundwater for groundwater units GWU1through GWU6 of the NIC Site.

This FS is organized as follows:

- Section 1 discusses the purpose and organization of the FS report, provides a summary of the results of the RI and source control investigations (SCIs) conducted between 1997 and 2007, provides a description of the environmental setting for the NIC Site, discusses chemicals of potential concern (COPCs) for the Site, and provides a description of proposed Site GWUs.

- Section 2 presents the results from a pre-FS Site-wide groundwater monitoring event.

- Section 3 describes the process for identifying preliminary remedial action objectives (PRAOs) based on the results of the baseline human health risk assessment (BLRA). This section also identifies potential applicable or relevant and appropriate requirements (ARARs) for the Site.

- Section 4 describes the options for general response actions (GRAs) and the screening and evaluation of different remedial technologies and process options.

- Section 5 discusses the remedial alternatives and the screening process followed to reduce the remedial alternatives to those considered to be most suitable for possible implementation.

- Section 6 describes the criteria used to evaluate the alternatives retained during the screening process completed in Section 5.

- Sections 7 through Section 12 present detailed analyses of the remedial alternatives retained for each of the GWUs and summarize the analyses conducted to compare and contrast the remedial alternatives for GWU1 through GWU6, respectively.

- Section 13 lists references.

- Appendix A contains analytical results tables from the NIC RI and RI Addendum reports for reference.

- Appendix B provides a summary of the source controls implemented at each of the GWUs.

- Appendix C documents the qualitative screening of alternatives.
- Appendix D presents the detailed analyses of retained alternatives with respect to the criteria discussed in Section 6.
- Appendix E provides the detailed cost analyses of the retained alternatives for GWU1, GWU3, and GWU4. Detailed analysis cost estimates have an expected accuracy range between +50% and -30% of the actual costs.
- Appendix F presents the groundwater model report and its results as used as part of the alternative evaluations during this FS process.

1.2 Site Description

The NIC Site is located in the north-central portion of the City of Wichita, Sedgwick County, Kansas. The NIC Site consists of approximately 4,011 acres of urban industrial, commercial, recreational, residential, and agricultural property. The NIC Site was established in 1995 to combine and focus the efforts of three separate environmental investigations (as discussed in Section 1.3.1). Site history and background are provided in Section 1.3.

1.2.1 Site Boundary

Figure 1-1 depicts the current Site boundary. The original NIC Site boundary was established by the KDHE in the Settlement Agreement signed in November 1995. The Site boundary has subsequently been changed to: include additional areas, maintain consistency with City limits, and eliminate overlap with the nearby Gilbert & Mosley (GilMo) Site.

1.3 Site History and Environmental Investigations

In 1983, an EPA investigation revealed the presence of volatile organic compounds (VOCs) in groundwater produced from two industrial wells in the area. Subsequent investigations throughout the 1980s and early 1990s revealed widespread VOC contamination in groundwater beneath the NIC Site.

1.3.1 Previous Investigations

Three significant historical environmental investigation areas are present within the NIC Site boundary: the Northeast Investigation Area, the 29th and Mead Site, and the 13th and Washington Site (**Figure 1-1**). The names of the 29th and Mead and the 13th and Washington Sites were taken from street intersections near the center of the Sites. The former 29th and Mead Site is a former National Priorities List (NPL) site that has been officially delisted and is discussed further in Section 1.3.1.2. The former 13th and Washington Site is adjacent to the southern extent of the 29th and Mead Site area and was investigated by the KDHE after VOCs were detected in samples collected from groundwater wells located on the St. Francis Hospital property (9th and Santa Fe area) in 1991. The former 13th and Washington Site is discussed further in Section 1.3.1.3.

The former Northeast Investigation Area is located north and northeast of the former 29th and Mead Site.

The degree of investigation previously conducted in the NIC Site's three subsections prior to the NIC RI varies. In general, the former29th and Mead Site area has been heavily investigated while the former 13th and Washington Site area has primarily been subjected only to preliminary investigations. The former Northeast Investigation Area is primarily comprised of five industrial facilities who are conducting their own groundwater investigations. Remedial actions are also being conducted at some of these facilities. A list of reports associated with investigations and/or remedial actions conducted by others at facilities or areas within the NIC Site is included in the RI Report (CDM 2007a).

The three sub-areas of the NIC Site were discussed in the NIC Work Plan (CDM 1997a) and RI report (CDM 2007a) and are briefly summarized in the following subsections.

1.3.1.1 Former Northeast Investigation Area

The former Northeast Investigation Area, consisting of urban industrial, commercial, agricultural, and residential properties, is located in the northeast portion of the NIC Site and includes four facilities that were identified in the NIC Settlement Agreement as being under Consent Orders with the EPA and/or the KDHE: the Coleman Northeast Plant; the former Unocal Chemicals Division Distribution Facility; Unified School District 259 Service Center; and Continental Tank Car Corporation. Chemicals of concern (COCs) were identified as the VOCs tetrachloroethene (PCE), trichloroethene (TCE), *cis*-1,2-dichloroethene (C12DCE), and vinyl chloride (VC). TCE and PCE were the most prevalent contaminants present. The current status of these facilities is discussed in **Appendix B**.

North of and adjacent to the Northeast Investigation Area (outside the NIC Site boundary) is the Phillips Pipeline Wichita Bulk Terminal Facility (PPL). Groundwater contamination at the PPL Site is being addressed separately with the KDHE.

1.3.1.2 Former 29th and Mead Site

The former 29th and Mead Site, located south of the former Northeast Investigation Area, was a former NPL site that has been officially delisted. The former 29th and Mead Site area consists of approximately 1,440 acres comprised of urban industrial, commercial, recreational, and residential properties that have been developed from agricultural land over the past 100 years.

In 1983, an EPA investigation of potential groundwater contamination revealed the presence of VOCs in groundwater produced from two industrial wells in the area. Detected contaminants included: TCE, carbon tetrachloride (CT), benzene (BEN), toluene (TOL), ethylbenzene (EBN), and xylene (XYL) (BTEX), methylene chloride (MECL), VC, and 1,1,1-trichloroethane (111TCA). United States Geological Survey

(USGS) investigations conducted in 1984 and 1985 for the EPA provided additional information on the extent of groundwater contamination in the area.

In 1987, the Wichita North Industrial District (WNID) Group, including the City, was organized. This group initiated an investigation of possible groundwater contamination in the area. The WNID Group entered a Consent Agreement with the KDHE on September 27, 1989 which provided for the preparation of an RI/FS. The Consent Agreement was executed by each participant and the City agreed to become a participant in the Consent Agreement on September 12, 1989. The former 29th and Mead Site was officially listed as a NPL Site in February 1990.

Fieldwork at 29th and Mead was conducted from 1990 through 1992 and an RI Report was submitted to the KDHE in late 1992 for review and approval. The KDHE noted numerous data gaps in the report and issued a Notice of Disapproval on July 16, 1993. Consent Orders were signed with four additional potentially responsible parties (PRPs) based upon the data presented in the RI.

In July 1994, the City petitioned the EPA to remove the former 29th and Mead Site from the NPL. The City made this request with the objective of negotiating a Settlement Agreement with the KDHE. The terms of the Settlement Agreement would allow the City to restore economic viability to the area by: allowing property transactions and financing to occur, to restore the declining tax base in the area, and to facilitate the completion of RI/FS activities. On April 7, 1995, the EPA advised that it would initiate removal of the former 29th and Mead Site from the NPL if the City carried out the response actions required in the Settlement Agreement for the NIC Site. The EPA published the notice of deletion of the former 29th and Mead Site from the NPL Sites on April 29, 1996.

Over the past several years, a variety of actions have been taken to remediate contamination at individual facilities within the former 29th and Mead Site area. Descriptions of remediation activities and investigations at individual facilities are presented in **Appendix B**.

Monitoring wells installed in the former 29th and Mead Site area as part of the large-scale investigations performed on behalf of the WNID PRP Group are indicated by the prefix "WND." These WND-series wells (locations WND-01 through WND-37) were installed between March 1991 and May 1992. Generally, these wells are installed in nested pairs to monitor the shallow and deep aquifer zones.

1.3.1.3 Former 13th and Washington Site

The former 13th and Washington Site, south of the former 29th and Mead Site, was identified in May 1991 when VOC contamination was detected in a dewatering well used during a construction project at the St. Francis Regional Medical Center. Land use in the approximately 1,600-acre area includes industrial, commercial, recreational, and residential properties.

In May 1991, the KDHE completed a Preliminary Assessment of the Site utilizing direct-push sampling techniques. The Preliminary Assessment concluded that contamination from the former 29th and Mead Site was migrating into the former 13th and Washington Site, and that four potential source areas within the former 13th and Washington Site were also impacting groundwater. COCs were identified as PCE, TCE, 111TCA, 1,1-dichloroethene (11DCE), *trans*- and *cis*-1,2-dichloroethene (T12DCE and C12DCE), 1,1-dichloroethane (11DCA), and VC.

Additional investigation of the Site was conducted by the City in 1993 through a negotiated Consent Agreement with the KDHE (#92-E-222) signed October 1992. These investigation activities consisted of the installation and sampling of monitoring wells. VOCs were detected in most of the 11 monitoring well clusters installed. VOCs detected at levels exceeding the KDHE Tier 2 groundwater pathway action levels or federal drinking water standard maximum contaminant levels (MCLs) included PCE, TCE, C12DCE, VC, 111TCA, 11DCE, and 11DCA. The analytical results did not indicate the presence of free phase chlorinated solvents. High levels of petroleum contaminants were also detected at one location. The additional investigation indicated that contamination from the former 29th and Mead Site was migrating into the former 13th and Washington Site from the north as well as from four potential source areas within the former 13th and Washington Site.

Monitoring wells installed in the former 13th and Washington Site area in March and April 1993 as part of former 29th and Mead Site downgradient investigations are indicated by the prefix "WND" (well locations WND-38 through WND-49). Generally these wells were installed in nested pairs to monitor the shallow and deep zones of the aquifer.

1.3.1.4 City Actions

The KDHE and City finalized the NIC Settlement Agreement on November 14, 1995. Among other items, the Settlement Agreement obligated the City:

- To conduct an RI/FS program;
- To create a Redevelopment of Central Business District Area (tax increment finance (TIF) area) pursuant to K.S.A. 12-1770, et seq., or as amended; and
- To establish a Certificate and Release Program;

The Settlement Agreement was facilitated by the following City actions:

- The NIC Site was designated as a “blighted area” on March 5, 1996, which was one of the steps necessary to establishing a TIF District.
- The North Industrial Corridor Redevelopment District, also known as the NIC TIF District, was established on March 19, 1996, under City Ordinance 43-009.

On May 21, 1996 the City signed a participation agreement with a group of 26 representatives identified as the NIC Participants. The NIC Participation Agreement included:

- Provisions for limited funding of the NIC RI/FS from the Participants;
- The formation of the NIC Technical Advisory Committee (TAC); and
- An agreement from the Participants to be part of the Remedial Design/Remedial Action (RD/RA) allocation process.

The NIC Participant Agreement was followed by a June 11, 1996 Agreement between the City and representatives of major lending institutions in the Wichita area. The purpose of this Agreement regarding the NIC Site was to encourage lending institutions to resume business and private lending to applicants within the NIC TIF District who have obtained Certificates of Release for Environmental Conditions from the City.

The "Certificate and Release for Environmental Conditions" program, was initiated on July 10, 1996 when the City sent out official notice of the program. Under the program, existing or potential new property owners within the NIC Site could obtain and fill out an application for Certificate and Release for Environmental Conditions. These applications are also referred to as liability release forms (LRFs). The City officially initiated the RI/FS program by hiring a consultant (CDM) on January 7, 1997.

Another major City action was the implementation of institutional controls. On June 25, 1996, the City passed a water well ordinance that provides the City with the power to restrict the installation of a groundwater well for personal use within an area deemed by the City to be contaminated. The City Ordinance is Municipal Code of Ordinances, Title 7, Chapter 7.30, section 7.30.105. The specific language of the code is provided below.

> Section 7.30.105 Water wells in contaminated areas.
>
> (a) From and after the date of the ordinance codified in this section, no new water well shall be constructed and used for personal use if the health officer determines that such well is in a contaminated area.
>
> (b) Any existing water well shall cease to be used for personal use if the health officer determines that (1) the well is in a contaminated area, (2) public water is available to the water well user, and (3) the cessation of use of the water well for personal use is in the best interest of public health, safety and welfare. (Ord. No. 43-156 §2)

1.3.2 CDM Remedial Investigation

The RI was conducted in three phases, Phase 1/1A, Phase 2, and Phase 3. The Phase 1 and Phase 1A field investigations at the Site were conducted between December 1997 and January 1998 and between May and June 1998, respectively. These investigations were designed to delineate VOC groundwater contamination within the Site and also to identify VOC source areas. Planning documents for the RI included the *North Industrial Corridor Work Plan for RI/FS* (CDM 1997a), the *North Industrial Corridor Field Sampling Plan* (CDM 1997b), and the *North Industrial Corridor Quality Assurance Project Plan* (CDM 1997c). Results from the RI were discussed in the *North Industrial Corridor (NIC) Site Remedial Investigation Report* (CDM 2007a) and the *North Industrial Corridor (NIC) Site Remedial Investigation Addendum* (CDM 2007b). Summary data tables from these reports are provided in **Appendix A** for reference.

The sampling activities during the Phase 1 and Phase 1A field investigations involved collecting water level measurements; conducting direct-push groundwater sampling; and performing limited monitoring well sampling. From the data collected during these activities, CDM summarized the water level measurements and analytical data and presented the results in a draft technical memorandum in February 1999, which was approved by the KDHE in February 2000.

The Phase 2 investigation was conducted between October 1999 and September 2001 and was designed to collect data necessary for facility-specific responsible party identification and risk assessment. The Phase 2 investigation included sampling of groundwater, soils, sediment, surface water, and indoor air. Additional planning documents for the Phase 2 investigation included the *North Industrial Corridor Final Work Plan Addendum* (CDM 2000).

The Phase 1/1A and Phase 2 investigations consisted of the following field activities:

- Collection of water level measurements at over 200 locations during four water level events;
- Collection of 1,070 direct-push groundwater samples and analysis of samples from 513 locations;
- Continuous sampling to bedrock at three locations for lithologic characterization;
- Electroconductivity (EC) logging at 68 locations;
- Collection of 40 lithologic soil samples for confirmation of EC logging.
- Collection of 35 subsurface soil samples for total organic carbon analysis;
- Collection and analysis of three background surface soil samples;
- Installation of 119 wells at 72 locations;

- Collection of 247 monitoring well samples representing 106 locations;
- Collection of nine surface water samples from three drainages within the Site;
- Collection of 12 sediment samples from three drainages within the Site;
- Collection of nine indoor and two outdoor air samples within the Site; and
- Investigation of six sludge pits at two former refinery sites.

Phase 2 direct-push sampling began in October 1999 and was completed by March 2001. Phase 2 well installation and sampling began in December 2000 and was completed in July 2001. Additionally, 10 other companies coordinated sampling of over 200 of their monitoring wells on their properties within the NIC Site during this time frame.

A letter report discussing downgradient investigation activities was submitted to the KDHE in December 2003 (CDM 2003). Based on the results, CDM and the City concluded that concentrations within the downgradient investigation area appeared to be increasing, and that the MCL boundary appeared to be expanding. Four consecutive quarterly rounds of groundwater monitoring in the investigation area were proposed.

The NIC Site draft RI Report was completed and submitted to the KDHE. Section 9 of the draft RI report discussed sources of COPCs within the NIC Site. These source areas were divided into three general categories:

Confirmed – source areas with identified groundwater impact and either identified soil impact or confirmed use or storage of contaminant-related chemical(s) on the property.

Identified – source areas with groundwater data that implicate a specific release area; generally confined to a single property. The identified source area lacks confirmatory soil data and information that conclusively demonstrates the use or storage of contaminant-related chemical(s) on the property.

Suspect – areas with groundwater data which indicate that a release to groundwater may have occurred but lack sufficient data to identify a specific property or release area. A suspect source area will generally be larger in size than an identified source area and will also lack confirmatory soil data and information that conclusively demonstrates the use or storage of contaminant-related chemical(s) on the property.

The KDHE provided comments on Section 9 and Appendix L of the draft RI report in a letter dated March 25, 2003. In this letter, the KDHE requested a variety of actions to either confirm the source areas or to identify PRPs at specific locations. The City

prepared two work plans for additional investigation to address KDHE comments regarding confirmation of source areas. A letter-format work plan for additional investigation at Suspect Source Areas (CDM 2004a) presented the general investigation approach and methodology for the source area investigation activities. A work plan for Identified Source areas (CDM 2004b) provided additional details on planned Identified Source Area investigation activities. The activities proposed in the two work plans were designed to address actions to confirm physical source areas.

Additional direct-push groundwater sampling was performed in the southern portion of the NIC Site in July and August 2003. A total of 81 samples were collected from 40 direct-push boring locations during this downgradient investigation. The objectives of this investigation were as follows:

- Delineate the current MCL boundary in the southeast part of the Site;
- Determine appropriate locations for monitoring wells in the southeast part of the Site; and
- Determine whether existing monitoring wells located in the southwestern part of the Site are appropriately located to monitor VOC concentrations entering the GilMo Site to the south.

The NIC Site final RI Report (CDM 2007a) was completed in June 2004.

The source area investigations (Phase 3) began in August 2004 and were completed in March 2005. The primary objectives of the investigation activities performed between August 2004 and March 2005 were to:

- Collect sufficient data to confirm sources at identified areas where the KDHE indicated additional confirmation was needed;
- Confirm the existence of a source at suspect areas in order to reclassify the Site as an identified source;
- Determine that a historical suspect or identified source area is no longer an active source area that requires further remedial action; and
- Determine that a source is not present and that the facility or location requires no further action.

The Phase 3 source area investigations were conducted at properties or areas that were found to be potential source areas based on the RI data, but where additional data were needed to confirm whether a contaminant release occurred. The investigations consisted of a limited water level round, a limited Site-wide monitoring well sampling round, and collection of over 450 direct-push groundwater samples. The results of the source area investigations were summarized in the RI Addendum Report (CDM 2007b). Revisions to the RI report and RI Addendum Report were made based on KDHE comments, and these revisions were submitted to the KDHE in

February 2007. The KDHE granted final approval of the RI and RI Addendum reports in March 2007.

The draft Baseline Risk Assessment (BRA) was submitted to the KDHE in May 2003. The BRA provided Site-specific estimates of risk for current and reasonably anticipated future land uses and potential and future groundwater and surface water uses. Revisions to the BRA, based on KDHE comments, were submitted to the KDHE in early 2007 (CDM 2007c). The KDHE approved the final BRA Report in March 2007.

1.4 Environmental Setting

This section presents a summary of the environmental setting of the region and the NIC Site. The climate, physiography, geology, hydrogeology, land use, and demographics are summarized. The topics were presented in greater detail in the RI report (CDM 2007a).

1.4.1 Physiographic Setting

The city of Wichita lies at the western edge of the Central Lowland physiographic province. The Wichita area is drained by the Arkansas and Little Arkansas Rivers and their tributaries. The Little Arkansas River is located to the west of the NIC Site and is depicted in **Figure 1-1**. The Little Arkansas River joins the Arkansas River just west of the southwest corner of the NIC Site. Chisholm Creek, its tributaries, and several ponds within and along the eastern boundary are the only surface water bodies located within and/or around the NIC Site.

1.4.2 Climate

The climate of the area is subhumid, continental, and is subject to large variations in temperature. The average annual temperature at Wichita between 1954 and 2008 was 56.8ºF (13.7ºC) with average monthly temperatures ranging from 31.7ºF (-0.2ºC) in January to 81.3ºF (27.4ºC) in July (NCDC 2010a and NCDC 2010b), and with an average growing season of usually more than 190 days. Moisture-laden air from the Gulf of Mexico is the primary source of precipitation in the area. Average annual rainfall between 1954 and 2009 in Wichita was 29.4 inches with average monthly precipitation during this 54 year time frame varying from 0.8 inches in November to 4.6 inches in June (NCDC 2010a and NCDC 2010b).

Wind speeds in Wichita are generally constant between six to 20 miles per hour (mph) with average annual wind speeds around 12 mph. Wind generally blows from the south to southwest during the spring-summer-fall months (approximately May to September) shifting to predominantly north winds during the winter months (approximately September to May) (NCDC 2010c). The evapotranspiration for the area ranges from 25 to 30 inches per year, with a maximum rate of groundwater loss estimated at 3.5 inches per year. The latter generally occurs only where groundwater is within 10 feet of the land surface. Transpiration is the major component of

evapotranspiration during the growing season, but it is negligible during the non-growing season.

1.4.3 Site Geology and Hydrogeology

The basal geologic unit of the NIC Site is the Wellington Shale; this bedrock slopes gently toward the west. Locally, the Wellington Shale is overlain by clays that represent the weathered portions of the bedrock. The bedrock and weathered clays are overlain by alluvium from the Arkansas River. These alluvial deposits are characterized by fining-upward sequences of sands and gravels that include intermediate and locally discontinuous clay lenses. These alluvial deposits, in turn, are overlain by sandy to silty clays throughout much of the NIC Site. The sandy to silty clays comprise the surficial units across Site.

During the geologic investigation, four discreet hydrostratigraphic units were differentiated within the subsurface materials underlying the NIC Site. The characterization for each hydrostratigraphic unit was based on the physical characteristics and hydrogeologic properties of the subsurface materials. The hydrostratigraphic units are briefly described as follows:

- **Hydrostratigraphic Unit 1 –** The uppermost lithologic unit is comprised primarily of low permeability clays that are locally sandy or silty. Saturation of the base of this unit occurs locally. Saturation also occurs in the upper clay units within an area restricted to the upland terrace deposits in the northeast corner of the NIC Site. Unit 1 is encountered throughout the Site and is typically capped by asphalt, concrete, and/or fill. Unit 1 ranges from 0 to approximately 20 feet thick with an average thickness of approximately 8 to 10 feet.

- **Hydrostratigraphic Unit 2 –** Unit 2 consists of fine to coarse-grained sands which can be locally silty. Generally, Unit 2 is saturated and generally continuous throughout the NIC Site with the exception of the northeast corner where the sands thin to the east and become laterally discontinuous. The thickness of these sands across the Site range from approximately 10 to 45 feet with an average thickness of approximately 28 to 30 feet.

- **Hydrostratigraphic Unit 3 –** Unit 3 is comprised of stiff, moist, low permeability clays that can be locally sandy or silty and represent the weathered bedrock surface. This clay unit ranges from less than 0.5 feet to approximately 10 feet in thickness and averages approximately 5 feet thick. Unit 3 is laterally discontinuous throughout the Site.

- **Hydrostratigraphic Unit 4 –** This unit consists of competent shale bedrock (Wellington Shale) and is the basal geologic unit considered in this investigation. Unit 4 is the basal aquitard for the overlying alluvial sediments. The bedrock within the Site was encountered at depths ranging from 0.5 to approximately 45 feet below ground surface (bgs) and averages about 40 feet bgs.

The overall saturated thickness throughout the Site averages approximately 22 to 25 feet, with a depth-to-water of approximately 15 feet bgs in most areas. The overall groundwater flow direction in the Site trends toward the south. Overall, groundwater generally flows south to southwest in the upper portion of the Site; however, the groundwater flow direction in the northeast corner of the Site is nearly due west to southwest. Near the middle of the Site, the flow direction is south to southeast. In the southern portion of the Site, groundwater flows south to southeast with nearly due east flow in the very southeastern portion of the Site near Chisholm Creek at the eastern Site boundary. This appears to be a result of groundwater/ surface water interactions, which are discussed in detail in the RI Report (CDM 2007a). Groundwater also flows to the southwest within localized areas of the southwestern portion of the Site.

The predominant horizontal gradient across the Site is 0.001 feet/foot (ft/ft). Vertical gradients are generally negligible but are discussed in more detail in Section 4.3 of the NIC RI Report (CDM 2007a). The hydraulic conductivity of the saturated sand aquifer beneath the Site varies from 135 to 435 feet/day. Assuming a porosity of 0.25, the estimated groundwater velocity may range from 0.5 to 1.7 feet per day.

The hydrogeology of the terrace deposits in the northeastern corner of the Site differs from the predominant hydrology described above. The hydrogeology of the terrace deposit area and other areas that vary from the predominant hydrogeology are discussed in the RI Report (CDM 2007a).

1.4.4 Hydrology

The Little Arkansas River is located from approximately 200 and 6,500 feet outside the western boundary of the Site and flows toward the south. The branches of Chisholm Creek in the immediate vicinity of the NIC Site include the main fork, the East Fork, the Middle Fork, the West Fork, and an unnamed middle drainage. The main fork of Chisholm Creek is located near the eastern boundary of the Site. The confluences of the East and West Forks of Chisholm Creek and an unnamed middle drainage are located between 18th Street and 20th Street and between Ohio Street and I-135.

The Middle Fork of Chisholm Creek defines a portion of the northern boundary of the NIC Site. As depicted on **Figure 1-1**, the Middle Fork currently flows into the Little Arkansas River. Formerly, this drainage flowed via the unnamed middle drainage into Chisholm Creek; therefore, the unnamed middle drainage can be referred to as the former lower reach of the Middle Fork.

No major bodies of water exist in the NIC Site; however, several small surface water bodies exist in and around the Site. A large pond is located along the eastern boundary of the Site just south of the K-96 highway in Grove Park (hereafter referred to as the Grove Pond). One other pond currently exists within the Site boundaries. This pond is located along the western boundary of Coleman's property (hereafter referred to as the Coleman Pond) in front of their main office building, south of 37th

Street. A third pond existed at the time of the creation of the NIC Site and was located southwest of the I-135 and K-96 interchange. The pond was utilized by Cornejo Construction Company (hereafter referred to as the Cornejo pond) and was backfilled using construction debris in 1999. All surface water bodies existing in and around the Site are depicted on **Figure 1-1**.

The main fork of Chisholm Creek is a gaining stream, i.e., the stream receives base flow from groundwater. The other forks of Chisholm Creek may have both gaining and losing (discharging to groundwater) stretches, depending on the location and seasonal variability. Groundwater/surface water interaction appears to be minimal for the ponds located within the NIC Site boundary.

1.4.5 Land Use

The NIC Site primarily consists of approximately 4,011 acres of urban industrial, commercial, recreational, residential, and agricultural properties. The Site was developed from agricultural land over the last century. As of 2004, the land use within the Site was comprised as noted below. **Figure 1-2** provides a map showing land use based data in the City's GIS database as of March 2011.

Land Use	Acreage	Percent of Site
Agriculture	339	8.5 %
Parks	57	1.4 %
Schools	9	0.2 %
Hospitals	45	1.1 %
Residential	490	12.2 %
Vacant	149	3.7 %
Commercial/Industrial	2,922	72.8 %
TOTAL	4,011	100.0 %

Residential properties are primarily located in the southeastern and southwestern portions of the Site, generally south of 17th Street. There is also a small residential community consisting of approximately 14 properties located on the west side of Hydraulic and north of 37th Street, west and northwest of the USD #259 property. The majority of the residential properties within the NIC Site consist of low- to moderate-income single-family housing.

Agricultural areas are in the northernmost portions of the NIC Site. Commercial/industrial properties are primarily located in the northern portion of the Site between the northern boundary (north of 37th) and 19th Street, and along the Santa Fe/Washington corridor between 2nd Street and 19th Street.

1.4.6 Demographics

Based on 2000 census information, Wichita, Kansas has a population of 344,284, increasing approximately 13 percent between 1990 and 2000. Also based on census data, the population change varied between a 5 to 25 percent decrease to a 5 to 25 percent increase within the NIC Site boundary, with a potentially more significant population increase (26 to 50 percent increase) in the extreme southern portion of the Site (south of Central Avenue to the southern boundary) (Wichita-Sedgwick County 2001). Detailed information regarding potential exposures to populations can be found in the BRA Report (CDM 2007c).

1.5 Chemicals of Potential Concern

COPCs for Site-wide groundwater, indoor air, surface water, and sediment, as selected based on the findings from the RI, were presented in the BRA Report (CDM 2007c). COPCs were also selected for groundwater and soil in the sludge pit areas. **Table 1-1** provides a summary of the COPCs for each of the media.

Of the COPCs identified in the BRA Report (CDM 2007c), 10 compounds were identified as Site groundwater target compounds:

- PCE;
- TCE;
- C12DCE;
- VC;
- 111TCA;
- 11DCA;
- 11DCE;
- CT;
- Chloroform (CFM); and
- BEN.

These compounds were identified based on frequency of detection, exceedance of MCLs/KDHE Tier 2 action levels, extent of contamination, usability in source identification, and importance as a biodegradation product. Of the above compounds, TCE is the most widespread, with C12DCE the second-most widespread. The remaining target compounds are fairly localized in extent, but are important in contaminant source identification. For the reasons noted above, Site-wide groundwater remediation approaches discussed in this FS will focus on remediation of the groundwater target compounds. However, because other contaminants have been detected at concentrations above KDHE Tier 2 residential action levels, **Table 1-2** identifies the COCs in groundwater at each confirmed, identified, and suspect source area as identified in the NIC RI and RI Addendum Reports (CDM 2007a and CDM

2007b). **Table 1-2** also includes a brief discussion of how the contaminants impact the Site-wide groundwater and remedial alternatives. **Plate 1-1** shows the locations of the confirmed, identified, and suspect source areas and lists the primary COCs for each area.

1.6 Groundwater Units (GWUs)

GWUs in the NIC Site were established to facilitate the development of feasible remediation strategies for areas with similar COCs and/or physical limitations. The GWUs are shown on **Figure 1-3**. GWU1 through GWU5 were first proposed in a letter from CDM to the City dated August 2, 2006, which was subsequently forwarded to the KDHE. The City, CDM, TAC, and KDHE discussed the GWU submittal in a meeting held September 14, 2006. KDHE comments raised during this meeting were addressed in a letter dated January 25, 2007 and forwarded to the KDHE. GWU6 is a newly proposed GWU that includes the USD #259 source area. A brief summary of the GWU boundaries and constituent areas is included in the following subsections. **Table 1-2** identifies the COCs in groundwater at each confirmed, identified, and suspect source area within each GWU.

1.6.1 Groundwater Unit 1

The boundaries of GWU1 are commonly defined by the outermost general MCL boundary of the northeast lobe of the groundwater plume, terminating at the northern boundary of the former Coastal-Derby Refinery property just south of the projection of 25th Street. The general MCL boundary for GWU1 is a completion of the maximum lateral extent of contamination for all COCs observed in the northeast portion of the NIC Site during the RI. The Sites within GWU1 can be characterized as noted in **Table 1-2**.

1.6.2 Groundwater Unit 2

The boundaries of GWU2 are generally defined by Broadway to the west, GWU1 to the east, the northern NIC Site boundary to the north, and a generalized diagonal from 25th Street and Broadway to 17th Street and Cleveland to the south. The Sites within GWU2 can be characterized as noted in **Table 1-2**.

1.6.3 Groundwater Unit 3

GWU3 consists of the portion of the primary NIC groundwater plume (as defined by MCL boundaries) that is south of GWUs 1 and 2. As with GWU1, the southerly boundaries of the GWU consist of the outermost general MCL boundary. In general, GWU3 is bounded by Broadway on the west and Chisholm Creek on the east. The northern boundary generally extends from 22nd (extended) and Topeka (extended) in the northwest to Mathewson and 17th in the northeast. The southern boundary generally extends from Topeka and 2nd in the southwest and Murdock and Hydraulic in the southeast. The Sites within GWU3 can be characterized as noted in **Table 1-2**.

1.6.4 Groundwater Unit 4

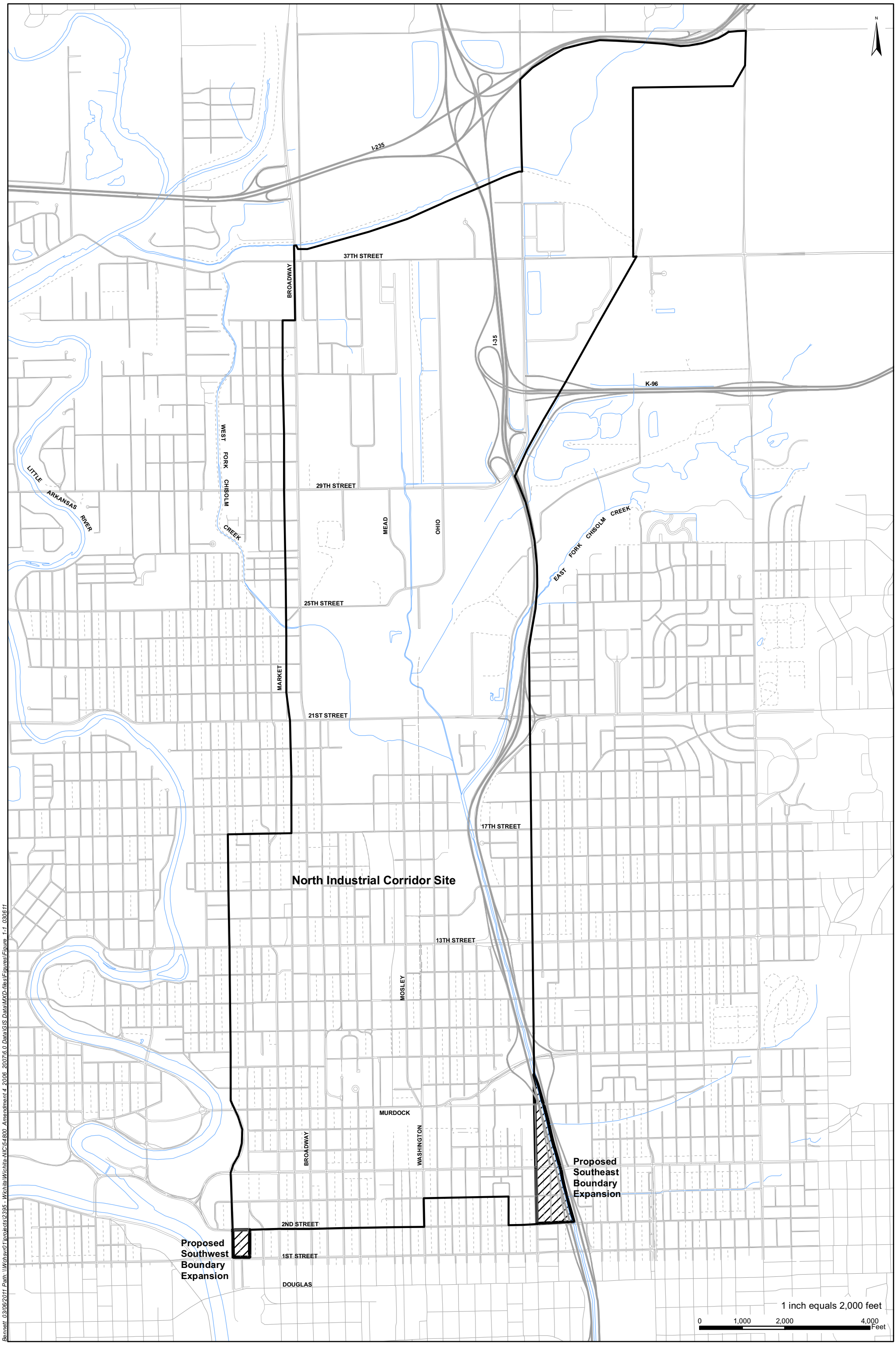
GWU4 consists of the Apex Site/11th and State Area and Waco Handi-Wash contaminant plumes. The Sites within GWU4 can be characterized as noted in **Table 1-2**.

1.6.5 Groundwater Unit 5

GWU5 consists of the former Coastal Derby Refinery (DRB) property located south of 25th Street and north of 17th Street generally east of Washington. This GWU is designed to address the significant petroleum hydrocarbon-related contamination of the soils and groundwater associated with former refinery operations (**Table 1-2**).

1.6.6 Groundwater Unit 6

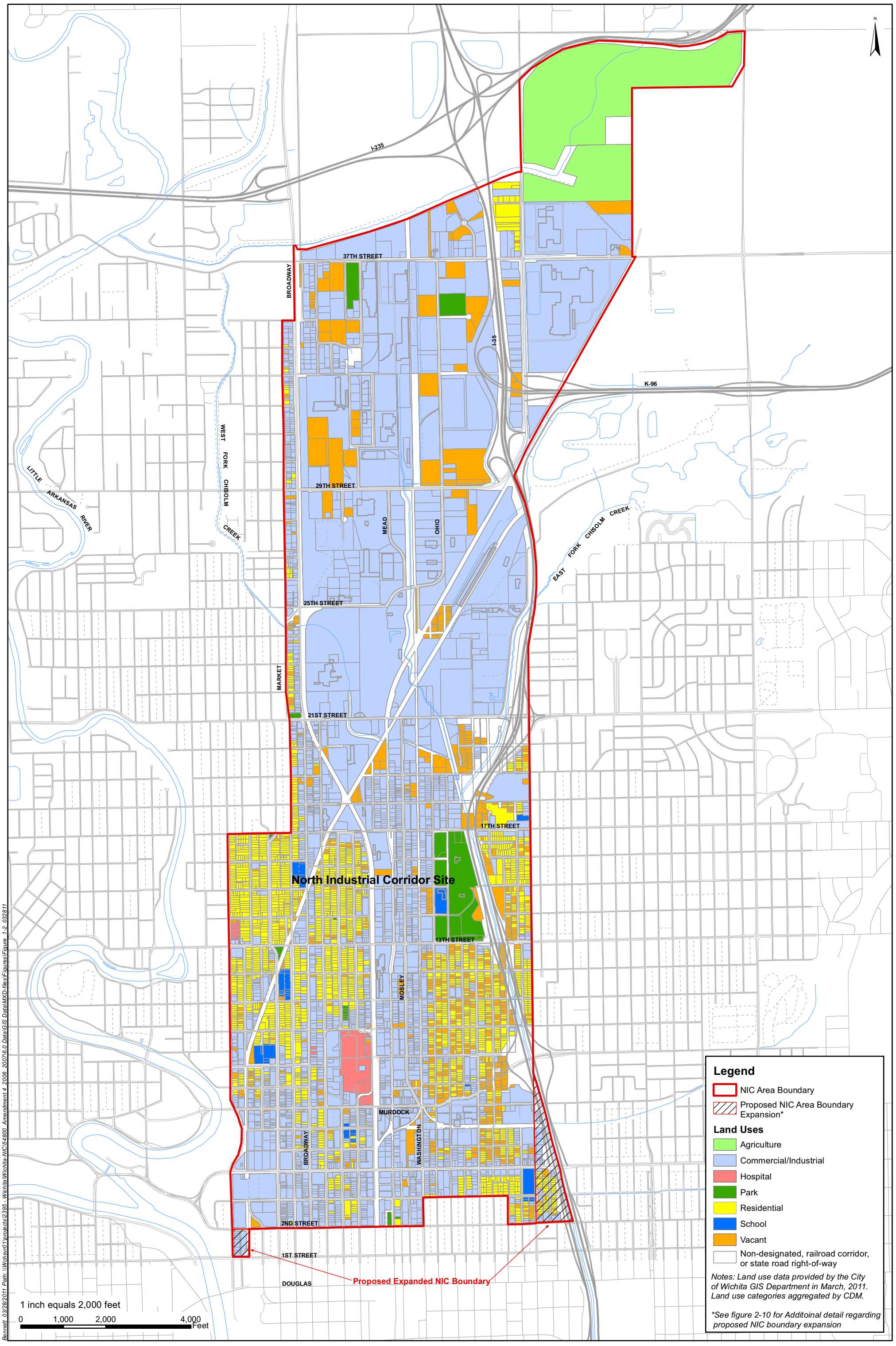
GWU6 is north of GWU1 and consists of the USD #259 confirmed source area, associated USD monitoring wells, and a portion of the Site downgradient of the USD #259 chlorinated solvents plume. GWU6 was developed because the USD #259 source area appears to be significantly distinctive from nearby source areas. The groundwater target compounds within GWU6 are primarily petroleum hydrocarbons, PCE, and TCE (**Table 1-2**.).



Bennett 03/06/2011 Path: \\Wchsvr01\projects\2395 - Wichita\Wichita-NIC\54800 Amendment 4 2006 2007\6.0 Data\GIS Data\MXD-files\Figures\Figure 1-1 030611

CDM

Figure 1-1
North Industrial Corridor (NIC) Site
Site Map



Bennett 03/28/2011 Path: \\Wchsvr01\projects\2395 - Wichita\Wichita-NIC\54800 Amendment 4 2006 2007\6.0 Data\GIS Data\MXD-files\Figures\Figure 1-2 032811

CDM

Figure 1-2
North Industrial Corridor (NIC) Site
Land Use Areas

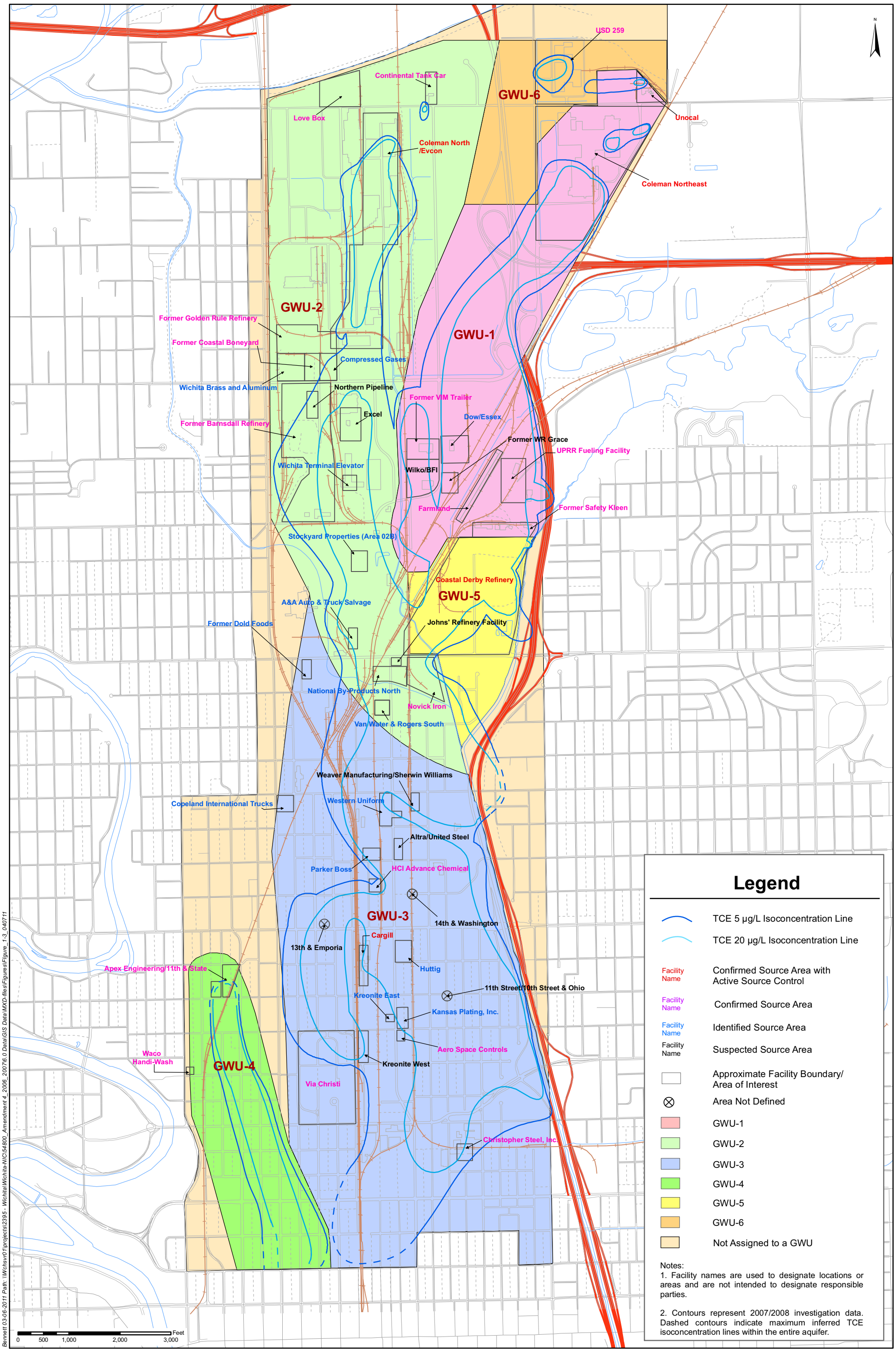


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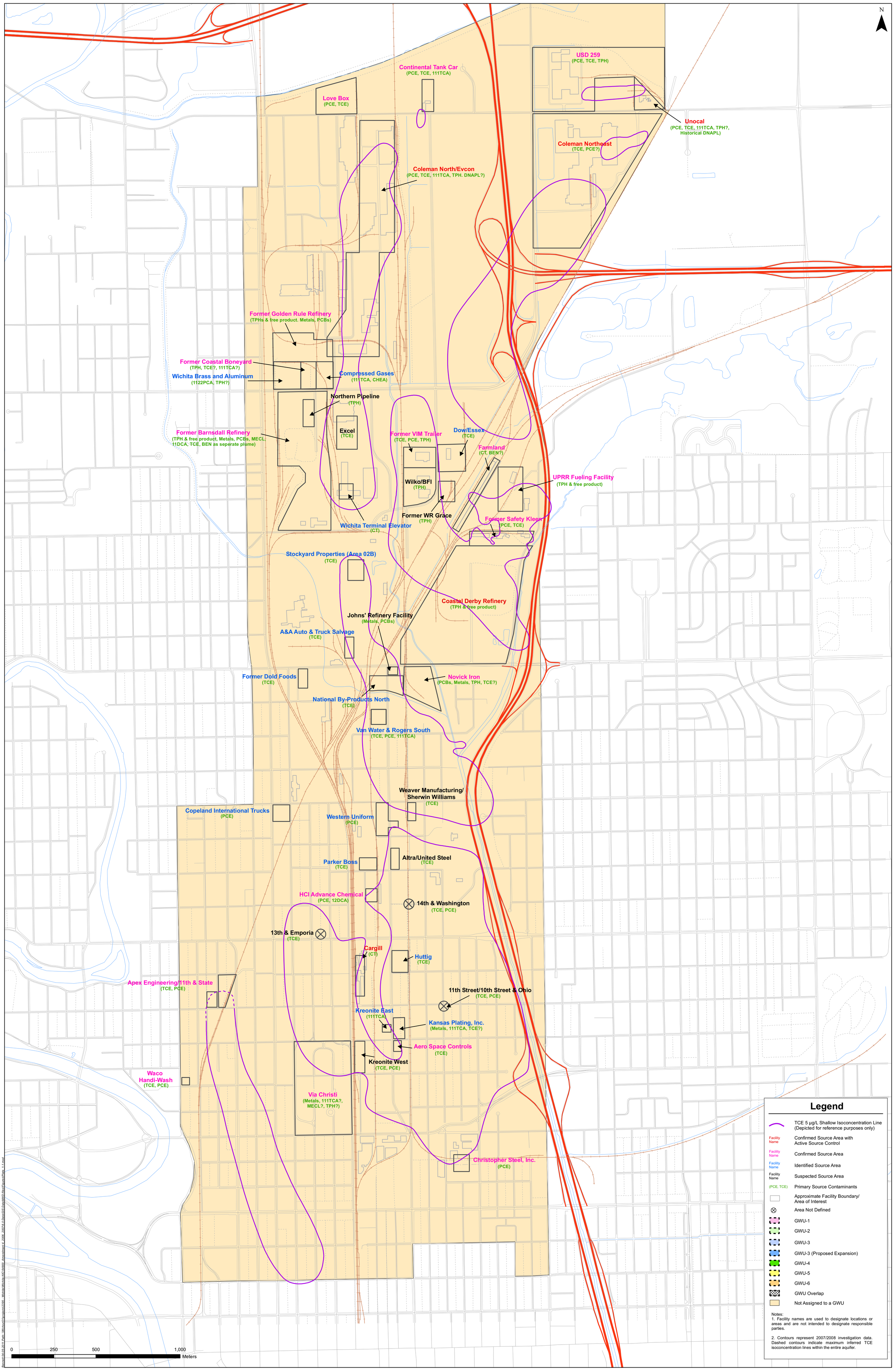
Figure 1-3
North Industrial Corridor (NIC) Site
Groundwater Unit Boundaries



CDM

Plate 1-1
North Industrial Corridor (NIC) Site
Primary Source Contaminants at Source Areas

Table 1-1
North Industrial Corridor (NIC) Site
Contaminants of Potential Concern[1]

	Groundwater	Indoor Air	Surface Water	Sediment	Sludge Pit Area Groundwater	Sludge Pit Area Soils
Volatile Organic Compounds						
Benzene	Y	Y			Y	
Bromodichloromethane	Y	Y				
Carbon tetrachloride	Y	Y				
Chloroethane	Y	Y			Y	
Chloroform	Y	Y				
Chloromethane	Y	Y				
Dibromochloromethane	Y	Y				
1,2-Dibromoethane	Y	Y				
1,1-Dichloroethane	Y	Y				
1,2-Dichloroethane	Y	Y				
1,1-Dichloroethene	Y	Y				
cis -1,2-Dichloroethene	Y	Y				
trans -1,2-Dichloroethene	Y	Y				
1,2-Dichloropropane	Y	Y				
Ethylbenzene	Y	Y			Y	
n -Butylbenzene	Y	Y				
sec -Butylbenzene	Y	Y				
Isopropylbenzene	Y	Y				
p -Isopropylbenzene	Y	Y				
n -Propylbenzene	Y	Y				
Methylene chloride	Y	Y				
Methyl *tert* -Butyl Ether	Y	Y				
1,1,2,2-Tetrachloroethane	Y	Y				
Tetrachloroethene	Y	Y				
Toluene	Y	Y				
1,1,1-Trichloroethane	Y	Y				
1,1,2-Trichloroethane	Y	Y				
Trichloroethene	Y	Y	Y			
1,2,4-Trimethylbenzene	Y	Y				
1,3,5-Trimethylbenzene	Y	Y				
Vinyl chloride	Y	Y	Y		Y	
m,p-Xylene	Y	Y			Y	
o-Xylene	Y	Y			Y	
Semivolatile Organic Compounds						
1,4-Dichlorobenzene	Y	Y				
Benzo(a)anthracene						Y
Benzo(a)pyrene				Y		Y
Benzo(b)fluoranthene				Y		Y
Bis(2-ethylhexyl)phthalate						Y
Chrysene					Y	
Ideno(1,2,3-cd)pyrene						Y
Naphthalene	Y	Y			Y	
Pyrene					Y	
Total Petroleum Hydrocarbons (TPH)	Y	Y				
TPH-Diesel-range Organics (DRO)	Y	Y			Y	Y
TPH-Gasoline-range Organics (GRO)	Y	Y			Y	Y
Metals						
Aluminum					Y	
Arsenic	Y	Y		Y	Y	Y
Barium	Y	Y			Y	
Iron	Y	Y			Y	Y
Lead	Y	Y			Y	Y
Manganese	Y	Y			Y	
Selenium	Y	Y				
Thallium	Y	Y				
Pesticides/Polychlorinated biphenyls (PCBs)						
PCB-1248						Y
PCB-1260				Y		Y

1 = List of COPCs (contaminants of potential concern) are from Tables 2-1 through 2-7 as presented in the KDHE-approved *Baseline Risk Assessment for the North Industrial Corridor* (CDM 2007c).

CDM

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
GWU1							
Coleman Northeast (CNE) Facility	C	3600 N. Hydraulic Ave.	The Coleman Co.	Yes (KDHE)	TCE, PCE?	Groundwater extraction & treatment; impermeable geomembrane barrier at Site 3; soil excavation & onsite treatment at Site 1B; SVE pilot testing at Site 3; enhanced reductive dechlorination pilot testing at Site 1B expanded. Tracer testing.	Groundwater was impacted downgradient of the Site prior to source control implementation; impact through at least GWU1.
DOW/Essex (DEC) and Wil-Gro (WG) Facilities	I	2808 N. Ohio Ave.; 2728 N. Ohio	DOW Automotive	No	TCE	Removal of heating oil UST; The existence of a historical source of TCE contamination on the DEC/WG Site remains inconclusive. NFA per the KDHE.	There appears to have been a historical downgradient impact (southern GWU1); however, the degree of the historical downgradient impact is uncertain.
Farmland (FLE) Facility	C	1050 E. 25th St. N.	Farmland	Yes (KDHE)	CT; BEN? (*source unknown*)	Completion of interim removal & construction work associated with CT UST. SCI & SCM CAS completed & approved by the KDHE. CAD currently in progress.	Historical groundwater impact to the southeast (southern GWU1, GWU5). Current impact to Site-wide groundwater appears to be minor. BEN impact may not be attributable to FLE; however, where present, BEN can enhance the MNA of chlorinated solvents.
Safety-Kleen (SK) Facility	C	2525 New York St.	Clean Harbors Kansas, LLC	Yes (EPA & KDHE)	PCE, TCE	Limited excavation & disposal of paint can burial pit. Health Risk Assessment Report under review by EPA & KDHE. Corrective Measures Study & performance pending EPA approval of Risk Assessment Report.	Groundwater impacted on and downgradient of the Site, primarily on southern GWU1 and the El Paso (GWU5) property.
Unocal Facility	C	2100 E. 37th St. N.	Unocal	Yes (KDHE)	PCE, TCE, 111TCA, BEN, NAP, 124TMB, 135TMB, TOL, EBN, XYL, Historical DNAPL	Excavation & disposal of contaminated soils; groundwater extraction & treatment (now decommissioned); SVE; phytoremediation; injections & HRC; FS completed and approved by the KDHE in July 2009.	Groundwater has been impacted on and downgradient of the Site. Groundwater impact is at least within GWU1 and possibly into GWU5. TPH constituent impact is typically confined to the vicinity of the source area, but can enhance the MNA of chlorinated solvents where present.

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
Union Pacific Railroad Fueling Terminal Facility (UPRF)	C	2645 N. New York Ave.	Union Pacific Railroad	Yes (KDHE UST Program)	TPH & free product	Free product removal via skimmers in impacted monitoring wells; vapor recovery. Site monitored by the KDHE.	Groundwater has been impacted onsite (GWU1). TPH contamination is likely to enhance the MNA of chlorinated solvents where present.
Former VIM Trailer Facility (VIM)	C	2811 N. Ohio St.	Waste Connections	Yes (KDHE)	TCE, PCE, TPH	CI completed. CAS pending approval by the KDHE.	Groundwater has been impacted within and downgradient of the Site. Downgradient groundwater impact appears to have been historically stronger. TPH impact is localized to the Site and will typically enhance the MNA of chlorinated solvents where present. Groundwater impact is within GWU1 and possibly GWU5.
Wilko Paints (WP) and BFI Facilities	S	2727 N. Ohio; 2745 N. Ohio	Wilco Paints and BFI	No	TPH	None to date	If TPH has been contributed to groundwater, it may enhance the MNA of chlorinated solvents where present. Impact of TPH is typically confined to the immediate vicinity of the source area.
Former WR Grace (WRG) Facility	S	2728 N. Ohio	Wil-Gro	No	TPH	None to date	Based on current information, the TPH appears attributable to offsite sources. If TPH is contributed to groundwater, it may enhance the MNA of chlorinated solvents where present. Impact of TPH is typically confined to the immediate vicinity of the source area.
GWU2							
A&A Auto and Truck Salvage (ATS) Facility	I	700 E. 21st St. N.	A&A Auto and Truck Salvage	No	TCE	RI Addendum recommended no source control measures	Concentrations have been declining. Historical downgradient impact may be more signficant than present conditions. At a minimum, groundwater is impacted in the southern portion of GWU2.

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
Former Barnsdall Refinery (BRND) Facility	C	SE of Broadway & 29th	Glickman and Kansas Metals	No	TPH & free product, Metals, PCBs, TCE. BEN as separate plume.	Some excavation of former sludge pits with sludge and soil disposal.	TCE impact is suspected but not confirmed. PCBs and metals impacts to the groundwater would typically be confined to the source area and not have an impact to downgradient groundwater. BEN and TPH impacts are typically localized to the immediate vicinity of the Site and, where present, can enhance the MNA of chlorinated solvents.
Former Coastal Refining & Marketing, Inc. Boneyard (CBY) Facility	C	500 Block of E. 29th St. N.; NW of Emporia Circle & 29th	El Paso Corp.	Letter agreement with KDHE	Confirmed for TPH; no VOCs in onsite soils. Identified site for TCE contamination.	EUCs and ongoing monitoring. RI Addendum recommended no source control measures.	Historical groundwater was impacted by TCE at significant concentrations (>1 mg/L). The TCE impact extends to at least southern half of GWU2. TPH impacts are generally confined to the immediate vicinity of the Site and will typically enhance the MNA of chlorinated solvents.
Coleman North/Evcon (CN) Facility	C	801 E. 37th St. N. (Evcon) & 3050 N. St. Francis (Recreational Vehicle Products)	Johnson Controls, Inc. and RV Products	Yes (EPA)	TCE, PCE, 111TCA, TPH	RI/FS. AS/SVE remediation system installed. Groundwater extraction and treatment.	Chlorinated solvent impact is at least through GWU2. TPH impact to groundwater is generally confined to vicinity of the source area. TPH can enhance the MNA of chlorinated solvents where present.
Compressed Gases, Inc. (CGI) Facility	I	602 E. 29th St. N.	Compressed Gases	Yes (KDHE) (Only to conduct site investigation)	111TCA, CHEA	Compressed Gases to submit revised work plan and conduct CI. RI Addendum recommended no source control measures.	Historical downgradient impacts within GWU2 but concentrations have been declining.
Continental Tank Car (CTC) Facility	C	1106 E. 37th St. N.	Continental Tank Car Corp.	Yes (KDHE)	PCE, TCE, 111TCA	IRMs requiring source control & delineation efforts. Source area pilot test for injection of Hydrogen Release Compound (HRC) into vadose zone soils. Report on pilot test has not been received by the KDHE. Ongoing groundwater monitoring although many of the required sampling events have not been conducted.	Historical downgradient impacts within GWU2 at least through CN and EXC facility. Concentrations appear to be decreasing since the pilot test in the source area.

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
Excel Facility (EXC)	S	2901 N. Mead	Excel	No	TCE	None	Facility still suspected of a TCE release with an impact to GWU2 groundwater.
Former Golden Rule Refinery (GRR) Facility	C	NE of Broadway & 29th	Wichita Brass & Aluminum, Compressed Gasses, undeveloped	PRP still to be determined	TPHs & free product, Metals, PCBs	Natural attenuation	TPH, metals, and PCB impacts appears to be confined to the Site with no downgradient groundwater impact. TPH can enhance the MNA of chlorinated solvents where present.
Former Johns' Refinery (JRF)	S	915 E. 21st St. N.	Parking Lot	No	Metals (Lead and Copper), PCBs, TPH	Emptied & removed 32 ASTs, 11 USTs, disposal of the tank contents, & removal of PCB contaminated soil. Capping with soil & gravel for parking lot. RI Addendum suggested source control measures unnecessary.	TPH, metals, and PCB impacts appears to be confined to the Site with no downgradient groundwater impact. TPH can enhance the MNA of chlorinated solvents where present.
Love Box (LBC) Facility	C	700 E. 37th St. N.	Love Box	Yes (KDHE-Administrative Order)	PCE, TCE	CI report conditionally approved January 2010. CAS in progress. Ongoing groundwater sampling.	Historical data indicate groundwater has been impacted downgradient of the Site (GWU2) but recent investigations show no significant impact. Most of the impact may have been captured by the CN extraction wells.
National By-Products North Facility	I	721 E. 21st St. N.; 2155 N. Mosley; 2150 N. Mosley	National By-Products	No	TCE	RI Addendum recommended no source control measures	Historical data indicate groundwater has been impacted within and downgradient of the Site within GWU2.
Northern Pipeline Construction (NPC) Facility	S	2915 N. Emporia St.	Northern Pipeline Const.	No	TPH	RI Addendum suggested source control measures unnecessary.	TPH impact appears to be confined to the vicinity of the property. No significant downgradient impact is apparent within GWU2. The source of the TPH impact could be the former Barnsdall operations. TPH can enhance the MNA of chlorinated solvents where present.

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
Novick Iron and Metal (NIM) Facility	C/I	1007 E. 21st St. N.	Novick Iron & Metal	Yes (KDHE - Administrative Order)	Confirmed for PCBs, Metals, TPH; possible TCE	Interim Measure Work Plan to address elevated concentrations of PCBs detected in southern part of property submitted. KDHE & EPA required additional groundwater sampling to confirm previous detections of PCBs in groundwater before proceeding with implementation. Monitoring wells installed in April 2010. Additional soil characterization efforts conducted during the 1st quarter of 2011 to support design & implementation of an IRM to address the southern PCB hotspot.	TPH, metals, and PCB impacts are anticipated to be confined to the immediate vicinity of the Site with no downgradient groundwater impact. TPH can enhance the MNA of chlorinated solvents where present. If TCE is released, the suspected extent of downgradient impact is within GWU2.
Stockyard Properties (Area 02B) (S2B) Facility	I	600 to 800 block of E. 25th St. N.; SW of Mead & 25th	Webb Road Development	No	TCE	None to date	Groundwater has been impacted downgradient of the Site. The historical impact appears to be greater than current impact; concentrations appear to be decreasing. Groundwater impact is at least through southern extent of GWU2.
Van Waters & Rogers South (VWRS) Facility	I	2041 to 2049 N. Mosley	Vopac USA, Inc.	Yes (KDHE)	TCE, 111TCA, PCE pre-2001	CI for VWRS approved but FS pending resolution of issues.	RI data indicate probable significant impact to GWU2, primarily for TCE, downgradient of the source area. There may be an impact to GWU3 as well.
Wichita Brass & Aluminum (WBA)	I	412 E. 29th St. N.	Wichita Brass & Aluminum	No	1122PCA, TPH?	None to date	Groundwater impact is minor with respect to chlorinated solvents; no downgradient impact (within GWU2) for 1122PCA has been documented. TPH impacts are typically confined to the vicinity of the source area but can enhance the MNA of chlorinated solvents where present.

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
Wichita Terminal Elevator (WTE)	I	508 E. 25th St. N.	Cargill	No	CT	Natural attenuation. RI Addendum recommended no source control measures.	Historical data show a limited extent of CT impacts (via daughter products). The downgradient plume appears to have been attenuated by MNA processes based on RI/FS data.
GWU3							
Aero Space Controls (ASC) Facility	C	1050 N. Mosley	Aero Space Controls, Inc.	To be determined	TCE	None	Significant TCE concentrations were found at the source area. GWU3 groundwater is impacted downgradient of the source area.
Altra Color Body Shop (ACB) Facility/ United Steel (US) Facility	S	1610 & 1632 N. Mosley	Altra Color Bodyshop and United Steel	No	TCE	RI Addendum suggested source control measures unnecessary.	Unable to confirm as source area. If TCE groundwater impacts are from one or both facilities, there are groundwater impacts in GWU3 downgradient of these properties.
Cargill Elevator (CGL) at 715th E.13th St.	C	715 E. 13th St.	Cargill	Yes (KDHE)	CT	Installation of two permeable reactive barriers to provide source control and limit downgradient migration of contaminants	GWU3 groundwater impacts relative to CT and daughter products appear to be confined to the vicinity of the source area with no significant downgradient plume extent within GWU3.
Christopher Steel Inc. (CSI) Facility	C	1221 E. Murdock	Christopher Steel	No	PCE	Some soil excavation at apparent source area. RI Addendum recommended no source control measures.	PCE contamination levels in the groundwater appear to be low level, even historically. Extent of groundwater contamination appears to be localized within the southern extent of GWU3.
Former Copeland Intl. Trucks (CIT) Facility	I	1770 N. Broadway	Copeland International Trucks, Inc.	No	PCE	RI Addendum recommended no source control measures	PCE contamination levels in the groundwater appear to be low level, even historically. Extent of groundwater contamination appears to be localized within the immediate area of the Site within GWU3.
Former Dold Foods (DLDS) Facility	I	421 E. 21st St. N.	Trailer Parts & Supplies	No	TCE	Historical pumping well may have provided remediation. RI Addendum recommended no source control measures.	Groundwater impacts downgradient of the Site appear confined to the southern extent of GWU3.

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
HCI Advance Chemical (HCI) Facility (now Brenntag)	C	1520 N. Barwise	Brenntag	Yes (KDHE-Administrative Order)	PCE, 12DCA	Soil excavation. Currently conducting CI/CAS.	Groundwater impacts downgradient of the Site appear confined to the southern extent of GWU3.
Huttig (HUT) Facility	I	1340 N. Mosley	Anderson Windows	No	TCE	RI Addendum recommended no source control measures	Source not confirmed and most of the impact appears to have been historical. Groundwater impacts downgradient of the Site appear confined to the southern extent of GWU3.
Kansas Plating (KPI) Facility	C	1110 N. Mosley	Kansas Plating, Inc.	To be determined	Confirmed for Metals (Cr). Identified for 111TCA (historical), TCE.	RI Addendum recommended no source control measures.	Originally identified as a 111TCA contributor during the NIC RI. Recent KDHE data indicates probable TCE contamination occuring now, along with metals (Cr). Metals impacts are expected to be confined to the vicinity of the source area. 111TCA impacts appear to have attenuated. TCE contamination impacts expected to impact the southern portion of GWU3.
Kreonite East (KRE)	I	1123 N. Mosley	Vacant	No	111TCA	RI Addendum recommended no source control measures	Groundwater impacts, mostly historical, were identified downgradient of the Site within GWU3, but may be attenuated at this time.
Kreonite West (KRW) Facility	S	715 E. 10th St. N.	Kreonite	No	TCE, PCE	RI Addendum suggested source control measures unnecessary.	Suspected soure, not confirmed. Degree of groundwater contamination appeared to be low level. Groundwater impacts downgradient of site appear confined to southern extent of GWU3.
Wichita Mirror and Glass (WMG) and Parker Boss (PKB) Facilities	I	712 & 780 E. 15th Street	Parker Boss Clay Traps	No	TCE	RI Addendum recommended no source control measures	Groundwater impacts, mostly historical, were identified downgradient of site within GWU 3,

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
Via Christi Medical (VCM) Center, St. Francis Campus	C	929 N. St. Francis	Via Christi Medical	Yes (KDHE) (KDHE will address any outstanding issues)	Confirmed for Metals in soils; possible 111TCA, MECL, TPH	Lead-contaminated soils excavated & removed; some capped beneath parking lot.	Metals and TPH impacts confined to site. No downgradient groundwater impacts by chlorinated solvents attributable VCM identified during sampling efforts.
Weaver Manufacturing (WM) and Sherwin Williams (SW) Facilities	S	1005 E. 17th Street N. & 1705 N. Wabash Ave.	Weaver Mfg.	No	TCE	RI Addendum suggested source control measures unnecessary.	Degree of groundwater contamination appeared to be low level. Historical impacts appeared significant. Recent concentrations are low level. Groundwater impacts downgradient of the Site appear confined to the southeastern extent of GWU3. Source not confimred.
Western Uniform (WU) Facility	I	1707 N. Mosley	Western Uniform & Towel	Yes (KDHE) (Only to conduct site investigation)	PCE	RI Addendum recommended no source control measures	Low level impacts. Degree of downgradient impact appears fairly limited within GWU3.
11th Street Area and 10th & Ohio Area	S	11th Street Area (11th & Mosley, 11th & Wabash, 11th & Indiana/ Cleveland); 10th & Ohio		No	TCE, PCE	RI Addendum suggested source control measures unnecessary.	Groundwater impacts downgradient of the Site appear confined to the southeastern extent of GWU3.
13th & Emporia (13E) Area	S	Alley N of car wash near 13th & Emporia	Alley N of car wash	No	TCE	RI Addendum suggested source control measures unnecessary.	Groundwater impacts downgradient of the Site appear confined to the southeastern extent of GWU3.
14th & Washington (14W) Area	S	Vicinity of 14th & Washington		No	TCE, PCE	RI Addendum suggested source control measures unnecessary.	Groundwater impacts downgradient of the Site appear confined to the southeastern extent of GWU3.
GWU4							
Apex Engineering Facility (Apex)	C	1211 & 1234 N. Wellington	Apex Engineering	Yes (KDHE)	TCE, PCE	CI completed. CAS pending approval by the KDHE.	Downgradient extent of chlorinated solvent impact appears to extend to the southern end of GWU4.

Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater
11th & State Area	C	NE of 11th & State	Former Airama (202 11th & 1209 N. Wellington); Winding Specialists (1217 N. Wellington, 1225 N. Wellington, & 1220 State)	No	TCE	Area has now been combined with Apex and may be removed from GWU as a separate area.	Downgradient extent of chlorinated solvent impact appears to extend to the southern end of GWU4.
Waco Handi-Wash Facility	C	1008 N. Waco	Waco Handi-Wash	Accepted by Dry Cleaner Trust Fund	PCE		Downgradient extent of chlorinated solvent impact appears to extend to the southern end of GWU4.
GWU5							
Former Coastal-Derby (DRB) Facility	C	1100 E. 21st St. N.	El Paso Corp.	Yes (KDHE)	TPH & free product	Groundwater extraction & product removal. Ecological risk assessments approved by KDHE. Human health risk assessment pending approval.	TPH impact appears to be confined to the vicinity of the property. No significant downgradient impact is apparent within GWU5. Source of TPH is from former refinery operations. TPH can enhance the MNA of chlorinated solvents where present.
GWU6							
USD 259 Facility	C	3850 N. Hydraulic	USD 259	Yes (KDHE)	PCE, TCE, TPH	Excavation & disposal of UST & contaminated soil; EAB pilot & expanded. Plans to install ZVI/PRB. RI complete. FS planned.	Groundwater has been impacted within the Site and apparently downgradient of the Site but still within GWU6.

* Facility names are used to designate location/areas and are not intended to designate responsible parties.
\# = Source area type is "C" for confirmed, "I" for Identified, and "S" for Suspect
** No evaluation of the effectiveness of any remedial actions has been performed.
^ = Assumes degradation products also

Degradation pathways:

PCE → TCE → C/T12DCE → VC
111TCA → 11DCA (abiotic) → 12DCA
111TCA → 11DCE (biodegradation)
CT → CFM

SCI = Source control investigation
UG = upgradient
MNA = Monitored Natural Attenuation
SCM = Source control measures
UST = Underground Storage Tank
EAB = Enhanced Anaerobic Bioremediation

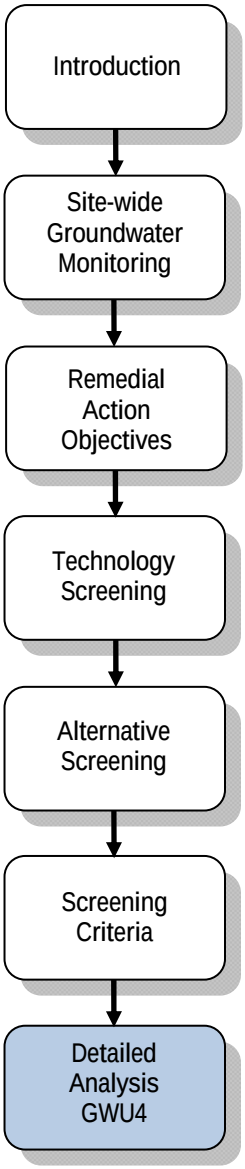
Table 1-2
North Industrial Corridor (NIC) Site
Summary of Confirmed, Identified, and Suspect Source Area Contaminants of Concern

Facility Name*	Source Area Type #	Address/Location	Current Operator/ Occupant	Under Regulatory Oversight / Regulatory Agency	Contaminants of Concern^	Remedial Actions**	Impact to Site-wide Groundwater

11DCA = 1,1-Dichloroethane
12DCA = 1,2-Dichloroethane
11DCE = 1,1-Dichloroethene
1122PCA = 1,1,2,2-Tetrachloroethane
111TCA = 1,1,1-Trichloroethane
BEN = Benzene
C12DCE - *cis* -1,2-Dichloroethene
CHEA = Chloroethane
CT = Carbon tetrachloride
DNAPL = Dense non-aqueous phase liquid
EBN = Ethybenzene
MECL = Methylene chloride
NAP = Naphthalene
PCBs = Polychlorinated byphenols
PCE = Tetrachloroethene
T12DCE - *trans* -1,2-Dichloroethene
TCE = Trichloroethene
124TMB = 1,2,4-Trimethylbenzene
135TMB = 1,3,5-Trimethylbenzene
TOL = Toluene
TPH = Petroleum hydrocarbons
VC = Vinyl chloride
XYL = Xylenes

Section 10
Detailed Analysis of Retained Alternatives – Groundwater Unit 4

Alternatives retained in Section 5 for GWU4 undergo detailed analysis in this section. During detailed analysis, each retained alternative is assessed using the two threshold and five balancing criteria presented in Section 6.0. The results of the detailed analysis for each retained alternative are arrayed to perform a comparative analysis, identifying key tradeoffs between alternatives. The detailed analyses for retained alternatives for GWU4 are presented below.



10.1 Secondary Assumptions Affecting Detailed Analysis of Remedial Alternatives

Fundamental assumptions for all remedial alternatives used during alternative development and screening were presented in Section 5. There are, however, also numerous secondary assumptions that affect the detailed analysis of alternatives even though these assumptions are not fundamental controlling considerations. These assumptions are driven mainly by site limitations and constraints that cannot be overcome by using one or more retained remedial technology/process options as described in Section 4. Secondary assumptions affecting the detailed analysis of remedial alternatives for GWU4 include the following.

- Source control measures are assumed to be implemented at all significantly active source areas for Alternatives GWU4-2, GWU4-3, and GWU4-4.

- Based on the groundwater modeling report for GWU4 (**Appendix F**), with an active pumping treatment system consisting of one extraction well near the NIC southern boundary (Alternatives GWU4-2 and GWU4-3), the contaminant plume would require approximately 28 years of O&M to capture the upgradient groundwater plume for a total of seven flushing volumes. It is assumed that seven flushing volumes, combined with natural attenuation effects will reduce the contaminant plume to concentrations below MCLs.

- Because the duration time of 28 years was identified for groundwater extraction alternatives GWU4-2 and GWU4-3, this time frame was also selected for the No Action alternative (GWU4-1) as well.

- Based on the groundwater modeling report for GWU4 (**Appendix F**), with an active pumping treatment system consisting of one extraction well near the NIC southern boundary plus one in-plume extraction well (Alternative GWU4-4), the contaminant plume would require approximately 18 years of O&M to capture the upgradient groundwater plume for a total of seven flushing volumes. It is assumed that seven flushing volumes, combined with natural attenuation effects will reduce the contaminant plume to concentrations below MCLs.

- The actual number of groundwater monitoring wells to be installed and established as part of the performance assessment and monitoring program for the selected alternative will be determined during the remedial design phase. However, a number of wells for assessment and monitoring was estimated for each alternative for costing purposes in this FS.

10.2 Remedial Alternatives Retained for GWU4

The following alternatives were retained for detailed analysis for GWU4:

Alternative GWU4-1 – No Action;

Alternative GWU4-2 – Groundwater Extraction (Containment Only) and Discharge after Treatment at the Gilbert-Mosley Treatment Plant;

Alternative GWU4-3 – Groundwater Extraction (Containment Only), New Treatment Plant, and Discharge to Storm Sewer; and

- Alternative GWU4-4 – Groundwater Extraction (Containment and Interior Extraction), Treatment at Either the Gilbert-Mosley Treatment Plant or a New Treatment Plant, and Discharge.

10.3 Alternative GWU4-1 – No Action

10.3.1 Alternative Component Description

The No Action alternative is required by the NCP to provide a baseline set of conditions against which other remedial actions may be compared. This alternative allows a site to remain in its current state with no remedial actions being implemented outside of separate source control efforts performed by responsible parties; these source controls are not considered for this FS. There would be no change in groundwater contaminant concentrations aside from that which occurs naturally because no treatment, containment, or removal of contaminated groundwater is included in this alternative. Existing water well ordinances, however, would still be enforced and existing institutional controls would be maintained.

Although no remedial action or monitoring is required for this alternative per EPA guidance (EPA 1989), the KDHE currently has a Settlement Agreement with the City for the NIC Site. Due to the Settlement Agreement, therefore, the No Action alternative for this FS includes limited groundwater monitoring of GWU4 and five-

year site reviews. For the NIC Site, this includes groundwater monitoring at 10 well pairs located throughout GWU4.

Sampling and analysis would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 18 years* to monitor the extent of groundwater contamination. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination is not treated, contained, or removed in this alternative. Abandonment of monitoring wells is assumed to occur at the end of the *period of performance of 28 years*.

10.3.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU4-1 as determined against criteria factors is provided in **Table D-GWU4-1A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment; however, since no treatment, containment, or removal of contaminated GWU4 groundwater is included in this alternative, this criterion is not met. The overall rating for Alternative GWU4-1 is none (⓪).

10.3.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU4-1 as determined against criteria factors is provided in **Table D-GWU4-1B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU4-1 against this criterion is none, primarily because concentrations in GWU4 groundwater exceed federal drinking water standards and KDHE Tier 2 action limits (⓪).

10.3.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU4-1 as determined against criteria factors is provided in **Table D-GWU4-1C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment; however, other short-term risks to the community are unchanged by this alternative because no treatment, containment, or removal of GWU4 contaminated groundwater is performed and the time-frame for monitoring is essentially open-ended. This criterion is therefore not met by Alternative GWU4-1 and the overall rating for is therefore none (⓪).

10.3.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU4-1 as determined against criteria factors is provided in **Table D-GWU4-1D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary; however, no containment or removal of contaminated GWU4 groundwater is included in this alternative. Treatment relies on natural attenuation processes and the time required to complete this remedy could exceed the 30 years used as a standard basis for alternative life. This criterion is therefore not met by this alternative and the overall rating for Alternative GWU4-1 is therefore none (⓪).

10.3.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU4-1 as determined against criteria factors is provided in **Table D-GWU4-1E** of **Appendix D**. This alternative does not provide for a GWU4 treatment component outside of natural attenuation which may result in incomplete degradation of chlorinated solvents. In addition, this alternative does not provide for containment or removal of contaminated GWU4 groundwater and therefore does not satisfy the preference for treatment as a principal element of the remedial action. This criterion is not met by this alternative. The overall rating for Alternative GWU4-1 is none (⓪).

10.3.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU4-1F** of **Appendix D**. Groundwater monitoring and maintenance of existing water well ordinances and institutional controls is easily implementable. The overall rating for Alternative GWU4-1 against this criterion is therefore high (❺).

10.3.8 Cost

Evaluation of cost for Alternative GWU4-1 along with a summary breakdown of cost components is provided in **Table D-GWU4-1G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU4-1 against this criterion is low ($).

10.4 Alternative GWU4-2 – Groundwater Extraction (Containment Only), Discharge after Treatment at the Gilbert-Mosley GWTP

10.4.1 Alternative Component Description

Containment of the GWU4 plume would be achieved through operation of one extraction well installed near the leading edge of the plume. The new extraction well (NIC#4-1) would be a 10-inch diameter well, screened from approximately 10 to 40 ft

bgs. Based on groundwater modeling, the extraction well would need to have an estimated pumping rate of 120 gpm to provide sufficient capture of the groundwater contaminant plume. As noted in Section 10.2 and discussed further in **Appendix F**, the extraction well would operate for a period of 28 years. Extracted groundwater from this well would be conveyed to the GilMo GWTP by connecting to an 8-inch pipe on Santa Fe Street assumed to be installed as part of Alternative GWU3-2, GWU3-4, or GWU3-5). The majority of the new pipe would be installed with directional boring to reduce road resurfacing and impact to traffic. The new piping would be placed only until the connection with the GWU3 discharge line currently planned for transit down the Santa Fe road corridor. Extraction well and piping locations assumed for costing purposes under this alternative are shown on **Figure 10-1**. This alternative assumes that pipe jacking would be required in two locations. Extracted groundwater would then be treated through an air stripper system at the GilMo GWTP. The treated groundwater would be discharged to the Arkansas River.

GilMo GWTP O&M costs proportional to the expected flow rate from GWU4 are included under this alternative. Costs for O&M of the GilMo GWTP were based on historically incurred costs. O&M of the extraction well was included for this alternative. It was assumed the extraction well would require annual development.

For purposes of the detailed analysis it was assumed the extraction well pump would require replacement every five years. Additionally it was assumed that components of the GilMo GWTP would be replaced every 30 years; however, since the expected operational period for the extraction well is only 28 years, GilMo GWTP replacement costs are not included in the estimate.

Sampling and analysis at 16 wells throughout the GWU4 groundwater plume would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 18 years* to monitor the effectiveness of the groundwater containment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of monitoring and extraction wells is assumed to occur at the end of the *period of performance of 28 years*. Decommissioning of the GilMo GWTP was not included in this alternative.

10.4.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU4-2 as determined against criteria factors is provided in **Table D-GWU4-2A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment,

containment, or removal of GWU4 contaminated groundwater is performed. The overall rating for Alternative GWU4-2 is moderate to high (❹).

10.4.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU4-2 as determined against criteria factors is provided in **Table D-GWU4-2B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU4-2 against this criterion is high (❺).

10.4.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU4-2 as determined against criteria factors is provided in **Table D-GWU4-2C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition treatment, containment, or removal of GWU4 contaminated groundwater is performed. The overall rating for Alternative GWU4-2 against this criterion is therefore moderate to high (❹).

10.4.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU4-2 as determined against criteria factors is provided in **Table D-GWU4-2D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary. In addition, treatment, containment, or removal of GWU4 contaminated groundwater is performed and the operational duration is less than the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU4-2 against this criterion is therefore moderate to high (❹).

10.4.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU4-2 as determined against criteria factors is provided in **Table D-GWU4-2E** of **Appendix D**. This alternative provides for a GWU4 treatment component, provides for containment or removal of contaminated GWU4 groundwater, and therefore satisfies the preference for treatment as a principal element of the remedial action. The overall rating for Alternative GWU4-2 is moderate (❸).

10.4.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU4-2F** of **Appendix D**. Groundwater monitoring, extraction well O&M, and maintenance of existing water well ordinances and institutional controls is readily implementable. The overall rating for Alternative GWU4-2 against this criterion is therefore moderate to high (❹).

10.4.8 Cost

Evaluation of cost for Alternative GWU4-2 along with a summary breakdown of cost components is provided in **Table D-GWU4-2G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU4-2 against this criterion is low to moderate (**$$**).

10.5 Alternative GWU4-3 – Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Storm Sewer

10.5.1 Alternative Component Description

Alternative GWU4-3 provides the same containment as Alternative GWU4-2; however, under GWU4-3, groundwater pumped from the extraction well would be piped to a new GWTP constructed within GWU4 instead of being conveyed to the GilMo GWTP. Extraction well and piping locations assumed for costing purposes under this alternative are shown on **Figure 10-1**. The new GWU4 GWTP would consist of an air stripper unit and treated water would be discharged to the storm sewer.

Most of the new pipe would be installed by directional boring to reduce road resurfacing and impact to traffic. The GWU4 GWTP is assumed to be located within 1,000 feet of the extraction well and on City-owned property. The discharge line is assumed to be less than 300 feet with discharge going to an existing storm sewer.

O&M of the GWU4 GWTP and extraction well was included under this alternative. It was assumed the extraction well would require annual development. For purposes of the detailed analysis it was assumed the extraction well pump would require replacement every five years.

Sampling and analysis at 16 wells throughout the GWU4 groundwater plume would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 18 years* to monitor the effectiveness of the groundwater containment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of monitoring and extraction wells is assumed to occur at the end of the *period of performance of 28 years*. Decommissioning of the GWU4 GWTP is included in this alternative.

10.5.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU4-3 as determined against criteria factors is provided in **Table D-GWU4-3A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU4 contaminated groundwater is performed. The overall rating for Alternative GWU4-3 is moderate to high (❹).

10.5.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU4-3 as determined against criteria factors is provided in **Table D-GWU4-3B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU4-3 against this criterion is high (❺).

10.5.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU4-3 as determined against criteria factors is provided in **Table D-GWU4-3C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU4 contaminated groundwater is performed. The overall rating for Alternative GWU4-3 against this criterion is therefore moderate to high (❹).

10.5.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU4-3 as determined against criteria factors is provided in **Table D-GWU4-3D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary. In addition, treatment, containment, or removal of GWU4 contaminated groundwater is performed and the operational duration is less than the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU4-3 against this criterion is therefore moderate to high (❹).

10.5.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU4-3 as determined against criteria factors is provided in **Table D-GWU4-3E** of **Appendix D**. This alternative provides for a GWU4 treatment component, provides for containment or removal of contaminated GWU4 groundwater, and therefore satisfies the preference for treatment as a principal element of the remedial action. The overall rating for Alternative GWU4-3 is moderate (❸).

10.5.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU4-3F** of **Appendix D**. Groundwater monitoring, extraction well O&M, and maintenance of existing water well ordinances and institutional controls is readily implementable. The overall rating for Alternative GWU4-3 against this criterion is therefore moderate to high (❹).

10.5.8 Cost

Evaluation of cost for Alternative GWU4-3 along with a summary breakdown of cost components is provided in **Table D-GWU4-3G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU4-3 against this criterion is moderate (**$$$**).

10.6 Alternative GWU4-4 – Groundwater Extraction (Containment and Interior Extraction), Treatment at Either the Gilbert-Mosley GWTP or a New Treatment Plant, and Discharge

10.6.1 Alternative Component Description

Alternative GWU4-4 provides the same leading edge containment as Alternative GWU4-2 including conveyance of extracted groundwater to the GilMo GWTP for treatment. Alternative GWU4-4 also provides additional treatment via an in-plume extraction well. Groundwater from the in-plume extraction well would be piped to a new GWTP constructed within GWU4. The new GWU4 GWTP would consist of an air stripper unit. Treated water would be discharged to the storm sewer. Most of the new pipe would be installed by directional boring to reduce road resurfacing and impact to traffic. The GWU4 GWTP is assumed to be located within 1,000 feet of the extraction well and on City-owned property. The discharge line is assumed to be less than 300 feet with discharge going to a storm sewer. Extraction well and piping locations assumed for costing purposes under this alternative are shown on **Figure 10-1**.

Under Alternative GWU4-4, the leading edge extraction well (NIC#4-1) would pump at 120 gpm and be expected to operate for 18 years. GilMo GWTP O&M costs proportional to the expected flow rate from GWU4 are included under this alternative. Costs for O&M of the GilMo GWTP were based on historically incurred costs. O&M of the extraction well was included for this alternative. It was assumed the extraction well would require annual development.

Under Alternative GWU4-4, the in-plume extraction well (NIC#4-2) would pump at 100 gpm and be expected to operate for 14 years. O&M of the GWU4 GWTP and extraction well was included for this alternative. It was assumed that the extraction well would require annual development.

For purposes of the detailed analysis it was assumed both extraction well pumps would require replacement every five years. Additionally, components of the GilMo GWTP would be replaced every 30 years; however, since the operational period for the corresponding extraction well is only 18 years, GilMo GWTP costs are not included.

Sampling and analysis at 16 wells throughout the GWU4 groundwater plume would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 18 years* to monitor the effectiveness of the groundwater containment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of monitoring and extraction wells is assumed to occur at the end of the *period of performance of 18 years*. Decommissioning of the GWU4 GWTP is included in this alternative; however, decommissioning of the GilMo GWTP was not included.

10.6.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU4-4 as determined against criteria factors is provided in **Table D-GWU4-4A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU4 contaminated groundwater is performed. The overall rating for Alternative GWU4-4 is moderate to high (❹).

10.6.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU4-4 as determined against criteria factors is provided in **Table D-GWU4-4B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU4-4 against this criterion is high (❺).

10.6.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU4-4 as determined against criteria factors is provided in **Table D-GWU4-4C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU4 contaminated groundwater is performed. The overall rating for Alternative GWU4-4 against this criterion is therefore moderate to high (❹).

10.6.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU4-4 as determined against criteria factors is provided in **Table D-GWU4-4D** of **Appendix D**. The existing water

well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary. In addition, treatment, containment, or removal of GWU4 contaminated groundwater is performed and the operational duration is less than the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU4-4 against this criterion is therefore high (❺).

10.6.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU4-4 as determined against criteria factors is provided in **Table D-GWU4-4E** of **Appendix D**. This alternative provides for a GWU4 treatment component, provides for containment or removal of contaminated GWU4 groundwater, and therefore satisfies the preference for treatment as a principal element of the remedial action. The overall rating for Alternative GWU4-4 is moderate (❸).

10.6.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU4-4F** of **Appendix D**. Groundwater monitoring, extraction well O&M, and maintenance of existing water well ordinances and institutional controls is readily implementable. The overall rating for Alternative GWU4-4 against this criterion is therefore moderate to high (❹).

10.6.8 Cost

Evaluation of cost for Alternative GWU4-4 along with a summary breakdown of cost components is provided in **Table D-GWU4-4G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU4-4 against this criterion is moderate (**$$$**).

10.7 State/Support Agency Acceptance

State/support agency acceptance is a modifying criterion under the NCP. Assessment of state/support agency acceptance will not be known until the final FS report is submitted to the KDHE and the KDHE issues the draft CAD. The draft CAD will provide the State's rationale for alternative selection and acceptance. Therefore, state/support agency acceptance is not considered in the detailed analysis of alternatives presented in this FS.

10.8 Community Acceptance

Community acceptance is also a modifying criterion under the NCP. Assessment of community acceptance will include responses to questions that any interested person in the community may have regarding any component of the remedial alternatives that will be presented in the KDHE's draft CAD for the NIC Site. This assessment will be completed after the KDHE receives public comments on the proposed plan during

the public commenting period. Community acceptance is therefore not considered in the detailed analysis of alternatives presented in this FS.

10.9 Comparative Analysis of Alternatives

This FS evaluated the four retained remedial alternatives discussed in this section against the two threshold criteria and five balancing criteria discussed in Section 6. A summary of the results of the detailed analyses for each remedial alterative (from **Appendix D**) is presented in **Table 10-1** to allow a comparison of the alternatives and identify the key tradeoffs between them.

10.9.1 Overall Protection of Human Health and the Environment

Alternatives GWU4-2, GWU4-3, and GWU4-4 meet this criterion.

10.9.2 Compliance with ARARs

Alternative GWU4-1 does not comply with ARARs. Alternatives GWU4-2, GWU4-3, and GWU4-4 meet all ARARs.

10.9.3 Short-term Effectiveness

Alternatives GWU4-2, GWU4-3, and GWU4-4 proposed for GWU4 groundwater are effective in the short term; however, each has a construction component that would impact the community during implementation. Alternatives GWU4-3 and GWU4-4 would result in more impact to the community during implementation because Alternative GWU4-3 and GWU4-4 include construction of a new GWTP, whereas Alternative GWU4-2 only uses the existing GilMo GWTP.

10.9.4 Long-Term Effectiveness and Permanence

Alternative GWU4-1 does not provide a long-term effective or a permanent remedy for groundwater at GWU4. Alternatives GWU4-2, GWU4-3, and GWU4-4 would provide long-term containment of the GWU4 groundwater plume and therefore provide the most effective long-term and permanent remedy for GWU4 groundwater.

10.9.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives GWU4-2, GWU4-3, and GWU4-4 provide a treatment component; however, only groundwater extracted for containment would undergo treatment. These alternatives do not address treatment of the entire groundwater plume.

10.9.6 Implementability

All four alternatives proposed for GWU4 groundwater are highly implementable; however, Alternatives GWU4-2, GWU4-3, and GWU4-4 require a construction phase and would therefore be relatively more difficult to implement than Alternative GWU4-1. The overall construction phase for Alternative GWU4-3 is longer than that of Alternative GWU4-2 because a new GWTP is constructed under Alternative GWU4-3. The overall construction phase for Alternative GWU4-4 is the lengthiest

due to construction of a new GWTP as well as installing piping to the existing GilMo GWTP.

10.9.7 Cost

Alternative GWU4-1 falls into the low cost range. Alternative GWU4-2, with costs for extraction well installation and piping to the GilMo GWTP has low to moderate cost. Alternative GWU4-3, with costs for extraction well installation, new GWTP construction, and installation associated piping has moderate cost. Alternative GWU4-4, with costs for extraction well installation, new GWTP construction, and installation of piping associated with both the new GWTP and the existing GilMo GWTP also has moderate cost but is the most expensive alternative proposed for GWU4. Capital, O&M, periodic, and present value costs for the four alternatives are provided in **Appendix D**; however, these costs are also summarized in **Table 10-1**.

10.10 Recommended Alternative

Four alternatives were evaluated to address GWU4 contaminated groundwater. Alternative GWU4-1 does not provide adequate protection to human health and the environment and does not meet ARARs. Alternatives GWU4-2, GWU4-3, and GWU4-4 involve plume containment. Alternative GWU4-2 uses the existing GilMo GWTP to treat extracted groundwater while Alternative GWU4-3 uses a newly constructed GWTP to treat extracted groundwater. Alternative GWU4-4 uses both the existing GilMo GWTP and a newly constructed GWTP to treat extracted groundwater. Alternative GWU4-2 is the least expensive of the three active remedial alternatives and provides a cleanup timeframe that is less than the other GWU's. Alternative GWU4-2 is the preferred alternative for GWU4.

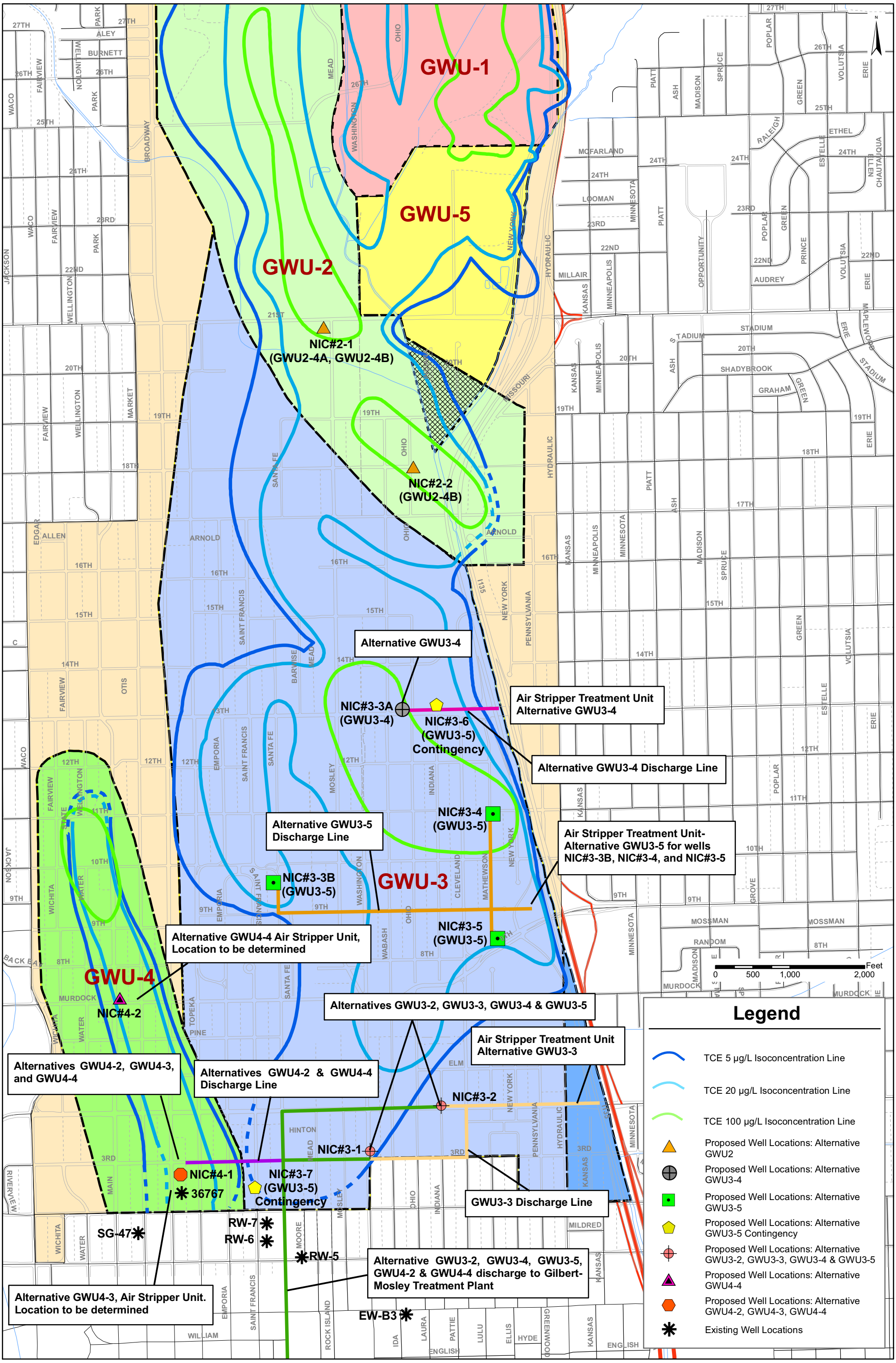


Figure 10-1
North Industrial Corridor (NIC) Site
GWU2, GWU3, and GWU4 Pumping Alternatives and Treatment Systems

CDM

Table 10-1
North Industrial Corridor (NIC) Site
Comparative Analysis of Alternatives for GWU4

Remedial Alternative:	Alternative GWU4-1 No Action	Alternative GWU4-2 Groundwater Extraction (Containment Only), Discharge after Treatment at GilMo GWTP	Alternative GWU4-3 Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Storm Sewer	Alternative GWU4-4 Groundwater Extraction (Containment and Interior Extraction), New Treatment Plant, Discharge to Storm Sewer and GilMo GWTP
Major Components:	Limited monitoring to support Five-Year Site Reviews	Installation of 1 EW at the leading edge of the groundwater plume. Extracted groundwater would be conveyed to the GilMo GWTP for treatment.	Installation of 1 EW at the leading edge of the groundwater plume. Extracted groundwater would be treated at a new GWTP within GWU4.	Installation of 1 EW at the leading edge of the groundwater plume and 1 EW in-plume. Extracted groundwater would be would be conveyed to the GilMo GWTP for treatment or treated at a new GWTP within GWU4.
Threshold Criteria				
Overall Protection of Human Health and the Environment	⓪ Cleanup objectives would not be achieved	❹ Containment of the groundwater plume via EWs and treatment will be protective of the environment. Ongoing institutional controls limiting new well installations are protective of human health.	❹ Containment of the groundwater plume via EWs and treatment will be protective of the environment. Ongoing institutional controls limiting new well installations are protective of human health.	❹ Containment of the groundwater plume via EWs and treatment will be protective of the environment. Ongoing institutional controls limiting new well installations are protective of human health.
Compliance with ARARs	⓪ Would not comply with ARARs	❺ Would comply with ARARs	❺ Would comply with ARARs	❺ Would comply with ARARs
Balancing Criteria				
Short-Term Effectiveness	⓪ The short term risks are not addressed and the time frame is open ended	❹ Some disruption from installation of water lines from EWs to the tie-in location with the GilMo GWTP piping; however, a new GWTP would not be constructed under this alternative.	❹ Disruption to the community from installation of water lines and treatment plant.	❹ Disruption to the community from installation of water lines and treatment plant.
Long-Term Effectiveness and Permanence	⓪ Future risks to human health and the environment would not be diminished	❹ Containment and treatment of contaminated groundwater prevents further migration. Over time the concentrations of contaminants would decrease.	❹ Containment and treatment of contaminated groundwater prevents further migration. Over time the concentrations of contaminants would decrease.	❺ Containment and treatment of contaminated groundwater prevents further migration. Over time the concentrations of contaminants would decrease.
Reduction of Toxicity, Mobility, or Volume through Treatment	⓪ No treatment or reduction in toxicity, mobility, or volume of contaminants	❸ This alternative does provide a treatment component; however, it will require time to capture all of the contaminated groundwater upgradient from the EW. Treatment will be applied to groundwater extracted through hydraulic containment.	❸ This alternative does provide a treatment component; however, it will require time to capture all of the contaminated groundwater upgradient from the EW. Treatment will be applied to groundwater extracted through hydraulic containment.	❸ This alternative does provide a treatment component; however, it will require time to capture all of the contaminated groundwater upgradient from the EWs. Treatment will be applied to groundwater extracted through hydraulic containment.
Implementability	❺ Monitoring is highly implementable	❹ Even assuming captured groundwater from GWU3 flows to the GilMo GWTP, this plant still has the capacity to accommodate the estimated flow rates required for capture of the GWU4 groundwater plume in this alternative.	❹ Installation of water lines and treatment systems is very implementable.	❹ Installation of water lines and treatment systems is very implementable. Even assuming captured groundwater from GWU3 flows to the GilMo GWTP, this plant still has the capacity to accommodate the estimated flow rates required for capture of the GWU4 groundwater plume in this alternative. Other aspects are very implementable.

Table 10-1
North Industrial Corridor (NIC) Site
Comparative Analysis of Alternatives for GWU4

Remedial Alternative:	Alternative GWU4-1 No Action	Alternative GWU4-2 Groundwater Extraction (Containment Only), Discharge after Treatment at GilMo GWTP	Alternative GWU4-3 Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Storm Sewer	Alternative GWU4-4 Groundwater Extraction (Containment and Interior Extraction), New Treatment Plant, Discharge to Storm Sewer and GilMo GWTP
Major Components:	Limited monitoring to support Five-Year Site Reviews	Installation of 1 EW at the leading edge of the groundwater plume. Extracted groundwater would be conveyed to the GilMo GWTP for treatment.	Installation of 1 EW at the leading edge of the groundwater plume. Extracted groundwater would be treated at a new GWTP within GWU4.	Installation of 1 EW at the leading edge of the groundwater plume and 1 EW in-plume. Extracted groundwater would be would be conveyed to the GilMo GWTP for treatment or treated at a new GWTP within GWU4.
Period of Operation (Years)				
Active Treatment	0	Well NIC#4-1 - 28 yrs, 120 gpm	Well NIC#4-1 - 28 yrs, 120 gpm	Well NIC#4-1 - 18 yrs, 120 gpm Well NIC#4-2 - 14 yrs, 100 gpm
Monitoring	28	28	28	18
Cost (Dollars)				
	$	$$	$$$	$$$
Total Capital Cost[1]	$124,000	$789,000	$1,409,000	$1,878,000
Total Annual O&M Cost[1,2]	$1,304,000	$3,300,000	$4,504,000	$3,670,000
Total Periodic Cost[1,2]	$312,000	$478,000	$618,000	$427,000
Present Value Cost[1,2]	$1,418,000	$3,745,000	$5,373,000	$7,298,000

EW = Extraction well
GilMo = Gilbert-Mosley

GWTP = Groundwater treatment plant
ARARs = Applicable or Relevant and Appropriate Requirements

Legend for Qualitative Ratings System:

Ratings Categories for Threshold and Balancing Criteria
⓪ None
❶ Low
❷ Low to Moderate
❸ Moderate
❹ Moderate to High
❺ High

Ratings categories for Cost Criteria (Present Value Cost)

⓪	None	
$	Low	(less than 2 million dollars)
$$	Low to moderate	(between 2 million and 5 million dollars)
$$$	Moderate	(between 5 million and 10 million dollars)
$$$$	Moderate to high	(between 10 million and 15 million dollars)
$$$$$	High	(greater than 15 million dollars)

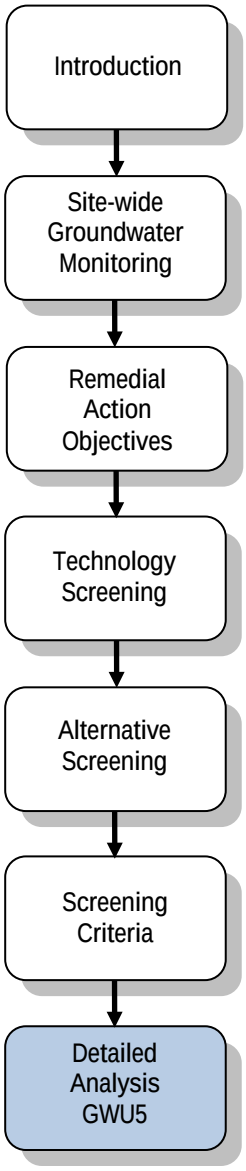
1 – Capital costs, annual costs, and periodic costs are presented in Appendix E.
2 – Estimated remedial timeframes and associated present value analysis for each remedial alternative are provided in Appendix E.
3 – Costs presented have an expected accuracy range for corrective action study estimates (-30% to +50% of the actual cost of the alternative).

Section 11
Detailed Analysis of Retained Alternatives – Groundwater Unit 5

11.1 Overview

GWU5 consists of a single source area: the former Coastal-Derby Refinery facility. Remedial activities for the facility are being conducted under KDHE Compliance Order 86-E-145A and are being reported under separate cover by El Paso Corporation's consultant. Under the KDHE Compliance Order, El Paso Corporation is required to prepare a FS for the former Coastal-Derby Refinery that includes the extent of refinery-related contaminants in GWU5. Therefore, with respect to the overall NIC Site-wide groundwater contamination, further detailed analysis of remedial alternatives for the refinery-related contaminants in GWU5 under this NIC FS does not appear to be warranted. A summary of El Paso's remediation measures to date and planned activities for the Coastal-Derby Refinery Site are included in **Appendix B**.

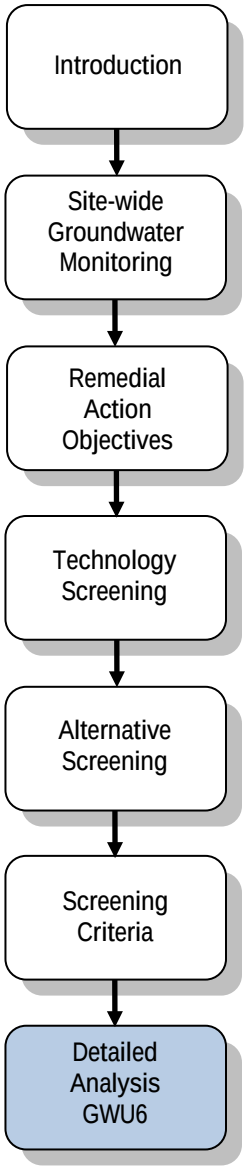
Monitoring activities related to the GWU1 remedial alternatives but within the GWU5 boundary are being considered. Chlorinated solvent contamination in GWU5 appears to emanate from GWU1; therefore, no active remediation is planned for the chlorinated solvent contamination under GWU5. Further discussion of monitoring activities and GWU1 and GWU5 chlorinated solvent remediation is provided in Section 7.



Section 12
Detailed Analysis of Retained Alternatives – Groundwater Unit 6

12.1 Overview

GWU6 consists of a single source area and a portion of the potential downgradient extent of the groundwater contamination associated with the USD #259 facility. Remedial activities for the facility are being conducted under KDHE Consent Order 92-E-121 and are being reported under separate cover by the consultant for USD #259. Under the KDHE Consent Order, USD #259 is required to prepare a FS for the USD #259 facility that includes the extent of GWU6. Therefore, with respect to the overall Site groundwater contamination, further detailed analysis of remedial alternatives for GWU6 under this NIC FS does not appear to be warranted. A summary of remediation measures to date and planned activities for the USD #259 Site are included in **Appendix B**.



Section 13
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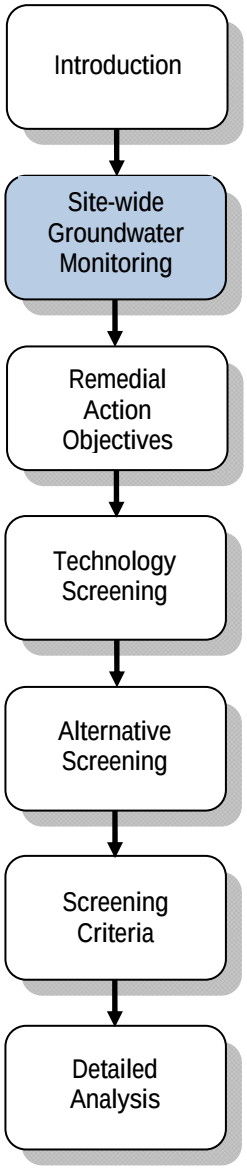
Section 2
Site-Wide Groundwater Monitoring

2.1 Purpose and Methodology

An additional Site-wide groundwater monitoring event was performed in December 2007 and January 2008. CDM performed additional field work in April 2008 which included sampling two existing wells, collecting one direct-push groundwater sample, and installing and sampling 10 temporary wells at former well locations (missing or destroyed wells). The purpose of the 2007/2008 sampling event was to acquire additional data to support selection of remedial alternatives for the FS.



The proposed sampling locations and parameters, sampling methodology, schedule, and deliverables were presented in a letter work plan to the KDHE dated December 3, 2007. The KDHE provided comments to the work plan in a letter dated December 7, 2007 but also provided approval for the City to proceed with the field program. A finalized work plan was submitted to the KDHE on January 21, 2008 (CDM 2008c). A supplemental work plan to address the issue of wells discovered to be missing or destroyed during the December 2007 field program was provided to the KDHE by e-mail on March 11, 2008 (CDM 2008b); the supplemental work plan provided for the installation of temporary wells at the locations CDM identified as necessary for the site-wide groundwater assessment. The supplemental work plan, dated January 15, 2008, was approved by the KDHE on March 24, 2008.

Water level measurement and groundwater sampling activities were conducted in accordance with the *North Industrial Corridor Work Plan for RI/FS* (CDM 1997a), *North Industrial Corridor Field Sampling Plan* (CDM 1997b), *North Industrial Corridor Quality Assurance Project Plan* (CDM 1997c), and the *North Industrial Corridor Final Work Plan Addendum* (CDM 2000). In general, 1-inch diameter monitoring wells were sampled using a peristaltic pump using clean polyethylene tubing new tubing and 2-inch diameter or larger wells were sampled using a dedicated disposable bailer.

Water level measurements were collected from 301 groundwater monitoring wells and 10 surface water monitoring locations on January 10 and 11, 2008. Samples were collected at a total of 236 wells (including 224 existing wells and 10 temporary wells and one direct-push sampling effort at locations of destroyed or missing wells) and 11 surface water monitoring locations and submitted for laboratory analysis of VOCs during the 2007-2008 field activities. Laboratory analysis was performed by Pace Analytical Services of Lenexa, Kansas.

VOC water samples were analyzed in accordance with EPA Method SW-846 8260. In addition, field measurements of pH, temperature, and conductivity were collected.

Monitored Natural Attenuation (MNA) parameters were collected from 57 of the 236 wells sampled for VOCs. MNA parameters and analysis methods are as follows:

Electron Donors

- Dissolved organic carbon (DOC) – SM 5310 C
- Volatile fatty acids (VFAs) – SM 5560 C

Reduction-Oxidation (Redox) Parameters

- Oxidation reduction potential (ORP) – field measurement using water quality meter
- Dissolved oxygen (DO) – field measurement using Chemetrics photometric and colorimetric test kits
- Nitrate/Nitrite (NO_3/NO_2) – EPA Methods for Chemical Analysis of Water and Wastes (MCAWW), 353.2
- Ferrous iron (Fe^{+2}) – field measurement using HACH Method 8146, field filtered
- Sulfate (SO_4^{-2}) – EPA MCAWW, 300, field filtered
- Sulfide (S^{-2}) (only if noticeable odor present at the well head) – SM 4500S2 E
- Methane (CH_4) – EPA SW-846 Method 3810

Biological Activity Parameters

- pH – field measurement using water quality meter
- Alkalinity – EPA MCAWW, 310.1, field filtered
- Carbon Dioxide (CO_2) – SM 4500-CO2 D

Contaminants of concern and by-products

- PCE – EPA SW-846 Method 8260B
- TCE – EPA SW-846 Method 8260B
- C12DCE and T12DCE – EPA SW-846 Method 8260B
- VC – EPA SW-846 Method 8260B
- 111TCA – EPA SW-846 Method 8260B
- 11DCA – EPA SW-846 Method 8260B
- Ethene and Ethane – EPA SW-846 Method 3810
- Chloride – EPA MCAWW, 300, field filtered

- BTEX – EPA SW-846 Method 8260B

Other Parameters

- Temperature – field measurement using water quality meter
- Metals – dissolved iron, manganese, and arsenic – EPA Method 6010, field filtered

In accordance with the finalized January 2008 work plan, methane, ethene, and ethane (MEE) analysis was performed using the standard EPA Method 3810 rather than the Microseeps standard operating procedure (SOP) AM33Gx method proposed in the *North Industrial Corridor Final Work Plan Addendum* (CDM 2000). Collection of samples for MEE consisted of filling 20-mL glass vials with approximately 10-mL of the water sample, and adding 2 to 4 drops of hydrochloric acid to the sample before capping of the vial. All other analytical methods were consistent with the previous planning documents referenced above.

Field filtering was conducted by passing the water sample through an inline 0.45-µm filter. Samples were field filtered for select analyses to eliminate possible interference due to turbidity which can interfere with metals and alkalinity values.

During the sampling program, if a well designated for VOC sampling had free phase petroleum hydrocarbon (FPH) present, only the water level gauging was performed. Depth-to-product and depth-to-water were measured using an oil/water interface probe. No samples were collected from a well having measurable FPH. If the FPH-affected well was clustered with a deep well that was not impacted, the deep well was sampled.

2.1.1 Deviations from Work Plan

2.1.1.1 Direct-push Groundwater Sampling

CDM discovered during December 2007 monitoring activities that 13 of the wells designated for sampling were missing and presumed destroyed. In some instances, physical evidence of the remnants of the wells was observed; however, in other instances, construction activities or maintenance activities appear to have resulted in the destruction of the wells.

The following wells were not available for sampling during the December 2007 Site-wide sampling event.

- WND-13D – Well was observed to be damaged. In addition, access to the property for sampling was not granted by the property owner.
- WND-13S – Access to the property for sampling was not granted by the property owner.
- WND-33S – Destroyed.

- WND-40S – Destroyed.
- WND-44S,D – Apparently destroyed during railroad construction at 9th and Santa Fe.
- WNC-49SR,D – Apparently destroyed during railroad construction northwest of Barwise and 15th Street (WND-49D was found and sampled during the April 2008 sampling event described below).
- NMW-40S,D – Destroyed.
- NMW-46D/DRB-MW11 – El Paso confirmed that DRB-MW11 was destroyed during the 21st Street and I-135 intersection reconfiguration. It appears that NMW-46D has also been destroyed. This well pair was to provide MNA assessment for the downgradient portion of GWU5 (El Paso).
- NWL-03S – Apparently destroyed by truck traffic into grain elevator area. This well is a water level control well and is not typically sampled.
- NWL-22S – Located north of 15th Street and Santa Fe intersection. Apparently destroyed by railroad construction.

The screened intervals of the missing wells are included below for reference.

Well ID	**Former Screen Interval (feet bgs)**
WND-13S	12 – 22
WND-13D	29 – 29
WND-40S	8 – 18
WND-44S	12 – 22
WND-44D	21 – 36
WNC-49SR	9.8 – 19.7
WNC-49D	23 – 38 (Existing Well Used)
NMW-40S	10 – 20
NMW-40D	27 – 37
DRB-MW11	5 – 20
NMW-46D	23 – 33

In order to collect data from the previous well locations, a temporary replacement well installation and sampling program was conducted from April 22 to 24, 2008. CDM installed and sampled 10 temporary wells at locations where existing wells were missing or destroyed. CDM collected one shallow groundwater sample by direct-push sampling where FPH were present (DRB-MW-11) and sampled two existing wells (WND-49D) and DRB-MW-110. Temporary wells were installed as:

TW-DRB-110D
TW-NMW-40D

TW-NMW-40S
TW-NMW-46D
TW-WNC-49SR
TW-WND-13S
TW-WND-13D
TW-WND-40S
TW-WND-44S
TW-WND-44D

The April 2008 work was performed as provided in the CDM January 15, 2008 work plan (CDM 2008c) which was approved by KDHE on March 24, 2008. A deep well was installed in vicinity of DRB-MW110 to further evaluate target groundwater compound concentrations in the downgradient portion of GWU5 (i.e. near Chisholm Creek).

Temporary wells were installed at all locations except DRB-MW11 using a direct-push rig equipped with 2-inch diameter rods. The direct-push rods were hydraulically driven to the target depth, at which point 1-inch diameter polyvinyl chloride (PVC) pipe placed within the annular space in the rods. The PVC pipe consisted of 10 feet of 0.010 slot screen with blank riser to the surface. Well depths were consistent with the table shown above. New location TW-DRB-MW-110 was completed to a depth of approximately 37 feet bgs.

Once the PVC was installed, the direct-push rods were removed and the formation was allowed to collapse into the annular space around the PVC. The remaining annular space above the water table was sealed with hydrated granular bentonite poured in from the ground surface. The temporary PVC wells were secured with a water-tight seal until after sampling.

Due to the potential presence of FPH, the DRB-MW-11 sample was collected through an approximately 3- to 4-foot length of drop screen installed by direct-push technology. The direct-push screen interval was driven to a depth of 18 to 22 feet bgs, or just below the anticipated water level. Purging of groundwater through the drop screen sampler was consistent with the *North Industrial Corridor Final Work Plan Addendum* (CDM 2000).

Sampling of the temporary wells was consistent with the sampling techniques used under the *Site-wide Groundwater Monitoring Work Plan* (CDM 2008c). Upon completion of the sampling event, the PVC casing was removed from the borehole and additional hydrated bentonite placed to the surface.

2.1.1.2 Other Deviations

Other significant deviations from the work plan submitted to the KDHE in January 2008 (CDM 2008c) are as follows:

1. Surface water sample locations SW-06, SW-20, and SW-22 were dry at the time of surface water sampling and were not sampled.

2. Samples were collected from three locations (TW-DRB-MW-110D, NMW-16I, and NMW-39I) not included in the work plan. DRB-MW-110D was collected at the Coastal-Derby well MW-110 location to obtain a sample from a well screened only in the deep aquifer. Samples designated as NMW-16I and NMW-39I were collected from previously unknown third wells found adjacent to the NWM-16S/D and NMW-39S/D well nests, respectively. Samples were collected from these locations to avoid remobilizations due to potential data gaps.

3. Five wells included in the work plan (DRB-MW-20, WND-16S, NWL-03S, WND-33S, and VCM-MW-06) were not sampled. Wells DRB-MW-20 and WND-16S were not sampled due to the presence of FPH. Wells NWL-03S and WND-33S were not found. Well VCM-MW-06 was not sampled due to damaged/bent well casing.

2.2 Sampling Results

The results of the sampling and water level measurement activities conducted between December 2007 and April 2008 are summarized below. All data associated with the 2007 and 2008 sampling event, including summary tables, figures, plates, and laboratory reports were provided to the KDHE by the City under a submittal dated October 27, 2008 (CDM 2008a). The laboratory reports are not included in this FS.

2.2.1 Water Levels

The potentiometric surface based on the January 2008 water level measurements is shown on **Plate 2-1**. A summary of water level measurements and groundwater/ surface water elevations is included in **Table 2-1**. The potentiometric surface appears to be generally comparable with the potentiometric surface maps included in the final RI Report and RI Addendum (CDM 2007a and CDM 2007b). The inward flow gradient apparently caused by the pumping of Coleman North extraction wells (roughly north/south between 27th and 32nd Streets, and east/west between Broadway and Ohio Streets) is more pronounced on the January 2008 map, although this may be an artifact of additional groundwater elevation data (new water level wells) for this area. A similar inward groundwater flow northeast of the I-135/K-96 interchange may be attributable to ongoing groundwater pumping at the Coleman Northeast facility. For the January 2008 sampling event, groundwater flow east of the Little Arkansas River near Murdock Avenue appears to be more consistent with the August 2001 groundwater flow than the August 2004 event. This change in flow may be caused by changes in position of a dam on the Little Arkansas River at Murdock Avenue to facilitate bridge repair at this location. The localized flow gradient toward Chisholm Creek is also more pronounced in the August 2004 sample event, although the flow characteristics may also be better defined due to additional Little Arkansas River surface water elevation data. Changes in the inferred flow along the northern portion of the East Branch of Chisholm Creek may be attributable to less surface water

elevation data for this area, as many of the surface water measurement points in this area were damaged or destroyed between 2004 and 2008.

2.2.2 VOC Sampling Results

VOC results for wells sampled by CDM during the current (December 2007 and April 2008) sampling event are presented on **Table 2-2**. VOC results from some source area wells that were provided to the City and are approximately concurrent with the current sampling event (i.e. four months prior to or following December 2007) are included in **Table 2-3** and **Table 2-4**. These tables include a summary of current and historic VOC data for selected NIC wells. Results from the RI were discussed in the *North Industrial Corridor (NIC) Site Remedial Investigation Report* (CDM 2007a) and the *North Industrial Corridor (NIC) Site Remedial Investigation Addendum* (CDM 2007b). Summary data tables from these reports are provided in **Appendix A**.

2.2.2.1 TCE and C12DCE in Groundwater

TCE concentrations exceeded the KDHE Tier 2 action level for the residential groundwater pathway of 5 µg/L (KDHE 2010) in 71 of 108 deep wells, one of two intermediate wells, and 47 of 132 shallow wells. A total of 119 out of 242 well samples had KDHE Tier 2 action level exceedances for TCE. The proposed TCE Alternate Target Goal (ATG) of 21 µg/L was exceeded in 45 of 108 deep wells, one of two intermediate wells, and 30 of 132 shallow wells. See Section 3.3 for discussion of ATG calculations. A total of 75 out of 242 wells had ATG exceedances for TCE. No KDHE Tier 2 action level or ATG exceedances for TCE were noted in the 11 surface water samples.

Concentrations of C12DCE exceeded the KDHE Tier 2 action level for the residential groundwater pathway of 70 µg/L (KDHE 2010) in seven of 108 deep wells, zero of two intermediate wells, and eight of 132 shallow wells. A total of 15 out of 242 well samples had KDHE Tier 2 action level exceedances. No KDHE Tier 2 action level exceedances for C12DCE were noted in the 11 surface water samples.

Dot-plot representations of TCE in shallow and deep groundwater are shown on **Figures 2-1a and 2-1b**, respectively. Isoconcentration contours of TCE in shallow and deep groundwater as of the 2007-2008 monitoring events are shown on **Plates 2-2a and 2-2b**, respectively. Dot-plot representations of C12DCE in shallow and deep groundwater are shown on **Figures 2-2a and 2-2b**, respectively. Isoconcentration contours of C12DCE in shallow and deep groundwater as of the 2007-2008 monitoring event are shown on **Plates 2-3a and 2-3b**, respectively. General observations regarding changes in plume boundaries from previous sampling events to the current sampling event are as follows:

- Areas with TCE concentrations above 500 µg/L are diminishing in shallow and deep groundwater at the Site. No concentrations above 500 µg/L were detected in the deep monitoring wells. Concentrations above 500 µg/L in shallow wells were near confirmed source areas with active remediation systems in place. The

operation of these remediation systems is likely resulting in the reduction of the highest TCE concentrations. A combination of plume degradation and downgradient distribution of contaminants through advection/dispersion processes are other likely contributors to diminishing areas of significant contamination.

- Areas of TCE contamination between 100 and 500 µg/L appear to be generally diminishing in shallow and deep groundwater in many areas of the Site. Exceptions include an increased deep plume of concentrations within this range to the southeast of 19th and Mosley. Continued downgradient and shallow-to-deep migration of contaminants may account for this increase. The 100-to-500 µg/L TCE plumes southeast of 14th and Washington, and between the 29th street/I-135 interchange and the Farmland facility appear relatively stable with respect to impacted area.

- Increased shallow concentrations of TCE and C12DCE in well NMW-23S, combined with detections of these compounds in the GilMo 501A/B well pair, may be an indicator that the GWU4 plume is shifting slightly to the southeast. A slight southeast to southwest fluctuation in groundwater flow is noted in this area and is the likely cause of the plume shift.

- The western extent of shallow and deep TCE/C12DCE contamination appears to be diminishing with respect to time. The shallow and deep MCL plume boundary is shifting toward the east over time. A slight downgradient shift in many plume boundaries is noted between the Phase 2 and Phase 3 investigation activities.

- A continued increase in TCE concentrations from Phase 2 to the current sampling event is noted in a general area encompassing portions of the Farmland Elevator, Union Pacific Railroad (UPRR) Fueling Facility, former Safety-Kleen, and Coastal-Derby Refinery Sites, and areas north and east of these Sites. An expanded area of shallow impacts is noted in this area, which is likely attributable both to actual increases of TCE in monitoring wells (NMW-03S, UPRF-09, UPRF-16, and WND-31S) and additional available data points.

- The southeastern plume boundary has continued to expand to the southeast. The deep southeastern MCL boundary for TCE now extends to the southeast of wells NMW-27D and NMW-51D. The shallow boundary now extends to the southeast of wells NMW-51S and CSI-01.

2.2.2.2 Other Target Groundwater Compounds

Other target groundwater compounds that were detected during Phase 3 sampling events are summarized below.

PCE

Dot-plot representations of PCE in shallow and deep groundwater are shown on **Figures 2-3a and 2-3b**, respectively. PCE concentrations exceeded the KDHE Tier 2

action level for the residential groundwater pathway of 5 µg/L (KDHE 2010) in eight of 108 deep wells, zero of two intermediate wells, and four of 132 shallow wells (total of 12 KDHE Tier 2 action level exceedances in 242 wells). No KDHE Tier 2 action level exceedances for PCE were noted in the 11 surface water samples.

Areas noted in the RI to have historical PCE concentrations in groundwater exceeding 100 µg/L include the former HCI Advance Chemical (now Brenntag), former Safety-Kleen (now Clean Harbors), Coleman Northeast, USD #259, and the former Unocal facilities. Concentrations exceeding 100 µg/L remain at or downgradient of these source areas. Increases in PCE concentration of wells within and downgradient of the Coleman Northeast source area are noted since the RI Phase 1 sampling event (WND-14D, CNE-16D, and CNE-MW-19D), although reductions are noted for other wells within the source area (i.e. CNE-MW-24). PCE concentrations at the Unocal facility appear to be lower than those noted in the RI. Current high PCE concentrations at the former Safety-Kleen facility appear to be comparable with those noted during the RI (CDM 2007a and CDM 2007b).

PCE concentrations increased significantly in well NMW-31 S/D from Phase 3 sampling to the current sampling round (5.5 µg/L to 44.2 µg/L in NMW-31S, 17 µg/L to 92.8 µg/L in NMW-31D) (CDM 2007a and CDM 2007b). This well nest is downgradient of the former HCI Advance Chemical (Brenntag) Facility. PCE concentrations were detected for the first time in well NMW-51S/D, which is further downgradient of the former HCI Advance Chemical Site. PCE concentrations also fluctuated in some downgradient wells, such as NMW-32S/D. Periodic shifts in groundwater flow may be contributing to the fluctuating concentrations in some areas downgradient of the Site, as the flow vectors downgradient of the Site trend both in a southerly direction and in an easterly direction toward Chisholm Creek. Other factors contributing to concentration fluctuations downgradient of HCI Advance Chemical may include partial dechlorination of the PCE (as evidenced by the presence of VC in downgradient wells), historical pumping for municipal projects, and potential releases into sewers. A discussion of the historic pumping and potential sewer releases, as well as general comments regarding PCE concentrations downgradient of former HCI Advance Chemical, can be found in a letter from CDM to the City of Wichita dated January 16, 2006 (CDM 2006), which was forwarded by the City to the KDHE on May 12, 2006.

A consistent increase in PCE concentrations is also noted in well NMW-02S (near 27th and Market). The PCE increase in NMW-02S appears to be attributable to PCE from an offsite release entering the NIC Site.

VC

Dot-plot representations of VC in shallow and deep groundwater are shown on **Figures 2-4a and 2-4b**, respectively. VC was primarily detected in the central portion of the Site, between 17th and 25th streets, in the northeast portion of the Site, and in the southeast portion of the Site. The extent of VC contamination above the KDHE Tier 2

action level for the residential groundwater pathway of 2 µg/L (KDHE 2010) appears to be expanding in the southeast portion of the Site, a first-time detection/ KDHE Tier 2 action level exceedance in NMW-51D (CDM 2007a and CDM 2007b).. This expansion corresponds with the expansion of the TCE plume and first-time detections of PCE in this area. The presence of VC at the NIC Site is a result of degradation of PCE/TCE/C12DCE.

BEN

Dot-plot representations of benzene in shallow and deep groundwater are shown on **Figures 2-5a and 2-5b**, respectively. Elevated concentrations of BEN in groundwater are largely found in the central portion of the Site, between 19th and 26th streets. Elevated BEN contamination was observed in several samples collected from the Coastal-Derby Refinery wells. The highest BEN concentration detected in Coastal-Derby wells during Phase 3 sampling was 399 µg/L in well DRB-MW-30. Two wells containing FPH (WND-16S and DRB-MW-20) may also have elevated BEN concentrations but were not sampled. BEN concentrations generally decreased between Phase 3 sampling and the current sampling event in some Coastal-Derby wells, although VOC data for wells containing FPH are not available. Coastal-Derby is performing separate monitoring and remediation efforts under a KDHE consent agreement (CDM 2007a and CDM 2007b).

During Phase 3 of the RI, BEN concentrations exceeding 1,000 µg/L were noted in several samples collected from wells located in the 26th Street area, with a maximum detected concentration of 11,000 µg/L in sample GP08-3, 13′. The source of BEN contamination in the 26th Street Area has not been identified. Many of these samples were collected from the direct-push sampling locations and were not reproduced during the current (December 2007 and April 2008) sampling event; however, BEN concentrations in FLE-01S (located south of the Farmland Elevator) decreased from 3,400 µg/L in March 2005 to 140 µg/L in October 2007 (CDM 2007a and CDM 2007b).

111TCA, 11DCA, and 11DCE

Dot-plot representations of 111TCA concentrations in shallow and deep groundwater are shown on **Figures 2-6a and 2-6b**, respectively. **Figures 2-7a and 2-7b** show 11DCA concentrations in shallow and deep groundwater, and **Figures 2-8a and 2-8b** show concentrations of 11DCE in shallow and deep groundwater, respectively. 111TCA has a fairly limited extent in groundwater within the NIC Site; however, the 111TCA biodegradation daughter product of 11DCA and the abiotic degradation product 11DCE are present in groundwater beneath a relatively large portion of the NIC Site. The limited extent and relatively low concentrations of 111TCA in groundwater suggest that 111TCA degrades relatively quickly to daughter products at the NIC Site.

11DCA concentrations are below the KDHE Tier 2 action level for the residential groundwater pathway of 25 µg/L (KDHE 2010) in all current groundwater samples. The only exceedance of the KDHE Tier 2 action level for the residential groundwater

pathway for 111TCA (200 µg/L) (KDHE 2010) is in one well in the Coleman North source area (CN-VEW-21D, based on PRP-provided data). Exceedances of the 11DCE KDHE Tier 2 action level for the residential groundwater pathway of 7 µg/L (KDHE 2010) are noted primarily in samples north of 29th Street (CDM 2007a and CDM 2007b).. In general, concentrations of 111TCA and 111TCA daughter products are declining at the NIC Site.

CT and CFM
Dot-plot representations of CT in shallow and deep groundwater are shown on **Figures 2-9a and 2-9b**, respectively. CT and its biodegradation daughter product, CFM, were historically present in areas of the NIC Site that are downgradient of sites that conduct grain storage operations (CDM 2007a and CDM 2007b).. Overall CT and CFM concentrations appear to be declining in the NIC Site. CT and CFM concentrations exceeding KDHE Tier 2 action levels are noted at or downgradient of the Farmland Elevator, Wichita Terminal Elevator, and Cargill 13th Street source areas.

2.2.3 MNA Sampling Results

Table 2-5 includes a summary of MNA field parameters. Results for metals and inorganic parameters are summarized in **Table 2-6**. A summary specific to chlorinated groundwater target compounds and MEE results is included as **Table 2-7**. Section 2.3.2 includes a detailed summary of MNA parameter results and conclusions regarding those results.

2.2.4 Data Quality Assessment

Field Quality Assurance/ Quality Control (QA/QC) samples included trip blanks and field duplicate samples. Laboratory QA/QC samples included Performance Evaluation (PE) samples, laboratory method blanks, laboratory control samples (LCS), and matrix spike/matrix spike duplicate (MS/MSD) samples.

Relative Percent Differences (RPDs) for original vs. duplicate samples are shown on **Table 2-8**. RPDs were within the 25% control limit for all sample pairs. No detects were found in trip blanks during the sampling event. Based on a review of the field QA/QC samples, no qualification of data is necessary.

Five PE samples were submitted as blind samples to the offsite laboratory to provide a measure of analytical performance and analytical method bias (accuracy). PE sample results are shown on **Table 2-9**. All recoveries obtained by the offsite laboratory were within the certified values. Based on a review of the laboratory QA/QC samples presented in the data package submittal provided to the KDHE on October 27, 2008 (CDM 2008a), no qualification of data is necessary.

Volatile fatty acids samples from one sample batch (including samples from wells EXC-MW-05B, EXC-MW-07B, NMW-03S, NMW-10S/D, NMW-04S, WND-03S, WND-23S/D, WND-32S/D, and WND-14S/D) were analyzed one to two days outside of the recommended holding time of seven days. This holding time exceedance is not

expected to significantly affect the use of sample results for the purpose of the FS report. No other issues affecting the usability of the laboratory analytical data have been identified.

2.3 Nature and Extent of Contamination

The general changes in the extent of target groundwater compounds are discussed in Section 2.2. The following subsections discuss proposed changes in GWU boundaries and a general discussion of MNA feasibility at the NIC Site.

2.3.1 GWU Boundary Adjustments

Based on a review of VOC data, 2008 proposed GWU boundary adjustments from the boundaries proposed in 2006 are:

1. The southeastern MCL boundary has expanded beyond the southeastern boundary for GWU3; therefore, the GWU3 boundary is proposed to be conservatively expanded to the southeastern extent of the NIC boundary.

2. A new GWU (GWU6) is proposed to be separated from GWU1. GWU6 consists of the USD #259 confirmed source area, associated USD monitoring wells, and a portion of the Site downgradient of the USD #259 chlorinated solvents plume.

The proposed modified GWU boundaries are shown on **Figure 2-10**.

2.3.2 MNA Assessment Update

The 2001 sample locations for the MNA assessment are presented in **Figure 2-11** along with MNA scores. The 2007-2008 sample locations for the MNA assessment are presented in **Figure 2-12** along with MNA scores. In general, the MNA locations were selected to provide both localized and Site-wide assessment of the potential for MNA within both shallow and deep portions of the alluvial aquifer within the NIC Site. The selected 2007-2008 MNA locations were duplicates of MNA sampling locations from the original 2001 RI sampling locations to provide a comparison between previous (May 2001) and current results (December 2007 and April 2008). Based on the analytical results from the RI and the current sampling event, the average of the chemical concentrations observed at wells WND-06S, WNC-06S, WND-22S, and WND-22D were used as an estimate of background aquifer conditions for the evaluation of the data.

Results of MNA sampling at background locations and within the contaminant plumes are for the previous (May 2001) and current (December 2007 and April 2008) sampling events are presented in **Tables 2-5 through and 2-7**, respectively, and are discussed below.

Electron Donors - The reductive dechlorination process is generally facilitated through the utilization of fermentable carbon compounds that serve as "electron donors" for subsurface bacteria that use the chloroethenes as "electron acceptors".

Bacteria utilize the electron donor first to remove naturally occurring electron acceptors such as oxygen, nitrate, ferric iron (Fe^{3+}), and sulfate, and then transform the chlorinated hydrocarbons to ethene. For example, if sulfate levels are too high and are inhibiting dechlorination, the addition of organic carbon will stimulate sulfate use as an electron acceptor until it is depleted, and then the next preferred electron acceptor will be used until the electron donor (available organic carbon) is depleted. Once the electron donor is depleted the dechlorination process will stop, until more donor is made available. Other compounds, such as hydrogen, can also be used as an electron donor for anaerobic reductive dechlorination, in addition to BTEX and other organic carbon. As an example of organic carbon requirements for the utilization of sulfate, the removal of 100 mg/L of sulfate would require 22 mg/L of BEN-equivalent organic carbon. Thus, bioavailable organic carbon is the most important parameter for the anaerobic reductive dechlorination of chlorinated solvents to progress at a site. The availability of electron donors was monitored by measuring the concentrations of DOC and VFAs at the NIC Site.

- **Dissolved organic carbon (DOC):** According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), a total organic carbon (TOC) concentration greater than 20 mg/L is conducive for reductive dechlorination of PCE and TCE to occur at a site. Since DOC was measured instead of TOC, it is assumed that the TOC and DOC values are approximately equal at this Site. During the current sampling event the DOC concentrations were observed to be low at each of the background sampling locations and ranged from 1.1 mg/L to 2.1 mg/L. The in-plume concentrations of DOC were only slightly higher and ranged from 1 mg/L (WND-39S) to 13.7 mg/L (WND-36S). Due to the sandy nature of the saturated soils at majority of the Site, elevated DOC concentrations were most likely due to anthropogenic carbon sources (from human sources, not naturally occurring) such as petroleum contaminants (BTEX, total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAHs), etc).

- **Volatile Fatty Acids (VFAs):** According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), a VFA concentration greater than 0.1 mg/L is conducive for reductive dechlorination of PCE and TCE to occur at a site. VFAs were not detected in any of the MNA samples analyzed for the Site.

Conclusions: According to the EPA screening criteria, insufficient concentrations of DOC and VFAs exists at the NIC Site to sustain complete anaerobic reductive dechlorination; however, the laboratory analysis for DOC may not account for all the anthropogenic carbon. Overall, the low levels of DOC and absence of VFAs at the Site indicates that the Site does not have sufficient bioavailable organic carbon, including petroleum contaminants, to deplete all naturally occurring electron acceptors (specifically high levels of sulfate that exist at this Site (discussed in the later sub-sections)) and provide for complete reductive dechlorination.

Redox Conditions: The most important aspect of groundwater chemistry with respect to the fate of chlorinated hydrocarbons is the redox conditions. As discussed earlier, chlorinated hydrocarbons serve as electron acceptors in microbially-mediated redox reactions during reductive dechlorination. Therefore, they have to compete with naturally occurring electron acceptors in groundwater. The use of electron acceptors is generally governed by the available free energy from redox reactions. In order of decreasing energy available, some common, naturally occurring electron acceptors are oxygen, nitrate, ferric iron, sulfate, and carbon dioxide. At a minimum, oxygen and nitrate must be depleted for any reductive dechlorination to occur. Dechlorination of PCE and TCE to C12DCE generally occurs under iron-reducing to sulfate-reducing conditions. Complete dechlorination to ethene typically occurs under methanogenic conditions (carbon dioxide is the only remaining naturally occurring electron acceptor). Thus, understanding redox conditions (aerobic, nitrate-reducing, iron-reducing, sulfate-reducing, and methanogenic) provides key insight into the potential for reductive dechlorination to occur at a site.

Oxidation-Reduction Potential (ORP): A general indicator of redox condition is the ORP of the groundwater. ORP is an electrode-based measurement that can be used to evaluate the relative ability of the groundwater to accept or donate electrons. According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), reductive dechlorination is generally possible with ORP values less than approximately +50 mV, but is more favorable at values less than approximately -100 mV. ORP, however, should be viewed as only a screening parameter because the electrodes often require long periods of exposure to water that is significantly different in ORP than a previous measurement before they will register an accurate reading. The relative concentrations of inorganic electron acceptors and/or their reduced products (DO, nitrate, ferrous iron, sulfate, and methane) are used as a more definitive indicator of redox conditions of the aquifer.

The ORP of the background aquifer conditions ranged from 47.3 mV to 88.3 mV, with an average of 68 mV during the current sampling event. The in-plume conditions were slightly lower, varying from –118.5 mV (DRB-MW250) to 127.7 mV (WND-31S) with an average of 23.6 mV. Overall, the average in-plume ORP showed a decrease from 118.7 mV in 2001 to 23.6 mV in 2007-2008. A similar decrease in ORP was observed in the background conditions as well which decreased from 197.1 mV in 2001 to 68 mV in 2007.

Conclusions: As discussed above, the data shows that redox conditions of the aquifer cannot be interpreted solely based on the ORP parameter. ORP is not considered the most reliable parameter for evaluating redox conditions of the aquifer; hence concentrations of electron acceptors were evaluated to fully understand the actual redox conditions present at the NIC Site.

Electron acceptors: As discussed earlier, the more reliable indicator of redox conditions is the aqueous concentrations of inorganic electron acceptors and their

reduced products. The redox conditions typically progress from aerobic → nitrate-reducing → iron-reducing → sulfate-reducing → methanogenic.

- **Dissolved oxygen (DO):** Aquifer groundwater must be anaerobic for reductive dechlorination to occur. According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), a DO concentration less than 0.5 mg/L is favorable and greater than 5 mg/L may inhibit the reductive dechlorination of PCE and TCE at a site.

  During the December 2007 sampling event, DO concentrations in the background wells ranged from 3.83 to 13.6 mg/L. The DO concentrations in the in-plume wells ranged from 1.1 mg/L (NMW-45D) to 15.3 mg/L (WND-03S), with an average DO of 4.4 mg/L. These concentrations were higher than previous sampling event performed in May 2001, when the concentrations in the background wells ranged from 0.15 to 0.9 mg/L. The DO concentrations in the in-plume wells ranged from 0.06 mg/L (WND-03S) to 2.5 mg/L (NMW-18S) with an average DO of 0.43 mg/L. For the April 2008 sampling, DO was measured only at wells TW-DRB-MW-11, TW-NMW-46D, and TW-WND-40S using both the Chemetrics V2000 Photometric test kit (consistent with the December 2007 sampling event), and the Chemetrics K7501/K7512 Colorimetric Test Kits (consistent with May 2001 sampling event). The photometric DO results for wells TW-DRB-MW11, TW-DRB-46D, and TW-WND-40S were: over the instrument's range), 6.90 mg/L, and 6.67 mg/L, respectively. The corresponding DO concentrations for wells TW-DRB-MW11, TW-DRB-46D, and TW-WND-40S using the colorimetric test kits were 0.75 mg/L, 0.50 mg/L, and 0.25 mg/L, respectively.

  Conclusions: DO levels were typically higher during the December 2007sampling event compared to the May 2001 sampling event; however; based on the low concentrations of the colorimetric DO samples collected during the April 2008 sampling event and the results of other indicator parameters, the in-plume portion of the aquifer is assumed to remain primarily anaerobic and the photometric DO results are believed to be erroneous (photometric results may have been affected by sample turbidity or other Site factors). It is therefore believed that the majority of the oxygen in the aquifer has been depleted and significant aerobic degradation of any Site contaminants is unlikely in the absence of added oxygen.

- **Nitrate:** According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), a nitrate concentration greater than 1 mg/L is not conducive for reductive dechlorination of PCE and TCE. The concentrations of nitrite were observed to be below detection limits in all of the wells sampled during the May 2001 sampling event. Based on these results, the combined concentrations of nitrate plus nitrite measured during December

2007 and April 2008 sampling events were assumed to primarily constitute of nitrate.

During the 2007-2008 sampling events, the nitrate plus nitrite concentrations in the background wells ranged from 0.48 to 4.1 mg/L (**Table 2-6**). Nitrate concentrations in the contaminated portions of the aquifer are similar to background concentrations, ranging from non-detect (< 0.5 mg/L) to 7.5 mg/L (WND-47S) with four wells containing nitrate at slightly elevated concentrations of 17.9 mg/L (WND-32S), 13.5 mg/L (WND-41D), 9.8 mg/L (NMW-45D), and 9.4 mg/L (NMW-29S).

Conclusions: The high concentration of nitrate in the in-plume wells indicates that there is not enough organic carbon present in the aquifer to deplete the nitrate present at the Site. This result indicates that the redox conditions are not conducive for complete reductive dechlorination to progress due to the insufficient amount of organic carbon present at the Site.

- **Ferrous iron:** Non-aqueous ferric iron (Fe^{3+}) may be present in the subsurface in solid phases such as hematite, ferric oxyhydroxide, and goethite. Ferric iron may be reduced to ferrous iron (Fe^{2+}) which may be soluble in water. The presence of ferrous iron in groundwater can be an indication that ferric iron is used as an electron acceptor. Ferric iron reducing conditions are conducive to PCE and TCE degradation but can inhibit the degradation of C12DCE. The measured ferrous iron concentration in groundwater may be lower than actual available ferrous iron due to precipitation in the subsurface as sulfides or carbonates. According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), a ferrous iron concentration less than 1 mg/L is not conducive for reductive dechlorination of PCE and TCE.

  During the 2007-2008 sampling events, the ferrous iron concentrations in the background wells ranged from 0 to 0.4 mg/L. Eleven of the monitoring wells (DRB-MW-250, NMW-10S, NMW-10D, NMW-14S, NMW-14D, WND-03S, WND-21S, WND-36S, WND-42D, TW-DRB-MW-11, and TW-NMW-46D) had elevated ferrous iron concentrations, ranging from 1.2 mg/L (NMW-10D) to 3.4 mg/L (TW-DRB-MW-11). Nine wells (DRB-MW-250, NMW-10S, NMW-10D, NMW-14S, NMW-14D, WND-03S, WND-21S, WND-36S, and WND-42D) also had negative ORP values (ranging from -31.7 to -118.5 mV) and all 11 wells had nitrate concentrations low or below the detection limit.

  Conclusions: The contaminant concentrations in the 11 wells with elevated ferrous iron concentrations demonstrate the electron acceptor utilization pattern and degradation of chlorinated solvents. Out of the 11, nine wells (DRB-MW-250, NMW-10D, NMW-10S, NMW-14D, NMW-14S, WND-03S, WND-21S, WND-36S, and WND-42D) showed elevated concentrations of

C12DCE but only two wells NMW-10S and NMW-10D showed presence of low levels of VC and no ethene production. The data indicate that under some circumstances where elevated ferrous iron is present, the degradation of C12DCE to VC may occur, but at a low rate. As mentioned above, all of the subsurface reactions involving electron acceptors are concentration dependent. The contaminant concentrations at these wells indicate that under elevated ferrous iron conditions, the degradation of C12DCE to VC is most likely being inhibited and resulting is an accumulation of C12DCE. Thus the results indicate that the redox conditions of the aquifer are conducive of PCE and TCE degradation but are not reducing enough for complete dechlorination; i.e., degradation of C12DCE and VC to ethene to occur. This is due to the insufficient amount of electron donor present at the Site.

- **Sulfate:** According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), a sulfate concentration greater than 1 mg/L is conducive for reductive dechlorination of C12DCE and potentially TCE.

  During the 2007-2008 sampling event the background concentrations of sulfate varied from 76.6 to 97.7 mg/L. The in-plume concentrations of sulfate ranged from below detection limit (WND-36S) to 330 mg/L (EXC-MW-05B), with an average concentration of 131.2 mg/L. Sulfate concentrations in areas with BTEX and other petroleum compounds (wells DRB-MW-250, NMW-45D, WND-03S, and WND-36S) ranged from non-detect to 116 mg/L (NMW-45D), with an average of 53 mg/L. Sulfate concentrations in areas without fuel related compounds ranged from 25.8 mg/L (WND-39S) to 330 mg/L, with an average of 137.4 mg/L. During the May 2001 sampling event, the background concentrations of sulfate varied from 56.4 to 87.3 mg/L. The in-plume concentrations of sulfate ranged from 5.13 mg/L (WND-16S) to 260 mg/L (EXC-MW-05B), with an average concentration of 147.2 mg/L.

  Conclusions: As noted previously in the RI (CDM 2007a and CDM 2007b), high concentrations of sulfate in the groundwater have continued to be inhibitory of anaerobic dechlorination except in areas where additional carbon sources are present as observed during the current sampling events. Petroleum hydrocarbons in the middle portion of the NIC Site appear to be electron donors, leading to the consumption of sulfate as an electron acceptor and reducing the chlorinated solvents. Overall, the persistent high concentrations of sulfate present at the Site suggest that additional organic carbon is required for complete reductive dechlorination to progress at the Site.

- **Sulfide:** Sulfide was to be sampled at the MNA wells only if a sulfurous odor was noted at the wellhead. No sulfurous odors were noted during sampling; therefore, analysis for sulfide was not conducted.

- **Methane:** Methane concentrations in the subsurface can indicate the presence or absence of methanogenesis. Methanogenesis is the metabolic mode that represents the preferred aquifer redox conditions for the complete dechlorination of PCE and TCE to ethene. According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), a methane concentration greater than 0.5 mg/L represents conditions conducive for degradation of C12DCE.

  During the current sampling event, the background methane concentrations were below the detection limit of 1 µg/L. Numerous in-plume wells had concentrations much higher than background concentrations ranging from 12.6 µg/L (NMW-19D) to 8,980 µg/L (WND-36S). Using the EPA MNA weighting criterion for methane, there are four wells, DRB-MW-250, WNC-23D, WND-03S, and WND-36S, with significant methane concentrations. The highest concentrations were observed at wells WND-36S (8,980 µg/L) and WND-03S (6,450 µg/L). Of these wells, three wells (DRB-MW-250, WND-03S, and WND-36S) also showed the highest sulfate reduction. All wells showed below to near detection limit of PCE and TCE. Although conditions are favorable for elevated VC, ethene, and ethane concentrations, all wells also showed below to near detection limits for these compounds.

  Conclusions: The four locations with the higher methane concentrations indicate much more significant methanogenic activity than is found in the majority of the Site. Each of these locations is in the vicinity of former petroleum refineries and has petroleum hydrocarbon contaminants that may provide sufficient electron donors to drive the aquifer to methanogenic conditions. Sulfate must be depleted to achieve methanogenesis, which is demonstrated by the data.

Biological Activity Parameter

- **pH:** pH was observed to be ranging from 6.65 (WND-39S) to 8.07 (WND-23S) during the current sampling events.

- **Alkalinity:** Alkalinity concentrations in background wells ranged from 269 to 389 mg/L, with an average concentration of 310 mg/L. Concentrations of alkalinity for in-plume wells ranged from 91.1 mg/L (WNC-23D) to 1,100 mg/L (TW-DRB-MW-11), with an average concentration of 381.2 mg/L.

- **Carbon Dioxide:** Carbon dioxide concentrations in background wells ranged from 276 to 418 mg/L, with an average concentration of 328.3 mg/L. Concentrations of carbon dioxide for in-plume wells ranged from 89.3 mg/L (WNC-23D) to 663 mg/L (TW-DRB-MW-11), with an average concentration of 393.4 mg/L.

According to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998), pH between 5 and 9 is considered optimum for reductive dechlorination and alkalinity and carbon dioxide concentrations should be greater than twice the background concentrations to indicate conditions conducive for reductive degradation.

Conclusions: pH was in the normal range that allows occurrence of biological activity. Alkalinity and carbon dioxide concentrations were mostly similar or slightly greater than the background concentration. The optimum pH and higher concentrations of alkalinity and carbon dioxide are general indicators of ongoing biological activity (not necessarily reductive dechlorination) in those areas of the plume.

Contaminant of Concern and their Degradation Products

The concentrations of organic acids and redox conditions only indicate whether conditions are favorable for reductive dechlorination to progress at a site. Thus, the concentrations of chloroethenes, ethene and ethane, were monitored as direct evidence of the removal of choloroethenes, the contaminants of concern at the NIC Site. The following contaminant discussions are applicable to the wells sampled for MNA parameters. The averages and ranges provided in the following assessments do not apply to all the wells sampled during the 2007-2008 field program.

- **PCE:** The concentrations of PCE were found to be below detection limits in the background wells both during the previous and current sampling events. The PCE concentration ranged from below detection limit to 4 µg/L (NMW-31D), with an average concentration of 0.47 µg/L as observed during the May 2001 sampling event. During the 2007-2008 sampling events the PCE concentrations were observed to increase at a number of locations across the Site and ranged from below detection limit to 93.8 µg/L (NMW-31D).

  Conclusion: PCE is a minor component of the contaminant plume. The increase in concentration of PCE was observed only at one location (wells NMW-31S and NMW-31D).

- **TCE:** The concentrations of TCE were found to be below detection limits in the background wells both during the May 2001 and December 2007 sampling events. During the May 2001 sampling event the TCE concentrations ranged from below detection limit to 230 µg/L (WND-21D), with an average concentration of 57.6 µg/L. During the December 2007 and April 2008 sampling events the TCE concentrations ranged from below detection limit to 202 µg/L (NMW-08D), with an average concentration of 44 µg/L.

  Conclusion: The concentrations of TCE have decreased slightly between the previous and current sampling events indicating that minor degradation of TCE has occurred. However, the degradation rate is very slow since the

concentrations have not decreased much over the past 6 to 7 year and only partial transformation of TCE to C12DCE is occurring at the Site.

- **C12DCE:** The concentrations of C12DCE were found to be below detection limits in the background wells during the December 2007 sampling event. The C12DCE concentrations were observed to range from below detection limit to 240 µg/L (WND-03S), with an average concentration of 38.4 µg/L during the May 2001 sampling event. During the December 2007 and April 2008 sampling events the C12DCE concentrations ranged from below detection limit to 155 µg/L (NMW-05S), with an average concentration of 39.3 µg/L.

  Conclusion: The concentrations of C12DCE have essentially remained the same between the previous and current sampling events indicating that the rate of production and degradation of C12DCE appear to be about the same at the NIC Site.

- **VC:** The presence of low levels VC at the Site (ranging from 1 to 35.3 µg/L) indicates that dechlorination proceeds past C12DCE at some locations. The concentrations of VC in shallow and deep aquifer are shown on **Figures 2-2a** and **2-2b**, respectively. The highest concentrations of VC were found in the well NMW-05S (35.3 µg/L) located at the northeast corner of the Site near Coleman Northeast and in the upper middle portion of the Site near the VIM Trailer Site, between 29th Street and 25th Street. The majority of the remainder of low levels of VC, ranging from 1 to 8 µg/L, was detected in both shallow and deep wells generally located in the middle and southeast portion of the plume.

  Conclusions: The shallow well NMW-05S where the highest VC concentration was observed is known to have had historical petroleum hydrocarbon impacts. The other wells where low levels of VC concentrations were observed are located in or downgradient of the area of 26th and Mead which has current and historic petroleum hydrocarbon impacts. As noted in the RI (CDM 2007a and CDM 2007b), the distribution of VC at the NIC Site indicates that additional carbon is required for the reductive dechlorination of C12DCE to VC and ethene. The presence of some VC also suggests that appropriate bacteria capable of achieving complete reductive dechlorination (degrading PCE/TCE all the way to ethene) might be present at the Site and could be stimulated by the addition of carbon source. Lower concentrations of VC are found further downgradient (southeast portion) at the NIC Site. This VC concentration is most likely from degradation at or near carbon sources that has been transported through the aquifer without further degradation.

- **111TCA, 11DCA:** 111TCA and degradation daughter product 11DCA have a fairly limited extent in groundwater within the NIC Site.

Conclusion: The limited extent and relatively low concentrations of 111TCA and 11DCA in groundwater suggest that 111TCA and 11DCA degrade relatively quickly to ethane at the NIC Site.

- **Ethene and Ethane:** Concentrations of ethene and ethane that are significantly higher than background concentrations may indicate complete dechlorination of 111TCA, PCE, and TCE. Neither ethene nor ethane was above the detection limit (< 1.0 µg/L) in any well (background or in-plume) during the December 2007 and April 2008 sampling events.

  Conclusions: The highest concentrations of ethane detected during the RI monitoring events were noted in wells that contained 111TCA or reductive dechlorination byproducts of 111TCA (11DCA). Based on current data, the conclusions of the RI (CDM 2007a and CDM 2007b), and according EPA screening criteria, ethene and ethane concentrations at the NIC Site may be considered low and suggest within the general overall Site conditions that complete degradation is limited. The presence of some ethene and ethane observed at the Site suggests that dechlorinating bacteria might be present at the Site and complete reductive dechlorination of PCE, TCE, and 111TCA might be achieved if sufficient electron donor was present at the Site.

2.3.3 MNA Summary and Conclusions

Abiotic mechanisms such as dispersion, dilution, sorption, and biodegradation may contribute to MNA processes. The focus of the discussion in this subsection is based on biological processes because they are major destructive processes. The EPA states, "When relying on natural attenuation processes for site remediation, EPA prefers those processes that degrade or destroy contaminants"(EPA 1999). In addition, the initial screening process described in the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (EPA 1998) indicates that if biodegradation is not occurring, then engineered remediation is required, thereby indicating the importance of biodegradation to the MNA process.

As discussed earlier, to achieve complete dechlorination of PCE and TCE, the chlorinated ethenes must act as the preferred electron acceptors for microorganisms in the subsurface. The data indicates that the highly oxidized species (PCE and TCE) are more readily reduced under anaerobic and nitrate reducing conditions than C12DCE and VC, which are in a lower oxidation state. The biodegradation of C12DCE and VC appears to be limited by lack of available carbon. Because of the lower oxidation state of C12DCE and VC they had to compete with alternate electron acceptors (Fe^{3+} and SO_4^{2-}), which may not be thermodynamically preferable but are present at much greater concentrations. Additional electron donors (in the form of petroleum hydrocarbons) were present but not at sufficient amounts to drive the aquifer's redox conditions to levels where degradation can proceed past C12DCE.

The areas with low sulfate concentrations generally correspond to areas with BTEX, TPH, and other fuel related compounds. **Figure 2-13a** shows areas with petroleum hydrocarbons present in 2001 and **Figure 2-13b** shows area with petroleum hydrocarbons present in 2007-2008. Sulfate concentrations in 2001 and 2007-2008 are shown as **Figures 2-14a and 2-14b**, respectively. It should be noted that leaking underground storage tank (LUST) sites typically have a very localized extent and tend to only influence the upper portion of the aquifer. As such, while their carbon contribution can be locally significant, they tend to have a limited impact with respect to the entire Site.

The locations at the NIC Site that have methanogenic conditions generally correspond to the locations with low sulfate concentrations confirming that sulfate concentrations must be depleted before methanogenic conditions can exist. F**igures 2-15a and 2-15b** show the distribution of methane in the aquifer during the 2001 and 2007-2008 sampling events, respectively. The fermentation of methane from carbon dioxide (methanogenesis) is less favorable thermodynamically than the dechlorination of C12DCE and VC. Therefore, methanogenic conditions in the aquifer will result in the most complete dechlorination of PCE and TCE. Based on the electron donor and redox condition results, it is apparent that additional organic carbon may be required to achieve complete reductive dechlorination of chlorinated ethenes at the NIC Site.

Areas with Favorable Conditions for MNA

The areas with favorable conditions for MNA of chlorinated solvents were determined based on a screening process where a MNA score is calculated for each well according to the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998). For this screening process, weighting values are assigned to each parameter that can be indicative of anaerobic reductive dechlorination (e.g. electron donors, redox parameters, degradation byproducts, etc.). Once all the parameters are weighted, these weighted values for a well are summed to obtain the MNA score. This MNA score is then used as a preliminary screening tool to determine if biodegradation is occurring at the well. The MNA score is interpreted as follow:

- MNA score 0 - 5 indicates inadequate evidence;
- MNA score 6 - 14 indicates limited evidence;
- MNA score 15 - 20 indicates adequate evidence; and
- MNA score >20 indicates strong evidence.

Both the current and previous sampling event data were scored for MNA to evaluate the performance of MNA for Site remediation. The MNA scoring results are presented in **Table 2-10**.

Previous Sampling Event: The May 2001 sampling event showed that the areas within the NIC Site favorable for MNA were localized due to the specific electron donor needs of the reductive dechlorination process. Nine wells (DRB-MW-20, NMW-06D, NMW-08S, NMW-08D, NMW-10S, NMW-10D, WND-03S, WND-21S, and WND-36D) in the middle portion of the NIC Site had MNA score between 15 and 20 which showed that there was adequate evidence that MNA was occurring at these wells. Based on the MNA score, the conditions at these wells appeared to be favorable for the complete dechlorination of PCE, TCE, and 111TCA. These locations are shown on **Figure 2-11**.

These nine wells also exhibited methanogenic conditions that are conducive for complete dechlorination and generally had higher concentrations of end products (ethene and ethane). While these nine wells exhibited proper conditions for complete reductive dechlorination, only three wells (DRB-MW-20, DRB-MW-250, and NMW-08S) had the available carbon supply (petroleum contaminants) to sustain complete reductive dechlorination for a long period of time. Without a long-term supply of electron donor, complete reductive dechlorination of the Site contaminants was expected to be unlikely.

The insufficient carbon supply may be only one limiting factor for not achieving complete reductive dechlorination. All three wells (DRB-MW-20, DRB-MW-250, and NMW-08S) showed the presence of ethene and ethane; however, low concentrations (< 100 μg/L) (EPA 1998) indicate that indigenous bacteria might be limited in their capability to perform complete anaerobic reductive dechlorination.

Current Sampling Event: The December 2007 and April 2008 sampling events showed all the wells with MNA score of less than 15, suggesting limited to inadequate evidence of MNA at the NIC Site. These locations are shown on **Figure 2-12**. Only four wells exhibited methanogenic conditions conducive for complete dechlorination but showed no production of end products (VC, ethene, or ethane). While these four wells exhibited proper redox conditions for complete reductive dechlorination, only one well (WND-36S) had the available carbon supply (petroleum contaminants) to sustain complete reductive dechlorination. All other wells neither exhibited favorable conditions for dechlorination nor had sufficient carbon supply to allow for long-term reductive dechlorination. As expected with the limited supply of electron donor, complete reductive dechlorination of the contaminants was not observed at the Site.

As suggested earlier, the insufficient carbon supply may be only one limiting factor for not achieving complete reductive dechlorination. The low levels of VC and absence of ethene and ethane at the Site suggests that the indigenous bacteria may have limited capability of performing complete anaerobic reductive dechlorination. The dechlorinating bacteria, *Dehalococcoides spp.*, have been found to be very important for achieving complete dechlorination of PCE and TCE to ethene in groundwater (Hendrickson et al. 2002). While these bacteria are fairly common, they

are not present at every site, and their absence can lead to the stall of dechlorination at C12DCE.

Overall, the relatively low MNA scores for majority of the plume wells indicate that the conditions at the NIC Site are not conducive for complete biodegradation of chlorinated solvents to ethene. The expanding downgradient plume indicates that the MNA process (dispersion, dilution, sorption, and biodegradation) are not occurring at a fast enough rate to sustain a stable or shrinking plume. Degradation processes appear to be less significant than in 2001 suggesting that the processes will not be sustained over long time periods. Based upon the available data, MNA is unlikely to be a stand-alone remedy for any groundwater operable units within the NIC Site; however, MNA may warrant further evaluation as a component of the comprehensive remedial strategy for some areas of the NIC Site.

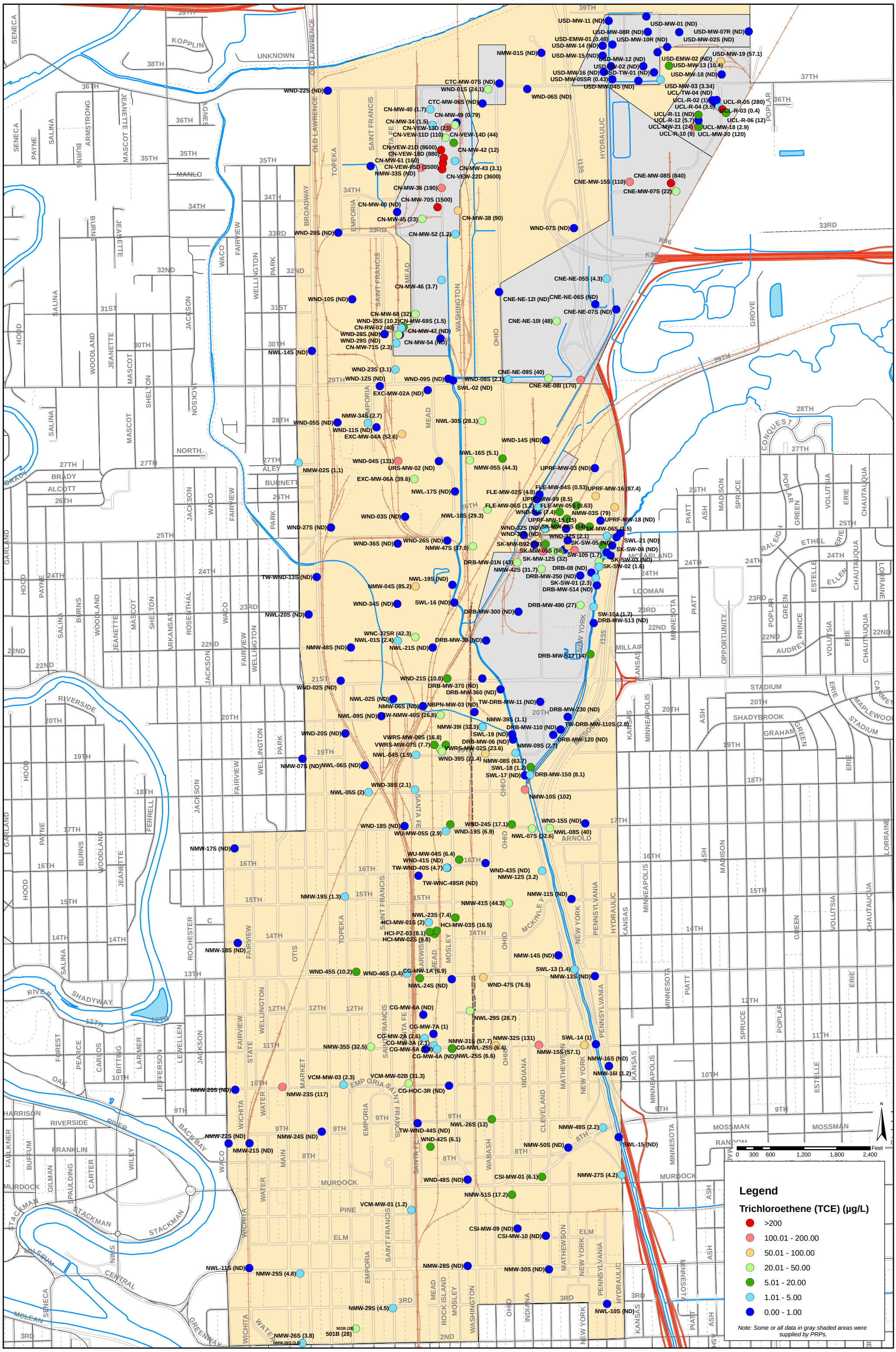


Figure 2-1a
North Industrial Corridor (NIC) Site
TCE in Shallow Groundwater

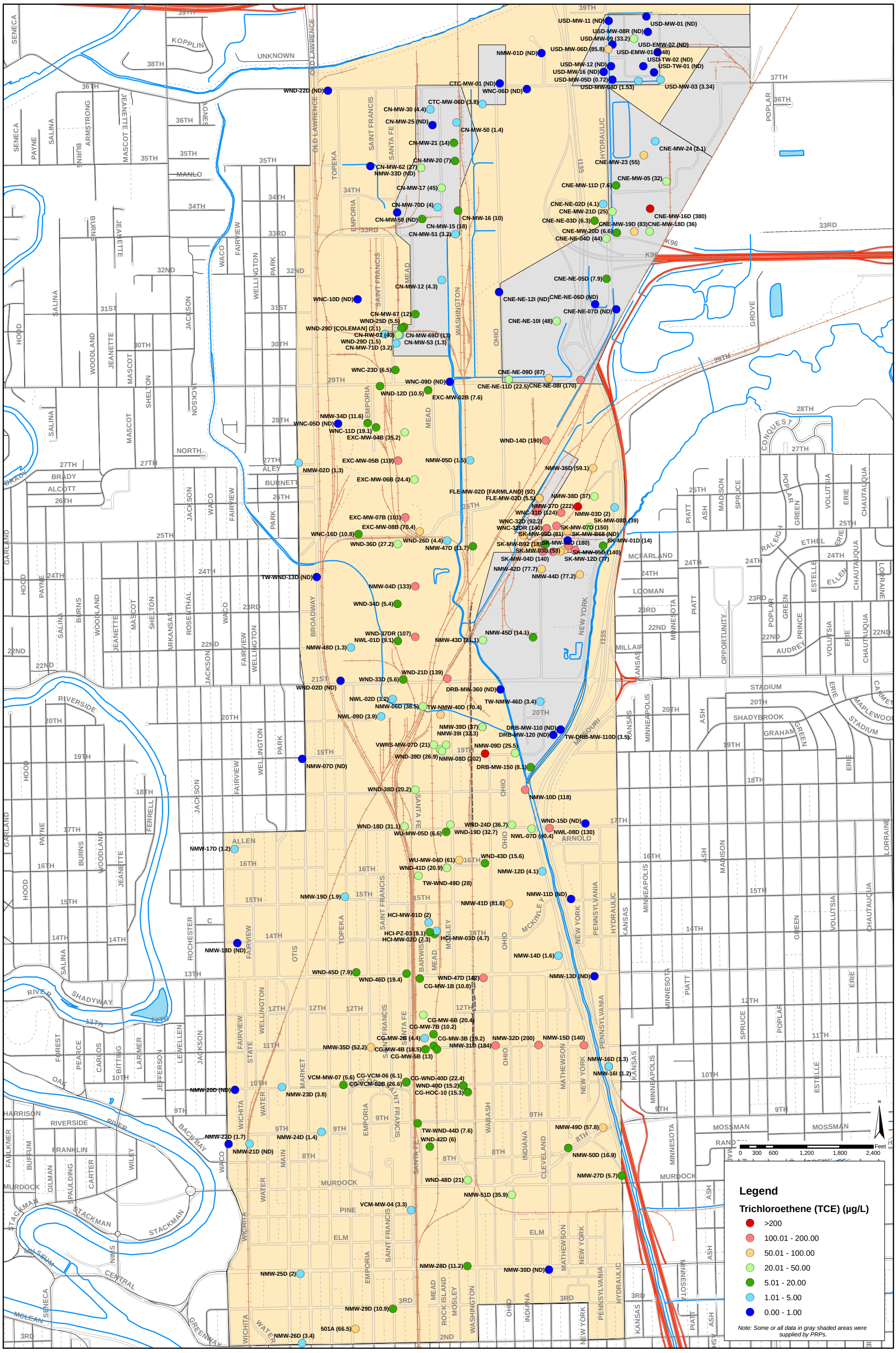


Figure 2-1b
North Industrial Corridor (NIC) Site
TCE in Deep Groundwater

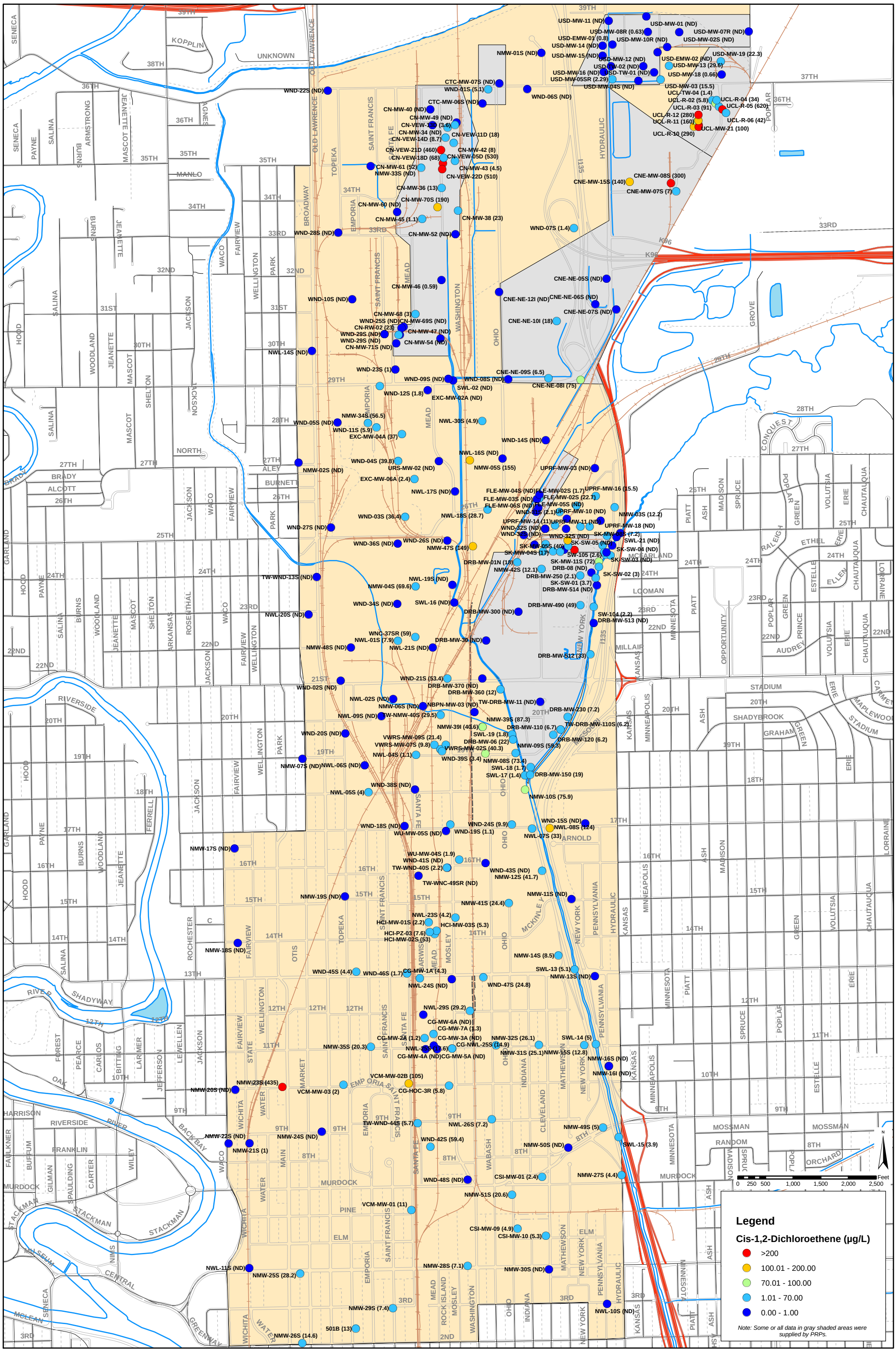


Figure 2-2a
North Industrial Corridor (NIC) Site
cis-1,2-DCE in Shallow Groundwater

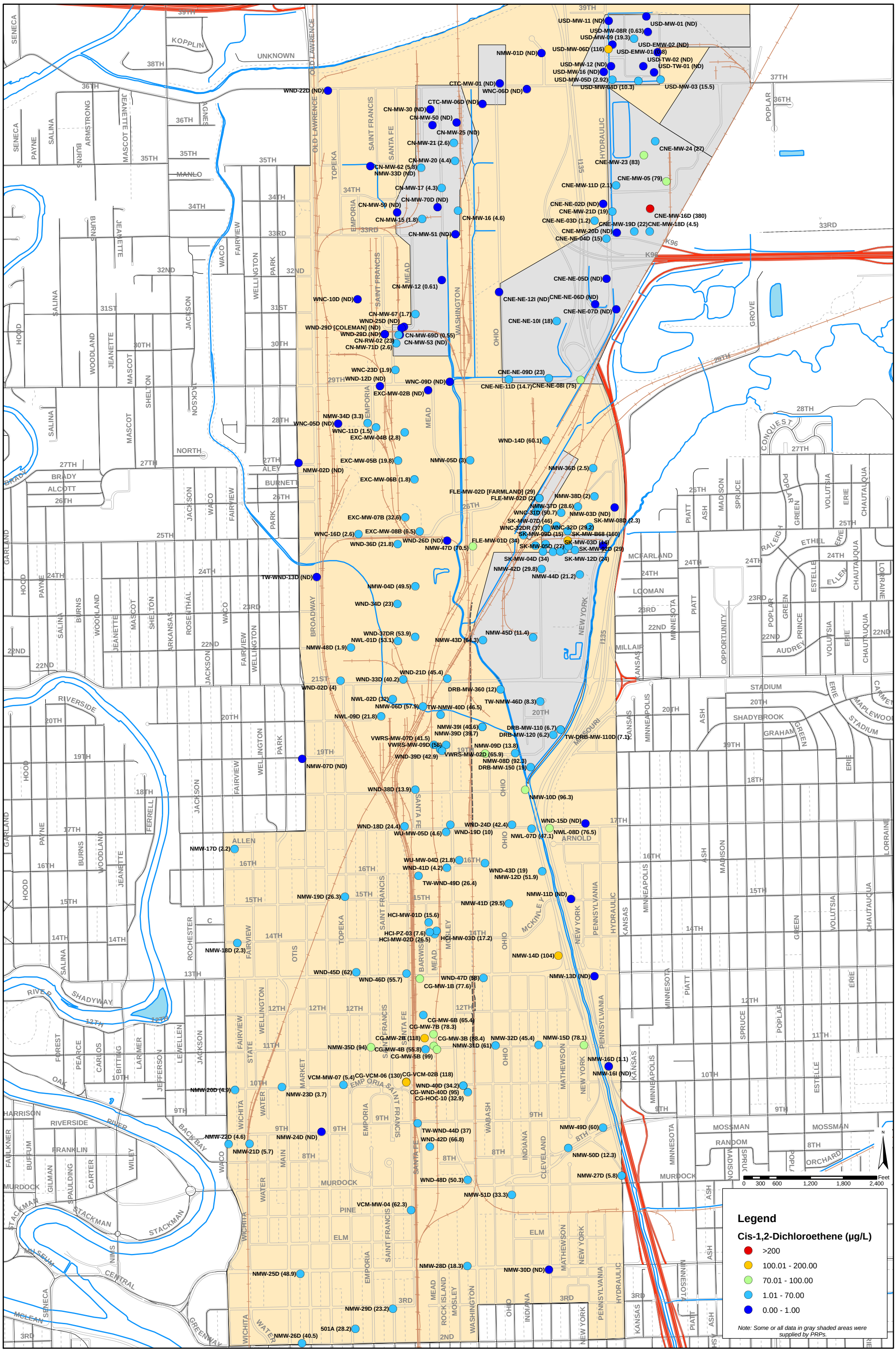


Figure 2-2b
North Industrial Corridor (NIC) Site
cis-1,2-DCE in Deep Groundwater

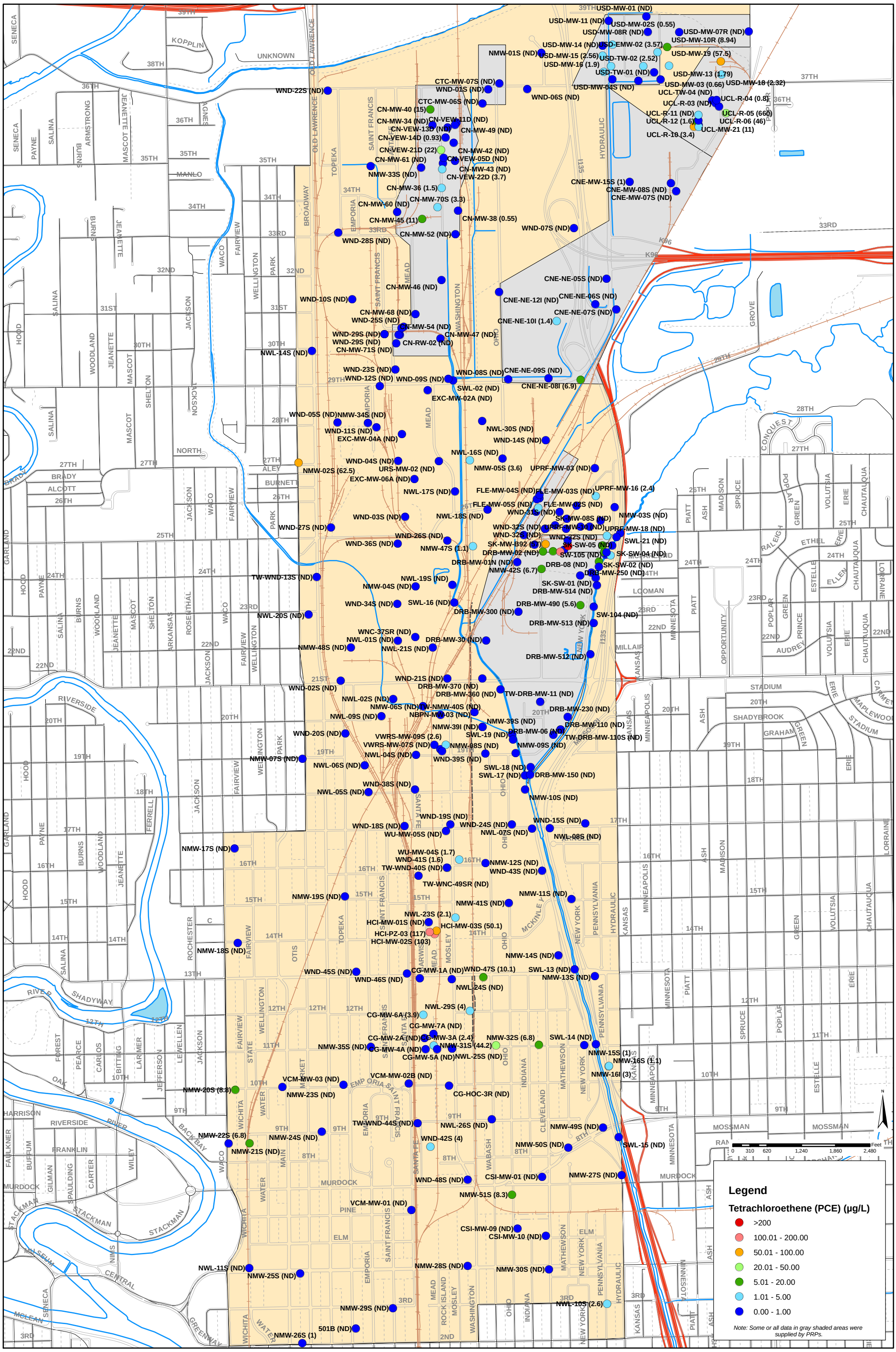


Figure 2-3a
North Industrial Corridor (NIC) Site
PCE in Shallow Groundwater

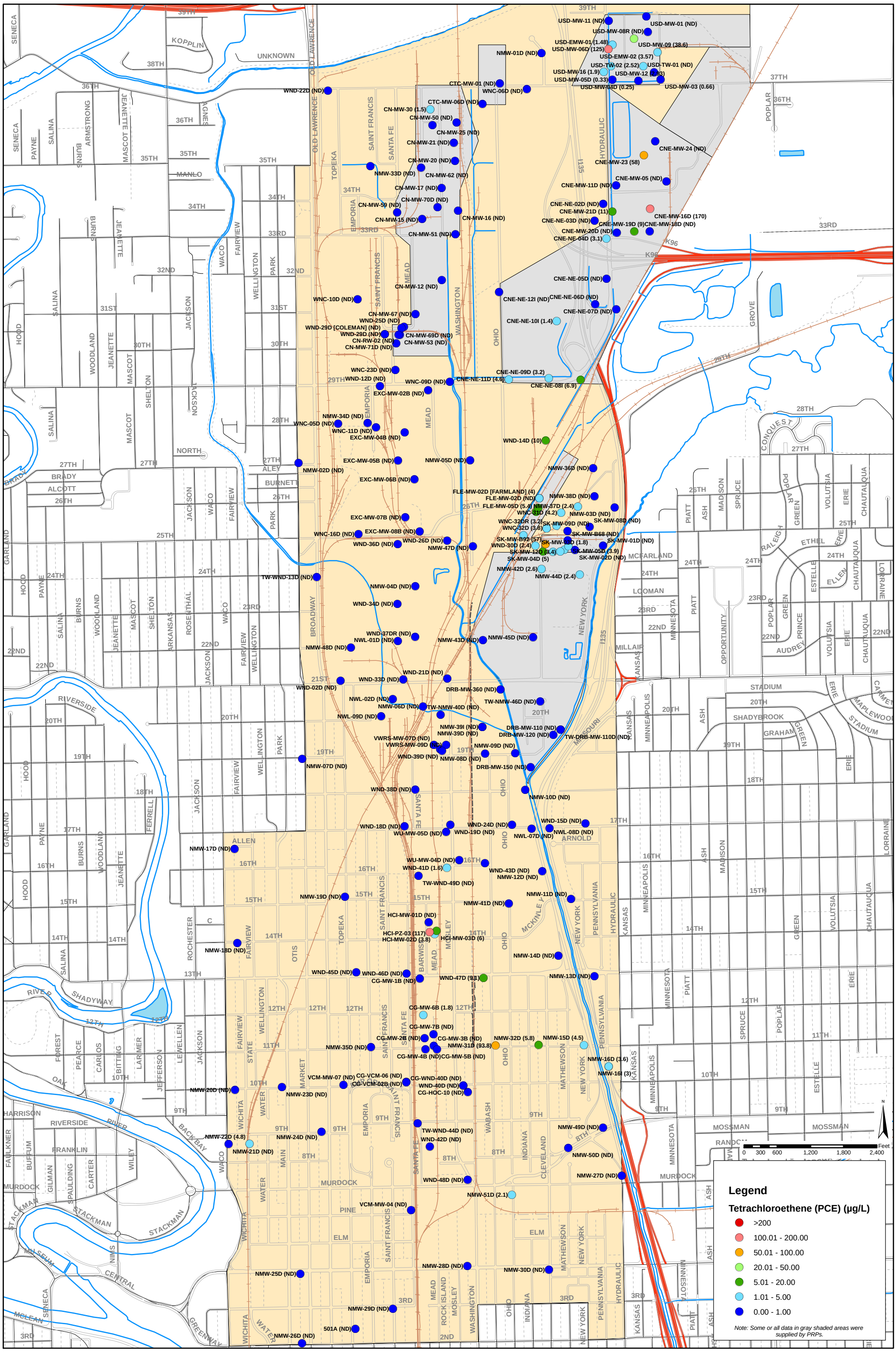


Figure 2-3b
North Industrial Corridor (NIC) Site
PCE in Deep Groundwater

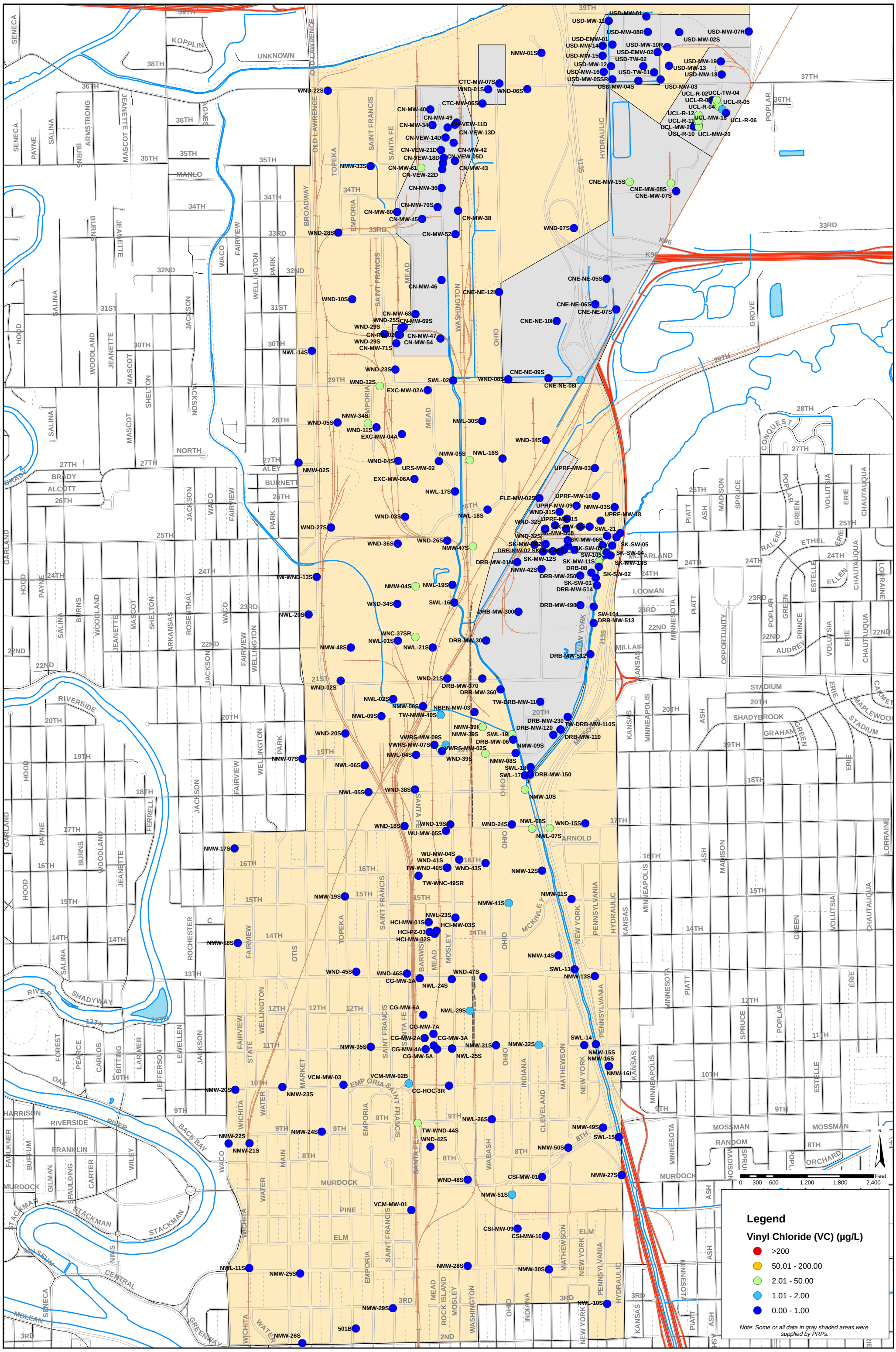


Figure 2-4a
North Industrial Corridor (NIC) Site
VC in Shallow Groundwater

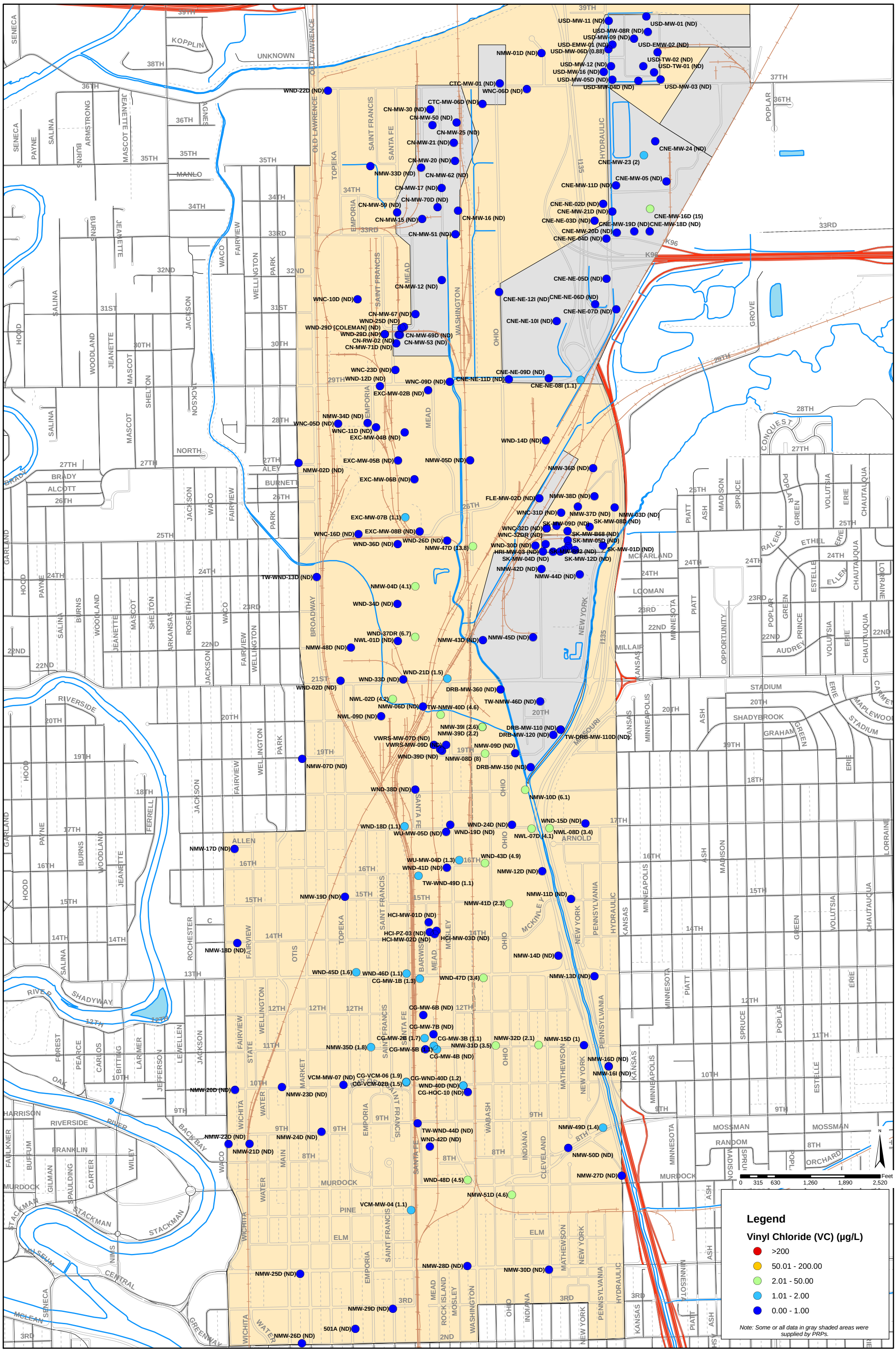


Figure 2-4b
North Industrial Corridor (NIC) Site
VC in Deep Groundwater

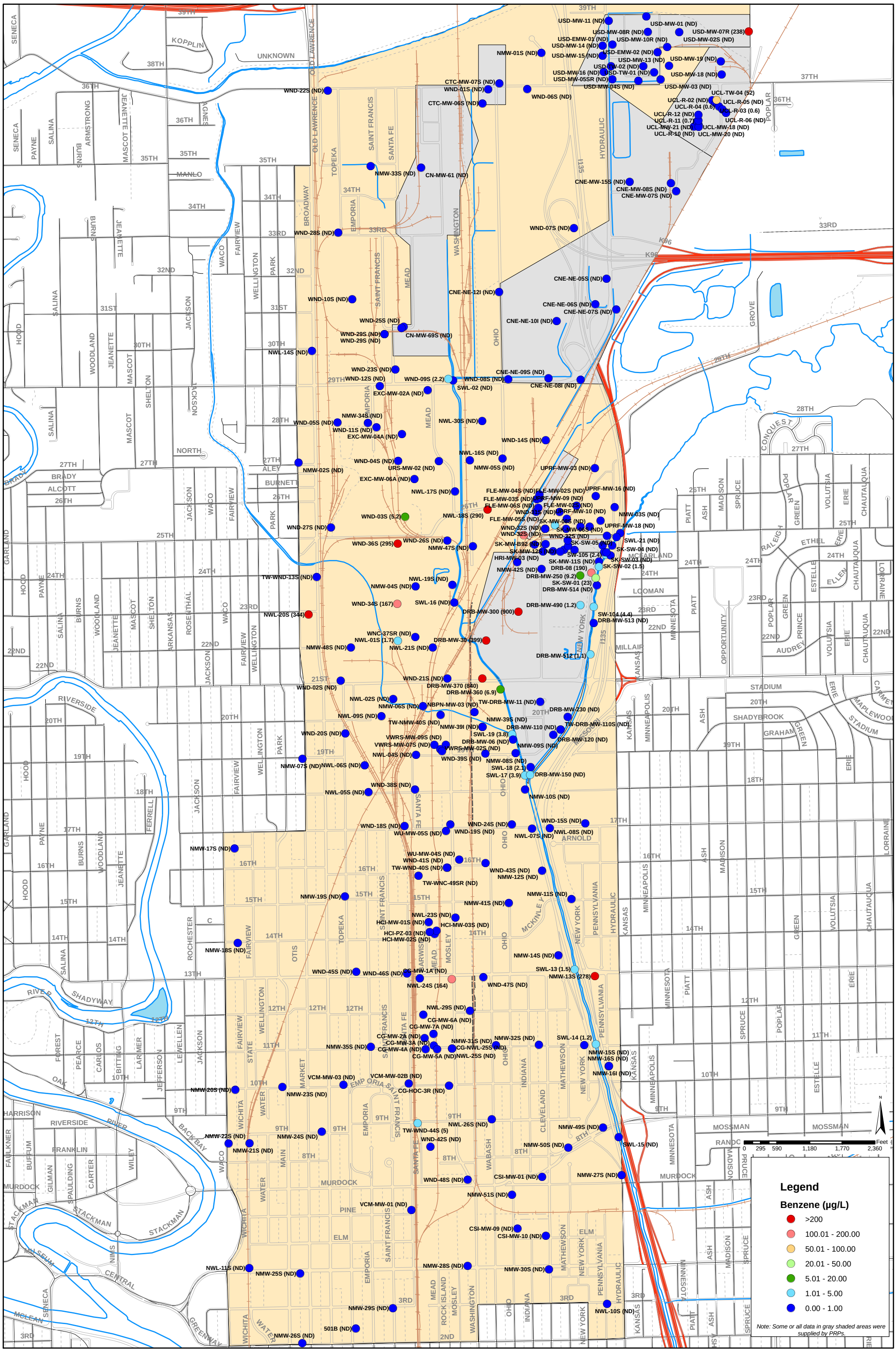


Figure 2-5a
North Industrial Corridor (NIC) Site
Benzene in Shallow Groundwater

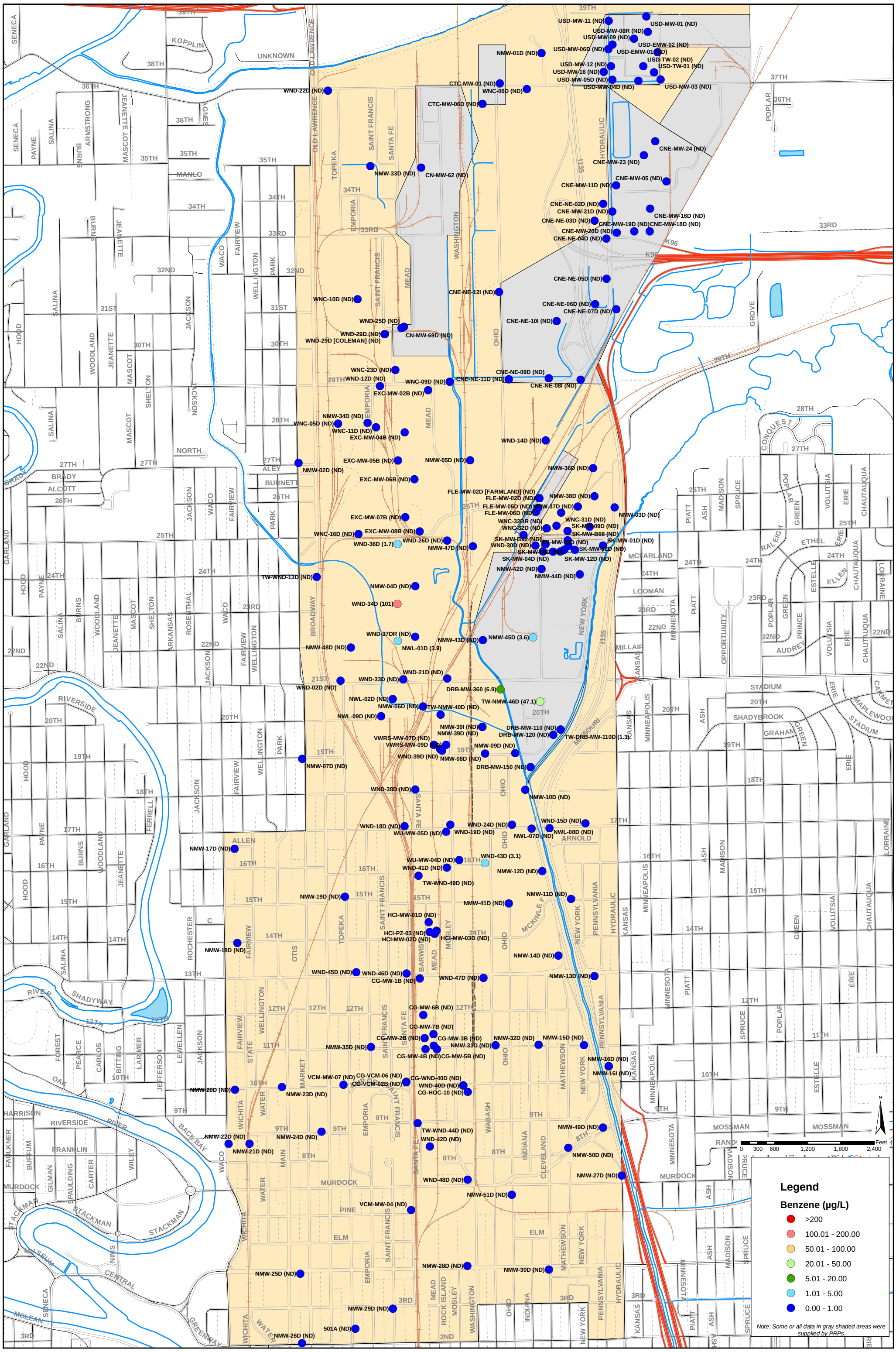


Figure 2-5b
North Industrial Corridor (NIC) Site
Benzene in Deep Groundwater

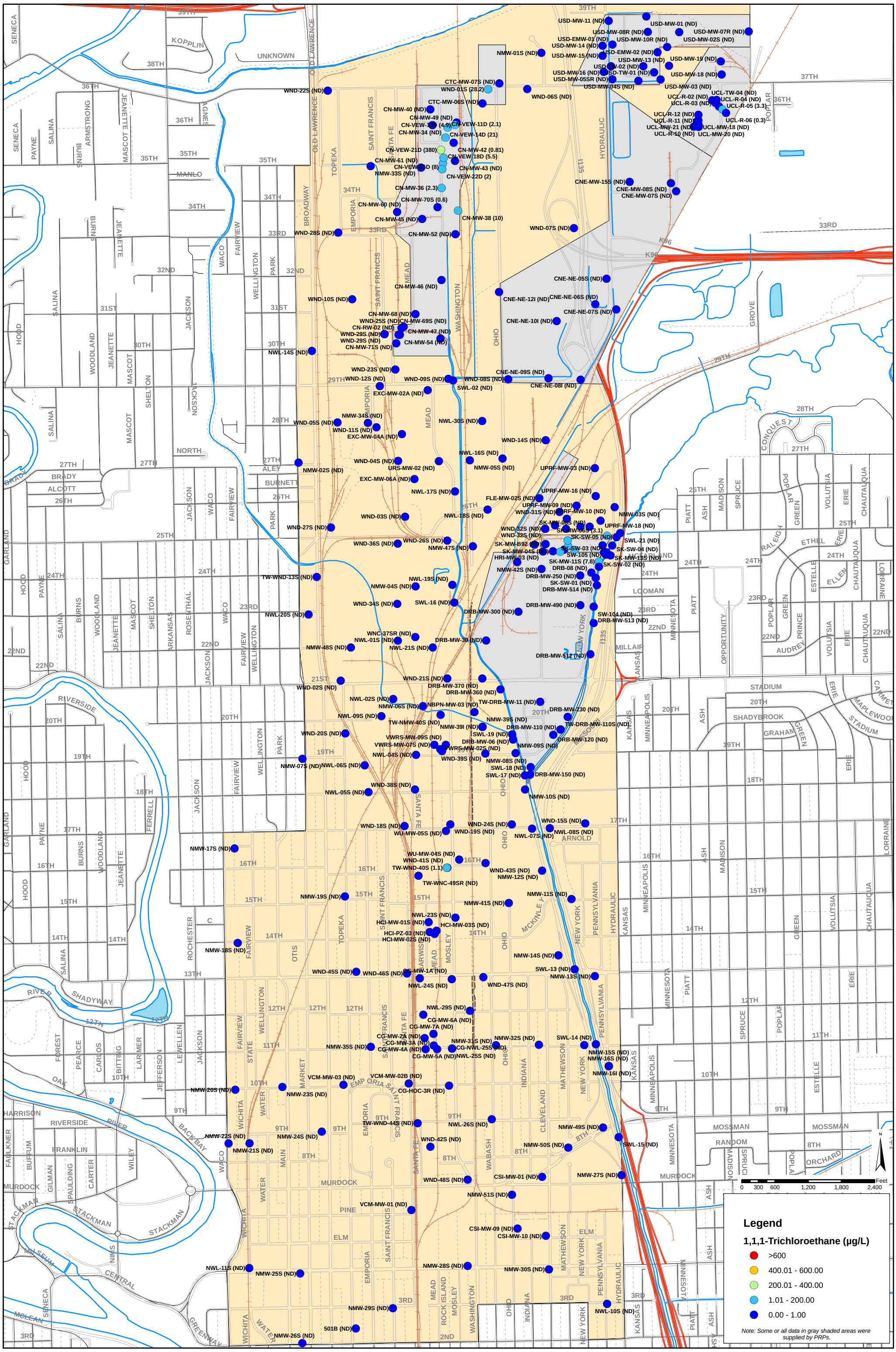


Figure 2-6a
North Industrial Corridor (NIC) Site
1,1,1-TCA in Shallow Groundwater

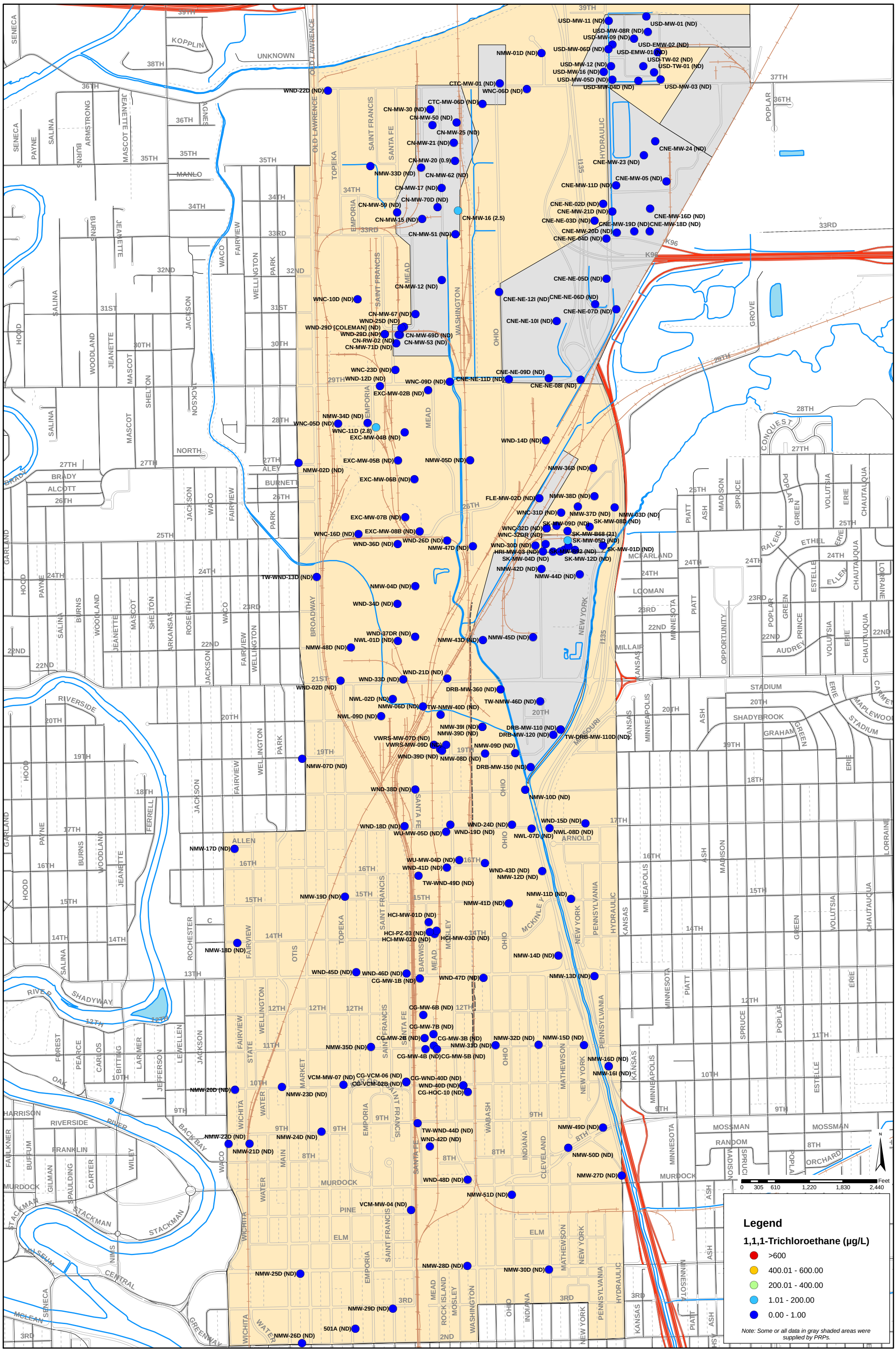


Figure 2-6b
North Industrial Corridor (NIC) Site
1,1,1-TCA in Deep Groundwater

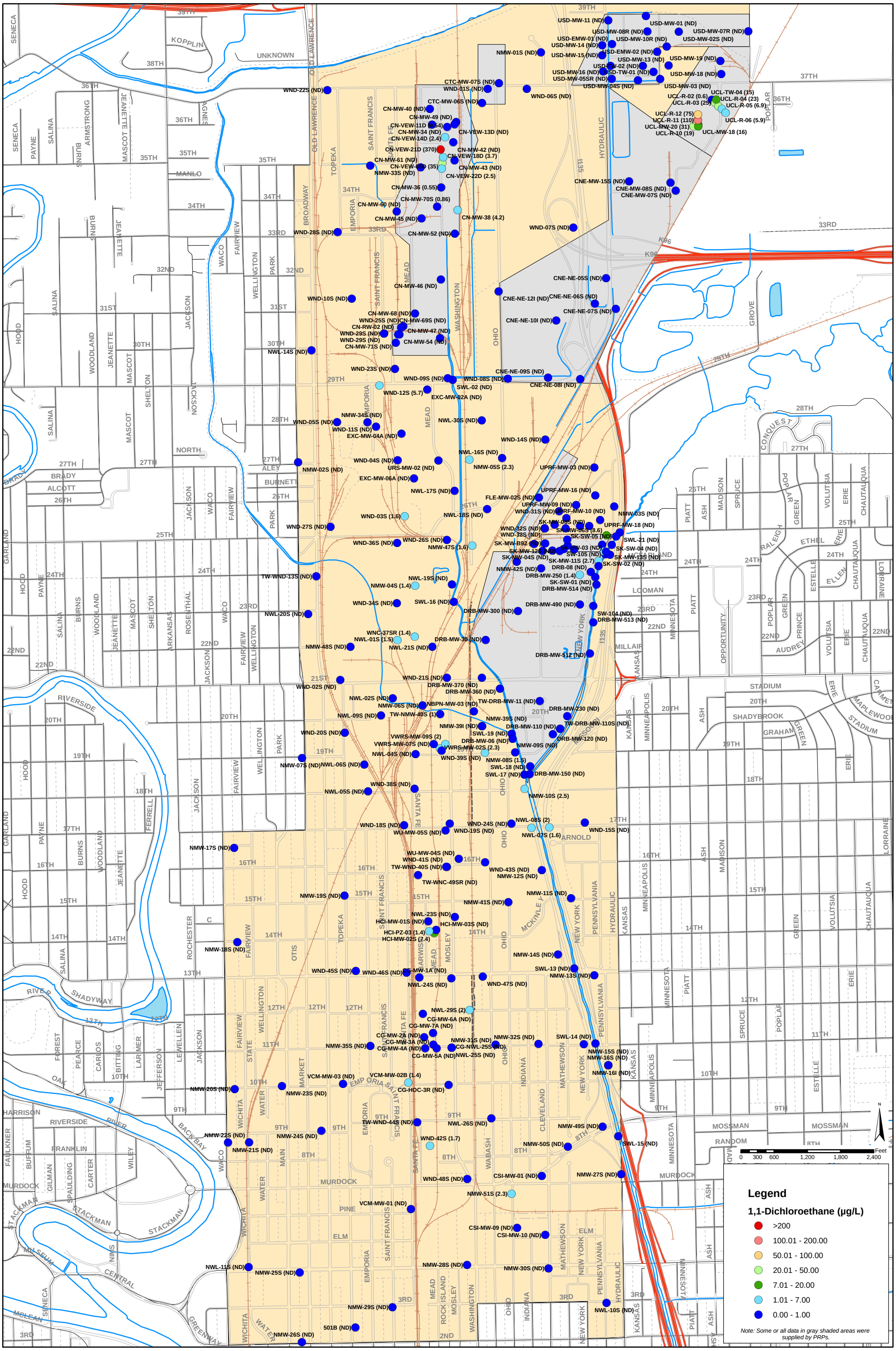


Figure 2-7a
North Industrial Corridor (NIC) Site
1,1-DCA in Shallow Groundwater

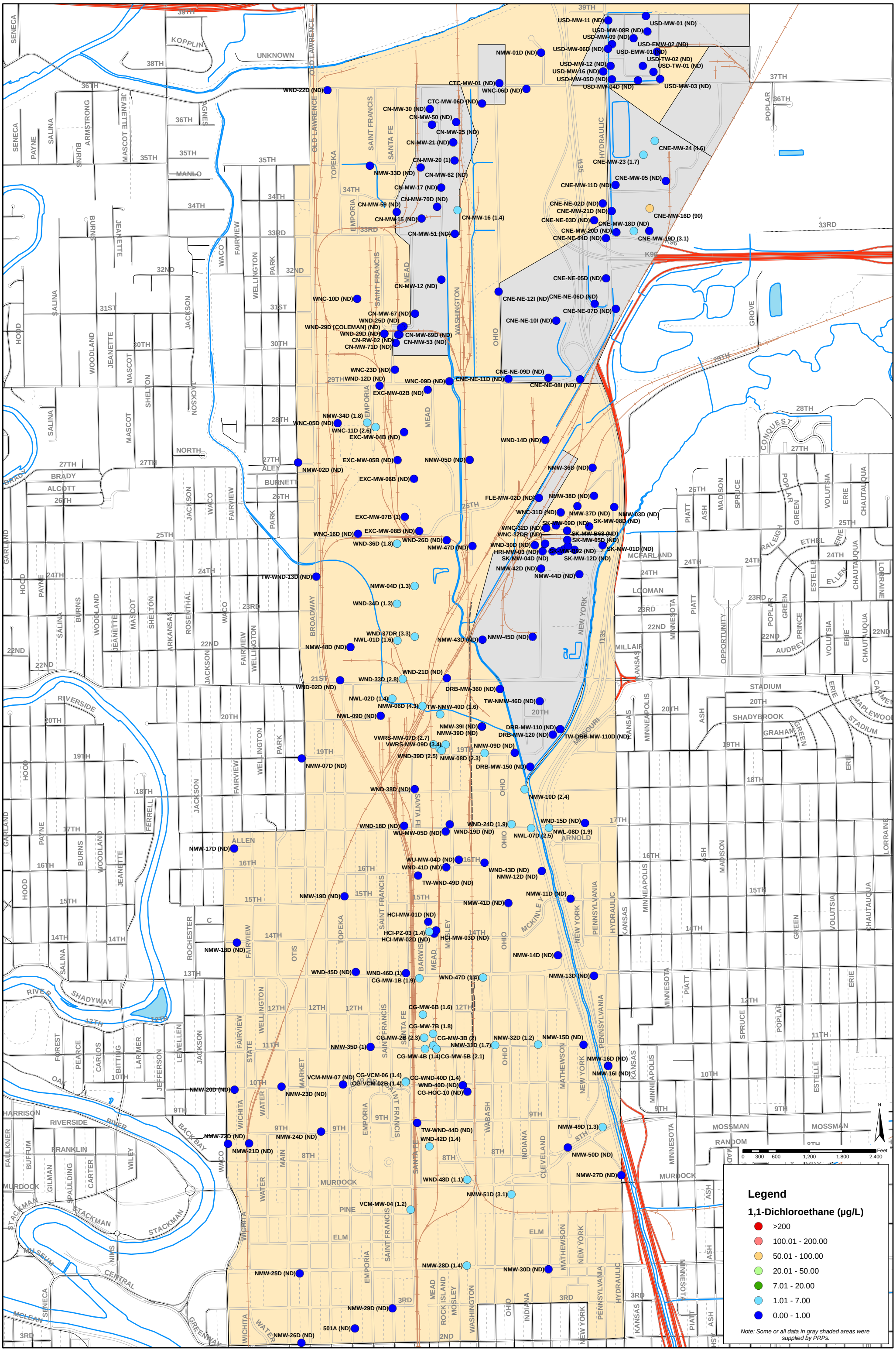


Figure 2-7b
North Industrial Corridor (NIC) Site
1,1-DCA in Deep Groundwater

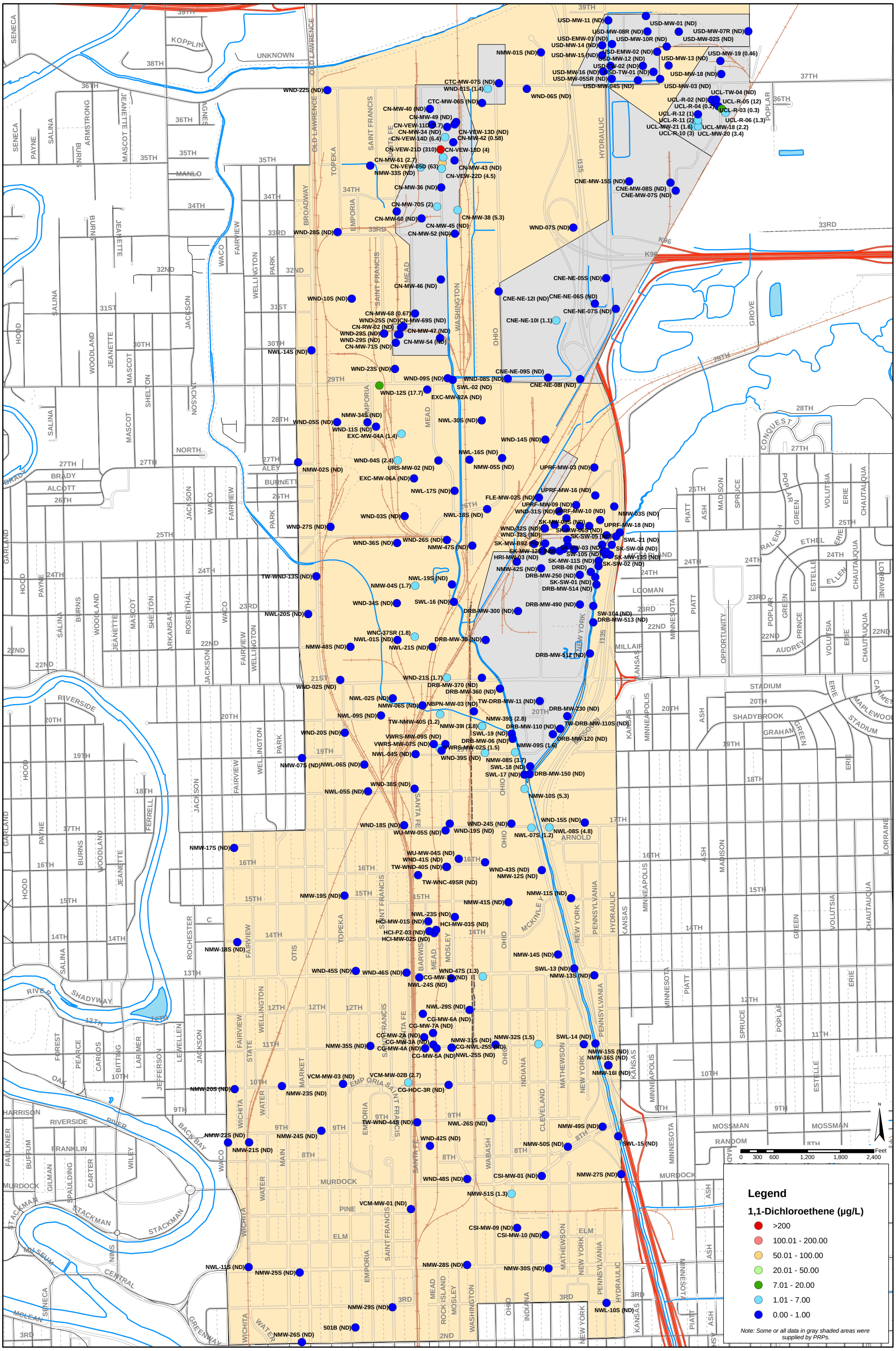


Figure 2-8a
North Industrial Corridor (NIC) Site
1,1-DCE in Shallow Groundwater

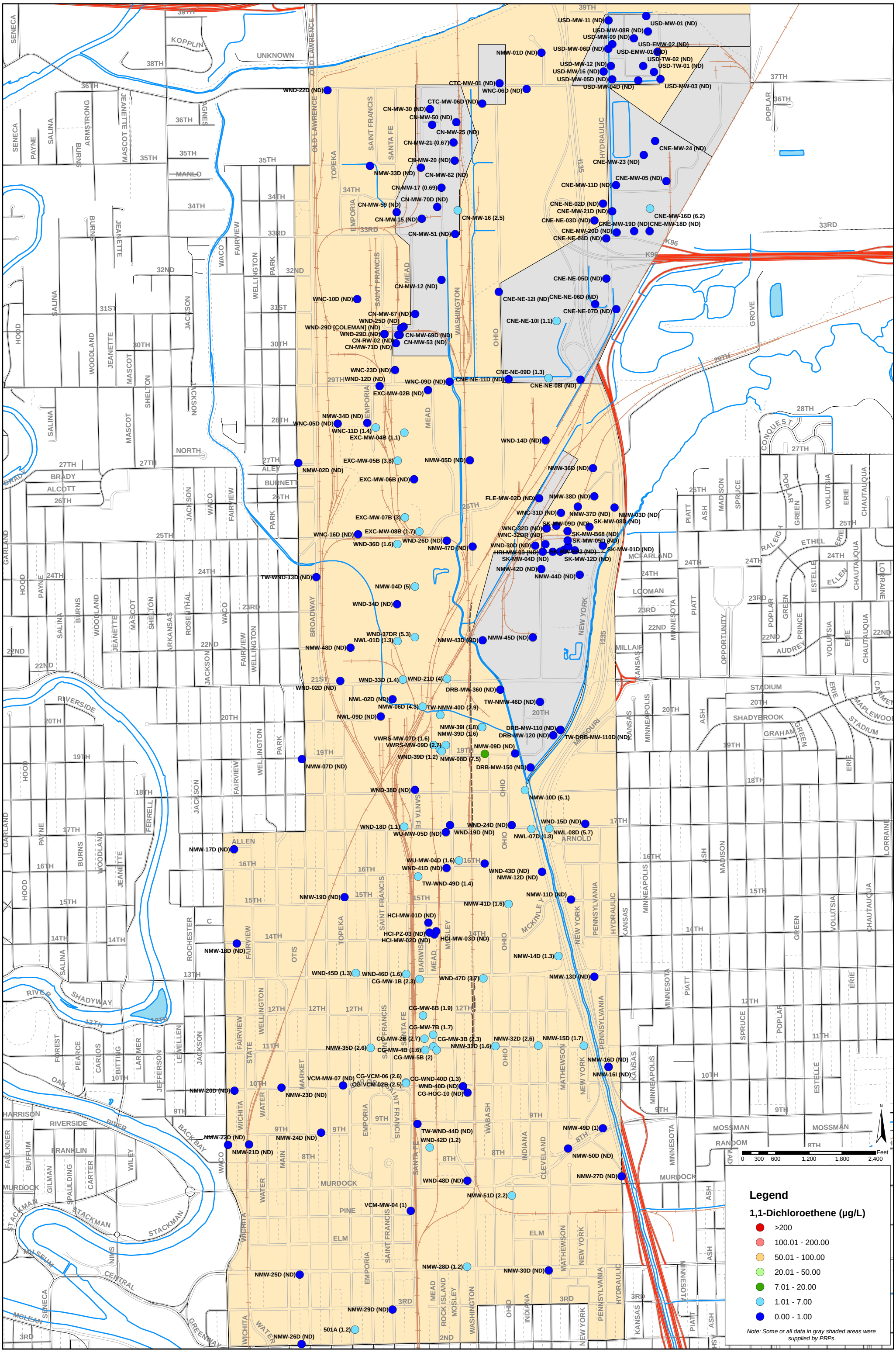


Figure 2-8b
North Industrial Corridor (NIC) Site
1,1-DCE in Deep Groundwater

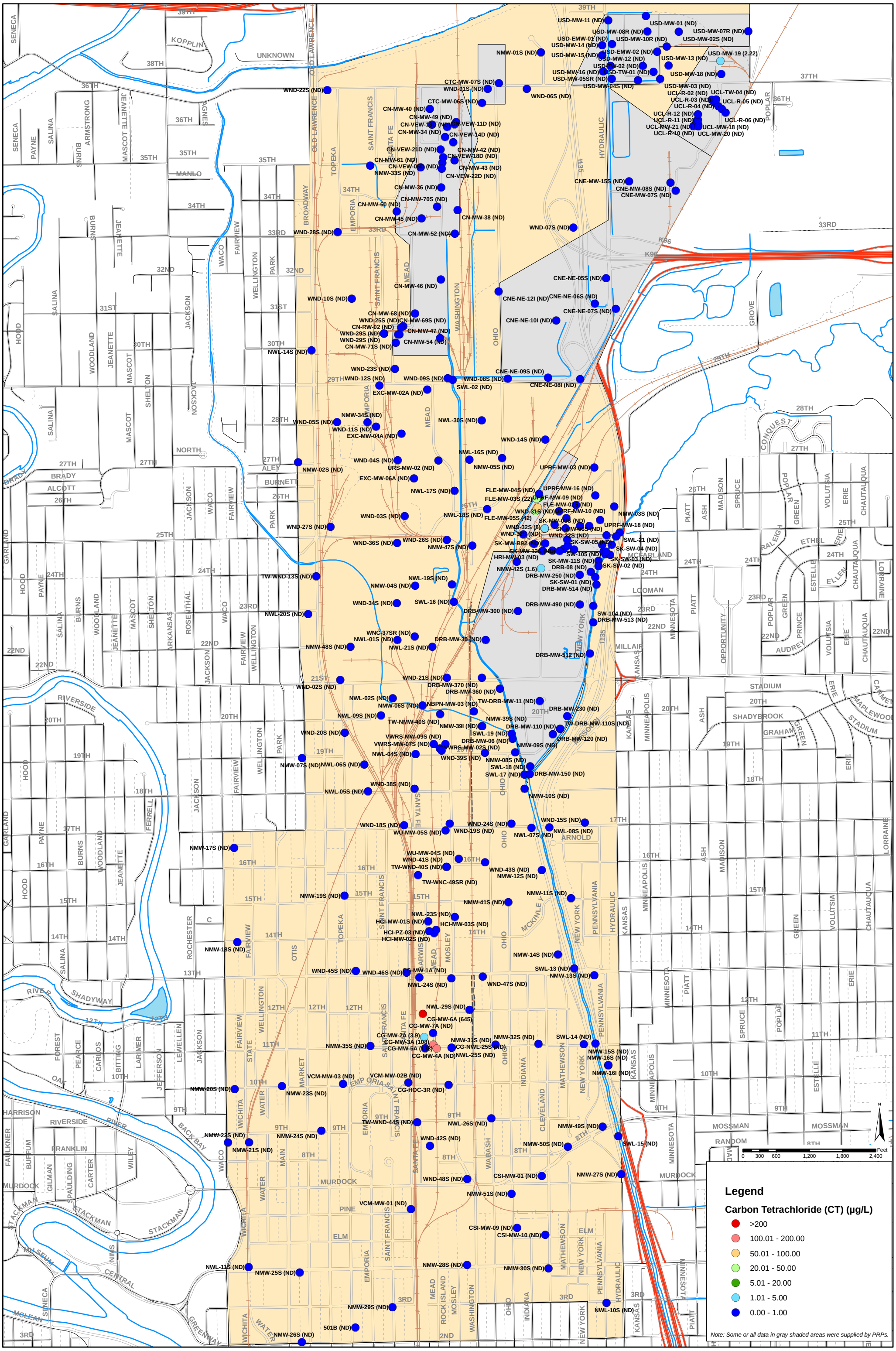


Figure 2-9a
North Industrial Corridor (NIC) Site
CT in Shallow Groundwater

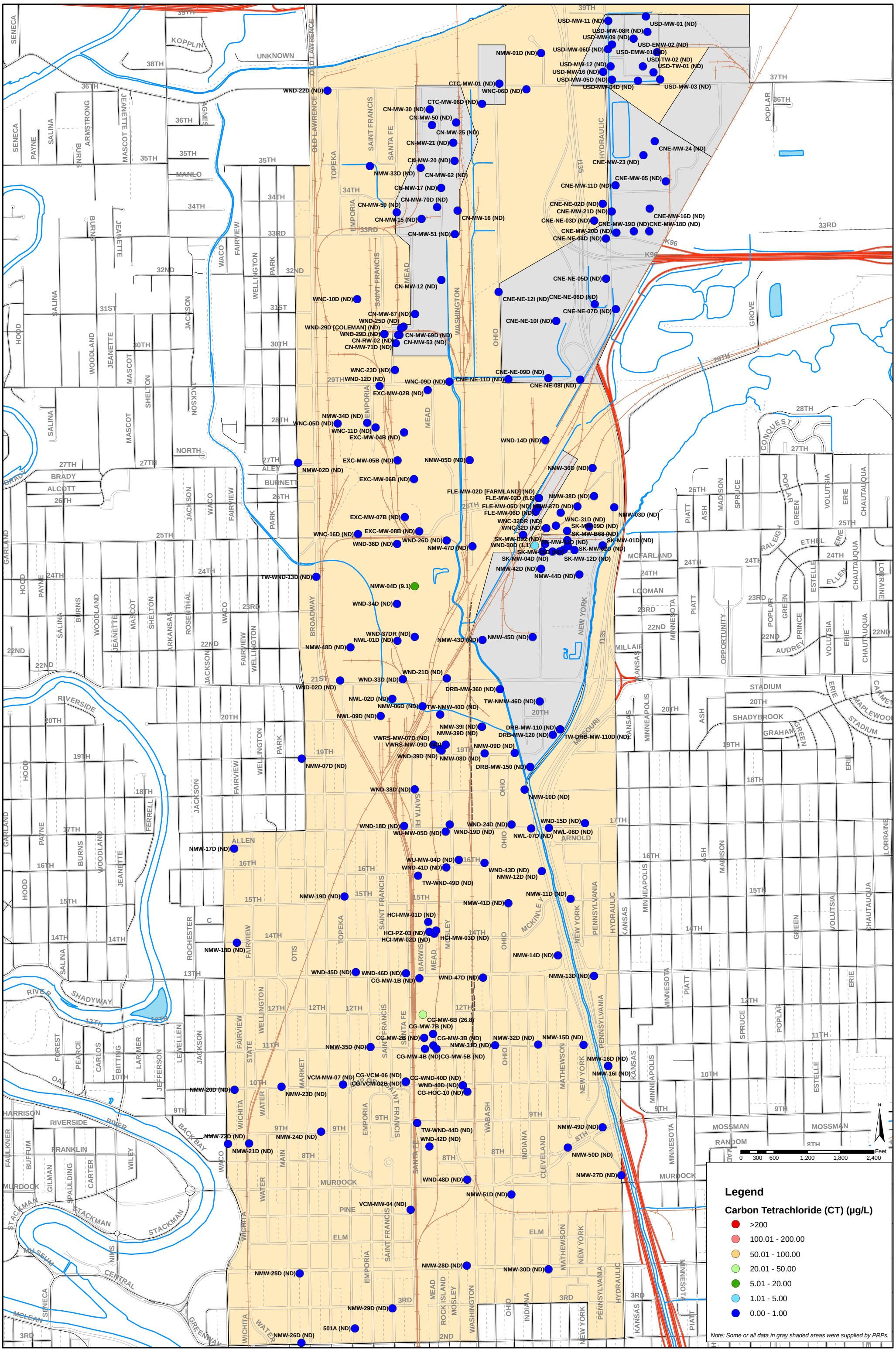
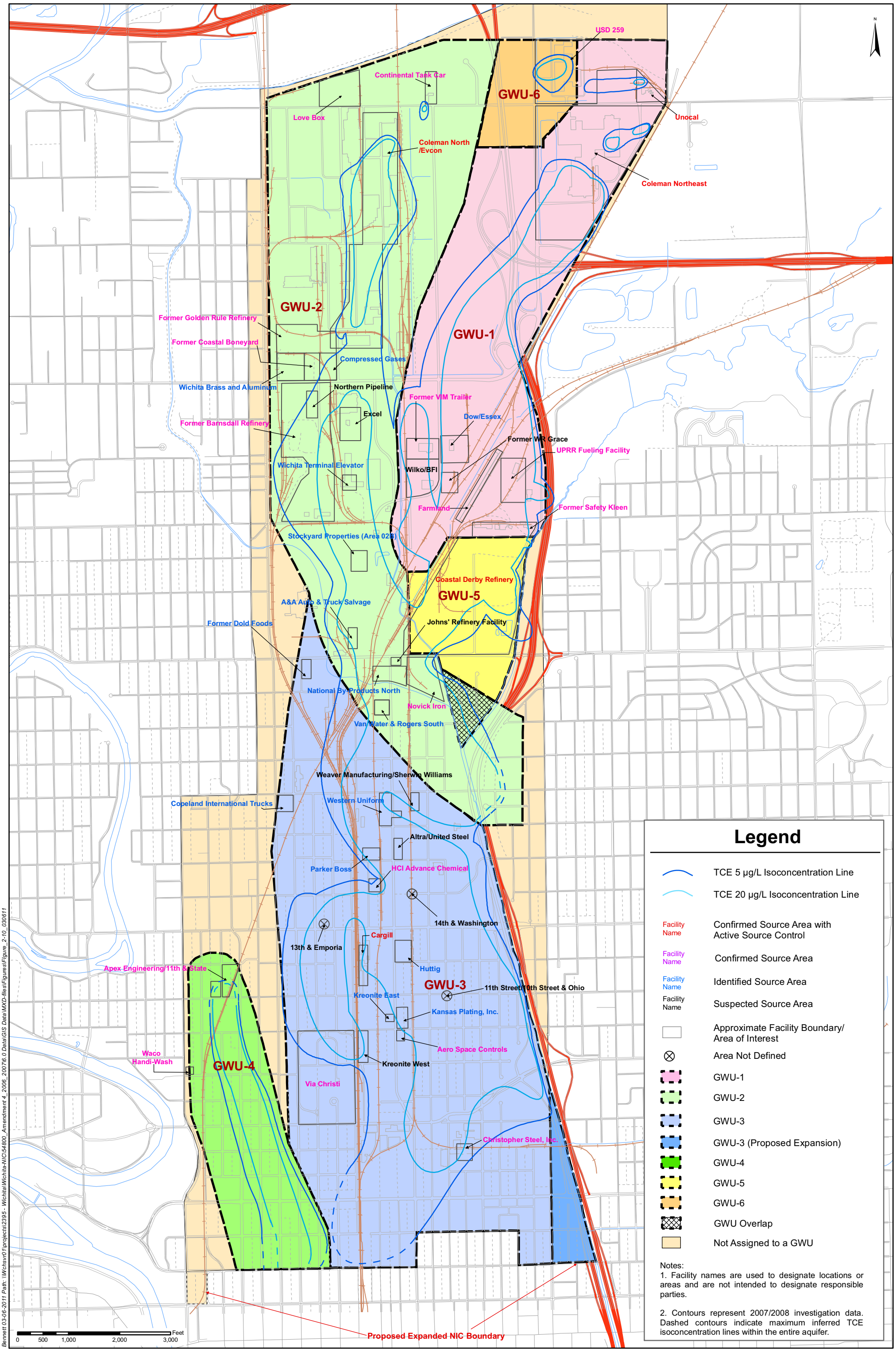


Figure 2-9b
North Industrial Corridor (NIC) Site
CT in Deep Groundwater



CDM

Figure 2-10
North Industrial Corridor (NIC) Site
Proposed Revisions to the Groundwater Unit and NIC Site Boundaries

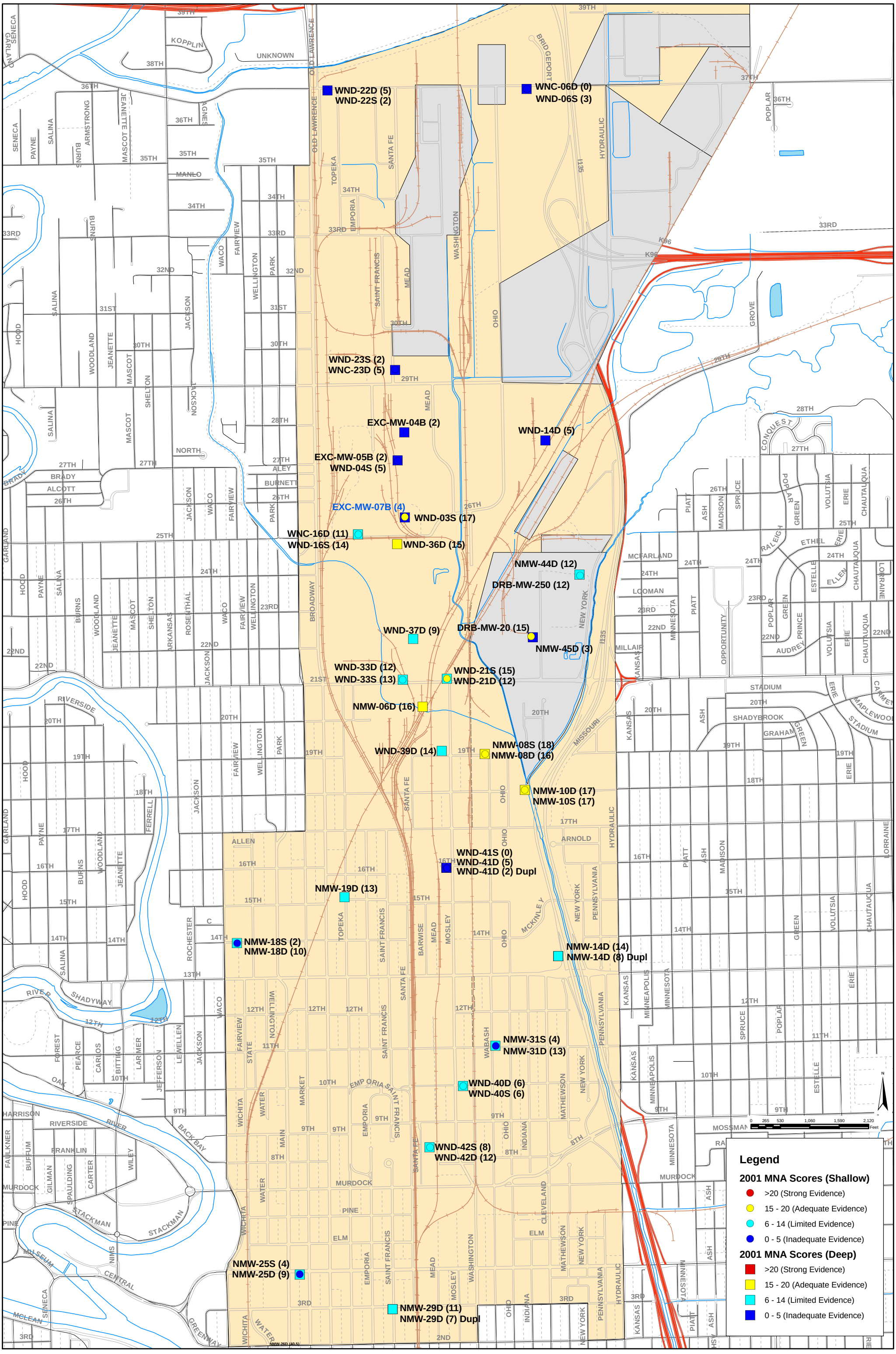


Figure 2-11
North Industrial Corridor (NIC) Site
2001 MNA Scores

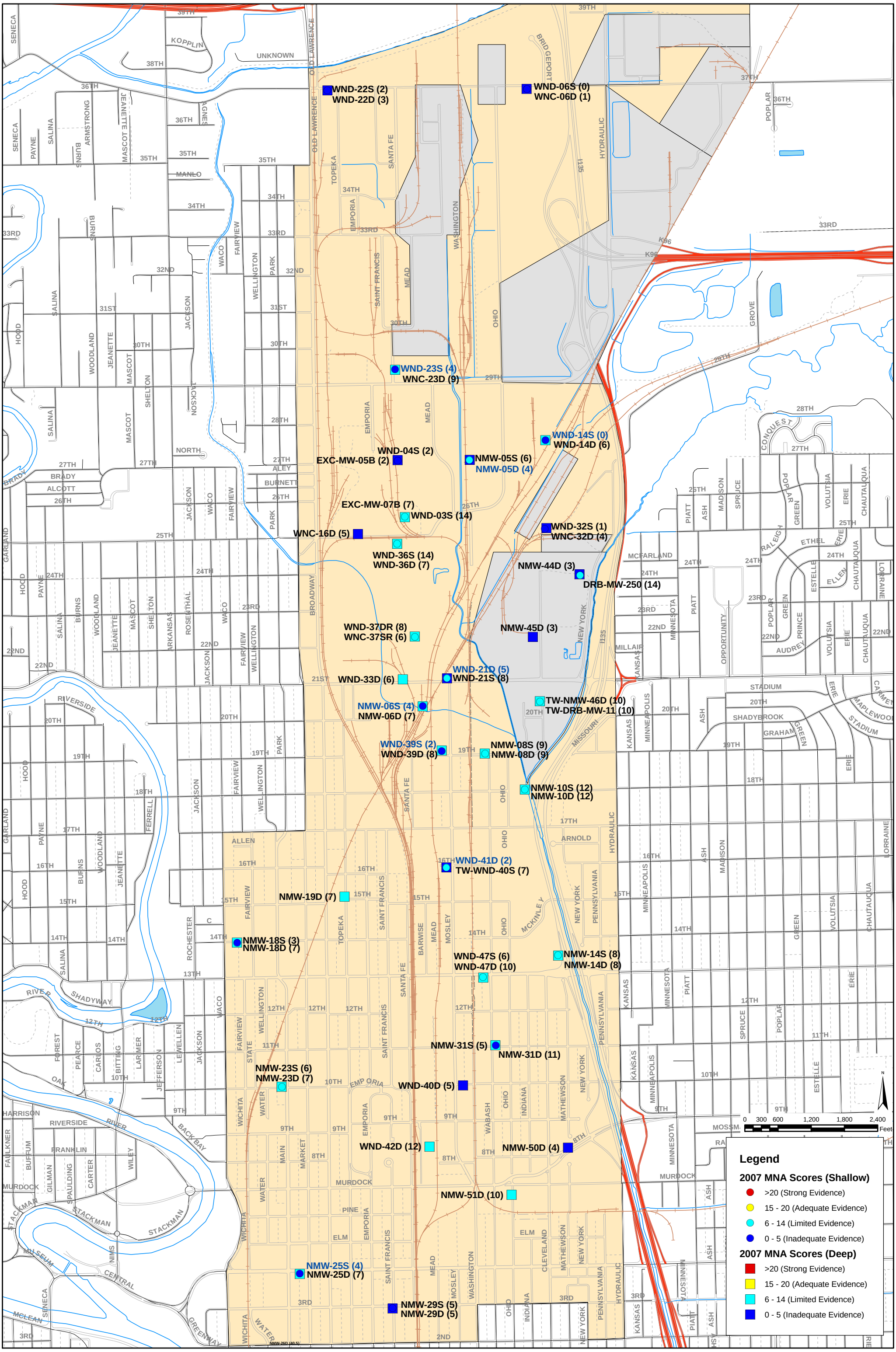


Figure 2-12
North Industrial Corridor (NIC) Site
2007-2008 MNA Scores

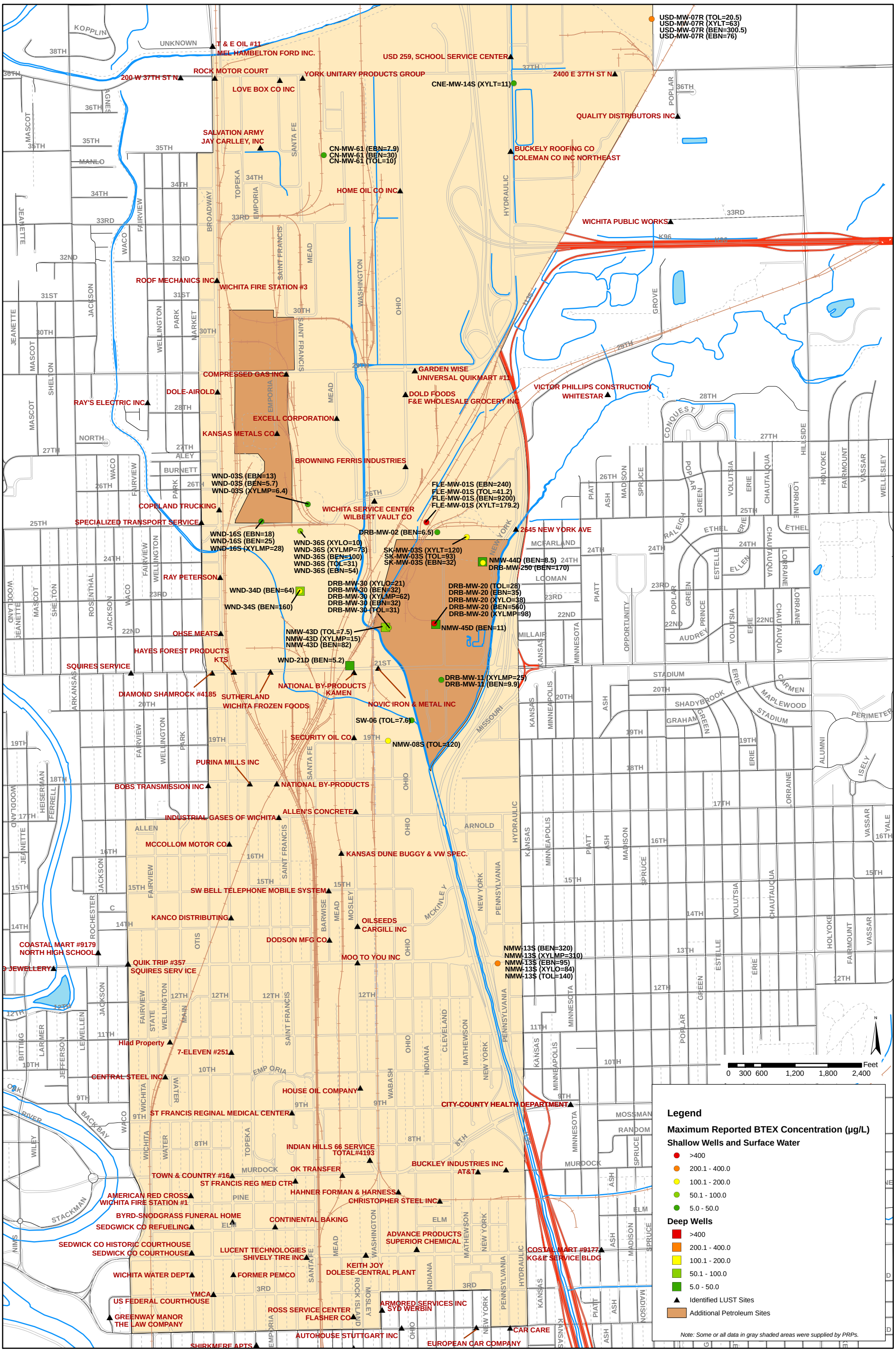


Figure 2-13a
North Industrial Corridor (NIC) Site
2001 Petroleum Hydrocarbon Occurrences

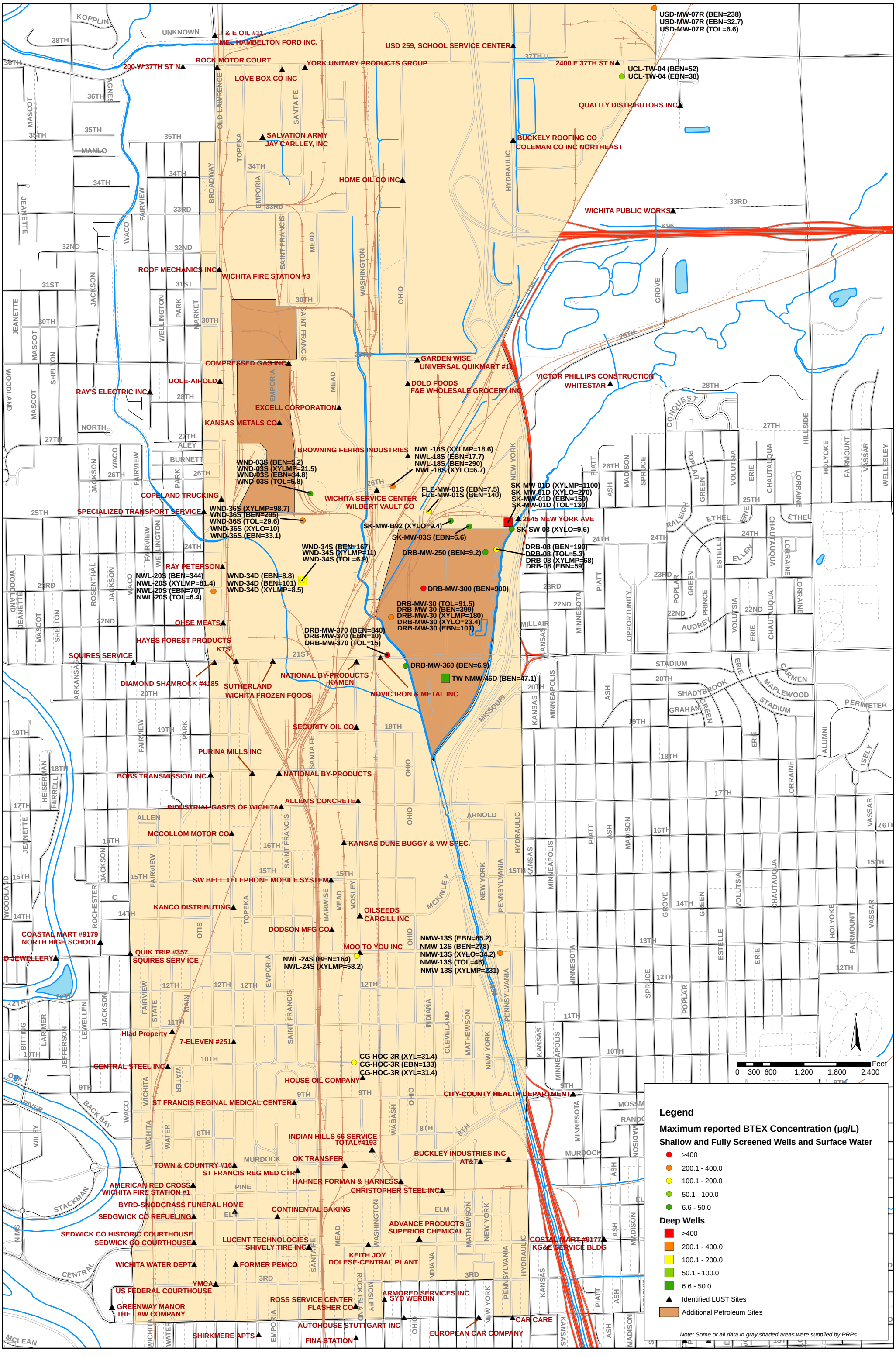


Figure 2-13b
North Industrial Corridor (NIC) Site
Petroleum Hydrocarbon Occurrences 2007-2008

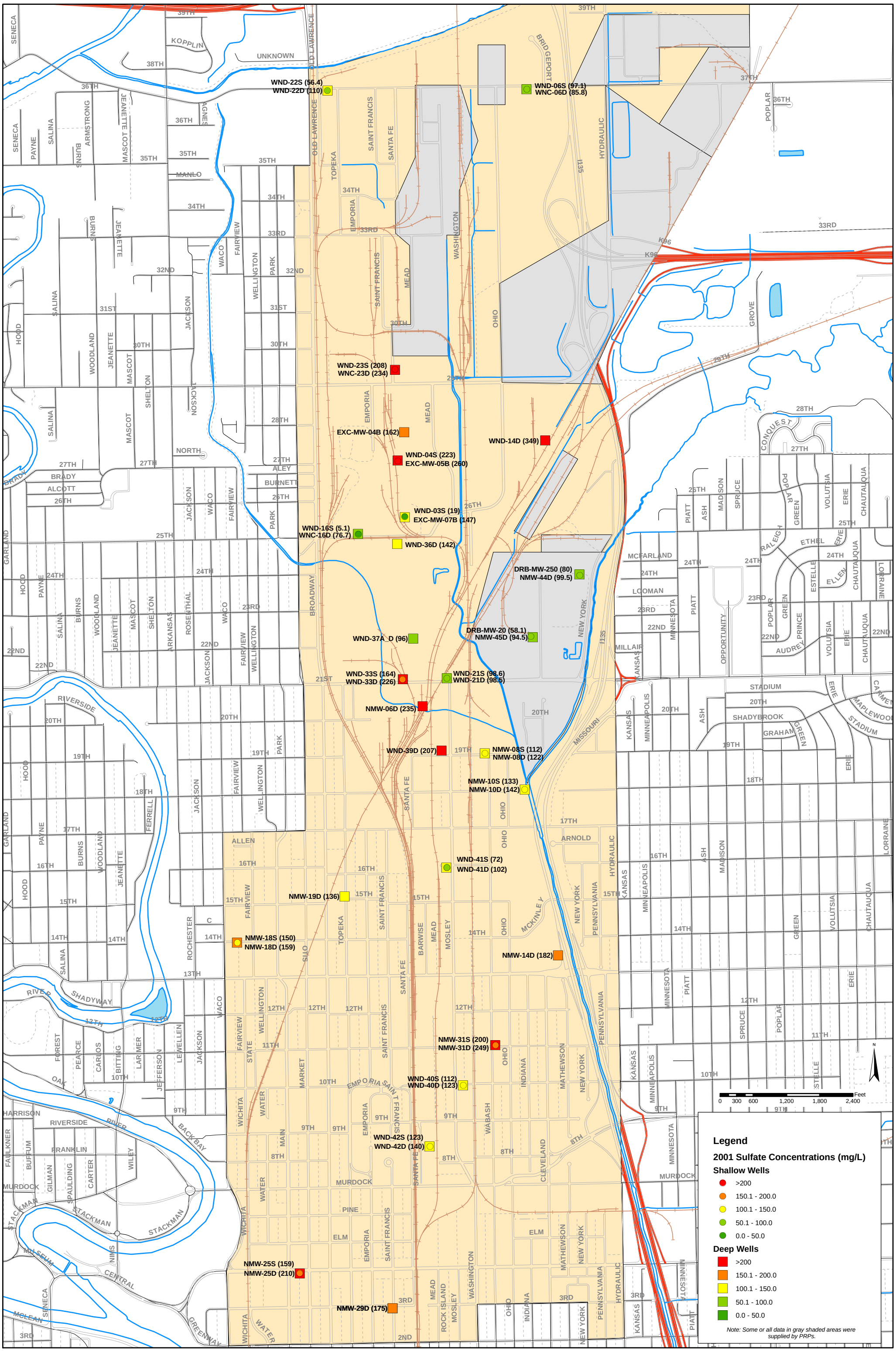


Figure 2-14a
North Industrial Corridor (NIC) Site
2001 Sulfate Concentrations

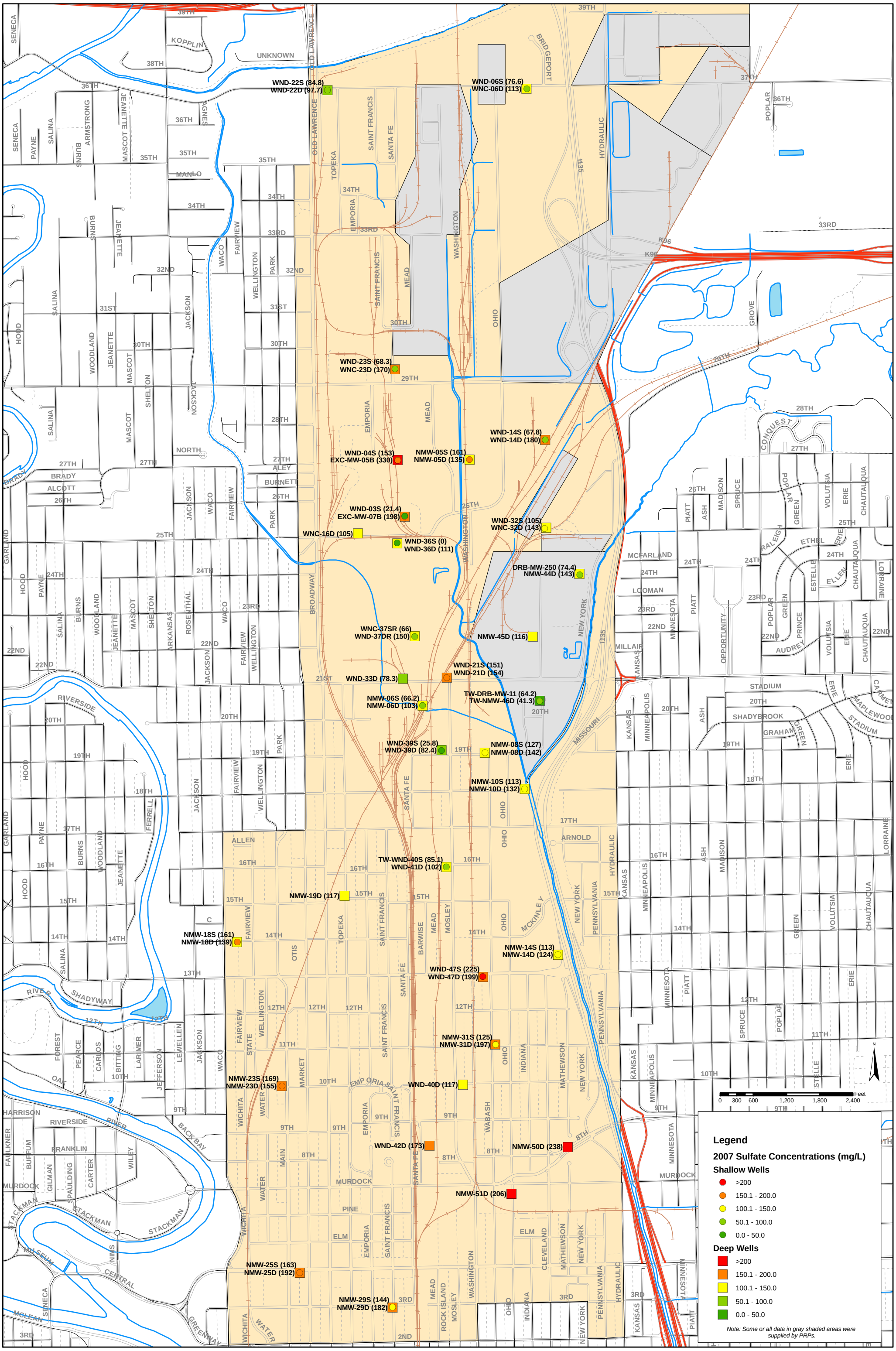


Figure 2-14b
North Industrial Corridor (NIC) Site
2007-2008 Sulfate Concentrations

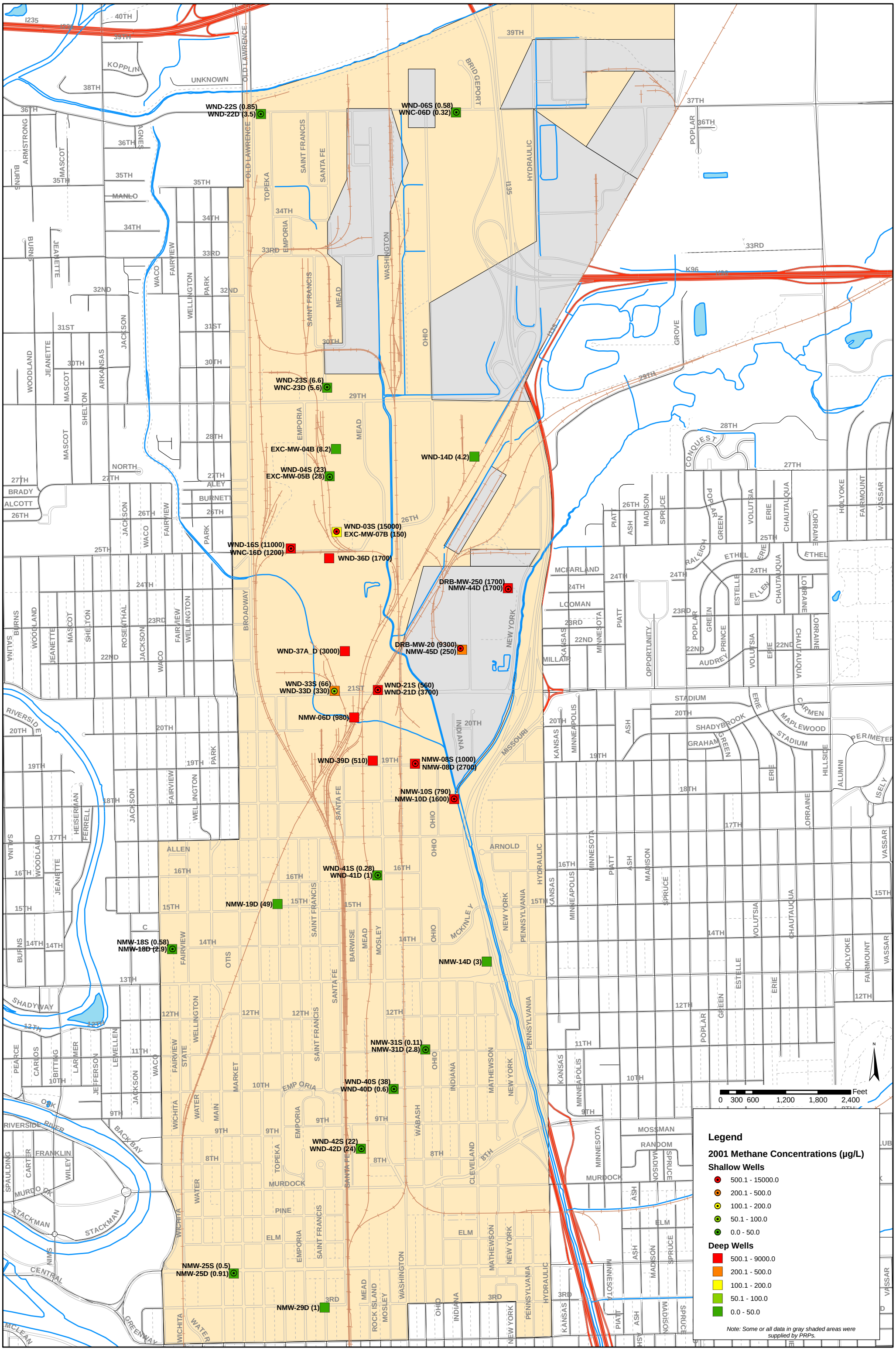


Figure 2-15a
North Industrial Corridor (NIC) Site
2001 Methane Concentrations

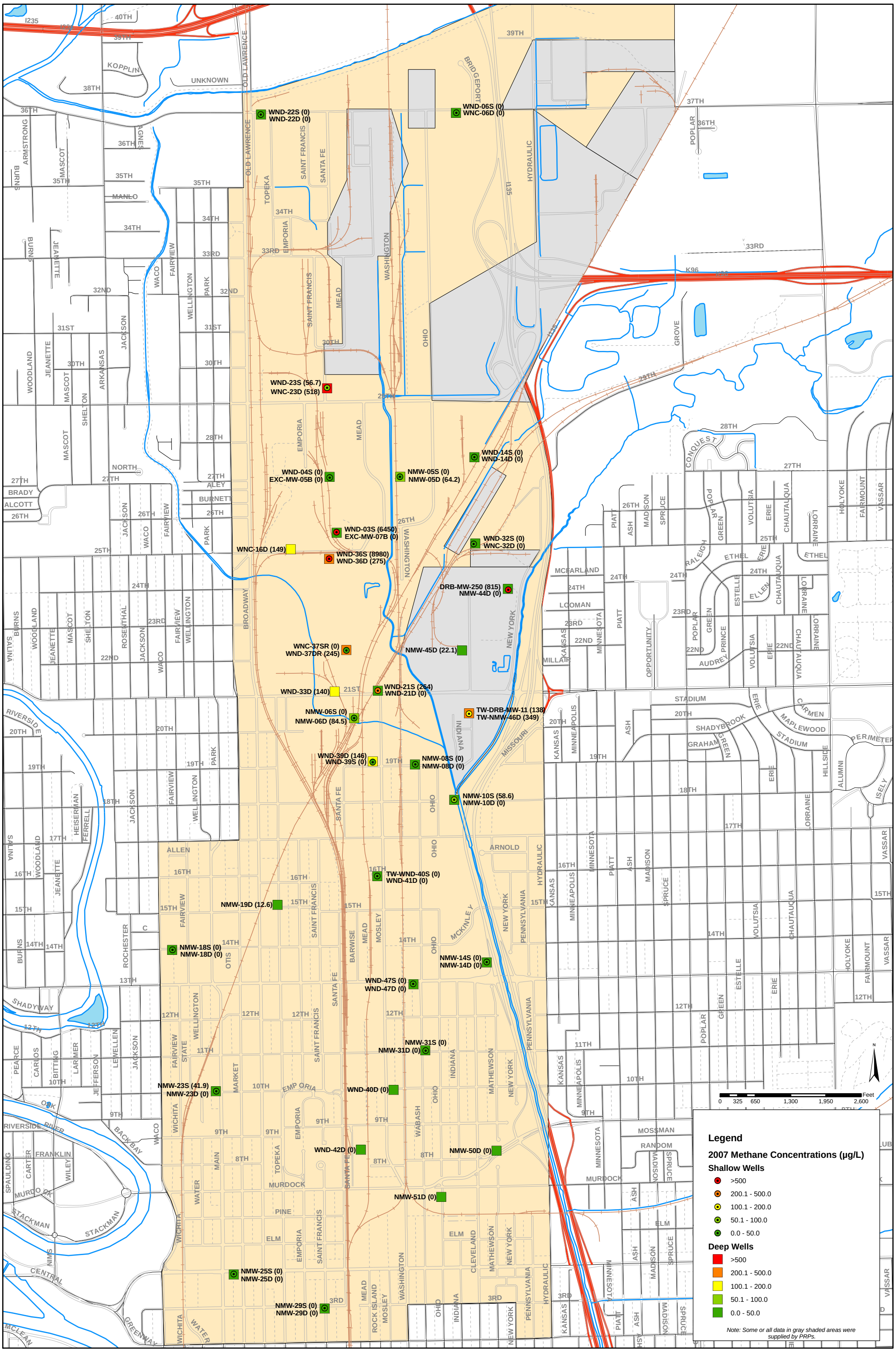


Figure 2-15b
North Industrial Corridor (NIC) Site
2007-2008 Methane Concentrations

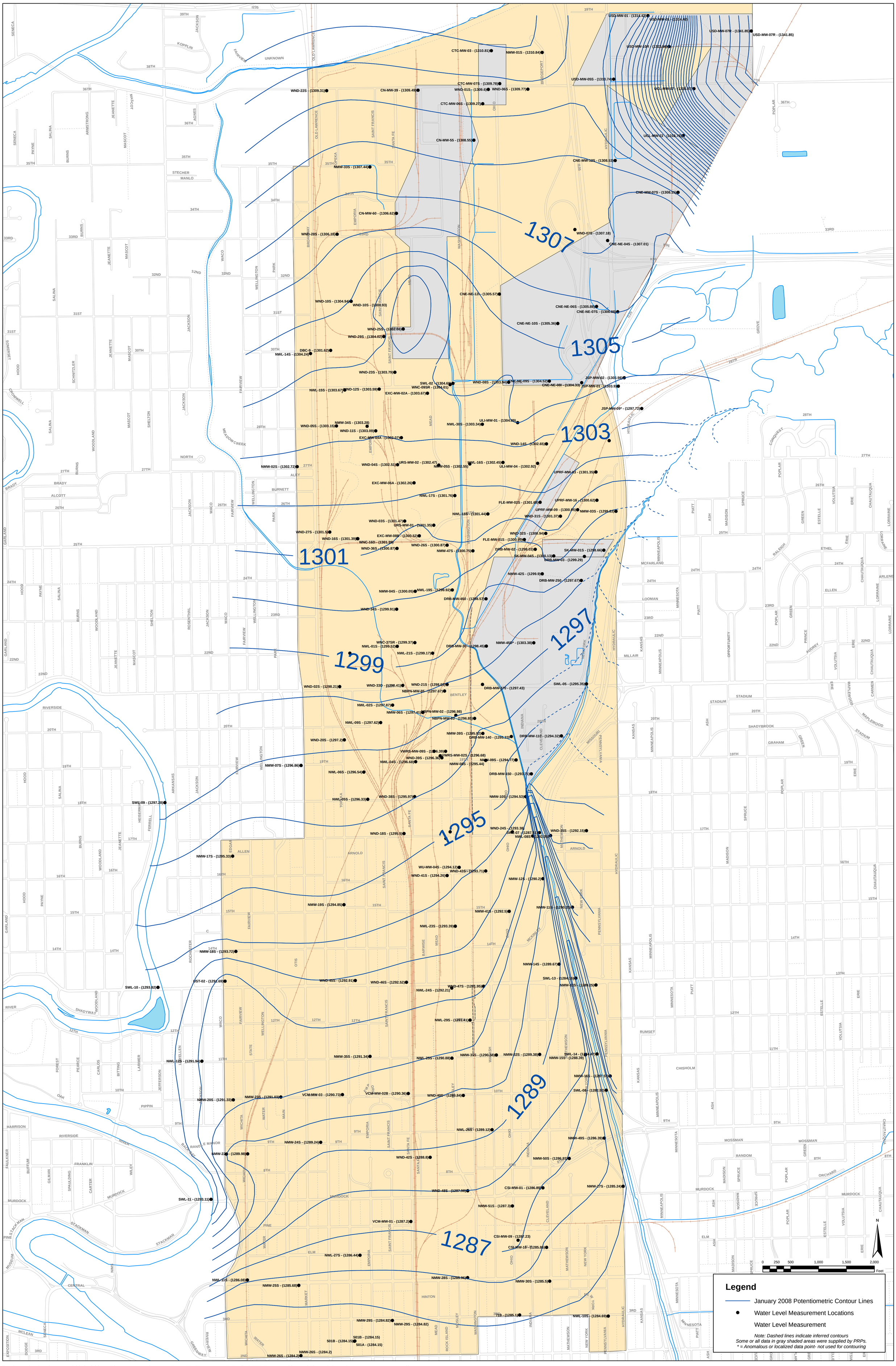


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Plate 2-1
North Industrial Corridor (NIC) Site
January 2008 Potentiometric Surface Map

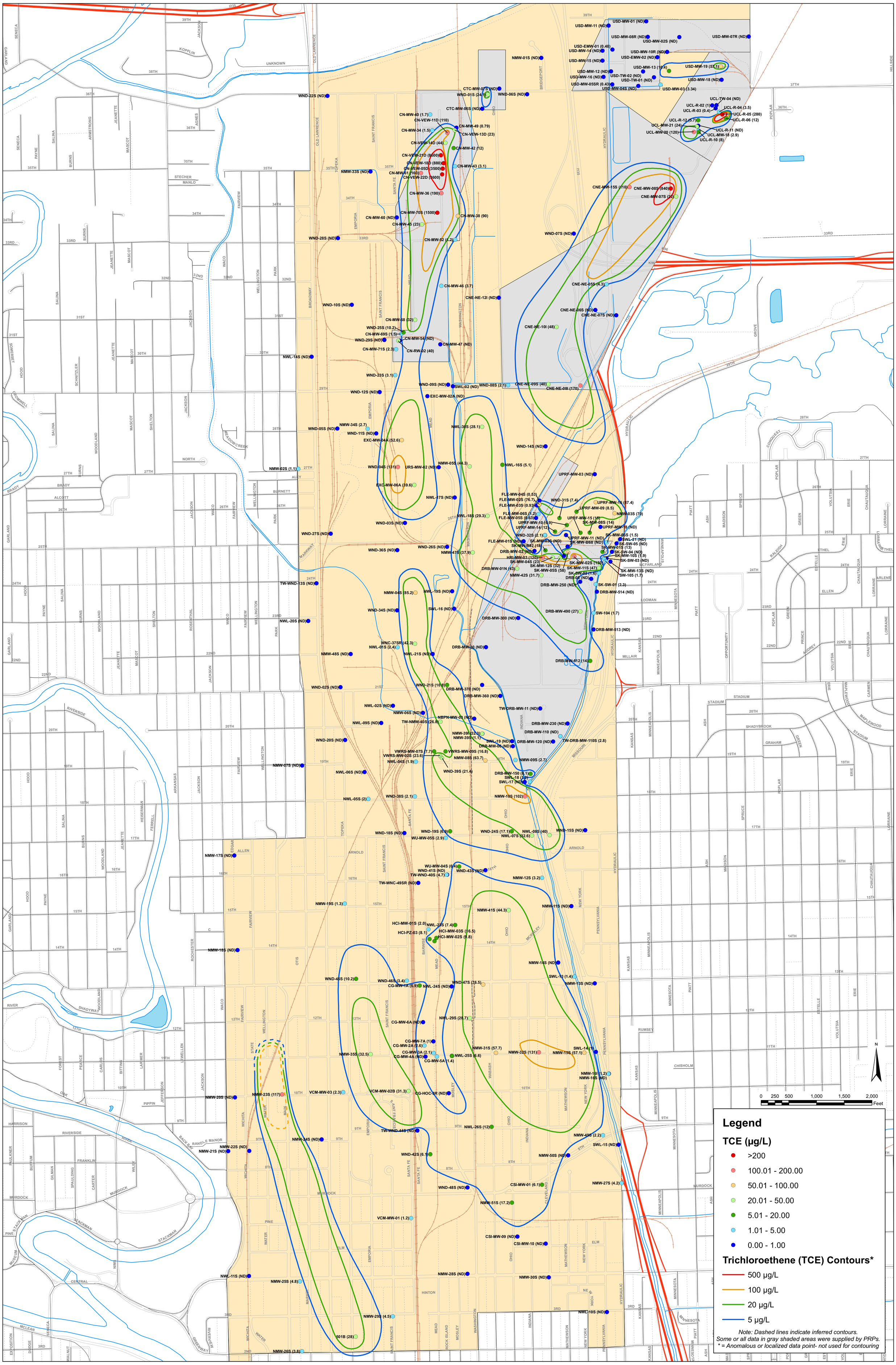

Plate 2-2a
North Industrial Corridor (NIC) Site
TCE in Shallow Groundwater Isoconcentration Map

CDM

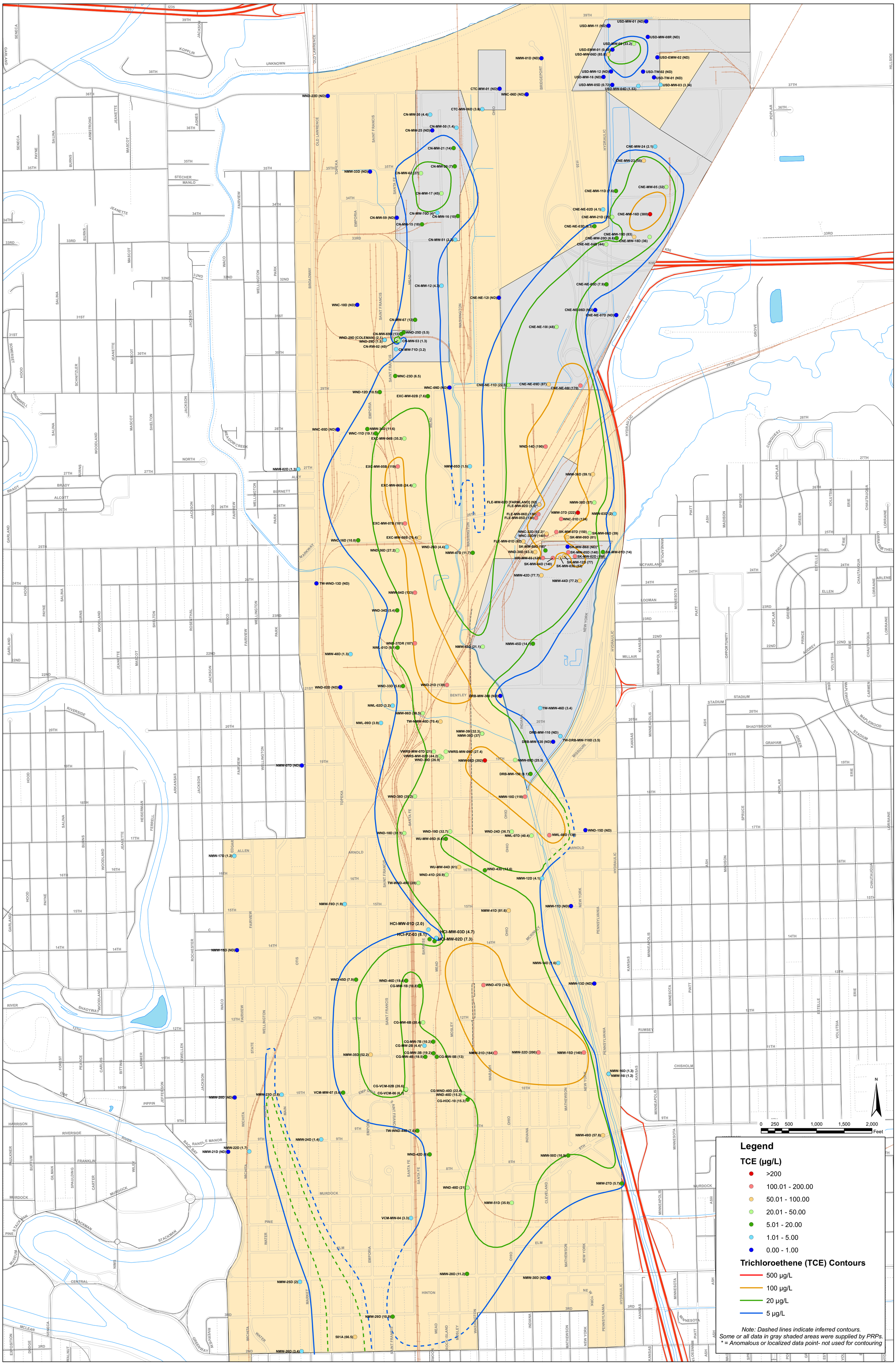

Plate 2-2b
North Industrial Corridor (NIC) Site
TCE in Deep Groundwater Isoconcentration Map

CDM

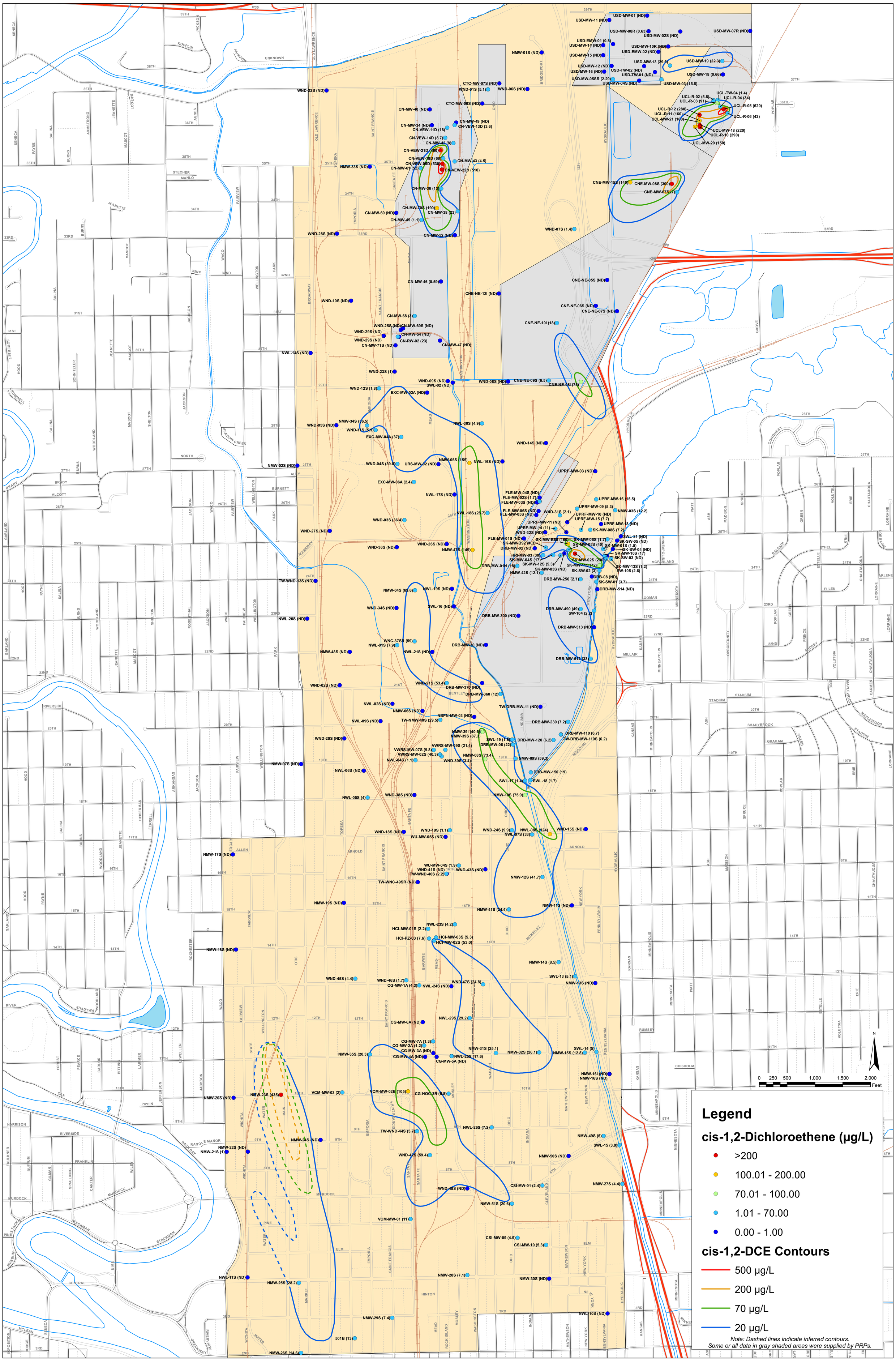

Plate 2-3a
North Industrial Corridor (NIC) Site
cis-1,2-DCE in Shallow Groundwater Isoconcentration Map

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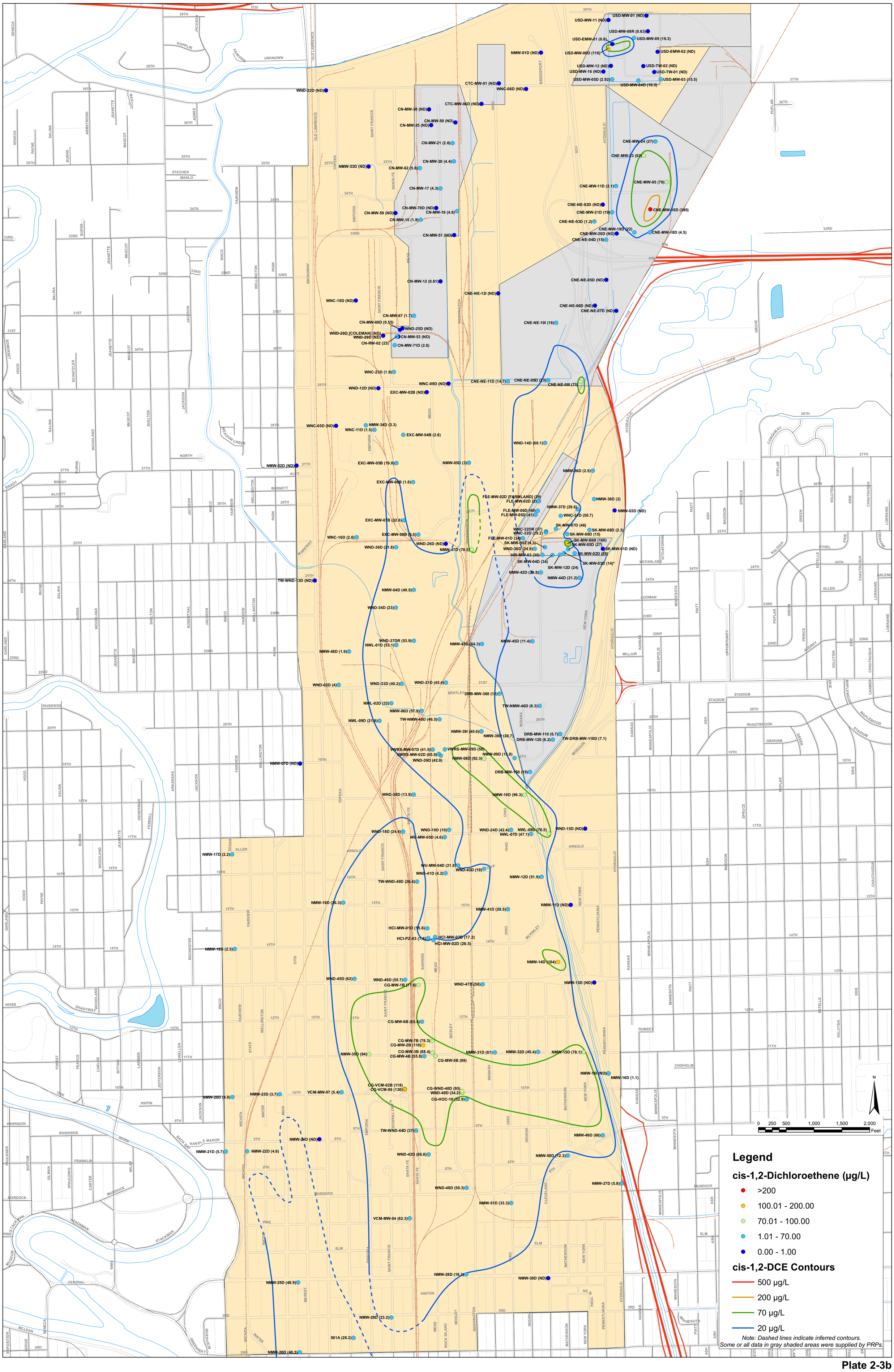

Plate 2-3b
North Industrial Corridor (NIC) Site
Cis-1,2-DCE in Deep Groundwater Isoconcentration Map

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Table 2-1
North Industrial Corridor (NIC) Site
Water Level Measurement Data, January 2008

Sample ID	Date Measured	Measuring Point Elevation (ft msl)	Depth to Product (ft bmp)	Depth to Water (ft bmp)	Product Thickness (ft)	Potentiometric Elevation (ft msl)
313A	1/10/2008	1299.96		16.36		1283.60
313B	1/10/2008	1299.82		16.25		1283.57
501A	1/9/2008	1300.62		16.44		1284.18
501B	1/9/2008	1301.26		17.11		1284.15
719	1/10/2008	1297.44		12.34		1285.10
729	1/10/2008	1296.73		13.15		1283.58
B-2ND	1/11/2008	1304.20		23.50		1280.70
CNE-MW-07D	1/10/2008	1323.45		15.23		1308.22
CNE-MW-07S	1/10/2008	1323.21		15.06		1308.15
CNE-MW-12D	1/10/2008	1323.67		15.08		1308.59
CNE-MW-12S	1/10/2008	1323.49		14.96		1308.53
CNE-NE-04D	1/10/2008	1320.78		13.82		1306.96
CNE-NE-04S	1/10/2008	1320.60		13.59		1307.01
CNE-NE-06D	1/10/2008	1319.11		13.49		1305.62
CNE-NE-06S	1/10/2008	1318.88		13.00		1305.88
CNE-NE-07D	1/10/2008	1320.75		14.59		1306.16
CNE-NE-07S	1/10/2008	1320.66		14.58		1306.08
CNE-NE-08I	1/10/2008	1320.48		16.15		1304.33
CNE-NE-09D	1/10/2008	1317.43		13.02		1304.41
CNE-NE-09S	1/10/2008	1317.66		13.14		1304.52
CNE-NE-10D	1/10/2008	1319.37		14.00		1305.37
CNE-NE-10S	1/10/2008	1319.21		13.85		1305.36
CNE-NE-11D	1/10/2008	1315.74		11.60		1304.14
CNE-NE-12I	1/10/2008	1318.92		13.35		1305.57
CN-MW-06	1/10/2008	1323.54		14.12		1309.42
CN-MW-39	1/10/2008	1323.48		13.99		1309.49
CN-MW-55	1/10/2008	1321.19		12.64		1308.55
CN-MW-56	1/10/2008	1321.76		13.25		1308.51
CN-MW-59	1/10/2008	1320.44		13.87		1306.57
CN-MW-60	1/10/2008	1319.90		13.28		1306.62
CSI-MW-01	1/10/2008	1304.00		17.11		1286.89
CSI-MW-09	1/10/2008	1302.63		15.40		1287.23
CSI-MW-10	1/10/2008	1302.08		16.22		1285.86
CTC-MW-01	1/10/2008	1327.13		17.16		1309.97
CTC-MW-03	1/11/2008	1327.68		16.87		1310.81
CTC-MW-06D	1/10/2008	1324.61		15.39		1309.22
CTC-MW-06S	1/10/2008	1324.61		15.34		1309.27
CTC-MW-07S	1/10/2008	1326.12		16.34		1309.78
DBC-9	1/10/2008	1313.59		11.97		1301.62
DRB-MW-02	1/10/2008	1313.50		15.47		1298.03
DRB-MW-03	1/10/2008	1315.40		16.11		1299.29
DRB-MW-110	1/10/2008	1311.70		17.38		1294.32
DRB-MW-140	1/10/2008	1312.61		17.28		1295.33
DRB-MW-150	1/10/2008	1312.12		18.41		1293.71
DRB-MW-20	1/10/2008	1312.39	13.05	17.75	4.70	1294.64
DRB-MW-250	1/10/2008	1314.20		16.53		1297.67
DRB-MW-30	1/10/2008	1312.72		14.27		1298.45
DRB-MW-370	1/10/2008	1311.64		14.21		1297.43

Table 2-1
North Industrial Corridor (NIC) Site
Water Level Measurement Data, January 2008

Sample ID	Date Measured	Measuring Point Elevation (ft msl)	Depth to Product (ft bmp)	Depth to Water (ft bmp)	Product Thickness (ft)	Potentiometric Elevation (ft msl)
DRB-MW-450	1/10/2008	1316.95		18.38		1298.57
EXC-MW-02A	1/10/2008	1314.74		11.07		1303.67
EXC-MW-02B	1/10/2008	1315.00		11.24		1303.76
EXC-MW-04A	1/10/2008	1317.39		14.32		1303.07
EXC-MW-04B	1/10/2008	1317.75		14.69		1303.06
EXC-MW-05B	1/10/2008	1316.36		13.79		1302.57
EXC-MW-06A	1/10/2008	1313.17		10.91		1302.26
EXC-MW-06B	1/10/2008	1313.12		10.85		1302.27
EXC-MW-07B	1/10/2008	1313.81		12.29		1301.52
EXC-MW-08B	1/10/2008	1311.73		11.21		1300.52
FLE-MW-01D	1/10/2008	1318.19		17.23		1300.96
FLE-MW-01S	1/10/2008	1318.05		17.10		1300.95
FLE-MW-02D	1/10/2008	1318.16		16.49		1301.67
FLE-MW-02S	1/10/2008	1318.13		16.45		1301.68
JSP-MW-01	1/10/2008	1324.25		20.35		1303.90
JSP-MW-02	1/10/2008	1322.05		18.07		1303.98
JSP-MW-05	1/10/2008	1321.95		19.15		1302.80
JSP-MW-09	1/10/2008	1320.08		22.36		1297.72
NBPN-MW-02	1/10/2008	1310.00		13.02		1296.98
NBPN-MW-03	1/10/2008	1311.62		14.77		1296.85
NBPN-MW-05	1/10/2008	1310.65		12.98		1297.67
NMW-01D	1/10/2008	1328.72		17.88		1310.84
NMW-01S	1/10/2008	1328.75		17.91		1310.84
NMW-02D	1/10/2008	1315.77		13.26		1302.51
NMW-02D	1/10/2008	1315.77		13.08		1302.69
NMW-02S	1/10/2008	1315.65		12.91		1302.74
NMW-02S	1/10/2008	1315.65		12.93		1302.72
NMW-03D	1/10/2008	1315.88		15.10		1300.78
NMW-03S	1/10/2008	1315.98		16.15		1299.83
NMW-04D	1/10/2008	1316.14		16.06		1300.08
NMW-04S	1/10/2008	1316.30		16.25		1300.05
NMW-05D	1/10/2008	1316.21		13.56		1302.65
NMW-05S	1/10/2008	1316.08		13.53		1302.55
NMW-06D	1/10/2008	1314.92		17.51		1297.41
NMW-06D	1/10/2008	1314.92		17.47		1297.45
NMW-06S	1/10/2008	1314.82		17.41		1297.41
NMW-06S	1/10/2008	1314.82		17.37		1297.45
NMW-07D	1/10/2008	1313.33		16.47		1296.86
NMW-07S	1/10/2008	1313.18		NM		---
NMW-08D	1/10/2008	1306.90		11.45		1295.45
NMW-08S	1/10/2008	1306.90		11.46		1295.44
NMW-09D	1/9/2008	1306.87		12.12		1294.75
NMW-09S	1/9/2008	1306.89		12.12		1294.77
NMW-10D	1/10/2008	1309.71		15.18		1294.53
NMW-10S	1/10/2008	1309.63		15.10		1294.53
NMW-11D	1/10/2008	1305.58		16.16		1289.42
NMW-11S	1/10/2008	1306.24		16.09		1290.15
NMW-12D	1/10/2008	1305.08		14.88		1290.20

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Table 2-1
North Industrial Corridor (NIC) Site
Water Level Measurement Data, January 2008

Sample ID	Date Measured	Measuring Point Elevation (ft msl)	Depth to Product (ft bmp)	Depth to Water (ft bmp)	Product Thickness (ft)	Potentiometric Elevation (ft msl)
NMW-12S	1/10/2008	1304.83		NM		---
NMW-13D	1/9/2008	1304.55		15.24		1289.31
NMW-13S	1/9/2008	1304.34		15.09		1289.25
NMW-14D	1/10/2008	1302.89		13.28		1289.61
NMW-14S	1/10/2008	1302.78		13.11		1289.67
NMW-15D	1/9/2008	1303.53		15.18		1288.35
NMW-15S	1/9/2008	1303.40		15.01		1288.39
NMW-16D	1/9/2008	1306.28		18.54		1287.74
NMW-16S	1/9/2008	1306.19		18.62		1287.57
NMW-17D	1/10/2008	1312.55		17.26		1295.29
NMW-17S	1/10/2008	1312.63		17.30		1295.33
NMW-18D	1/10/2008	1307.89		14.17		1293.72
NMW-18S	1/10/2008	1307.78		14.06		1293.72
NMW-19D	1/10/2008	1308.10		13.48		1294.62
NMW-19S	1/10/2008	1308.13		13.28		1294.85
NMW-20D	1/10/2008	1306.48		15.59		1290.89
NMW-20S	1/10/2008	1306.65		15.32		1291.33
NMW-21D	1/10/2008	1306.10		15.84		1290.26
NMW-21S	1/10/2008	1306.03		16.02		1290.01
NMW-22D	1/10/2008	1304.53		14.55		1289.98
NMW-22S	1/9/2008	1304.40		NM		---
NMW-23D	1/10/2008	1304.77		13.71		1291.06
NMW-23S	1/10/2008	1304.68		13.65		1291.03
NMW-24D	1/9/2008	1303.79		13.91		1289.88
NMW-24S	1/9/2008	1303.06		13.82		1289.24
NMW-25D	1/10/2008	1300.65		14.98		1285.67
NMW-25S	1/10/2008	1300.66		14.98		1285.68
NMW-26D	1/9/2008	1298.76		14.67		1284.09
NMW-26S	1/9/2008	1298.71		14.51		1284.20
NMW-27D	1/10/2008	1299.85		14.58		1285.27
NMW-27S	1/10/2008	1299.89		14.65		1285.24
NMW-28D	1/9/2008	1299.33		13.39		1285.94
NMW-28S	1/9/2008	1299.25		13.29		1285.96
NMW-29D	1/10/2008	1300.00		15.19		1284.81
NMW-29S	1/10/2008	1300.13		15.31		1284.82
NMW-30D	1/9/2008	1299.62		14.09		1285.53
NMW-30S	1/9/2008	1299.73		14.23		1285.50
NMW-31D	1/10/2008	1303.55		12.96		1290.59
NMW-31S	1/10/2008	1303.69		13.11		1290.58
NMW-32D	1/10/2008	1303.78		14.25		1289.53
NMW-32S	1/10/2008	1303.61		14.23		1289.38
NMW-33D	1/10/2008	1322.59		14.77		1307.82
NMW-33S	1/10/2008	1322.43		14.99		1307.44
NMW-34D	1/10/2008	1314.59		11.33		1303.26
NMW-34S	1/10/2008	1314.69		11.41		1303.28
NMW-35D	1/9/2008	1303.73		12.34		1291.39
NMW-35S	1/9/2008	1303.74		12.40		1291.34
NMW-36D	1/10/2008	1318.44		16.37		1302.07

Table 2-1
North Industrial Corridor (NIC) Site
Water Level Measurement Data, January 2008

Sample ID	Date Measured	Measuring Point Elevation (ft msl)	Depth to Product (ft bmp)	Depth to Water (ft bmp)	Product Thickness (ft)	Potentiometric Elevation (ft msl)
NMW-37D	1/10/2008	1318.15		17.05		1301.10
NMW-38D	1/10/2008	1319.83		18.72		1301.11
NMW-39D	1/10/2008	1308.25		12.33		1295.92
NMW-39S	1/10/2008	1308.19		NM		---
NMW-41D	1/10/2008	1305.27		12.92		1292.35
NMW-41S	1/10/2008	1305.13		12.63		1292.50
NMW-42D	1/10/2008	1315.79		15.89		1299.90
NMW-42S	1/10/2008	1315.68		15.78		1299.90
NMW-44D	1/10/2008	1315.81		17.29		1298.52
NMW-45D	1/10/2008	1319.07		15.69		1303.38
NMW-47D	1/10/2008	1310.54		9.85		1300.69
NMW-47S	1/10/2008	1310.59		9.84		1300.75
NMW-48D	1/11/2008	1311.51		12.38		1299.13
NMW-48S	1/11/2008	1311.29		12.07		1299.22
NMW-49D	1/10/2008	1308.32		20.94		1287.38
NMW-49S	1/10/2008	1307.28		20.89		1286.39
NMW-50D	1/10/2008	1300.95		13.90		1287.05
NMW-50S	1/10/2008	1300.96		14.03		1286.93
NMW-51D	1/10/2008	1300.17		12.87		1287.30
NMW-51S	1/10/2008	1300.14		12.84		1287.30
NWL-01D	1/10/2008	1313.01		13.51		1299.50
NWL-01S	1/10/2008	1313.10		13.58		1299.52
NWL-02D	1/10/2008	1309.35		11.49		1297.86
NWL-02S	1/10/2008	1309.32		11.45		1297.87
NWL-04S	1/10/2008	1306.63		9.95		1296.68
NWL-05S	1/10/2008	1311.20		14.87		1296.33
NWL-06S	1/10/2008	1314.82		18.28		1296.54
NWL-07D	1/10/2008	1307.24		14.48		1292.76
NWL-07S	1/10/2008	1307.48		15.35		1292.13
NWL-08D	1/10/2008	1308.48		16.47		1292.01
NWL-08S	1/10/2008	1308.47		16.38		1292.09
NWL-09D	1/10/2008	1310.59		13.06		1297.53
NWL-09S	1/10/2008	1310.60		12.98		1297.62
NWL-10S	1/10/2008	1298.72		14.03		1284.69
NWL-11S	1/9/2008	1300.17		14.09		1286.08
NWL-12S	1/10/2008	1304.98		13.04		1291.94
NWL-13S	1/10/2008	1308.30		NM		---
NWL-14S	1/10/2008	1315.95		11.71		1304.24
NWL-15S	1/10/2008	1316.01		12.34		1303.67
NWL-16S	1/10/2008	1314.76		12.31		1302.45
NWL-17S	1/10/2008	1312.97		11.21		1301.76
NWL-18S	1/10/2008	1312.94		11.50		1301.44
NWL-19S	1/10/2008	1310.85		10.93		1299.92
NWL-21S	1/10/2008	1312.58		13.41		1299.17
NWL-22S	1/10/2008	1306.79		NM		---
NWL-23S	1/10/2008	1305.81		12.42		1293.39
NWL-24S	1/9/2008	1305.04		12.83		1292.21
NWL-25S	1/9/2008	1303.17		12.29		1290.88

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Table 2-1
North Industrial Corridor (NIC) Site
Water Level Measurement Data, January 2008

Sample ID	Date Measured	Measuring Point Elevation (ft msl)	Depth to Product (ft bmp)	Depth to Water (ft bmp)	Product Thickness (ft)	Potentiometric Elevation (ft msl)
NWL-26S	1/10/2008	1301.67		12.55		1289.12
NWL-27S	1/10/2008	1300.55		14.11		1286.44
NWL-29S	1/9/2008	1303.89		12.48		1291.41
NWL-30S	1/10/2008	1313.58		10.24		1303.34
SK-MW-01D	1/10/2008	1315.61		15.93		1299.68
SK-MW-01S	1/10/2008	1315.43		16.77		1298.66
SK-MW-04S	1/10/2008	1312.80		12.67		1300.13
SWL-01	1/11/2008	1322.76		NM		---
SWL-02	1/11/2008	1316.39		11.70		1304.69
SWL-03	1/10/2008	1313.10		NM		---
SWL-04	1/11/2008	1315.82		NM		---
SWL-05	1/11/2008	1316.85		21.50		1295.35
SWL-06	1/11/2008	1314.84		NM		---
SWL-07	1/11/2008	1309.71		22.20		1287.51
SWL-08	1/11/2008	1306.43		23.90		1282.53
SWL-09	1/11/2008	1316.63		19.35		1297.28
SWL-10	1/11/2008	1312.37		18.55		1293.82
SWL-11	1/11/2008	1310.16		17.05		1293.11
SWL-13	1/10/2008	1307.26		23.10		1284.16
SWL-14	1/11/2008	1307.57		23.10		1284.47
UCL-MW-07	1/10/2008	1339.96		4.09		1335.87
UCL-MW-11	1/10/2008	1327.30		NM		---
UCL-MW-12D	1/10/2008	1348.39		NM		---
UCL-MW-12S	1/10/2008	1348.49		NM		---
UCL-MW-22	1/10/2008	1327.81		9.09		1318.72
ULI-MW-01	1/10/2008	1315.40		11.31		1304.09
ULI-MW-04	1/10/2008	1316.79		13.87		1302.92
UPRF-MW-03	1/10/2008	1318.07		16.72		1301.35
UPRF-MW-09	1/10/2008	1317.83		16.88		1300.95
UPRF-MW-16	1/10/2008	1319.90		19.28		1300.62
URS-MW-01	1/10/2008	1313.66		12.31		1301.35
URS-MW-02	1/10/2008	1314.13		11.66		1302.47
USD-MW-01	1/11/2008	1332.92		18.50		1314.42
USD-MW-05D	1/11/2008	1327.80		16.63		1311.17
USD-MW-05S	1/11/2008	1327.46		16.72		1310.74
USD-MW-07R	1/11/2008	1348.70		6.85		1341.85
USD-MW-10R	1/11/2008	1330.68		8.12		1322.56
UST-02	1/10/2008	1306.56		14.87		1291.69
VCM-MW-01	1/10/2008	1303.09		15.89		1287.20
VCM-MW-02B	1/10/2008	1306.44		16.08		1290.36
VCM-MW-03	1/10/2008	1304.63		13.90		1290.73
VCM-MW-04	1/10/2008	1303.12		15.91		1287.21
VCM-MW-06	1/10/2008	1307.00		16.84		1290.16
VCM-MW-07	1/10/2008	1304.66		14.03		1290.63
VWRS-MW-02D	1/10/2008	1313.42		16.69		1296.73
VWRS-MW-02S	1/10/2008	1313.33		16.65		1296.68
VWRS-MW-07D	1/10/2008	1309.52		12.98		1296.54
VWRS-MW-07S	1/10/2008	1309.54		13.01		1296.53

Table 2-1
North Industrial Corridor (NIC) Site
Water Level Measurement Data, January 2008

Sample ID	Date Measured	Measuring Point Elevation (ft msl)	Depth to Product (ft bmp)	Depth to Water (ft bmp)	Product Thickness (ft)	Potentiometric Elevation (ft msl)
VWRS-MW-09D	1/10/2008	1309.38		12.92		1296.46
VWRS-MW-09S	1/10/2008	1309.20		12.81		1296.39
WNC-05D	1/10/2008	1318.20		15.10		1303.10
WNC-06D	1/10/2008	1328.12		18.19		1309.93
WNC-09D	1/10/2008	1315.16		10.11		1305.05
WNC-09SR	1/10/2008	1315.14		11.13		1304.01
WNC-10D	1/11/2008	1316.81		11.95		1304.86
WNC-11D	1/11/2008	1314.36		11.20		1303.16
WNC-16D	1/10/2008	1313.61		12.22		1301.39
WNC-23D	1/10/2008	1318.61		15.01		1303.60
WNC-31D	1/10/2008	1318.31		16.98		1301.33
WNC-32D	1/10/2008	1318.82		17.71		1301.11
WNC-37SR	1/10/2008	1315.18		15.81		1299.37
WND-01S	1/10/2008	1326.57		16.97		1309.60
WND-02D	1/11/2008	1311.66		13.50		1298.16
WND-02S	1/11/2008	1311.53		13.32		1298.21
WND-03S	1/10/2008	1316.50		15.03		1301.47
WND-04S	1/10/2008	1319.04		16.53		1302.51
WND-05S	1/10/2008	1317.74		14.59		1303.15
WND-06S	1/10/2008	1327.75		17.98		1309.77
WND-07S	1/11/2008	1321.37		14.19		1307.18
WND-08S	1/10/2008	1315.72		11.78		1303.94
WND-10S	1/10/2008	1318.58		13.64		1304.94
WND-10S	1/10/2008	1318.58		13.65		1304.93
WND-11S	1/10/2008	1316.77		13.68		1303.09
WND-12D	1/10/2008	1315.84		12.23		1303.61
WND-12S	1/10/2008	1315.76		12.17		1303.59
WND-13D	1/11/2008	1313.36		NM		---
WND-13S	1/11/2008	1313.55		NM		---
WND-14D	1/10/2008	1317.53		14.80		1302.73
WND-14S	1/10/2008	1317.70		15.05		1302.65
WND-15D	1/10/2008	1306.41		14.22		1292.19
WND-15S	1/10/2008	1306.76		14.61		1292.15
WND-16S	1/10/2008	1313.47	11.70	14.84	3.14	1298.63
WND-18D	1/11/2008	1310.90		15.36		1295.54
WND-18S	1/11/2008	1310.95		15.45		1295.50
WND-19D	1/10/2008	1306.76		11.80		1294.96
WND-19S	1/10/2008	1306.73		11.75		1294.98
WND-20S	1/10/2008	1314.05		16.85		1297.20
WND-21D	1/10/2008	1309.33		11.32		1298.01
WND-21S	1/10/2008	1309.31		11.28		1298.03
WND-22D	1/10/2008	1323.58		14.52		1309.06
WND-22S	1/10/2008	1323.36		14.05		1309.31
WND-23S	1/10/2008	1317.73		13.94		1303.79
WND-24D	1/10/2008	1306.77		12.88		1293.89
WND-24S	1/10/2008	1306.88		13.50		1293.38
WND-25D	1/11/2008	1318.75		14.70		1304.05
WND-25S	1/11/2008	1318.73		16.65		1302.08

CDM

Table 2-1
North Industrial Corridor (NIC) Site
Water Level Measurement Data, January 2008

Sample ID	Date Measured	Measuring Point Elevation (ft msl)	Depth to Product (ft bmp)	Depth to Water (ft bmp)	Product Thickness (ft)	Potentiometric Elevation (ft msl)
WND-26D	1/10/2008	1315.53		14.66		1300.87
WND-26S	1/10/2008	1315.61		14.74		1300.87
WND-27S	1/10/2008	1315.01		13.51		1301.50
WND-28S	1/11/2008	1320.72		14.54		1306.18
WND-29D	1/11/2008	1320.04		16.13		1303.91
WND-29S	1/11/2008	1319.64		15.62		1304.02
WND-30D	1/10/2008	1315.70		15.20		1300.50
WND-31S	1/10/2008	1317.89		16.52		1301.37
WND-32S	1/10/2008	1318.25		17.31		1300.94
WND-33D	1/10/2008	1310.65		12.24		1298.41
WND-34D	1/10/2008	1314.40		14.49		1299.91
WND-34S	1/10/2008	1314.34		14.43		1299.91
WND-36D	1/10/2008	1314.69		13.91		1300.78
WND-36S	1/10/2008	1314.75		13.88		1300.87
WND-37DR	1/10/2008	1314.75		15.42		1299.33
WND-38D	1/9/2008	1307.62		11.70		1295.92
WND-38S	1/9/2008	1307.48		11.51		1295.97
WND-39D	1/11/2008	1308.29		11.94		1296.35
WND-39S	1/11/2008	1308.31		11.95		1296.36
WND-40D	1/10/2008	1302.38		12.54		1289.84
WND-41D	1/10/2008	1306.94		12.63		1294.31
WND-41S	1/10/2008	1306.97		12.71		1294.26
WND-42D	1/10/2008	1303.79		14.98		1288.81
WND-42S	1/10/2008	1303.64		14.84		1288.80
WND-43D	1/11/2008	1307.40		13.77		1293.63
WND-43S	1/11/2008	1307.54		13.83		1293.71
WND-45D	1/11/2008	1305.54		12.55		1292.99
WND-45S	1/11/2008	1305.66		12.75		1292.91
WND-46D	1/11/2008	1304.87		12.37		1292.50
WND-46S	1/11/2008	1304.98		12.46		1292.52
WND-47D	1/10/2008	1304.63		12.89		1291.74
WND-47S	1/10/2008	1304.81		12.86		1291.95
WND-48D	1/9/2008	1301.21		13.22		1287.99
WND-48S	1/9/2008	1301.01		13.03		1287.98
WU-MW-04D	1/10/2008	1307.36		13.13		1294.23
WU-MW-04S	1/10/2008	1307.23		13.11		1294.12
WU-MW-05D	1/10/2008	1307.65		12.66		1294.99
WU-MW-05S	1/10/2008	1307.38		12.38		1295.00

Table 2-2
North Industrial Corridor (NIC) Site
Summary of CDM 2007-2008 VOC Results

Sation ID	Well Depth Zone	Date Collected	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds
501A	Deep	12/13/2007	<1	**1.2**	<1	**28.2**	<1	<1	<1	<1	<1	**66.5**	<1	
501B	Shallow	12/13/2007	<1	<1	<1	**13**	<1	<1	<1	<1	<1	**28**	<1	
CNE-NE-11D	Deep	12/12/2007	<1	<1	<1	**14.7**	<1	<1	**4.6**	<1	<1	**22.5**	<1	
CSI-MW-01	Shallow	12/12/2007	<1	<1	<1	**2.4**	<1	<1	<1	<1	<1	**6.1**	<1	
CSI-MW-09	Shallow	12/12/2007	<1	<1	<1	**4.9**	<1	<1	<1	<1	<1	<1	<1	
CSI-MW-10	Shallow	12/12/2007	<1	<1	<1	**5.3**	<1	<1	<1	<1	<1	<1	<1	
CTC-MW-01	Deep	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
CTC-MW-06D	Deep	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**3.8**	<1	
CTC-MW-06S	Shallow	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
CTC-MW-07S	Shallow	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
DRB-MW-02	Shallow	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
DRB-MW-250	Shallow	12/13/2007	**1.4**	<1	**9.2**	**2.1**	<1	<1	<1	<1	<1	<1	<1	Methane 815
DRB-MW-30	Shallow	12/13/2007	<1	<1	**399**	<1	<1	<1	<1	<1	<1	<1	<1	EBN 101, TOL 91.5, XYLMP 180, XYLO 23.4
EXC-MW-02A	Shallow	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
EXC-MW-02B	Deep	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**7.6**	<1	
EXC-MW-04A	Shallow	12/17/2007	<1	**1.4**	<1	**37**	<1	<1	<1	<1	<1	**52.6**	<1	
EXC-MW-04B	Deep	12/17/2007	<1	**1.1**	<1	**2.8**	<1	<1	<1	<1	<1	**35.2**	<1	
EXC-MW-05B	Deep	12/17/2007	<1	**3.8**	<1	**19.8**	<1	<1	<1	<1	<1	**119**	<1	
EXC-MW-06A	Shallow	12/17/2007	<1	<1	<1	**2.4**	<1	<1	<1	<1	<1	**39.6**	<1	
EXC-MW-06B	Deep	12/17/2007	<1	<1	<1	**1.8**	<1	<1	<1	<1	<1	**24.4**	<1	
EXC-MW-07B	Deep	12/17/2007	**1**	**3**	<1	**32.6**	<1	<1	<1	<1	<1	**101**	**1.1**	
EXC-MW-08B	Deep	12/17/2007	<1	**1.7**	<1	**6.5**	<1	<1	<1	<1	<1	**70.4**	<1	
FLE-MW-02D	Deep	12/19/2007	<1	<1	<1	**2**	**8.6**	**6.7**	<1	<1	<1	**5.5**	<1	
FLE-MW-02S	Shallow	12/19/2007	<1	<1	<1	**22.7**	<1	<1	**3.5**	<1	<1	**76.7**	<1	
NBPN-MW-03	Shallow	12/14/2007	<1	<1	<1	<1	<1	**2.1**	<1	<1	<1	<1	<1	
NMW-01D	Deep	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-01S	Shallow	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-02D	Deep	12/15/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**1.3**	<1	
NMW-02S	Shallow	12/15/2007	<1	<1	<1	<1	<1	<1	**62.5**	<1	<1	**1.1**	<1	MTBE 43.4
NMW-03D	Deep	12/21/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**2**	<1	
NMW-03S	Shallow	12/15/2007	<1	<1	<1	**12.2**	<1	<1	<1	<1	<1	**79**	<1	
NMW-04D	Deep	12/13/2007	**1.3**	**5**	<1	**49.5**	**9.1**	**2.1**	<1	<1	<1	**133**	**4.1**	
NMW-04S	Shallow	12/13/2007	**1.4**	**1.7**	<1	**69.6**	<1	<1	<1	**1.8**	<1	**85.2**	**10.2**	
NMW-05D	Deep	12/20/2007	<1	<1	<1	**3**	<1	<1	<1	<1	<1	**1.5**	<1	Methane 64.2
NMW-05S	Shallow	12/20/2007	**2.3**	<1	<1	**155**	<1	<1	**3.6**	**1.4**	<1	**44.3**	**35.3**	
NMW-06D	Deep	12/13/2007	**4.3**	**4.3**	<1	**57.9**	<1	<1	<1	**1.9**	<1	**38.5**	<1	Methane 84.5
NMW-06S	Shallow	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-07D	Deep	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-07S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-08D	Deep	12/12/2007	**2.3**	**7.5**	<1	**92.3**	<1	<1	<1	**4**	<1	**202**	**8**	
NMW-08S	Shallow	12/12/2007	**1.5**	**3.7**	<1	**73.4**	<1	<1	<1	**2.2**	<1	**63.7**	**3**	
NMW-09D	Deep	12/10/2007	<1	<1	<1	**13.8**	<1	<1	<1	<1	<1	**25.5**	<1	
NMW-09S	Shallow	12/10/2007	<1	**1.6**	<1	**59.3**	<1	<1	<1	**1.3**	<1	**2.7**	<1	
NMW-10D	Deep	12/17/2007	**2.4**	**6.1**	<1	**96.3**	<1	<1	<1	**3.5**	<1	**118**	**6.1**	MTBE 1.6
NMW-10S	Shallow	12/17/2007	**2.5**	**5.3**	<1	**85.1**	<1	<1	<1	**3**	<1	**102**	**4.8**	Methane 58.6, MTBE 2.4
NMW-11D	Deep	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	BFM 2.8
NMW-11S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-12D	Deep	12/14/2007	<1	<1	<1	**51.9**	<1	<1	<1	<1	<1	**4.1**	<1	

Table 2-2
North Industrial Corridor (NIC) Site
Summary of CDM 2007-2008 VOC Results

Sation ID	Well Depth Zone	Date Collected	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds
NMW-12S	Shallow	12/18/2007	<1	<1	<1	**41.7**	<1	<1	<1	<1	<1	**3.2**	<1	
NMW-13D	Deep	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-13S	Shallow	12/14/2007	<1	<1	**278**	<1	<1	<1	<1	<1	<1	<1	<1	CHEA 9.3, EBN 85.2, TOL 46, XYLMP 231, XYLO 34.2
NMW-14D	Deep	12/14/2007	<1	**1.3**	<1	**104**	<1	<1	<1	**1.2**	<1	**1.6**	<1	
NMW-14S	Shallow	12/14/2007	<1	<1	<1	**8.5**	<1	<1	<1	<1	<1	<1	<1	
NMW-15D	Deep	12/14/2007	<1	**1.7**	<1	**78.1**	<1	<1	**4.5**	**2**	<1	**140**	**1**	
NMW-15S	Shallow	12/14/2007	<1	<1	<1	**12.8**	<1	<1	**1**	<1	<1	**57.1**	<1	
NMW-16D	Deep	12/18/2007	<1	<1	<1	**1.1**	<1	<1	**3.6**	<1	<1	**1.3**	<1	
NMW-16I	Intermediate	12/14/2007	<1	<1	<1	<1	<1	<1	**3**	<1	<1	**1.2**	<1	
NMW-16S	Shallow	12/14/2007	<1	<1	<1	<1	<1	<1	**1.1**	<1	<1	<1	<1	
NMW-17D	Deep	12/14/2007	<1	<1	<1	**2.2**	<1	<1	<1	<1	<1	**1.2**	<1	
NMW-17S	Shallow	12/21/2007	<1	<1	<1	<1	<1	**2.9**	<1	<1	<1	<1	<1	BDCM 1.9, CBN 1.5, DBCM 2.8
NMW-18D	Deep	12/21/2007	<1	<1	<1	**2.3**	<1	<1	<1	<1	<1	<1	<1	
NMW-18S	Shallow	12/21/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-19D	Deep	12/21/2007	<1	<1	<1	**26.3**	<1	<1	<1	<1	<1	**1.9**	<1	Methane 12.6
NMW-19S	Shallow	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**1.3**	<1	
NMW-20D	Deep	12/13/2007	<1	<1	<1	**4.9**	<1	<1	<1	<1	<1	<1	<1	
NMW-20S	Shallow	12/13/2007	<1	<1	<1	<1	<1	**4.7**	**8.8**	<1	<1	<1	<1	BDCM 3.9
NMW-21D	Deep	12/13/2007	<1	<1	<1	**5.7**	<1	<1	<1	<1	<1	<1	<1	MTBE 1.9
NMW-21S	Shallow	12/13/2007	<1	<1	<1	**1**	<1	<1	<1	<1	<1	<1	<1	MTBE 1.2
NMW-22D	Deep	12/13/2007	<1	<1	<1	**4.6**	<1	<1	**4.8**	<1	<1	**1.7**	<1	
NMW-22S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	**6.8**	<1	<1	<1	<1	
NMW-23D	Deep	12/19/2007	<1	<1	<1	**3.7**	<1	<1	<1	<1	<1	**3.8**	<1	
NMW-23S	Shallow	12/21/2007	<1	<1	<1	**435**	<1	<1	<1	**2.3**	<1	**117**	<1	Methane 41.9
NMW-24D	Deep	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**1.4**	<1	
NMW-24S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-25D	Deep	12/12/2007	<1	<1	<1	**48.9**	<1	<1	<1	<1	<1	**2**	<1	
NMW-25S	Shallow	12/12/2007	<1	<1	<1	**28.2**	<1	<1	<1	<1	<1	**4.8**	<1	
NMW-26D	Deep	12/12/2007	<1	<1	<1	**40.5**	<1	<1	<1	<1	<1	**3.4**	<1	
NMW-26S	Shallow	12/12/2007	<1	<1	<1	**14.6**	<1	<1	**1**	<1	<1	**3.8**	<1	
NMW-27D	Deep	12/17/2007	<1	<1	<1	**5.8**	<1	<1	<1	<1	<1	**5.7**	<1	
NMW-27S	Shallow	12/17/2007	<1	<1	<1	**4.4**	<1	<1	<1	<1	<1	**4.2**	<1	
NMW-28D	Deep	12/12/2007	**1.4**	**1.2**	<1	**18.3**	<1	<1	<1	<1	<1	**11.2**	<1	
NMW-28S	Shallow	12/12/2007	<1	<1	<1	**7.1**	<1	<1	<1	<1	<1	<1	<1	112TCA 3.4
NMW-29D	Deep	12/12/2007	<1	<1	<1	**23.2**	<1	<1	<1	**1.9**	<1	**10.9**	<1	
NMW-29S	Shallow	12/12/2007	<1	<1	<1	**7.4**	<1	<1	<1	<1	<1	**4.5**	<1	
NMW-30D	Deep	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-30S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-31D	Deep	12/14/2007	**1.7**	**1.6**	<1	**61**	<1	<1	**93.8**	**1.5**	<1	**184**	**3.5**	
NMW-31S	Shallow	12/14/2007	<1	<1	<1	**25.1**	<1	<1	**44.2**	<1	<1	**57.7**	<1	MTBE 1.4
NMW-32D	Deep	12/18/2007	**1.2**	**2.6**	<1	**45.4**	<1	<1	**5.8**	**1.9**	<1	**200**	**2.1**	CBN 1.8
NMW-32S	Shallow	12/18/2007	<1	**1.5**	<1	**26.1**	<1	<1	**6.8**	**1.2**	<1	**131**	**1.1**	CBN 1.1
NMW-33D	Deep	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-33S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-34D	Deep	12/18/2007	**1.8**	<1	<1	**3.3**	<1	<1	<1	<1	<1	**11.6**	<1	
NMW-34S	Shallow	12/18/2007	<1	<1	<1	**56.5**	<1	<1	<1	<1	<1	**2.7**	**3.6**	
NMW-35D	Deep	12/13/2007	**1**	**2.6**	<1	**94**	<1	<1	<1	**2**	<1	**52.2**	**1.8**	
NMW-35S	Shallow	12/13/2007	<1	<1	<1	**20.3**	<1	<1	<1	<1	<1	**32.5**	<1	

Table 2-2
North Industrial Corridor (NIC) Site
Summary of CDM 2007-2008 VOC Results

Sation ID	Well Depth Zone	Date Collected	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds
NMW-36D	Deep	12/18/2007	<1	<1	<1	**2.5**	<1	<1	<1	<1	<1	**59.1**	<1	
NMW-37D	Deep	12/18/2007	<1	<1	<1	**28.6**	<1	<1	**2.4**	<1	<1	**222**	<1	TCFM 1.8
NMW-38D	Deep	12/18/2007	<1	<1	<1	**2**	<1	<1	<1	<1	<1	**37**	<1	
NMW-39D	Deep	12/14/2007	<1	**1.6**	<1	**39.7**	<1	<1	<1	<1	<1	**37**	**2.2**	
NMW-39I	Intermediate	12/14/2007	<1	**1.8**	<1	**40.6**	<1	<1	<1	<1	<1	**32.3**	**2.6**	
NMW-39S	Shallow	12/18/2007	<1	**2.8**	<1	**87.3**	<1	<1	<1	**1.8**	<1	**1.1**	**6.9**	
NMW-41D	Deep	12/12/2007	<1	**1.6**	<1	**29.5**	<1	<1	<1	<1	<1	**81.6**	**2.3**	
NMW-41S	Shallow	12/12/2007	<1	<1	<1	**24.4**	<1	<1	<1	<1	<1	**44.3**	**1.5**	
NMW-42D	Deep	12/14/2007	<1	<1	<1	**29.8**	<1	<1	**2.6**	<1	<1	**77.7**	<1	
NMW-42S	Shallow	12/14/2007	<1	<1	<1	**12.1**	**1.6**	**3.2**	**6.7**	<1	<1	**31.7**	<1	
NMW-43D	Deep	12/13/2007	<1	<1	<1	**64.3**	<1	<1	<1	<1	<1	**21.1**	<1	EBN 1.2
NMW-44D	Deep	12/13/2007	<1	<1	<1	**21.2**	<1	<1	**2.4**	<1	<1	**77.2**	<1	
NMW-45D	Deep	12/17/2007	<1	<1	**3.6**	**11.4**	<1	<1	<1	<1	<1	**14.1**	<1	Methane 22.1, MTBE 17.8
NMW-47D	Deep	12/15/2007	<1	<1	<1	**70.5**	<1	<1	<1	<1	<1	**11.7**	**13.8**	
NMW-47S	Shallow	12/15/2007	**1.6**	<1	<1	**149**	<1	<1	**1.1**	**2.6**	<1	**37.9**	**19.4**	
NMW-48D	Deep	1/11/2008	<1	<1	<1	**1.9**	<1	<1	<1	<1	<1	**1.3**	<1	
NMW-48S	Shallow	1/11/2008	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-49D	Deep	12/17/2007	**1.3**	**1**	<1	**60**	<1	<1	<1	**1.4**	<1	**57.8**	**1.4**	MTBE 1.4
NMW-49S	Shallow	12/17/2007	<1	<1	<1	**5**	<1	<1	<1	<1	<1	**2.2**	<1	
NMW-50D	Deep	12/19/2007	<1	<1	<1	**12.3**	<1	<1	<1	<1	<1	**16.9**	<1	
NMW-50S	Shallow	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-51D	Deep	12/13/2007	**3.2**	**2.2**	<1	**33.8**	<1	<1	**2.1**	<1	<1	**36.4**	**4.6**	
NMW-51S	Shallow	12/13/2007	**2.3**	**1.3**	<1	**20.6**	<1	<1	**8.3**	<1	<1	**17.2**	**1.7**	
NWL-01D	Deep	12/13/2007	**1.6**	**1.3**	**3.9**	**53.1**	<1	<1	<1	<1	<1	**9.1**	<1	
NWL-01S	Shallow	12/13/2007	**1.5**	<1	**1.7**	**7.9**	<1	<1	<1	<1	<1	**2.4**	<1	MTBE 3.3
NWL-02D	Deep	12/14/2007	**1.4**	<1	<1	**32**	<1	<1	<1	<1	<1	**3.2**	**4.2**	
NWL-02S	Shallow	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NWL-04S	Shallow	12/12/2007	<1	<1	<1	**1.1**	<1	<1	<1	<1	<1	**1.9**	<1	
NWL-05S	Shallow	12/13/2007	<1	<1	<1	**4**	<1	<1	<1	<1	<1	**2**	<1	
NWL-06S	Shallow	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NWL-07D	Deep	12/10/2007	**2.5**	**1.8**	<1	**47.1**	<1	<1	<1	**1.3**	<1	**40.4**	**4.1**	
NWL-07S	Shallow	12/10/2007	**1.6**	**1.2**	<1	**33**	<1	<1	<1	<1	<1	**32.6**	**3.3**	
NWL-08D	Deep	12/12/2007	**1.9**	**5.7**	<1	**76.5**	<1	<1	<1	**2.6**	<1	**130**	**3.4**	
NWL-08S	Shallow	12/12/2007	**2**	**4.8**	<1	**124**	<1	<1	<1	**2.7**	<1	**40**	**2.2**	
NWL-09D	Deep	12/12/2007	<1	<1	<1	**21.8**	<1	<1	<1	<1	<1	**3.9**	<1	
NWL-09S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NWL-10S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	**2.6**	<1	<1	<1	<1	
NWL-11S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NWL-14S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NWL-16S	Shallow	12/15/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**5.1**	<1	
NWL-17S	Shallow	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NWL-18S	Shallow	12/18/2007	<1	<1	**290**	**28.7**	<1	<1	<1	<1	<1	**29.3**	<1	EBN 17.7, TOL 1.5, XYLMP 18.6, XYLO 6.7
NWL-19S	Shallow	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NWL-20S	Shallow	12/18/2007	<1	<1	**344**	<1	<1	<1	<1	<1	<1	<1	<1	EBN 70, TOL 6.4, XYLMP 81.4
NWL-21S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	TOL 3
NWL-23S	Shallow	12/14/2007	<1	<1	<1	**4.2**	<1	<1	**2.1**	<1	<1	**7.4**	<1	
NWL-24S	Shallow	12/13/2007	<1	<1	**164**	<1	<1	<1	<1	<1	<1	<1	<1	EBN 1.4, MTBE 9, TOL 2.7, XYLMP 58.2, XYLO 4.4

Table 2-2
North Industrial Corridor (NIC) Site
Summary of CDM 2007-2008 VOC Results

Sation ID	Well Depth Zone	Date Collected	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds
NWL-25S	Shallow	12/14/2007	<1	<1	<1	**17.6**	<1	<1	<1	<1	<1	**6.6**	<1	
NWL-26S	Shallow	12/14/2007	<1	<1	<1	**7.2**	<1	<1	<1	<1	<1	**12**	<1	
NWL-29S	Shallow	12/14/2007	**2**	<1	<1	**29.2**	<1	<1	**4**	<1	<1	**28.7**	**1.4**	MTBE 5.7
NWL-30S	Shallow	12/21/2007	<1	<1	<1	**4.9**	<1	<1	<1	<1	<1	**28.1**	<1	
SW-104	Surface Water	12/20/2007	<1	<1	**4.4**	**2.2**	<1	<1	<1	<1	<1	**1.7**	<1	
SW-105	Surface Water	12/20/2007	<1	<1	**2.4**	**2.6**	<1	<1	<1	<1	<1	**1.7**	<1	
SWL-02	Surface Water	1/9/2008	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
SWL-13	Surface Water	12/20/2007	<1	<1	**1.5**	**5.1**	<1	<1	<1	<1	<1	**1.4**	<1	
SWL-14	Surface Water	12/14/2007	<1	<1	**1.2**	**5**	<1	<1	<1	<1	<1	**1**	<1	
SWL15	Surface Water	12/14/2007	<1	<1	<1	**3.9**	<1	<1	<1	<1	<1	<1	<1	
SWL-16	Surface Water	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
SWL-17	Surface Water	12/20/2007	<1	<1	**3.9**	**1.4**	<1	<1	<1	<1	<1	<1	<1	
SWL-18	Surface Water	12/20/2007	<1	<1	**2.1**	**1.7**	<1	<1	<1	<1	<1	**1.2**	<1	
SWL-19	Surface Water	12/20/2007	<1	<1	**3.8**	**1.8**	<1	<1	<1	<1	<1	<1	**2.3**	
SWL-21	Surface Water	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
UPRF-MW-03	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
UPRF-MW-09	Shallow	12/18/2007	<1	<1	<1	**5.3**	<1	<1	<1	<1	<1	**8.5**	<1	
UPRF-MW-16	Shallow	12/18/2007	<1	<1	<1	**15.5**	<1	<1	**2.4**	<1	<1	**87.4**	<1	
URS-MW-02	Shallow	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
VCM-MW-01	Shallow	12/21/2007	<1	<1	<1	**11**	<1	<1	<1	<1	<1	**1.2**	<1	
VCM-MW-02B	Shallow	12/21/2007	**1.4**	**2.7**	<1	**105**	<1	<1	<1	**2.6**	<1	**31.3**	**1.5**	
VCM-MW-03	Shallow	12/21/2007	<1	<1	<1	**2**	<1	<1	<1	<1	<1	**2.3**	<1	
VCM-MW-04	Deep	12/21/2007	**1.2**	**1**	<1	**62.3**	<1	<1	<1	**1**	<1	**3.3**	**1.1**	
VCM-MW-07	Deep	12/21/2007	<1	<1	<1	**5.4**	<1	<1	<1	<1	<1	**5.6**	<1	
VWRS-MW-02D	Deep	12/17/2007	**4.1**	**4.1**	<1	**65.9**	<1	<1	<1	**2.4**	<1	**44.2**	<1	
VWRS-MW-02S	Shallow	12/17/2007	**2.3**	**1.5**	<1	**40.3**	<1	<1	<1	**2**	<1	**23.6**	**8**	
VWRS-MW-07D	Deep	12/17/2007	**2.7**	**1.6**	<1	**41.5**	<1	<1	<1	<1	<1	**21**	<1	
VWRS-MW-07S	Shallow	12/17/2007	<1	<1	<1	**9.8**	<1	<1	<1	<1	<1	**7.7**	<1	
VWRS-MW-09D	Deep	12/17/2007	**3.4**	**2.7**	<1	**58**	<1	<1	<1	**2.3**	<1	**27.4**	<1	
VWRS-MW-09S	Shallow	12/17/2007	**1.9**	<1	<1	**24**	<1	<1	**2.9**	**1.4**	<1	**17.9**	**1.4**	
WNC-05D	Deep	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WNC-06D	Deep	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WNC-09D	Deep	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WNC-10D	Deep	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WNC-11D	Deep	12/17/2007	**2.6**	**1.4**	<1	**1.5**	<1	<1	<1	<1	**2.8**	**19.1**	<1	
WNC-16D	Deep	12/20/2007	<1	<1	<1	**2.6**	<1	<1	<1	<1	<1	**10.8**	<1	Methane 149
WNC-23D	Deep	12/17/2007	<1	<1	<1	**1.9**	<1	<1	<1	<1	<1	**6.5**	<1	Methane 518
WNC-31D	Deep	12/18/2007	<1	<1	<1	**50.7**	<1	<1	**4.2**	<1	<1	**124**	<1	
WNC-32D	Deep	12/18/2007	<1	<1	<1	**29.2**	<1	<1	**3.8**	<1	<1	**92.2**	<1	
WNC-37SR	Shallow	12/20/2007	**1.4**	**1.8**	<1	**59**	<1	<1	<1	**3.8**	<1	**42.3**	**5.9**	
WND-01S	Shallow	12/19/2007	<1	**1.4**	<1	**5.1**	<1	<1	<1	<1	**28.2**	**24.1**	<1	
WND-02D	Deep	12/13/2007	<1	<1	<1	**4**	<1	<1	<1	<1	<1	<1	<1	
WND-02S	Shallow	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-03S	Shallow	12/17/2007	**1.6**	<1	**5.2**	**36.4**	<1	<1	<1	<1	<1	<1	<1	Methane 6450, EBN 34.8, TOL 5.8, XYLMP 21.5, XYLO 4.2
WND-04S	Shallow	12/17/2007	<1	**2.4**	<1	**39.8**	<1	<1	<1	<1	<1	**131**	<1	
WND-05S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-06S	Shallow	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-07S	Shallow	12/19/2007	<1	<1	<1	**1.4**	<1	<1	<1	<1	<1	<1	<1	

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North Industrial Corridor (NIC) Site
Summary of CDM 2007-2008 VOC Results

Sation ID	Well Depth Zone	Date Collected	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds
WND-08S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**2.1**	<1	
WND-09S	Shallow	1/11/2008	<1	<1	**2.2**	<1	<1	<1	<1	<1	<1	<1		
WND-10S	Shallow	12/21/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-11S	Shallow	12/17/2007	<1	<1	<1	**5.9**	<1	<1	<1	<1	<1	<1	<1	
WND-12D	Deep	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**10.5**	<1	
WND-12S	Shallow	12/12/2007	**5.7**	**17.7**	<1	**1.8**	<1	<1	<1	<1	<1	<1	**5**	CHEA 9.9
WND-14D	Deep	12/18/2007	<1	<1	<1	**61.7**	<1	<1	**11**	<1	<1	**201**	<1	
WND-14S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-15D	Deep	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-15S	Shallow	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-18D	Deep	12/18/2007	<1	**1.1**	<1	**24.4**	<1	<1	<1	<1	<1	**31.1**	**1.1**	
WND-18S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-19D	Deep	12/10/2007	<1	<1	<1	**10**	<1	<1	<1	<1	<1	**32.7**	<1	
WND-19S	Shallow	12/10/2007	<1	<1	<1	**1.1**	<1	<1	<1	<1	<1	**6.9**	<1	
WND-20S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-21D	Deep	12/21/2007	<1	**4**	<1	**45.4**	<1	<1	<1	**1**	<1	**139**	**1.5**	
WND-21S	Shallow	12/21/2007	<1	**1.7**	<1	**53.4**	<1	<1	<1	<1	<1	**10.8**	<1	Methane 264
WND-22D	Deep	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-22S	Shallow	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-23S	Shallow	12/17/2007	<1	<1	<1	**1**	<1	<1	<1	<1	<1	**3.1**	<1	Methane 56.7
WND-24D	Deep	12/13/2007	**1.9**	<1	<1	**42.4**	<1	<1	<1	<1	<1	**36.7**	<1	
WND-24S	Shallow	12/13/2007	<1	<1	<1	**9.9**	<1	<1	<1	<1	<1	**17.1**	<1	
WND-25D	Deep	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**6.4**	<1	
WND-25S	Shallow	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**11.2**	<1	
WND-26D	Deep	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**4.4**	<1	
WND-26S	Shallow	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-27S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-28S	Shallow	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-29D	Deep	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**1.5**	<1	
WND-29S	Shallow	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-30D	Deep	12/14/2007	<1	<1	<1	**24.9**	**1.1**	<1	**2.4**	<1	<1	**63.3**	<1	
WND-31S	Shallow	12/21/2007	<1	<1	<1	**2.1**	<1	**3.6**	<1	<1	<1	**7.4**	<1	
WND-32S	Shallow	12/18/2007	<1	<1	<1	<1	<1	**3.2**	<1	<1	<1	<1	<1	
WND-33D	Deep	12/12/2007	**2.8**	**1.4**	<1	**40.2**	<1	<1	<1	<1	<1	**5.6**	<1	Methane 140
WND-34D	Deep	12/13/2007	**1.3**	<1	**101**	**23**	<1	<1	<1	<1	<1	**5.4**	<1	EBN 8.8, TOL 4.9, XYLMP 8.5, XYLO 1
WND-34S	Shallow	12/13/2007	<1	<1	**167**	<1	<1	<1	<1	<1	<1	<1	<1	TOL 6.9, XYLMP 11
WND-36D	Deep	12/20/2007	**1.8**	**1.6**	**1.7**	**21.8**	<1	<1	<1	<1	<1	**27.2**	<1	Methane 275
WND-36S	Shallow	12/20/2007	<1	<1	**295**	<1	<1	<1	<1	<1	<1	<1	<1	Methane 8980, EBN 33.1, TOL 29.6, XYLMP 98.7, XYLO 10
WND-37DR	Deep	12/20/2007	**3.6**	**5.5**	<1	**56.1**	<1	<1	<1	**1.9**	<1	**108**	**6.3**	
WND-38D	Deep	12/10/2007	<1	<1	<1	**13.9**	<1	<1	<1	<1	<1	**20.2**	<1	
WND-38S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**2.1**	<1	
WND-39D	Deep	12/21/2007	**2.5**	**1.2**	<1	**42.9**	<1	<1	<1	<1	<1	**26.9**	<1	Methane 146
WND-39S	Shallow	12/21/2007	<1	<1	<1	**3.4**	<1	<1	<1	<1	<1	**21.4**	<1	
WND-40D	Deep	12/19/2007	<1	<1	<1	**34.2**	<1	<1	<1	<1	<1	**15.2**	<1	
WND-41D	Deep	12/21/2007	<1	<1	<1	**4.2**	<1	<1	**1.6**	<1	<1	**20.9**	<1	
WND-41S	Shallow	12/19/2007	<1	<1	<1	<1	<1	<1	**1.6**	<1	<1	<1	<1	
WND-42D	Deep	12/19/2007	**1.4**	**1.2**	<1	**66.8**	<1	<1	<1	**1.2**	<1	**6**	<1	

Table 2-2
North Industrial Corridor (NIC) Site
Summary of CDM 2007-2008 VOC Results

Sation ID	Well Depth Zone	Date Collected	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds
WND-42S	Shallow	12/19/2007	**1.7**	<1	<1	**59.4**	<1	<1	**4**	**1.3**	<1	**6.1**	<1	
WND-43D	Deep	12/13/2007	<1	<1	**3.1**	**19**	<1	**1.1**	<1	<1	<1	**15.6**	**4.9**	
WND-43S	Shallow	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-45D	Deep	12/12/2007	<1	**1.3**	<1	**62**	<1	<1	<1	<1	<1	**7.9**	**1.6**	
WND-45S	Shallow	12/12/2007	<1	<1	<1	**4.4**	<1	<1	<1	<1	<1	**10.2**	<1	
WND-46D	Deep	12/13/2007	**1**	**1.6**	<1	**55.7**	<1	<1	<1	**1.3**	<1	**19.4**	**1.1**	
WND-46S	Shallow	12/13/2007	<1	<1	<1	**1.7**	<1	<1	<1	<1	<1	**3.4**	<1	
WND-47D	Deep	12/14/2007	**1.4**	**3.7**	<1	**58**	<1	<1	**9.1**	**1.6**	<1	**142**	**3.4**	
WND-47S	Shallow	12/14/2007	<1	**1.3**	<1	**24.8**	<1	<1	**10.1**	<1	<1	**76.5**	**1**	
WND-48D	Deep	12/13/2007	**1.1**	<1	<1	**50.3**	<1	<1	<1	<1	<1	**21**	**4.5**	
WND-48S	Shallow	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WU-MW-04D	Deep	12/13/2007	<1	**1.6**	<1	**21.8**	<1	<1	<1	<1	<1	**61**	**1.3**	
WU-MW-04S	Shallow	12/13/2007	<1	<1	<1	**1.9**	<1	<1	**1.7**	<1	<1	**6.4**	<1	
WU-MW-05D	Deep	12/14/2007	<1	<1	<1	**4.6**	<1	<1	<1	<1	<1	**6.6**	<1	
WU-MW-05S	Shallow	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	**2.9**	<1	
TW-DRB-MW-11	Shallow	4/24/2008	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	Methane 138, MTBE 1.7
TW-DRB-MW-110D	Deep	4/24/2008	<1	<1	**1.3**	**7.1**	<1	<1	<1	<1	<1	**3.5**	<1	MTBE 24.8
DRB-MW-110	Fully Screened	4/24/2008	<1	<1	<1	**6.2**	<1	<1	<1	<1	<1	**2.8**	<1	MTBE 24
TW-NMW-40D	Deep	4/23/2008	**1.6**	**2.9**	<1	**46.5**	<1	<1	<1	**2.9**	<1	**70.4**	**4.6**	MTBE 4.1
TW-NMW-40S	Shallow	4/23/2008	**1**	**1.2**	<1	**29.5**	<1	<1	<1	**1.9**	<1	**26.8**	**1.4**	MTBE 3.6
TW-NMW-46D	Deep	4/24/2008	<1	<1	**47.1**	**8.3**	<1	<1	<1	<1	<1	**3.4**	<1	Methane 349, MTBE 23.7, EBN 1.4
TW-WNC-49SR	Shallow	4/24/2008	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
TW-WND-13D	Deep	4/23/2008	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
TW-WND-13S	Shallow	4/23/2008	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
TW-WND-40S	Shallow	4/23/2008	<1	<1	<1	**2.2**	<1	<1	<1	<1	**1.1**	**4.7**	<1	
TW-WND-44D	Deep	4/23/2008	<1	<1	<1	**37**	<1	<1	<1	**1.3**	<1	**7.6**	<1	
TW-WND-44S	Shallow	4/23/2008	<1	<1	**5**	**5.7**	<1	<1	<1	<1	<1	<1	**4.8**	
TW-WND-49D	Deep	4/24/2008	<1	**1.4**	<1	**26.4**	<1	<1	<1	**1.1**	<1	**28**	**1.1**	

Primary VOC's
11DCA = 1,1-Dichloroethane
11DCE = 1,1-Dichloroethene
BEN = Benzene
C12DCE = cis-1,2-Dichloroethene
CT = Carbon tetrachloride
CFM = Chloroform
PCE = Tetrachloroethene
T12DCE = trans-1,2-Dichloroethene
111TCA = 1,1,1-Trichloroethane
TCE = Trichloroethene
VC = Vinyl chloride

Other Compounds Detected
BFM = Bromofluoromethane
BDCM = Bromodichloromethane
CBN = Chlorobenzene
CHEA = Chloroethane
DBCM = Dibromochloromethane
EBN = Ethylbenzene
MTBE = Methyl tert-butyl ether
112TCA = 1,1,2-Trichloroethane
TCFM = Trichlorofluoromethane

Table 2-3
North Industrial Corridor (NIC) Site
Summary of PRP 2007 Groundwater Analytical Data

Station ID	Date Collected	Well Depth Zone	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds	Data Source
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
CG-HOC-10	11/20/2007	Deep	0	0	0	32.9	0	0	0	0	0	15.3	0		Cargill 13th street
CG-HOC-3R	11/20/2007	Shallow	0	0	0	5.8	0	0	0	0	0	0	0	135TMB 1.6, EBN 133, IPB 36.8, NAP 42, NBB 12.4, NPB 124, SBB 8.6, TOL 1.2, XYL 31.4	Cargill 13th street
CG-MW-1A	11/18/2007	Shallow	0	0	0	4.3	0	0	0	0	0	6.9	0		Cargill 13th street
CG-MW-1B	11/18/2007	Deep	1.9	2.3	0	77.6	0	0	0	1.7	0	10.8	1.3		Cargill 13th street
CG-MW-2A	11/19/2007	Shallow	0	0	0	1.2	3.9	1.9	0	0	0	2.6	0		Cargill 13th street
CG-MW-2B	11/19/2007	Deep	2.3	2.7	0	118	0	0	0	2.9	0	4.4	1.7		Cargill 13th street
CG-MW-3A	11/19/2007	Shallow	0	0	0	0	108	180	2.4	0	0	2.1	0	EDB 1.3, MECL 1.2	Cargill 13th street
CG-MW-3B	11/19/2007	Deep	2	2.3	0	88.4	0	0	0	2.7	0	19.2	1.1		Cargill 13th street
CG-MW-3B	11/19/2007	Deep	1.9	2.2	0	85	0	0	0	2.9	0	18.9	1.3		Cargill 13th street
CG-MW-4A	11/19/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0		Cargill 13th street
CG-MW-4B	11/19/2007	Deep	1.4	1.6	0	55.8	0	0	0	1.6	0	18.5	0		Cargill 13th street
CG-MW-5A	11/19/2007	Shallow	0	0	0	0	138	86.9	0	0	0	1.4	0	EDB 1.7	Cargill 13th street
CG-MW-5B	11/19/2007	Deep	2.1	2	0	99	0	0	0	2.4	0	13	1.1		Cargill 13th street
CG-MW-6A	11/19/2007	Shallow	0	0	0	0	645	89.2	3.9	0	0	0	0	EDB 2.9	Cargill 13th street
CG-MW-6B	11/19/2007	Deep	1.6	1.9	0	65.4	26.8	20.5	1.8	1.9	0	20.4	0		Cargill 13th street
CG-MW-7A	11/19/2007	Shallow	0	0	0	1.3	0	0	0	0	0	1	0		Cargill 13th street
CG-MW-7B	11/19/2007	Deep	1.8	1.7	0	78.3	0	0	0	1.8	0	10.2	0		Cargill 13th street
CG-NWL-25S	11/19/2007	Shallow	0	0	0	14.9	0	0	0	0	0	6.4	0		Cargill 13th street
CG-VCM-2B	12/18/2007		1.4	2.5	0	118	0	0	0	2.7	0	26.6	1.5		Cargill 13th street
CG-VCM-6	12/18/2007		1.4	2.6	0	130	0	0	0	2.7	0	6.1	1.9		Cargill 13th street
CG-WND-40D	11/19/2007	Deep	1.4	1.3	0	95	0	0	0	1.7	0	22.4	1.2		Cargill 13th street
CN-MW-12	10/18/2007	Deep	0	0		0.61	0	0	0	0	0	4.3	0		Coleman North
CN-MW-15	10/16/2007	Deep	0	0		1.8	0	0	0	0	0	18	0		Coleman North
CN-MW-16	10/17/2007	Deep	1.4	2.5		4.6	0	0	0	0	2.5	10	0		Coleman North
CN-MW-17	10/18/2007	Deep	0	0.69		4.3	0	0	0	0	0	45	0		Coleman North
CN-MW-20	10/18/2007	Deep	1	0		4.4	0	0	0	0	0.9	7	0		Coleman North
CN-MW-21	10/18/2007	Deep	0	0.67		2.6	0	0	0	0	0	14	0		Coleman North
CN-MW-25	10/18/2007	Deep	0	0		0	0	0	0	0	0	0	0		Coleman North
CN-MW-30	10/16/2007	Deep	0	0		0	0	0	1.5	0	0	4.4	0		Coleman North
CN-MW-34	10/18/2007	Shallow	0	0		0	0	0	0	0	0	1.5	0		Coleman North
CN-MW-36	10/18/2007	Shallow	0.55	0		13	0	0.81	1.5	0	2.3	190	0		Coleman North
CN-MW-38	10/17/2007	Shallow	4.2	5.3		23	0	0	0.55	1	10	90	0		Coleman North
CN-MW-40	10/16/2007	Shallow	0	0		0	0	0	15	0	0	1.7	0		Coleman North
CN-MW-42	10/18/2007	Shallow	0	0.58		8	0	0	0	0	0.81	12	0		Coleman North
CN-MW-43	10/18/2007	Shallow	0	0		4.5	0	0	0	0	0	3.1	0		Coleman North
CN-MW-45	10/16/2007	Shallow	0	0		1.1	0	0	11	0	0	23	0		Coleman North
CN-MW-46	10/18/2007	Shallow	0	0		0.59	0	0	0	0	0	3.7	0		Coleman North
CN-MW-47	10/16/2007	Shallow	0	0		0	0	0	0	0	0	0	0		Coleman North
CN-MW-49	10/18/2007	Shallow	0	0		0	0	0	0	0	0	0.79	0		Coleman North
CN-MW-50	10/18/2007	Deep	0	0		0	0	0	0	0	0	1.4	0		Coleman North
CN-MW-51	10/17/2007	Deep	0	0		0	0	0	0	0	0	3.2	0		Coleman North
CN-MW-52	10/17/2007	Shallow	0	0		0	0	0	0	0	0	1.2	0		Coleman North
CN-MW-53	10/16/2007	Deep	0	0		0	0	0	0	0	0	1.3	0		Coleman North
CN-MW-54	10/16/2007	Shallow	0	0		0	0	0	0	0	0	0	0		Coleman North
CN-MW-59	10/16/2007	Deep	0	0		0	0	0	0	0	0	0	0		Coleman North
CN-MW-60	10/16/2007	Shallow	0	0		0	0	0	0	0	0	0	0		Coleman North
CN-MW-61	10/16/2007	Shallow	0	2.7	0	52	0	0	0	3	0	160	24		Coleman North
CN-MW-62	10/16/2007	Deep	0	0	0	5.8	0	0	0	0	0	27	0		Coleman North
CN-MW-67	10/16/2007	Deep	0	0		1.7	0	0	0	0	0	12	0		Coleman North

Table 2-3
North Industrial Corridor (NIC) Site
Summary of PRP 2007 Groundwater Analytical Data

Station ID	Date Collected	Well Depth Zone	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds	Data Source
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
CN-MW-68	10/16/2007	Shallow	0	0.67		3	0	0	0	0	0	32	0		Coleman North
CN-MW-69D	10/16/2007	Deep	0	0	0	0.55	0	0	0	0	0	13	0		Coleman North
CN-MW-69S	10/16/2007	Shallow	0	0	0	0	0	0	0	0	0	1.5	0		Coleman North
CN-MW-70D	10/18/2007	Deep	0	0		0	0	0	0	0	0	4	0		Coleman North
CN-MW-70S	10/18/2007	Shallow	0.86	2		190	0	0	3.3	5.8	0.6	1500	0	112TCA 0.52	Coleman North
CN-MW-71D	10/16/2007	Deep	0	0		2.6	0	0	0	0	0	3.2	0		Coleman North
CN-MW-71S	10/16/2007	Shallow	0	0		0	0	0	0	0	0	2.3	0		Coleman North
CN-RW-02	10/16/2007		0	0		23	0	0	0	0	0	40	0		Coleman North
CN-VEW-05D	10/18/2007	Shallow	35	63		530	0	0	0	37	8	3500	0		Coleman North
CN-VEW-11D	10/18/2007	Shallow	0.54	0.7		18	0	0	0	0	2.1	110	0		Coleman North
CN-VEW-13D	10/18/2007	Shallow	0	0		3.6	0	0	0	0	4.9	23	0		Coleman North
CN-VEW-14D	10/18/2007	Shallow	2.4	6.4		8.7	0	0.65	0.93	0	21	44	0		Coleman North
CN-VEW-18D	10/18/2007	Shallow	3.7	4		68	0	0.57	0.75	0.75	5.5	880	0	112TCA 0.84	Coleman North
CN-VEW-21D	10/18/2007	Shallow	370	310		460	0	0	22	4.3	380	8600	0		Coleman North
CN-VEW-22D	10/18/2007	Shallow	2.5	4.5		510	0	0.73	3.7	14	2	3600	0	112TCA 8.2	Coleman North
WND-29D	10/16/2007	Deep	0	0	0	0	0	0	0	0	0	2.1	0		Coleman North
WND-29S	10/16/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0		Coleman North
CNE-MW-05	10/10/2007	Deep	0	0	0	79	0	0	0	1.1	0	32	0		Coleman
CNE-MW-07S	10/10/2007	Shallow	0	0	0	7	0	0	0	0	0	22	0		Coleman
CNE-MW-08S	10/10/2007	Shallow	0	0	0	300	0	0	0	0	0	840	18		Coleman
CNE-MW-11D	10/10/2007	Deep	0	0	0	2.1	0	0	0	0	0	7.6	0		Coleman
CNE-MW-15S	10/10/2007	Shallow	0	0	0	140	0	0	1	3.7	0	110	2.2		Coleman
CNE-MW-16D	10/11/2007	Deep	90	6.2	0	380	0	0	170	0	0	380	15		Coleman
CNE-MW-18D	10/11/2007	Deep	0	0	0	4.5	0	0	0	0	0	36	0		Coleman
CNE-MW-19D	10/10/2007	Deep	3.1	0	0	22	0	0	9	0	0	83	0		Coleman
CNE-MW-20D	10/10/2007	Deep	0	0	0	0	0	0	0	0	0	6.6	0		Coleman
CNE-MW-21D	10/11/2007	Deep	0	0	0	19	0	0	11	0	0	25	0		Coleman
CNE-MW-23	10/10/2007	Deep	1.7	0	0	83	0	0	58	1.9	0	55	2		Coleman
CNE-MW-24	10/10/2007	Deep	4.6	0	0	27	0	0	0	0	0	2.1	0		Coleman
CNE-NE-02D	10/10/2007	Deep	0	0	0	0	0	0	0	0	0	4.1	0		Coleman
CNE-NE-03D	10/10/2007	Deep	0	0	0	1.2	0	0	0	0	0	6.3	0		Coleman
CNE-NE-04D	10/10/2007	Deep	0	0	0	15	0	0	3.1	0	0	44	0		Coleman
CNE-NE-05D	12/12/2007	Deep	0	0	0	0	0	0	0	0	0	7.9	0		Coleman
CNE-NE-05S	12/12/2007	Shallow	0	0	0	0	0	0	0	0	0	4.3	0		Coleman
CNE-NE-06D	12/12/2007	Deep	0	0	0	0	0	0	0	0	0	0	0		Coleman
CNE-NE-06S	12/12/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0		Coleman
CNE-NE-07D	12/12/2007	Deep	0	0	0	0	0	0	0	0	0	0	0		Coleman
CNE-NE-07S	12/12/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0		Coleman
CNE-NE-08I	12/11/2007	Intermediate	0	0	0	75	0	0	6.9	0	0	170	1.1		Coleman
CNE-NE-09D	12/11/2007	Deep	0	1.3	0	23	0	0	3.2	0	0	87	0		Coleman
CNE-NE-09S	12/11/2007	Shallow	0	0	0	6.5	0	0	0	0	0	40	0		Coleman
CNE-NE-10I	12/11/2007	Intermediate	0	1.1	0	18	0	0	1.4	0	0	48	0		Coleman
CNE-NE-12I	12/11/2007	Intermediate	0	0	0	0	0	0	0	0	0	0	0		Coleman
DRB-08	11/8/2007	Shallow	0	0	190	0	0	0	0	0	0	0	0	124TMB 840, 135TMB 160, EBN 59, IPB 62, MTBE 38, NAP 58, NPB 190, SBB 7.2, TOL 5.3, XYLMP 68	El Paso (Derby)
DRB-MW-01N	11/8/2007	Shallow	0	0	0	18	0	0	0	0	0	43	0		El Paso (Derby)
DRB-MW-06	11/7/2007	Shallow	0	0	0	22	0	0	0	0	0	0	0		El Paso (Derby)
DRB-MW-110	11/7/2007	Full	0	0	0	6.7	0	0	0	0	0	0	0	MTBE 32	El Paso (Derby)

Table 2-3
North Industrial Corridor (NIC) Site
Summary of PRP 2007 Groundwater Analytical Data

Station ID	Date Collected	Well Depth Zone	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds	Data Source
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
DRB-MW-120	11/7/2007	Full	0	0	0	6.2	0	0	0	0	0	0	0	MTBE 21	El Paso (Derby)
DRB-MW-150	11/7/2007	Full	0	0	0	19	0	0	0	0	0	8.1	0		El Paso (Derby)
DRB-MW-230	11/7/2007	Shallow	0	0	0	7.2	0	0	0	0	0	0	0	MTBE 30	El Paso (Derby)
DRB-MW-300	11/7/2007	Shallow	0	0	900	0	0	0	0	0	0	0	0	MTBE 59	El Paso (Derby)
DRB-MW-360	11/7/2007	Full	0	0	6.9	12	0	0	0	0	0	0	0		El Paso (Derby)
DRB-MW-370	11/7/2007	Intermediate	0	0	840	0	0	0	0	0	0	0	0	EBN 10, IPB 21, NPB 29, TOL 15	El Paso (Derby)
DRB-MW-490	11/7/2007	Shallow	0	0	1.2	49	0	0	5.6	0	0	27	0		El Paso (Derby)
DRB-MW-512	11/7/2007	Shallow	0	0	1.1	33	0	0	0	0	0	14	0		El Paso (Derby)
DRB-MW-513	11/7/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0		El Paso (Derby)
DRB-MW-514	11/7/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0		El Paso (Derby)
FLE-MW-01D	10/3/2007	Deep			0.27	34	0	0	3.1			82			Farmland Elevator
FLE-MW-01S	10/3/2007	Shallow			140	0	0	0	0			0		124TMB 1.2, EBN 7.5, NPB 0.37, XYLMP 0.88	Farmland Elevator
FLE-MW-02D	10/3/2007	Deep			0	29	0	0	4			92			Farmland Elevator
FLE-MW-02S	10/3/2007	Shallow			0	1.7	5.1	10	0			4.8			Farmland Elevator
FLE-MW-03S	10/3/2007	Shallow			0	0	22	5.2	0			0.93			Farmland Elevator
FLE-MW-04S	10/3/2007	Shallow			0	0	0	0	0			0.53			Farmland Elevator
FLE-MW-05D	10/3/2007	Deep			0	41	0	0	5.4			130			Farmland Elevator
FLE-MW-05S	10/3/2007	Shallow			0	0	42	22	0			0.63			Farmland Elevator
FLE-MW-06D	10/3/2007	Deep			0	40	0	0	5.6			130			Farmland Elevator
FLE-MW-06S	10/3/2007	Shallow			0	0	100	110	2.6			1.2			Farmland Elevator
WND-32S	10/3/2007	Shallow			0	0	0	0.32	0			0			Farmland Elevator
HRI-MW-03	4/10/2007	Full	0	0	0	30	0	0	5.4	0	0	120	0	XYLO 3.8, EBN 3.3	Clean Harbors
RSC-MW-01	4/12/2007		0	0	0	0	0	0	0	0	0	20	0	EBN 1.7, XYLO 1.9	Clean Harbors
SK-MW-01D	4/11/2007	Deep	0	0	0	0	0	0	0	0	0	14	0		Clean Harbors
SK-MW-01S	4/11/2007	Shallow	0	0	0	1.5	0	0	13	0	0	13	0		Clean Harbors
SK-MW-02D	4/10/2007	Deep	0	0	0	29	0	0	0	0	0	180	0	MECL 19	Clean Harbors
SK-MW-02S	4/11/2007	Shallow	0	0	0	230	0	0	320	0	28	130	0	MECL 39	Clean Harbors
SK-MW-03D	4/11/2007	Deep	0	0	0	14	0	0	1.8	0	0	53	0	124TMB 1.3, NAP 1.2	Clean Harbors
SK-MW-03S	4/11/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0	TOL 130, NAP 160, 124TMB 1300, 135TMB 270, XYLO 270, EBN 150, XYLMP 1100	Clean Harbors
SK-MW-04D	4/11/2007	Deep	0	0	0	34	0	0	5	0	0	140	0		Clean Harbors
SK-MW-04S	4/10/2007	Shallow	0	0	0	17	0	0	7.7	0	0	23	0		Clean Harbors
SK-MW-05D	4/9/2007	Deep	0	0	0	27	0	0	3.9	0	0	140	0		Clean Harbors
SK-MW-05S	4/12/2007	Shallow	0	0	0	40	0	0	250	0	8.3	58	0		Clean Harbors
SK-MW-06S	4/12/2007	Shallow	8.6	0	0	1.7	0	0	3.8	0	3.1	1.5	0		Clean Harbors
SK-MW-07D	4/12/2007	Deep	0	0	0	46	0	0	4.9	0	0	150	0		Clean Harbors
SK-MW-08D	4/13/2007	Deep	0	0	0	2.3	0	0	0	0	0	39	0		Clean Harbors
SK-MW-08S	4/13/2007	Shallow	0	0	0	7.2	0	0	0	0	0	14	0		Clean Harbors
SK-MW-09D	4/13/2007	Deep	0	0	0	15	0	0	0	0	0	81	0	MECL 5.5	Clean Harbors
SK-MW-10S	4/12/2007	Shallow	3.7	0	0	17	0	0	6.3	1.1	0	1.9	20		Clean Harbors
SK-MW-11S	4/11/2007	Shallow	2.7	0	0	72	0	0	6.3	0	7.8	47	3.1	MECL 2.1	Clean Harbors
SK-MW-12D	4/10/2007	Deep	0	0	0	24	0	0	3.4	0	0	77	0		Clean Harbors
SK-MW-12S	4/11/2007	Shallow	0	0	0	5.3	0	0	120	0	4.1	32	0	EBN 6.6	Clean Harbors
SK-MW-13S	4/11/2007	Shallow	0	0	0	1.2	0	0	1.2	0	0	0	0		Clean Harbors
SK-MW-B68	4/13/2007	Full	0	0	0	160	0	0	0	0	21	0	0	XYLO 9.4	Clean Harbors
SK-MW-B92	4/12/2007	Full	0	0	0	4.3	0	0	57	0	0	18	0	EBN 1.6, XYLO 1.9	Clean Harbors
SK-SW-01	4/12/2007	Surface Water	0	0	23	3.7	0	0	0	0	0	2.3	0	XYLO 2.1, TOL 1.5, EBN 2.2	Clean Harbors

Table 2-3
North Industrial Corridor (NIC) Site
Summary of PRP 2007 Groundwater Analytical Data

Station ID	Date Collected	Well Depth Zone	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds	Data Source
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
SK-SW-02	4/12/2007	Surface Water	0	0	1.5	3	0	0	0	0	0	1.6	0	TOL 2.8, EBN 2.5, XYLO 2.2	Clean Harbors
SK-SW-03	4/13/2007	Surface Water	0	0	0	0	0	0	0	0	0	0	0		Clean Harbors
SK-SW-04	4/12/2007	Surface Water	0	0	0	0	0	0	0	0	0	0	0		Clean Harbors
SK-SW-05	4/12/2007	Surface Water	0	0	0	0	0	0	0	0	0	0	0		Clean Harbors
UPRF-MW-10	4/9/2007	Shallow	0	0	0	0	0	0	0	0	0	6.9	0	NBB 6.7, XYLO 9.6, NPB 7.7, NAP 130	Clean Harbors
UPRF-MW-11	4/10/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0		Clean Harbors
UPRF-MW-14	4/9/2007	Shallow	0	0	1.5	11	0	0	0	1.3	0	12	0	XYLO 2.1, EBN 1.8, IPB 2.3, NAP 29	Clean Harbors
UPRF-MW-15	4/10/2007	Shallow	0	0	0	7.7	0	0	0	0	0	15	0	EBN 1.6	Clean Harbors
UPRF-MW-18	4/10/2007	Shallow		0	0	0	0	0	0	0	0	0	0		Clean Harbors
WNC-32DR	4/12/2007	Deep	0	0	0	37	0	0	3.2	0	0	140	0		Clean Harbors
WND-32S	4/11/2007	Shallow	0	0	0	0	5	17	0	0	0	2.1	0		Clean Harbors
UCL-MW-18	12/1/2007	Full	16	2.2	0	220	0		0.8	3.6	0	2.9	5.7	CHEA 8.3	UCL
UCL-MW-20	12/1/2007	Full	31	3.4	0	150	0		100	0.6	0	120	0	112TCA 0.6, 12DCA 0.6	UCL
UCL-MW-21	12/1/2007	Full	100	1.6	0	100	0		11	0.9	0	24	11	12DCA 1.1, 12DCB 0.8	UCL
UCL-R-02	12/1/2007	Full	0.6	0	0	5.8	0		0.3	0	0	1	0.9	CDS 0.1	UCL
UCL-R-02	12/1/2007	Full	0.8	0	0	6.7	0		0.4	0	0	1.2	1		UCL
UCL-R-03	12/1/2007	Full	25	0.3	0.6	91	0		0	2.4	0	0.4	28	12DCA 0.4, 12DCB 0.4, CDS 0.2, CHEA 0.8, MEK 1, NAP 0.3	UCL
UCL-R-03	12/1/2007	Full	23	0.4	0.6	85	0		0	2.8	0	0.4	27		UCL
UCL-R-04	12/1/2007	Full	23	0.2	0.6	34	0		0.8	0.6	0	3.5	14	IPB 0.2, MEK 3.1, MTBE 0.2, NAP 0.4	UCL
UCL-R-05	12/1/2007	Full	6.9	12	0	620	0		660	3.8	3.3	280	1.4		UCL
UCL-R-06	12/1/2007	Full	5.9	1.3	0	42	0		46	0.4	0.3	12	0.7	112TCA 0.2, 12DCA 0.2, 12DCB 0.1, TOL	UCL
UCL-R-10	12/1/2007	Full	19	3	0	290	0		3.4	1.6	0	8	3		UCL
UCL-R-11	12/1/2007	Full	110	2	0.7	160	0		0	3	0	0	29	12DCA 2.2, 12DCB 2.6	UCL
UCL-R-12	12/1/2007	Full	75	1	0	280	0		1.6	2.6	0	5.7	3.4	12DCA 1.1, CHEA 4.9	UCL
UCL-TW-04	12/1/2007	Full	15	0	52	1.4	0		0	0.6	0	0	3.6	124TMB 2.7, 12DCA 3.9, 12DCB 10, 135TMB 31, CDS 0.7, CHEA 52, EBN 38, IPB 72, MECL 1.4, MEK 8.9, NAP 310, NBB 18, TOL	UCL
USD-EMW-01	12/5/2007	Full	0	0	0	0.8	0	0	1.48	0	0	0.48	0		USD-259
USD-EMW-02	12/5/2007	Full	0	0	0	0	0	0	3.57	0	0	0	0	NAP 2.45	USD-259
USD-MW-01	12/4/2007	Full	0	0	0	0	0	0	0	0	0	0	0		USD-259
USD-MW-02S	12/4/2007	Shallow	0	0	0	0	0	0	0.55	0	0	0	0		USD-259
USD-MW-03	12/4/2007	Full	0	0	0	15.5	0	0	0.66	0	0	3.34	0		USD-259
USD-MW-04D	12/4/2007	Deep	0	0	0	10.3	0	0	0.25	0	0	1.53	0		USD-259
USD-MW-04S	12/4/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0		USD-259
USD-MW-05D	12/4/2007	Deep	0	0	0	2.92	0	0	0.33	0	0	0.72	0		USD-259
USD-MW-	12/4/2007	Shallow	0	0	0	2.29	0	0	0	0	0	0.43	0		USD-259
USD-MW-06D	12/3/2007	Deep	0	0	0	116	0	0	125	1.25	0	85.8	0.88		USD-259

Table 2-3
North Industrial Corridor (NIC) Site
Summary of PRP 2007 Groundwater Analytical Data

Station ID	Date Collected	Well Depth Zone	11DCA	11DCE	BEN	C12DCE	CT	CFM	PCE	T12DCE	111TCA	TCE	VC	Other Detected Compounds	Data Source
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
USD-MW-07R	12/5/2007	Shallow	0	0	238	0	0	0	0	0	0	0	0	124TMB 6.89, 135TMB 10.6, ACE 46.3, EBN 32.7, IPB 23.6, NAP 55.3, NBB 5.82, NPB 24.3, PIPT 2.6, SBB 6.67, TBB 1.82, TOL	USD-259
USD-MW-08R	12/5/2007	Full	0	0	0	0.63	0	0	0	0	0	0	0	124TMB 0.77, TOL 0.51	USD-259
USD-MW-09	12/5/2007	Deep	0	0	0	19.3	0	0	38.6	0	0	33.2	0	124TMB 0.79, ACE 12100, CDS 0.96, TOL	USD-259
USD-MW-10R	12/4/2007	Shallow	0	0	0	0	0	0	8.94	0	0	0	0		USD-259
USD-MW-11	12/3/2007	Full	0	0	0	0	0	0	0	0	0	0	0		USD-259
USD-MW-12	12/5/2007	Full	0	0	0	0	0	0	2.93	0	0	0	0	ACE 38.4, TOL 0.33	USD-259
USD-MW-13	12/4/2007	Shallow	0	0	0	29.6	0	0	1.79	0	0	10.4	0	14DCB 0.44, CBN 1.43	USD-259
USD-MW-14	12/3/2007		0	0	0	0	0	0	0	0	0	0	0		USD-259
USD-MW-15	12/3/2007		0	0	0	0	0	0	2.56	0	0	0	0		USD-259
USD-MW-16	12/3/2007	Full	0	0	0	0	0	0	1.9	0	0	0	0		USD-259
USD-MW-18	12/4/2007	Full	0	0	0	0.66	0	0	2.32	0	0	0	0		USD-259
USD-MW-19	12/4/2007	Full	0	0.46	0	22.3	2.22	0.55	57.5	0	0	57.1	0		USD-259
USD-TW-1	12/3/2007		0	0	0	0	0	0	0	0	0	0	0		USD-259
USD-TW-2	12/4/2007		0	0	0	0	0	0	2.52	0	0	0	0	IPB 0.74	USD-259

Primary VOC's
11DCA = 1,1-Dichloroethane
11DCE = 1,1-Dichloroethene
BEN = Benzene
C12DCE = cis-1,2-Dichloroethene
CT = Carbon tetrachloride
CFM = Chloroform
PCE = Tetrachloroethene
T12DCE = trans-1,2-Dichloroethene
111TCA = 1,1,1-Trichloroethane
TCE = Trichloroethene
VC = Vinyl chloride

Other Componds Detected
ACE = Acetone
CBN = Chlorobenzene
CDS = Carbon Disulfide
CHEA = Chloroethane
12DCA = 1,2-Dichloroethane
12DCB = 1,2-Dichlorobenzene
14DCB = 1,4-Dichlorobenzene
EBN = Ethylbenzene
EDB = 1,2-Dibromoethane (EDB)
IPB = Isopropylbenzene (cumene)
MECL = Methylene chloride
MEK = Methyl Ethyl Ketone (2-Butanone
MTBE = Methyl tert-butyl ether
NAP = Naphthalene
NBB = n-Butylbenzene
NPB = n-Propylbenzene
PIPT = p-Isopropyltoluene
SBB = sec-Butylbenzene
TBB = tert-Butylbenzene
112TCA = 1,1,2-Trichloroethane
124TMB = 1,2,4-Trimethylbenzene
135TMB = 1,3,5-Trimethylbenzene
TOL = Toluene
XYL = Xylenes (Total)
XYLMP = m,p-Xylene
XYLO = o-Xylene

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
CNE-MW-01	6/7/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	2.9	<1
CNE-MW-02	6/6/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-05	6/7/2001	<1	<1	<1	190	<1	<1	<1	-	<1	10	13
CNE-MW-05	10/10/2007	<1	<1	<1	79	<1	<1	<1	1.1	<1	32	<1
CNE-MW-06D	6/5/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-06S	6/5/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-07D	6/7/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-07S	6/7/2001	<1	<1	<1	230	<1	<1	<1	-	<1	770	12
CNE-MW-07S	10/10/2007	<1	<1	<1	7	<1	<1	<1	<1	<1	22	<1
CNE-MW-08D	6/7/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-08S	6/7/2001	<1	<1	<1	320	<1	<1	<1	-	<1	1300	59
CNE-MW-08S	10/10/2007	<1	<1	<1	300	<1	<1	<1	<1	<1	840	18
CNE-MW-09D	6/6/2001	110	8.7	<1	540	<1	<1	240	-	<1	98	44
CNE-MW-09S	6/6/2001	260	18	<1	1200	<1	<1	360	-	<1	140	100
CNE-MW-10D	6/6/2001	<1	<1	<1	4.8	<1	<1	3.4	-	<1	3.9	<1
CNE-MW-10S	6/6/2001	<1	<1	<1	2700	<1	<1	<1	-	<1	7100	190
CNE-MW-11D	6/6/2001	<1	<1	<1	4.6	<1	<1	1.4	-	<1	20	<1
CNE-MW-11D	10/10/2007	<1	<1	<1	2.1	<1	<1	<1	<1	<1	7.6	<1
CNE-MW-11S	6/6/2001	<1	<1	<1	<1	<1	<1	1.5	-	<1	7.7	<1
CNE-MW-12D	6/6/2001	<1	<1	<1	3.6	<1	<1	<1	-	<1	1.2	<1
CNE-MW-12S	6/6/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-13D	6/8/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-13S	6/8/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-14D	6/8/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-14S	6/8/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-15D	6/7/2001	<1	<1	<1	1.7	<1	<1	1.2	-	<1	4.5	<1
CNE-MW-15S	6/7/2001	<1	<1	<1	250	<1	<1	<1	-	<1	110	<1
CNE-MW-15S	10/10/2007	<1	<1	<1	140	<1	<1	1	3.7	<1	110	2.2
CNE-MW-16D	6/4/2001	7.7	<1	<1	160	<1	<1	91	-	<1	190	3.3
CNE-MW-16D	10/11/2007	90	6.2	<1	380	<1	<1	170	<1	<1	380	15
CNE-MW-16S	6/4/2001	6.9	1.5	<1	99	<1	<1	55	-	<1	89	3.9
CNE-MW-17D	6/4/2001	2.7	<1	<1	24	<1	<1	4.6	-	<1	130	<1
CNE-MW-17S	6/4/2001	<1	<1	<1	12	<1	<1	<1	-	<1	86	<1
CNE-MW-18D	6/4/2001	<1	<1	<1	12	<1	<1	<1	-	<1	77	<1
CNE-MW-18D	10/11/2007	<1	<1	<1	4.5	<1	<1	<1	<1	<1	36	<1
CNE-MW-18S	6/4/2001	<1	<1	<1	12	<1	<1	<1	-	<1	83	<1
CNE-MW-19D	6/4/2001	<1	<1	<1	29	<1	<1	<1	-	<1	220	<1
CNE-MW-19D	10/10/2007	3.1	<1	<1	22	<1	<1	9	<1	<1	83	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
CNE-MW-19S	6/4/2001	<1	<1	<1	39	<1	<1	<1	-	<1	360	<1
CNE-MW-20D	6/6/2001	<1	<1	<1	8.9	<1	<1	<1	-	<1	82	<1
CNE-MW-20D	10/10/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	6.6	<1
CNE-MW-20S	6/6/2001	<1	<1	<1	2.8	<1	<1	<1	-	<1	30	<1
CNE-MW-21D	6/4/2001	2.8	<1	<1	61	<1	<1	31	-	<1	77	1.5
CNE-MW-21D	10/11/2007	<1	<1	<1	19	<1	<1	11	<1	<1	25	<1
CNE-MW-21S	6/4/2001	<1	<1	<1	1.9	<1	<1	<1	-	<1	5.1	<1
CNE-MW-22D	6/7/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-22S	6/7/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-MW-23	6/8/2001	<1	<1	<1	29	<1	<1	56	-	<1	58	<1
CNE-MW-23	10/10/2007	1.7	<1	<1	83	<1	<1	58	1.9	<1	55	2
CNE-MW-24	6/8/2001	24	4.3	<1	250	<1	<1	170	-	<1	78	10
CNE-MW-24	10/10/2007	4.6	<1	<1	27	<1	<1	<1	<1	<1	2.1	<1
CNE-MW-25	6/7/2001	<1	<1	<1	<1	<1	<1	1.1	-	<1	<1	<1
CNE-MW-26	6/7/2001	220	17	<1	580	<1	<1	640	-	<1	130	<1
CNE-NE-01D	6/6/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-NE-01S	6/6/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-NE-02D	6/6/2001	<1	<1	<1	1.3	<1	<1	<1	-	<1	10	<1
CNE-NE-02D	10/10/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	4.1	<1
CNE-NE-02S	6/6/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	2.5	<1
CNE-NE-03D	6/6/2001	<1	<1	<1	1.3	<1	<1	<1	-	<1	9.6	<1
CNE-NE-03D	10/10/2007	<1	<1	<1	1.2	<1	<1	<1	<1	<1	6.3	<1
CNE-NE-03S	6/6/2001	<1	<1	<1	<1	<1	<1	1.8	-	<1	12	<1
CNE-NE-04D	6/5/2001	<1	<1	<1	37	<1	<1	<1	-	<1	190	<1
CNE-NE-04D	10/10/2007	<1	<1	<1	15	<1	<1	3.1	<1	<1	44	<1
CNE-NE-04S	6/5/2001	<1	<1	<1	20	<1	<1	2	-	<1	62	<1
CNE-NE-05D	6/7/2001	<1	<1	<1	2.4	<1	<1	<1	-	<1	26	<1
CNE-NE-05D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	7.9	<1
CNE-NE-05S	6/7/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	3.6	<1
CNE-NE-05S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	4.3	<1
CNE-NE-06D	6/5/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	3.2	<1
CNE-NE-06D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CNE-NE-06S	6/5/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-NE-06S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CNE-NE-07D	6/5/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-NE-07D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CNE-NE-07S	6/5/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-NE-07S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
CNE-NE-08I	6/5/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CNE-NE-08I	12/11/2007	<1	<1	<1	75	<1	<1	6.9	<1	<1	170	1.1
CNE-NE-09D	6/4/2001	<1	<1	<1	130	<1	<1	18	-	<1	580	<1
CNE-NE-09D	12/11/2007	<1	1.3	<1	23	<1	<1	3.2	<1	<1	87	<1
CNE-NE-09S	6/4/2001	<1	<1	<1	3.9	<1	<1	<1	-	<1	36	<1
CNE-NE-09S	12/11/2007	<1	<1	<1	6.5	<1	<1	<1	<1	<1	40	<1
CNE-NE-10D	6/4/2001	<1	<1	<1	16	<1	<1	<1	-	<1	65	<1
CNE-NE-10I	12/11/2007	<1	1.1	<1	18	<1	<1	1.4	<1	<1	48	<1
CNE-NE-10S	6/4/2001	<1	<1	<1	3.1	<1	<1	<1	-	<1	7.7	<1
CNE-NE-11D	6/7/2001	<1	<1	<1	5.1	<1	<1	<1	-	<1	30	<1
CNE-NE-11D	12/12/2007	<1	<1	<1	14.7	<1	<1	4.6	<1	<1	22.5	<1
CNE-NE-12I	6/4/2001	<1	<1	<1	1.1	<1	<1	<1	-	<1	10	<1
CNE-NE-12I	12/11/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CNE-OW-4	6/4/2001	<1	<1	<1	21	<1	<1	1.1	-	<1	60	<1
CSI-MW-01	12/12/2007	<1	<1	<1	2.4	<1	<1	<1	<1	<1	6.1	<1
CSI-MW-09	12/12/2007	<1	<1	<1	4.9	<1	<1	<1	<1	<1	<1	<1
CSI-MW-10	12/12/2007	<1	<1	<1	5.3	<1	<1	<1	<1	<1	<1	<1
CTC-MW-01	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-01	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CTC-MW-02	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-03	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-04D	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-04S	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-05D	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-05S	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-06D	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-06D	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.8	<1
CTC-MW-06S	6/1/2001	<1	20	<1	38	<1	<1	20	-	520	140	<1
CTC-MW-06S	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CTC-MW-07S	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-07S	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CTC-MW-08S	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-09S	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-10S	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
CTC-MW-11S	6/1/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	13	<1
DRB-MW-02	7/25/2001	<1	1.1	6.5	14	9.1	4.3	2.1	<1	<1	60	1.2
DRB-MW-02	8/25/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
DRB-MW-02	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
DRB-MW-11	7/26/2001	<1	<1	9.9	13	<1	<1	<1	<1	<1	<1	12
DRB-MW-20	7/26/2001	<1	<1	560	9.6	<1	<1	<1	<1	<1	13	<1
DRB-MW-20	8/25/2004	<1	<1	820	<1	<1	<1	<1	<1	<1	<1	<1
DRB-MW-25	12/13/2007	1.4	<1	9.2	2.1	<1	<1	<1	<1	<1	<1	<1
DRB-MW-250	7/26/2001	<1	<1	170	33	<1	<1	<1	<1	<1	<1	24
DRB-MW-250	8/25/2004	<1	<1	13	<1	<1	<1	<1	<1	<1	<1	<1
DRB-MW-30	7/25/2001	<1	<1	32	<1	<1	<1	<1	<1	<1	<1	<1
DRB-MW-30	8/25/2004	<1	<1	550	<1	<1	<1	<1	<1	<1	<1	<1
DRB-MW-30	12/13/2007	<1	<1	399	<1	<1	<1	<1	<1	<1	<1	<1
EXC-MW-02A	8/10/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.7	<1
EXC-MW-02A	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
EXC-MW-02B	8/10/2004	<1	<1	<1	2.4	<1	<1	<1	<1	<1	15	<1
EXC-MW-02B	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	7.6	<1
EXC-MW-04A	5/2/2001	2.7	15	<1	91	<1	<1	1.4	1.3	2.4	290	2.4
EXC-MW-04A	8/10/2004	<1	3.3	<1	49	<1	<1	<1	1.2	<1	88	<1
EXC-MW-04A	12/17/2007	<1	1.4	<1	37	<1	<1	<1	<1	<1	52.6	<1
EXC-MW-04B	5/2/2001	<1	1.9	<1	7	<1	<1	<1	<1	<1	39	<1
EXC-MW-04B	8/10/2004	<1	3.4	<1	7.4	<1	<1	<1	<1	<1	82	<1
EXC-MW-04B	12/17/2007	<1	1.1	<1	2.8	<1	<1	<1	<1	<1	35.2	<1
EXC-MW-05B	5/2/2001	<1	2.4	<1	8.7	<1	<1	<1	<1	<1	62	<1
EXC-MW-05B	8/10/2004	1.1	12	<1	33	<1	<1	1.4	<1	1.5	120	<1
EXC-MW-05B	12/17/2007	<1	3.8	<1	19.8	<1	<1	<1	<1	<1	119	<1
EXC-MW-06A	12/17/2007	<1	<1	<1	2.4	<1	<1	<1	<1	<1	39.6	<1
EXC-MW-06B	12/17/2007	<1	<1	<1	1.8	<1	<1	<1	<1	<1	24.4	<1
EXC-MW-07B	5/2/2001	1.3	2.1	<1	18	<1	<1	<1	<1	<1	51	<1
EXC-MW-07B	12/17/2007	1	3	<1	32.6	<1	<1	<1	<1	<1	101	1.1
EXC-MW-08A	8/10/2004	<1	1.1	<1	6.5	1.1	<1	<1	<1	<1	53	<1
EXC-MW-08B	8/10/2004	<1	4.5	<1	13	<1	<1	<1	<1	1.2	23	<1
EXC-MW-08B	12/17/2007	<1	1.7	<1	6.5	<1	<1	<1	<1	<1	70.4	<1
NMW-01D	5/1/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-01D	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-01S	5/1/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-01S	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-02D	5/2/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-02D	8/11/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.2	<1
NMW-02D	12/15/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.3	<1
NMW-02S	5/2/2001	<1	<1	<1	<1	<1	<1	41	<1	<1	<1	<1
NMW-02S	8/11/2004	<1	<1	<1	<1	<1	<1	50	<1	<1	1	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-02S	12/15/2007	<1	<1	<1	<1	<1	<1	62.5	<1	<1	1.1	<1
NMW-03D	5/9/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-03D	12/21/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1
NMW-03S	5/9/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.2	<1
NMW-03S	8/23/2004	<1	<1	<1	5.1	<1	<1	<1	<1	<1	36	<1
NMW-03S	12/15/2007	<1	<1	<1	12.2	<1	<1	<1	<1	<1	79	<1
NMW-04D	5/7/2001	5.4	8.7	1.2	42	<1	<1	<1	1.9	<1	140	14
NMW-04D	8/26/2004	4.5	9.4	<1	91	10	1.7	<1	1.6	1.3	230	6.4
NMW-04D	12/13/2007	1.3	5	<1	49.5	9.1	2.1	<1	<1	<1	133	4.1
NMW-04S	5/7/2001	5.2	5.8	2	67	1.4	1.6	<1	20	<1	60	36
NMW-04S	8/26/2004	5.2	8.1	<1	160	<1	<1	<1	5.4	<1	160	14
NMW-04S	12/13/2007	1.4	1.7	<1	69.6	<1	<1	<1	1.8	<1	85.2	10.2
NMW-05D	5/9/2001	<1	<1	<1	20	<1	<1	<1	<1	<1	14	1.6
NMW-05D	8/12/2004	<1	<1	<1	9.8	<1	<1	<1	<1	<1	8.4	6.1
NMW-05D	12/20/2007	<1	<1	<1	3	<1	<1	<1	<1	<1	1.5	<1
NMW-05S	5/9/2001	10	3.7	1.9	500	<1	<1	7.8	5.4	<1	250	86
NMW-05S	8/12/2004	1.5	<1	<1	95	<1	<1	4.7	1.6	<1	42	34
NMW-05S	12/20/2007	2.3	<1	<1	155	<1	<1	3.6	1.4	<1	44.3	35.3
NMW-06D	5/7/2001	3.6	3.3	<1	49	<1	<1	<1	<1	<1	80	24
NMW-06D	8/17/2004	3.1	2.4	<1	55	<1	<1	<1	1.2	<1	26	4.8
NMW-06D	12/13/2007	4.3	4.3	<1	57.9	<1	<1	<1	1.9	<1	38.5	<1
NMW-06S	5/7/2001	<1	<1	<1	2.1	<1	<1	<1	<1	<1	<1	<1
NMW-06S	8/17/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-06S	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-07D	5/2/2001	<1	<1	<1	1.7	<1	<1	<1	<1	<1	2.2	<1
NMW-07D	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-07S	5/2/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-07S	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-08D	5/10/2001	7.9	18	1.2	110	<1	<1	<1	11	<1	230	34
NMW-08D	8/12/2004	3.5	4.9	<1	56	<1	<1	<1	4.5	<1	91	5.8
NMW-08D	12/12/2007	2.3	7.5	<1	92.3	<1	<1	<1	4	<1	202	8
NMW-08S	5/10/2001	4.3	9.4	<1	65	<1	<1	<1	5	<1	130	17
NMW-08S	8/12/2004	2.2	3.9	<1	48	<1	<1	<1	3.2	<1	62	5.5
NMW-08S	12/12/2007	1.5	3.7	<1	73.4	<1	<1	<1	2.2	<1	63.7	3
NMW-09D	5/10/2001	8.4	27	<1	130	<1	<1	<1	20	2.3	290	25
NMW-09D	8/18/2004	2.2	6.8	<1	120	<1	<1	<1	3.8	<1	76	6.7
NMW-09D	12/10/2007	<1	<1	<1	13.8	<1	<1	<1	<1	<1	25.5	<1
NMW-09S	5/10/2001	6.8	20	<1	180	<1	<1	<1	12	<1	190	14

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-09S	8/18/2004	<1	8.6	<1	170	<1	<1	<1	5.2	<1	18	9.7
NMW-09S	12/10/2007	<1	1.6	<1	59.3	<1	<1	<1	1.3	<1	2.7	<1
NMW-10D	5/9/2001	4	6.5	<1	51	<1	1.3	<1	1.6	<1	140	20
NMW-10D	8/18/2004	3.7	5.6	<1	68	<1	1.3	<1	3.4	<1	88	12
NMW-10D	12/17/2007	2.4	6.1	<1	96.3	<1	<1	<1	3.5	<1	118	6.1
NMW-10S	5/9/2001	4.6	7.5	<1	53	<1	<1	<1	1.4	<1	150	18
NMW-10S	8/18/2004	5.3	10	<1	94	<1	1.4	<1	4.7	<1	130	<1
NMW-10S	12/17/2007	2.5	5.3	<1	85.1	<1	<1	<1	3	<1	102	4.8
NMW-11D	5/3/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-11D	8/12/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-11D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-11S	5/3/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-11S	8/12/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-11S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-12D	5/8/2001	1.9	5	<1	180	<1	<1	<1	2.6	<1	3.1	4.5
NMW-12D	4/22/2004	<1	<1	<1	71	<1	<1	<1	1.1	<1	2.3	<1
NMW-12D	7/28/2004	<1	<1	<1	73	<1	<1	<1	1.1	<1	3.2	1.8
NMW-12D	10/21/2004	<1	1.3	<1	79	<1	<1	<1	<1	<1	<1	2.3
NMW-12D	1/24/2005	<1	1.2	<1	91	<1	<1	<1	<1	<1	1.9	<1
NMW-12D	12/14/2007	<1	<1	<1	51.9	<1	<1	<1	<1	<1	4.1	<1
NMW-12S	5/8/2001	1.7	3.1	<1	88	<1	<1	<1	1.6	<1	70	2.5
NMW-12S	12/18/2007	<1	<1	<1	41.7	<1	<1	<1	<1	<1	3.2	<1
NMW-13D	5/10/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-13D	8/11/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-13D	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-13S	5/10/2001	<1	<1	320	<1	<1	<1	<1	<1	<1	<1	<1
NMW-13S	8/11/2004	1.2	<1	250	<1	<1	3.7	<1	<1	<1	1.7	<1
NMW-13S	12/14/2007	<1	<1	278	<1	<1	<1	<1	<1	<1	<1	<1
NMW-14D	5/9/2001	1.7	1.9	<1	200	<1	<1	<1	3.6	<1	8.9	2.4
NMW-14D	4/22/2004	<1	<1	<1	130	<1	<1	<1	2.6	<1	1.6	<1
NMW-14D	7/28/2004	<1	<1	<1	120	<1	<1	<1	2.4	<1	3	<1
NMW-14D	10/21/2004	<1	1.3	<1	130	<1	<1	<1	1.8	<1	2.7	<1
NMW-14D	1/24/2005	<1	<1	<1	140	<1	<1	<1	<1	<1	1.3	<1
NMW-14D	12/14/2007	<1	1.3	<1	104	<1	<1	<1	1.2	<1	1.6	<1
NMW-14S	5/9/2001	1.4	1.3	<1	130	<1	<1	<1	2.6	<1	3.8	1.7
NMW-14S	4/22/2004	<1	<1	<1	95	<1	<1	<1	2.1	<1	1.8	<1
NMW-14S	7/28/2004	<1	<1	<1	140	<1	<1	<1	2.9	<1	4	<1
NMW-14S	10/21/2004	<1	1.7	<1	170	<1	<1	<1	2.4	<1	2.7	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-14S	1/24/2005	1.2	1.4	<1	130	<1	<1	<1	<1	<1	2	<1
NMW-14S	12/14/2007	<1	<1	<1	8.5	<1	<1	<1	<1	<1	<1	<1
NMW-15D	5/8/2001	1.1	<1	<1	59	<1	<1	<1	<1	<1	20	<1
NMW-15D	4/22/2004	<1	<1	<1	51	<1	<1	1.2	1.7	<1	88	<1
NMW-15D	7/28/2004	1	<1	<1	66	<1	<1	1.7	2.4	<1	120	1.1
NMW-15D	10/21/2004	1.2	1.6	<1	76	<1	<1	1.7	2.1	<1	160	1.5
NMW-15D	1/24/2005	1.8	2.4	<1	97	<1	<1	3.2	<1	<1	170	<1
NMW-15D	12/14/2007	<1	1.7	<1	78.1	<1	<1	4.5	2	<1	140	1
NMW-15S	5/8/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-15S	4/22/2004	<1	<1	<1	<1	<1	1.2	<1	<1	<1	<1	<1
NMW-15S	7/28/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-15S	10/21/2004	<1	<1	<1	<1	<1	3.1	<1	<1	<1	<1	<1
NMW-15S	1/24/2005	<1	<1	<1	13	<1	2.4	<1	<1	<1	38	<1
NMW-15S	12/14/2007	<1	<1	<1	12.8	<1	<1	1	<1	<1	57.1	<1
NMW-16D	5/4/2001	<1	<1	<1	<1	<1	<1	7.3	<1	<1	2.4	<1
NMW-16D	8/11/2004	<1	<1	<1	<1	<1	<1	3.5	<1	<1	1.8	<1
NMW-16D	12/18/2007	<1	<1	<1	1.1	<1	<1	3.6	<1	<1	1.3	<1
NMW-16I	12/14/2007	<1	<1	<1	<1	<1	<1	3	<1	<1	1.2	<1
NMW-16S	5/4/2001	<1	<1	<1	<1	<1	<1	3.5	<1	<1	1.7	<1
NMW-16S	8/11/2004	<1	<1	<1	<1	<1	<1	2.1	<1	<1	<1	<1
NMW-16S	12/14/2007	<1	<1	<1	<1	<1	<1	1.1	<1	<1	<1	<1
NMW-17D	5/3/2001	<1	<1	<1	6.7	<1	<1	<1	<1	<1	1.4	<1
NMW-17D	12/14/2007	<1	<1	<1	2.2	<1	<1	<1	<1	<1	1.2	<1
NMW-17S	5/3/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-17S	12/21/2007	<1	<1	<1	<1	<1	2.9	<1	<1	<1	<1	<1
NMW-18D	5/8/2001	<1	<1	<1	10	<1	<1	<1	<1	<1	1.5	<1
NMW-18D	8/11/2004	<1	<1	<1	4.7	<1	<1	<1	<1	<1	1.3	<1
NMW-18D	12/21/2007	<1	<1	<1	2.3	<1	<1	<1	<1	<1	<1	<1
NMW-18S	5/8/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-18S	8/11/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-18S	12/21/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-19D	5/8/2001	1.5	3.6	<1	68	<1	<1	<1	1.4	<1	110	3.7
NMW-19D	8/11/2004	<1	1.2	<1	59	<1	<1	<1	<1	<1	9.1	2
NMW-19D	12/21/2007	<1	<1	<1	26.3	<1	<1	<1	<1	<1	1.9	<1
NMW-19S	5/8/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.7	<1
NMW-19S	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.3	<1
NMW-20D	5/3/2001	<1	<1	<1	4.5	<1	<1	<1	<1	<1	<1	<1
NMW-20D	8/12/2004	<1	<1	<1	6.2	<1	<1	<1	<1	<1	<1	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-20D	12/13/2007	<1	<1	<1	4.9	<1	<1	<1	<1	<1	<1	<1
NMW-20S	5/3/2001	<1	<1	<1	<1	<1	<1	40	<1	<1	<1	<1
NMW-20S	8/12/2004	<1	<1	<1	<1	<1	<1	25	<1	<1	<1	<1
NMW-20S	12/13/2007	<1	<1	<1	<1	<1	4.7	8.8	<1	<1	<1	<1
NMW-21D	5/4/2001	<1	<1	<1	5.8	<1	<1	<1	<1	<1	<1	<1
NMW-21D	12/13/2007	<1	<1	<1	5.7	<1	<1	<1	<1	<1	<1	<1
NMW-21S	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-21S	12/13/2007	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1
NMW-22D	5/7/2001	<1	<1	<1	2.3	<1	<1	2.8	<1	<1	1.8	<1
NMW-22D	8/12/2004	<1	<1	<1	3.8	<1	2.8	17	<1	<1	5.7	<1
NMW-22D	12/13/2007	<1	<1	<1	4.6	<1	<1	4.8	<1	<1	1.7	<1
NMW-22S	5/7/2001	<1	<1	<1	<1	<1	<1	19	<1	<1	1.7	<1
NMW-22S	8/12/2004	<1	<1	<1	<1	<1	3	<1	<1	<1	<1	<1
NMW-22S	12/18/2007	<1	<1	<1	<1	<1	<1	6.8	<1	<1	<1	<1
NMW-23D	5/3/2001	<1	<1	<1	2	<1	<1	<1	<1	<1	3.5	<1
NMW-23D	8/23/2004	<1	<1	<1	1.8	<1	<1	<1	<1	<1	1.6	<1
NMW-23D	12/19/2007	<1	<1	<1	3.7	<1	<1	<1	<1	<1	3.8	<1
NMW-23S	5/3/2001	<1	<1	<1	7.4	<1	<1	<1	<1	<1	50	<1
NMW-23S	8/23/2004	<1	<1	<1	21	<1	<1	<1	<1	<1	17	<1
NMW-23S	12/21/2007	<1	<1	<1	435	<1	<1	<1	2.3	<1	117	<1
NMW-24D	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-24D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.4	<1
NMW-24S	5/4/2001	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
NMW-24S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-25D	5/8/2001	<1	<1	<1	20	<1	<1	<1	<1	<1	19	<1
NMW-25D	7/31/2003	<1	<1	<1	42	<1	<1	<1	<1	<1	14	<1
NMW-25D	8/12/2004	<1	<1	<1	20	<1	<1	<1	<1	<1	14	<1
NMW-25D	12/12/2007	<1	<1	<1	48.9	<1	<1	<1	<1	<1	2	<1
NMW-25S	5/8/2001	<1	<1	<1	18	<1	<1	1.2	<1	<1	21	<1
NMW-25S	7/31/2003	<1	<1	<1	18	<1	<1	<1	<1	<1	9.6	<1
NMW-25S	8/12/2004	<1	<1	<1	10	<1	<1	<1	<1	<1	8.4	<1
NMW-25S	12/12/2007	<1	<1	<1	28.2	<1	<1	<1	<1	<1	4.8	<1
NMW-26D	5/8/2001	<1	<1	<1	34	<1	<1	1.2	<1	<1	11	<1
NMW-26D	7/31/2003	<1	<1	<1	50	<1	<1	2	<1	<1	3.9	<1
NMW-26D	4/21/2004	<1	<1	<1	42	<1	<1	1.5	<1	<1	3.6	<1
NMW-26D	7/28/2004	<1	<1	<1	43	<1	<1	1.6	<1	<1	2.9	<1
NMW-26D	10/21/2004	<1	<1	<1	47	<1	<1	1	1.1	<1	3.9	<1
NMW-26D	1/24/2005	<1	<1	<1	50	<1	<1	1.2	1.6	<1	7.9	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-26D	12/12/2007	<1	<1	<1	40.5	<1	<1	<1	<1	<1	3.4	<1
NMW-26S	5/8/2001	<1	<1	<1	14	<1	<1	2.2	<1	<1	13	<1
NMW-26S	7/31/2003	<1	<1	<1	23	<1	<1	2.5	<1	<1	5.5	<1
NMW-26S	4/21/2004	<1	<1	<1	26	<1	<1	2.9	<1	<1	5.1	<1
NMW-26S	7/28/2004	<1	<1	<1	15	<1	<1	2.4	<1	<1	3.2	<1
NMW-26S	10/21/2004	<1	<1	<1	16	<1	<1	3.1	<1	<1	5.4	<1
NMW-26S	1/24/2005	<1	<1	<1	16	<1	<1	2.7	<1	<1	4.2	<1
NMW-26S	12/12/2007	<1	<1	<1	14.6	<1	<1	1	<1	<1	3.8	<1
NMW-27D	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27D	4/21/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27D	7/28/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27D	10/21/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27D	1/24/2005	<1	<1	<1	1.9	<1	<1	<1	<1	<1	<1	<1
NMW-27D	12/17/2007	<1	<1	<1	5.8	<1	<1	<1	<1	<1	5.7	<1
NMW-27S	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27S	4/21/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27S	7/28/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27S	10/21/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27S	1/24/2005	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-27S	12/17/2007	<1	<1	<1	4.4	<1	<1	<1	<1	<1	4.2	<1
NMW-28D	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-28D	4/21/2004	<1	<1	<1	3.9	<1	<1	<1	<1	<1	6.1	<1
NMW-28D	7/28/2004	<1	<1	<1	4.9	<1	<1	<1	<1	<1	6.3	<1
NMW-28D	10/21/2004	1.1	1	<1	4.9	<1	<1	<1	<1	<1	6.9	<1
NMW-28D	1/24/2005	1.2	<1	<1	5.7	<1	<1	<1	<1	<1	7.8	<1
NMW-28D	12/12/2007	1.4	1.2	<1	18.3	<1	<1	<1	<1	<1	11.2	<1
NMW-28S	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-28S	4/21/2004	<1	<1	<1	3.6	<1	<1	<1	<1	<1	<1	<1
NMW-28S	7/28/2004	<1	<1	<1	2.9	<1	<1	<1	<1	<1	<1	<1
NMW-28S	10/21/2004	<1	<1	<1	4.9	<1	<1	1	<1	<1	<1	<1
NMW-28S	1/24/2005	<1	<1	<1	7.1	<1	<1	<1	<1	<1	<1	<1
NMW-28S	12/12/2007	<1	<1	<1	7.1	<1	<1	<1	<1	<1	<1	<1
NMW-29D	5/8/2001	1.4	1	<1	9.1	<1	<1	<1	<1	<1	18	<1
NMW-29D	7/31/2003	<1	<1	<1	12	<1	<1	<1	<1	<1	16	<1
NMW-29D	4/21/2004	<1	<1	<1	12	<1	<1	<1	<1	<1	11	<1
NMW-29D	7/28/2004	1	<1	<1	14	<1	<1	<1	1.1	<1	11	<1
NMW-29D	10/21/2004	1.3	1.2	<1	17	<1	<1	1.1	<1	<1	13	<1
NMW-29D	1/24/2005	<1	<1	<1	22	<1	<1	<1	1.2	<1	12	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-29D	12/12/2007	<1	<1	<1	23.2	<1	<1	<1	1.9	<1	10.9	<1
NMW-29S	5/8/2001	<1	<1	<1	2.9	<1	<1	<1	<1	<1	6.2	<1
NMW-29S	7/31/2003	<1	<1	<1	5.4	<1	<1	<1	<1	1	7.1	<1
NMW-29S	4/21/2004	<1	<1	<1	4.7	<1	<1	<1	<1	<1	4.9	<1
NMW-29S	7/28/2004	<1	<1	<1	6.7	<1	<1	<1	<1	<1	6	<1
NMW-29S	10/21/2004	<1	<1	<1	7	<1	<1	1.2	<1	<1	6.5	<1
NMW-29S	1/24/2005	<1	<1	<1	3.6	<1	<1	<1	<1	<1	3.7	<1
NMW-29S	12/12/2007	<1	<1	<1	7.4	<1	<1	<1	<1	<1	4.5	<1
NMW-30D	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-30D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-30S	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-30S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-31D	5/9/2001	1.9	1	<1	43	<1	<1	4	5.2	<1	200	3.3
NMW-31D	8/11/2004	4.6	2.5	<1	98	<1	<1	17	3.9	<1	260	8.1
NMW-31D	12/14/2007	1.7	1.6	<1	61	<1	<1	93.8	1.5	<1	184	3.5
NMW-31S	5/9/2001	<1	<1	<1	11	<1	<1	3	1.3	<1	55	<1
NMW-31S	8/11/2004	1.4	<1	<1	23	<1	<1	5.5	<1	<1	59	<1
NMW-31S	12/14/2007	<1	<1	<1	25.1	<1	<1	44.2	<1	<1	57.7	<1
NMW-32D	5/8/2001	2.1	2.3	<1	55	<1	<1	5.2	3	<1	270	3.1
NMW-32D	8/11/2004	1.3	2.3	<1	43	<1	<1	6.4	2.8	<1	210	1.4
NMW-32D	12/18/2007	1.2	2.6	<1	45.4	<1	<1	5.8	1.9	<1	200	2.1
NMW-32S	5/8/2001	1.7	1.6	<1	40	<1	<1	4.5	2.7	<1	220	2.3
NMW-32S	8/11/2004	<1	1.1	<1	24	<1	<1	8.7	1.6	<1	180	<1
NMW-32S	12/18/2007	<1	1.5	<1	26.1	<1	<1	6.8	1.2	<1	131	1.1
NMW-33D	5/7/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-33D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-33S	5/7/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-33S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-34D	5/7/2001	<1	<1	<1	11	<1	<1	<1	<1	<1	55	2.3
NMW-34D	3/28/2005	<1	<1	<1	11	<1	<1	<1	<1	<1	34	<1
NMW-34D	12/18/2007	1.8	<1	<1	3.3	<1	<1	<1	<1	<1	11.6	<1
NMW-34S	5/7/2001	<1	<1	<1	62	<1	<1	<1	2.4	<1	30	23
NMW-34S	3/28/2005	<1	<1	<1	37	<1	<1	<1	<1	<1	14	<1
NMW-34S	12/18/2007	<1	<1	<1	56.5	<1	<1	<1	<1	<1	2.7	3.6
NMW-35D	5/8/2001	2.5	5.7	<1	95	<1	<1	<1	3	<1	270	4.5
NMW-35D	8/12/2004	1.8	6.2	<1	74	<1	<1	<1	2.8	<1	170	1.7
NMW-35D	12/13/2007	1	2.6	<1	94	<1	<1	<1	2	<1	52.2	1.8
NMW-35S	5/8/2001	<1	1.5	<1	29	<1	<1	<1	<1	<1	68	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-35S	8/12/2004	<1	<1	<1	13	<1	<1	<1	<1	<1	35	<1
NMW-35S	12/13/2007	<1	<1	<1	20.3	<1	<1	<1	<1	<1	32.5	<1
NMW-36D	7/27/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	5.8	<1
NMW-36D	8/24/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	16	<1
NMW-36D	12/18/2007	<1	<1	<1	2.5	<1	<1	<1	<1	<1	59.1	<1
NMW-37D	7/27/2001	<1	<1	<1	17	<1	<1	1.3	<1	<1	66	<1
NMW-37D	8/24/2004	<1	<1	<1	13	<1	<1	<1	<1	<1	110	<1
NMW-37D	12/18/2007	<1	<1	<1	28.6	<1	<1	2.4	<1	<1	222	<1
NMW-38D	7/27/2001	<1	<1	<1	1.2	<1	<1	<1	<1	<1	9.9	<1
NMW-38D	12/18/2007	<1	<1	<1	2	<1	<1	<1	<1	<1	37	<1
NMW-39D	5/9/2001	6.2	16	1.6	260	<1	<1	<1	13	1.5	76	18
NMW-39D	8/17/2004	2.6	9.4	<1	93	<1	<1	<1	3.6	<1	110	2.9
NMW-39D	12/14/2007	<1	1.6	<1	39.7	<1	<1	<1	<1	<1	37	2.2
NMW-39I	12/14/2007	<1	1.8	<1	40.6	<1	<1	<1	<1	<1	32.3	2.6
NMW-39S	5/9/2001	8	24	<1	320	<1	<1	<1	17	<1	37	25
NMW-39S	8/17/2004	4.2	3.7	<1	110	<1	<1	<1	3.9	<1	5.6	8
NMW-39S	12/18/2007	<1	2.8	<1	87.3	<1	<1	<1	1.8	<1	1.1	6.9
NMW-40D	5/8/2001	5.2	7.7	2.6	56	<1	<1	<1	4	<1	150	22
NMW-40D	8/31/2004	4	5.6	<1	74	<1	<1	<1	3.8	<1	110	8.8
NMW-40S	5/8/2001	7.2	14	<1	77	<1	<1	<1	10	<1	190	25
NMW-40S	8/31/2004	2.6	2.6	<1	42	<1	<1	<1	3.2	<1	73	3.5
NMW-41D	5/8/2001	2	4	<1	38	<1	<1	<1	2.6	<1	170	5.7
NMW-41D	8/12/2004	1.2	3.6	<1	38	<1	<1	<1	1.6	<1	130	3.9
NMW-41D	12/12/2007	<1	1.6	<1	29.5	<1	<1	<1	<1	<1	81.6	2.3
NMW-41S	5/8/2001	1.7	3.2	<1	55	<1	<1	<1	2.2	<1	250	3.8
NMW-41S	8/12/2004	<1	2.7	<1	38	<1	<1	<1	1.3	<1	92	2.2
NMW-41S	12/12/2007	<1	<1	<1	24.4	<1	<1	<1	<1	<1	44.3	1.5
NMW-42D	7/26/2001	<1	1.1	<1	35	1.4	<1	2.2	<1	<1	99	1.1
NMW-42D	8/25/2004	2.1	<1	<1	22	<1	<1	21	<1	1.2	22	6.2
NMW-42D	12/14/2007	<1	<1	<1	29.8	<1	<1	2.6	<1	<1	77.7	<1
NMW-42S	7/25/2001	<1	1.3	<1	16	5.5	8.6	13	<1	1.3	62	1.4
NMW-42S	8/25/2004	4.2	1.3	<1	26	<1	<1	38	<1	<1	32	7.1
NMW-42S	12/14/2007	<1	<1	<1	12.1	1.6	3.2	6.7	<1	<1	31.7	<1
NMW-43D	7/25/2001	<1	<1	82	64	<1	<1	<1	<1	<1	8.4	15
NMW-43D	8/25/2004	<1	<1	<1	37	<1	<1	<1	<1	<1	50	1.6
NMW-43D	12/13/2007	<1	<1	<1	64.3	<1	<1	<1	<1	<1	21.1	<1
NMW-44D	7/26/2001	<1	1.6	8.5	39	<1	<1	<1	<1	<1	13	18
NMW-44D	8/25/2004	7.3	2.2	2	65	<1	<1	67	<1	4.4	56	8.8

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-44D	12/13/2007	<1	<1	<1	21.2	<1	<1	2.4	<1	<1	77.2	<1
NMW-45D	7/26/2001	<1	<1	11	17	<1	<1	<1	<1	<1	32	<1
NMW-45D	8/25/2004	1	<1	3.6	23	<1	<1	3.9	<1	<1	15	5.2
NMW-45D	12/17/2007	<1	<1	3.6	11.4	<1	<1	<1	<1	<1	14.1	<1
NMW-46D	7/25/2001	<1	<1	1.9	43	<1	<1	<1	<1	<1	6.9	4.4
NMW-47D	5/9/2001	2.5	1.1	<1	270	<1	<1	<1	<1	<1	77	33
NMW-47D	8/11/2004	<1	<1	<1	21	<1	<1	<1	<1	<1	87	<1
NMW-47D	12/15/2007	<1	<1	<1	70.5	<1	<1	<1	<1	<1	11.7	13.8
NMW-47S	5/9/2001	<1	<1	<1	62	<1	<1	<1	<1	<1	25	11
NMW-47S	8/11/2004	1.1	<1	<1	96	<1	<1	<1	1.9	<1	76	7.9
NMW-47S	12/15/2007	1.6	<1	<1	149	<1	<1	1.1	2.6	<1	37.9	19.4
NMW-48D	7/27/2001	<1	<1	<1	5.7	<1	<1	<1	<1	<1	5	3.4
NMW-48D	8/12/2004	<1	<1	<1	6.3	<1	<1	<1	<1	<1	1.4	<1
NMW-48D	1/11/2008	<1	<1	<1	1.9	<1	<1	<1	<1	<1	1.3	<1
NMW-48S	7/27/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-48S	8/12/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-48S	1/11/2008	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-49D	4/21/2004	<1	<1	<1	16	<1	<1	<1	<1	<1	36	<1
NMW-49D	7/28/2004	<1	<1	<1	13	<1	<1	<1	<1	<1	12	<1
NMW-49D	10/21/2004	<1	<1	<1	13	<1	<1	<1	<1	<1	15	<1
NMW-49D	1/24/2005	<1	<1	<1	18	<1	<1	<1	<1	<1	26	<1
NMW-49D	12/17/2007	1.3	1	<1	60	<1	<1	<1	1.4	<1	57.8	1.4
NMW-49S	4/21/2004	<1	<1	<1	3.5	<1	<1	<1	<1	<1	2.6	<1
NMW-49S	7/28/2004	<1	<1	<1	3.9	<1	<1	<1	<1	<1	3.6	<1
NMW-49S	10/21/2004	<1	<1	<1	3.2	<1	<1	<1	<1	<1	4	<1
NMW-49S	1/24/2005	<1	<1	<1	4.2	<1	<1	<1	<1	<1	4.6	<1
NMW-49S	12/17/2007	<1	<1	<1	5	<1	<1	<1	<1	<1	2.2	<1
NMW-50D	4/21/2004	<1	<1	<1	2.8	<1	<1	<1	<1	<1	2.2	<1
NMW-50D	7/28/2004	<1	<1	<1	4.9	<1	<1	<1	<1	<1	3	<1
NMW-50D	10/21/2004	<1	<1	<1	9.4	<1	<1	<1	<1	<1	15	<1
NMW-50D	1/24/2005	<1	<1	<1	9.1	<1	<1	<1	<1	<1	19	<1
NMW-50D	12/19/2007	<1	<1	<1	12.3	<1	<1	<1	<1	<1	16.9	<1
NMW-50S	4/21/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-50S	7/28/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-50S	10/21/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-50S	1/24/2005	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-50S	12/19/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-51D	4/21/2004	<1	<1	<1	2	<1	<1	<1	<1	<1	<1	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NMW-51D	7/28/2004	<1	<1	<1	2.4	<1	<1	<1	<1	<1	<1	<1
NMW-51D	10/21/2004	1.3	1.2	<1	3.8	<1	<1	<1	<1	<1	1.5	<1
NMW-51D	1/24/2005	2	1.7	<1	5.8	<1	<1	<1	<1	<1	3	<1
NMW-51D	12/13/2007	3.2	2.2	<1	33.8	<1	<1	2.1	1	<1	36.4	4.6
NMW-51S	4/21/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NMW-51S	7/28/2004	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1	<1
NMW-51S	10/21/2004	<1	<1	<1	1.8	<1	<1	<1	<1	<1	<1	<1
NMW-51S	1/24/2005	<1	<1	<1	3.4	<1	<1	<1	<1	<1	<1	<1
NMW-51S	12/13/2007	2.3	1.3	<1	20.6	<1	<1	8.3	<1	<1	17.2	1.7
NWL-01D	12/13/2007	1.6	1.3	3.9	53.1	<1	<1	<1	<1	<1	9.1	<1
NWL-01S	12/13/2007	1.5	<1	1.7	7.9	<1	<1	<1	<1	<1	2.4	<1
NWL-02D	12/14/2007	1.4	<1	<1	32	<1	<1	<1	<1	<1	3.2	4.2
NWL-02S	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-04S	12/12/2007	<1	<1	<1	1.1	<1	<1	<1	<1	<1	1.9	<1
NWL-05S	12/13/2007	<1	<1	<1	4	<1	<1	<1	<1	<1	2	<1
NWL-06S	8/17/2004	<1	<1	<1	<1	<1	6	<1	<1	<1	<1	<1
NWL-06S	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-07D	12/10/2007	2.5	1.8	<1	47.1	<1	<1	<1	1.3	<1	40.4	4.1
NWL-07S	12/10/2007	1.6	1.2	<1	33	<1	<1	<1	<1	<1	32.6	3.3
NWL-08D	12/12/2007	1.9	5.7	<1	76.5	<1	<1	<1	2.6	<1	130	3.4
NWL-08S	12/12/2007	2	4.8	<1	124	<1	<1	<1	2.7	<1	40	2.2
NWL-09D	8/17/2004	<1	<1	<1	13	<1	<1	<1	<1	<1	5.1	<1
NWL-09D	12/12/2007	<1	<1	<1	21.8	<1	<1	<1	<1	<1	3.9	<1
NWL-09S	8/17/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-09S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-10S	12/12/2007	<1	<1	<1	<1	<1	<1	2.6	<1	<1	<1	<1
NWL-11S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-14S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-16S	12/15/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	5.1	<1
NWL-17S	12/17/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-18S	12/18/2007	<1	<1	290	28.7	<1	<1	<1	<1	<1	29.3	<1
NWL-19S	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-20S	12/18/2007	<1	<1	344	<1	<1	<1	<1	<1	<1	<1	<1
NWL-21S	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
NWL-23S	12/14/2007	<1	<1	<1	4.2	<1	<1	2.1	<1	<1	7.4	<1
NWL-24S	12/13/2007	<1	<1	164	<1	<1	<1	<1	<1	<1	<1	<1
NWL-25S	12/14/2007	<1	<1	<1	17.6	<1	<1	<1	<1	<1	6.6	<1
NWL-26S	12/14/2007	<1	<1	<1	7.2	<1	<1	<1	<1	<1	12	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
NWL-29S	12/14/2007	2	<1	<1	29.2	<1	<1	4	<1	<1	28.7	1.4
NWL-30S	12/21/2007	<1	<1	<1	4.9	<1	<1	<1	<1	<1	28.1	<1
VCM-MW-01	5/2/2001	1.5	<1	<1	17	<1	<1	<1	1.4	<1	9.2	<1
VCM-MW-01	7/31/2003	<1	<1	<1	20	<1	<1	<1	<1	<1	8.5	<1
VCM-MW-01	8/31/2004	<1	<1	<1	8.4	<1	<1	<1	<1	<1	3.5	<1
VCM-MW-01	12/21/2007	<1	<1	<1	11	<1	<1	<1	<1	<1	1.2	<1
VCM-MW-02B	5/2/2001	<1	<1	<1	7.5	<1	<1	<1	<1	<1	15	<1
VCM-MW-02B	8/31/2004	<1	1.2	<1	55	<1	<1	<1	1.4	<1	41	<1
VCM-MW-02B	12/21/2007	1.4	2.7	<1	105	<1	<1	<1	2.6	<1	31.3	1.5
VCM-MW-03	5/2/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
VCM-MW-03	12/21/2007	<1	<1	<1	2	<1	<1	<1	<1	<1	2.3	<1
VCM-MW-04	5/2/2001	1.7	<1	<1	28	<1	<1	<1	2	<1	11	<1
VCM-MW-04	7/31/2003	<1	<1	<1	50	<1	<1	<1	<1	<1	5.5	<1
VCM-MW-04	8/31/2004	<1	<1	<1	34	<1	<1	<1	<1	<1	3.6	<1
VCM-MW-04	12/21/2007	1.2	1	<1	62.3	<1	<1	<1	1	<1	3.3	1.1
VCM-MW-06	5/2/2001	1.4	1	<1	37	<1	<1	<1	2.4	<1	71	1.7
VCM-MW-06	8/31/2004	1.2	1.6	<1	89	<1	<1	<1	1.9	<1	36	<1
VCM-MW-07	5/2/2001	<1	<1	<1	6	<1	<1	<1	<1	<1	6.1	<1
VCM-MW-07	8/31/2004	<1	<1	<1	3.8	<1	<1	<1	<1	<1	5.4	<1
VCM-MW-07	12/21/2007	<1	<1	<1	5.4	<1	<1	<1	<1	<1	5.6	<1
WNC-05D	5/10/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-05D	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-06D	5/1/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-06D	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-09D	5/2/2001	<1	<1	1.1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-09D	8/10/2004	<1	<1	<1	6.8	<1	<1	<1	<1	<1	13	<1
WNC-09D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-09S	1/11/2008	<1	<1	2.2	<1	<1	<1	<1	<1	<1	<1	-
WNC-09SR	5/2/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-09SR	8/10/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-10D	5/1/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-10D	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WNC-11D	5/9/2001	<1	<1	<1	1.6	<1	<1	<1	<1	<1	31	<1
WNC-11D	12/17/2007	2.6	1.4	<1	1.5	<1	<1	<1	<1	2.8	19.1	<1
WNC-16D	5/10/2001	<1	<1	<1	3.2	<1	<1	<1	<1	<1	6.4	<1
WNC-16D	8/23/2004	<1	<1	<1	3.7	<1	<1	<1	<1	<1	5.8	<1
WNC-16D	12/20/2007	<1	<1	<1	2.6	<1	<1	<1	<1	<1	10.8	<1
WNC-23D	5/8/2001	<1	1.1	<1	3.7	<1	<1	<1	<1	<1	33	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
WNC-23D	8/10/2004	1	1.5	<1	3.1	<1	<1	<1	<1	2.1	33	<1
WNC-23D	12/17/2007	<1	<1	<1	1.9	<1	<1	<1	<1	<1	6.5	<1
WNC-31D	7/27/2001	<1	<1	<1	7.8	<1	<1	<1	<1	<1	48	<1
WNC-31D	8/24/2004	<1	<1	<1	22	<1	<1	3.7	<1	<1	110	<1
WNC-31D	12/18/2007	<1	<1	<1	50.7	<1	<1	4.2	<1	<1	124	<1
WNC-32D	7/27/2001	<1	<1	<1	12	<1	<1	1.1	<1	<1	69	<1
WNC-32D	11/13/2001	<1	<1	<1	17	<1	<1	<1	-	<1	110	<1
WNC-32D	12/18/2007	<1	<1	<1	29.2	<1	<1	3.8	<1	<1	92.2	<1
WNC-37SR	5/7/2001	<1	<1	<1	22	<1	<1	<1	<1	<1	37	<1
WNC-37SR	8/26/2004	4	1.2	<1	19	<1	<1	<1	1.5	<1	28	1.6
WNC-37SR	12/20/2007	1.4	1.8	<1	59	<1	<1	<1	3.8	<1	42.3	5.9
WNC-49SR	5/10/2001	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
WND-01S	5/8/2001	8.6	19	<1	180	<1	<1	<1	<1	14	380	5.1
WND-01S	6/1/2001	<1	27	<1	300	<1	<1	<1	-	<1	550	<1
WND-01S	12/19/2007	<1	1.4	<1	5.1	<1	<1	<1	<1	28.2	24.1	<1
WND-02D	5/10/2001	<1	<1	<1	6.9	<1	<1	<1	<1	<1	6.9	2.3
WND-02D	8/12/2004	<1	<1	<1	7.4	<1	<1	<1	<1	<1	3.4	1.5
WND-02D	12/13/2007	<1	<1	<1	4	<1	<1	<1	<1	<1	<1	<1
WND-02S	5/10/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-02S	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-03S	5/2/2001	2.5	12	5.7	240	<1	<1	<1	<1	<1	30	46
WND-03S	8/10/2004	2.1	<1	4.8	30	<1	<1	<1	1.7	<1	19	36
WND-03S	12/17/2007	1.6	<1	5.2	36.4	<1	<1	<1	<1	<1	<1	<1
WND-04S	5/2/2001	<1	5.1	<1	41	<1	<1	<1	<1	1.5	120	<1
WND-04S	8/10/2004	<1	4.2	<1	46	<1	<1	<1	<1	1.5	130	1
WND-04S	12/17/2007	<1	2.4	<1	39.8	<1	<1	<1	<1	<1	131	<1
WND-05S	5/10/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-05S	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-06S	5/1/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-06S	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-07S	5/9/2001	<1	<1	<1	6.4	<1	<1	<1	<1	<1	5.4	<1
WND-07S	12/19/2007	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1	<1
WND-08S	5/8/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	5.5	<1
WND-08S	6/7/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	2.4	<1
WND-08S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.1	<1
WND-10S	5/1/2001	<1	<1	<1	<1	1.5	<1	<1	<1	<1	<1	<1
WND-10S	12/21/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-11D	3/28/2005	<1	<1	<1	2	<1	<1	<1	<1	<1	28	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
WND-11S	5/9/2001	5.4	1.8	<1	56	<1	<1	<1	1	<1	7	3.8
WND-11S	9/10/2004	<1	<1	<1	9.8	<1	<1	<1	<1	<1	<1	<1
WND-11S	3/28/2005	<1	<1	<1	5.1	<1	<1	<1	<1	<1	<1	<1
WND-11S	12/17/2007	<1	<1	<1	5.9	<1	<1	<1	<1	<1	<1	<1
WND-12D	5/3/2001	<1	<1	<1	1.4	<1	<1	<1	<1	<1	18	<1
WND-12D	8/10/2004	<1	<1	<1	<1	<1	<1	<1	<1	2.1	10	<1
WND-12D	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	10.5	<1
WND-12S	5/3/2001	43	33	<1	3.7	<1	<1	<1	<1	1.5	1.4	7.1
WND-12S	3/28/2005	<1	11	<1	2.2	<1	<1	<1	<1	<1	<1	<1
WND-12S	12/12/2007	5.7	17.7	<1	1.8	<1	<1	<1	<1	<1	<1	5
WND-14D	5/7/2001	<1	<1	<1	11	<1	<1	1.4	<1	<1	51	<1
WND-14D	8/12/2004	1.1	1	<1	96	<1	<1	21	<1	<1	330	<1
WND-14D	12/18/2007	<1	<1	<1	61.7	<1	<1	11	<1	<1	201	<1
WND-14S	5/7/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-14S	8/12/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-14S	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-15D	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-15D	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-15S	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-15S	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-16S	5/10/2001	<1	<1	25	<1	<1	<1	<1	<1	<1	<1	<1
WND-16S	8/11/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-18D	5/9/2001	4.8	14	<1	80	<1	<1	<1	2.4	<1	170	15
WND-18D	8/12/2004	1.4	4.2	<1	52	<1	<1	<1	1.5	<1	75	3.7
WND-18D	12/18/2007	<1	1.1	<1	24.4	<1	<1	<1	<1	<1	31.1	1.1
WND-18S	5/9/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-18S	8/12/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-18S	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-19D	5/9/2001	1.7	5.2	<1	37	<1	<1	<1	1.3	<1	150	5.5
WND-19D	8/12/2004	<1	1.8	<1	20	<1	<1	<1	<1	<1	78	1.8
WND-19D	12/10/2007	<1	<1	<1	10	<1	<1	<1	<1	<1	32.7	<1
WND-19S	5/9/2001	<1	<1	<1	1.6	<1	<1	<1	<1	<1	14	<1
WND-19S	8/12/2004	<1	<1	<1	2.4	<1	<1	<1	<1	<1	14	<1
WND-19S	12/10/2007	<1	<1	<1	1.1	<1	<1	<1	<1	<1	6.9	<1
WND-20S	5/8/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-20S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-21D	5/4/2001	7.5	21	5.2	86	1.5	1.6	<1	12	2.9	230	22
WND-21D	8/20/2004	2.5	8.2	<1	85	<1	1	<1	4.2	1.3	230	3.3

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
WND-21D	12/21/2007	<1	4	<1	45.4	<1	<1	<1	1	<1	139	1.5
WND-21S	5/4/2001	1.2	3.1	<1	55	<1	<1	<1	1.7	<1	2.9	1.4
WND-21S	8/20/2004	1	2.1	<1	66	<1	<1	<1	1.3	<1	6.6	<1
WND-21S	12/21/2007	<1	1.7	<1	53.4	<1	<1	<1	<1	<1	10.8	<1
WND-22D	5/1/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-22D	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-22S	5/1/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-22S	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-23S	5/8/2001	<1	<1	<1	5.2	<1	<1	<1	<1	<1	9.5	<1
WND-23S	8/10/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	4.7	<1
WND-23S	12/17/2007	<1	<1	<1	1	<1	<1	<1	<1	<1	3.1	<1
WND-24D	5/9/2001	1.7	3.1	<1	44	<1	<1	<1	1.1	<1	130	6.8
WND-24D	8/18/2004	1.9	2.2	1.5	46	<1	<1	<1	<1	<1	82	3.8
WND-24D	12/13/2007	1.9	<1	<1	42.4	<1	<1	<1	<1	<1	36.7	<1
WND-24S	5/9/2001	<1	<1	<1	24	<1	<1	<1	<1	<1	79	<1
WND-24S	8/18/2004	<1	<1	<1	6.5	<1	2.3	<1	<1	<1	15	<1
WND-24S	12/13/2007	<1	<1	<1	9.9	<1	<1	<1	<1	<1	17.1	<1
WND-25D	5/10/2001	<1	1.7	<1	3.7	<1	<1	<1	<1	<1	56	<1
WND-25D	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	6.4	<1
WND-25S	5/10/2001	<1	<1	<1	1.2	<1	1.8	<1	<1	<1	46	<1
WND-25S	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	11.2	<1
WND-26D	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	6.4	<1
WND-26D	8/20/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	4.6	<1
WND-26D	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	4.4	<1
WND-26S	5/4/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-26S	8/20/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-26S	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-27S	5/9/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-27S	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-28S	5/1/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-28S	12/12/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-29D	5/3/2001	<1	<1	<1	<1	1.3	<1	<1	<1	<1	4.6	<1
WND-29D	5/15/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	6.2	<1
WND-29D	8/23/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.6	<1
WND-29D	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.5	<1
WND-29S	5/3/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.1	<1
WND-29S	5/15/2001	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1
WND-29S	8/23/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
WND-29S	12/14/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-30D	7/25/2001	<1	1.1	3.3	17	7.4	3.5	1.9	<1	<1	53	1.2
WND-30D	8/25/2004	<1	<1	<1	9	9.2	1.7	1.3	<1	<1	45	<1
WND-30D	12/14/2007	<1	<1	<1	24.9	1.1	<1	2.4	<1	<1	63.3	<1
WND-31S	5/7/2001	<1	<1	<1	<1	<1	24.3	<1	-	<1	2.3	<1
WND-31S	7/27/2001	<1	<1	<1	<1	<1	6.6	<1	<1	<1	3.2	<1
WND-31S	8/24/2004	<1	<1	<1	<1	<1	39	<1	<1	<1	1.7	<1
WND-31S	12/21/2007	<1	<1	<1	2.1	<1	3.6	<1	<1	<1	7.4	<1
WND-32S	5/7/2001	<1	<1	<1	<1	7.3	23.5	<1	-	<1	6.7	<1
WND-32S	7/27/2001	<1	<1	<1	1	12	39	<1	<1	<1	9.7	<1
WND-32S	11/11/2001	<1	<1	<1	1.1	6.6	32	<1	-	<1	11	<1
WND-32S	12/18/2007	<1	<1	<1	<1	<1	3.2	<1	<1	<1	<1	<1
WND-33D	5/7/2001	4.3	<1	<1	72	<1	<1	<1	<1	<1	43	<1
WND-33D	12/12/2007	2.8	1.4	<1	40.2	<1	<1	<1	<1	<1	5.6	<1
WND-33S	5/7/2001	3.5	2.4	<1	100	<1	<1	<1	1.9	<1	160	9.4
WND-33S	8/17/2004	1.6	<1	<1	22	<1	<1	<1	<1	<1	37	1.4
WND-34D	5/4/2001	1.7	1.4	64	23	<1	<1	<1	<1	<1	32	<1
WND-34D	8/18/2004	2.6	<1	110	30	<1	<1	<1	<1	<1	10	<1
WND-34D	12/13/2007	1.3	<1	101	23	<1	<1	<1	<1	<1	5.4	<1
WND-34S	5/4/2001	2.3	<1	160	7.3	<1	<1	<1	<1	<1	11	5
WND-34S	8/18/2004	2.9	<1	100	1.3	<1	<1	<1	<1	<1	<1	<1
WND-34S	12/13/2007	<1	<1	167	<1	<1	<1	<1	<1	<1	<1	<1
WND-36D	5/4/2001	2.2	2.5	1.2	49	<1	<1	<1	1.1	<1	44	15
WND-36D	8/18/2004	<1	<1	<1	18	<1	<1	12	<1	<1	66	<1
WND-36D	12/20/2007	1.8	1.6	1.7	21.8	<1	<1	<1	<1	<1	27.2	1.9
WND-36S	5/4/2001	4.6	<1	100	1.1	<1	<1	<1	<1	<1	3.2	<1
WND-36S	8/18/2004	2.9	<1	290	<1	<1	<1	<1	<1	<1	<1	<1
WND-36S	12/20/2007	<1	<1	295	<1	<1	<1	<1	<1	<1	<1	<1
WND-37A_D	5/7/2001	5.3	11	3.3	37	<1	<1	<1	2.8	<1	120	<1
WND-37DR	8/26/2004	5.8	9.7	1.2	73	<1	<1	<1	3.4	<1	130	8.1
WND-37DR	12/20/2007	3.6	5.5	<1	56.1	<1	<1	<1	1.9	<1	108	6.7
WND-38D	5/8/2001	<1	<1	<1	8.1	<1	<1	<1	<1	<1	22	<1
WND-38D	8/17/2004	<1	2	<1	26	<1	<1	<1	<1	<1	36	2.4
WND-38D	12/10/2007	<1	<1	<1	13.9	<1	<1	<1	<1	<1	20.2	<1
WND-38S	5/8/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.3	<1
WND-38S	8/17/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1
WND-38S	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.1	<1
WND-39D	5/8/2001	2.5	1.3	<1	13	<1	<1	<1	<1	<1	32	1.8

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
WND-39D	8/17/2004	1.5	1.9	<1	40	<1	<1	<1	1.3	<1	64	2.5
WND-39D	12/21/2007	2.5	1.2	<1	42.9	<1	<1	<1	<1	<1	26.9	<1
WND-39S	5/8/2001	<1	<1	<1	3	<1	<1	<1	<1	<1	29	<1
WND-39S	8/17/2004	<1	<1	<1	15	<1	<1	<1	<1	<1	50	<1
WND-39S	12/21/2007	<1	<1	<1	3.4	<1	<1	<1	<1	<1	21.4	<1
WND-40D	5/2/2001	1.9	6.2	<1	21	<1	<1	1.4	<1	9.5	54	<1
WND-40D	3/28/2005	<1	<1	<1	25	<1	<1	<1	1.9	<1	29	<1
WND-40D	12/19/2007	<1	<1	<1	34.2	<1	<1	<1	<1	<1	15.2	<1
WND-40S	5/2/2001	1.8	6	<1	9.6	<1	<1	<1	<1	9.7	36	<1
WND-41D	5/3/2001	<1	<1	<1	4.2	<1	<1	3.2	<1	<1	45	<1
WND-41D	8/24/2004	<1	<1	<1	8.4	<1	<1	1.8	<1	<1	39	<1
WND-41D	12/21/2007	<1	<1	<1	4.2	<1	<1	1.6	<1	<1	20.9	<1
WND-41S	5/3/2001	<1	<1	<1	<1	<1	<1	2.3	<1	<1	7.2	<1
WND-41S	8/24/2004	<1	<1	<1	<1	<1	<1	1.5	<1	<1	2.1	<1
WND-41S	12/19/2007	<1	<1	<1	<1	<1	<1	1.6	<1	<1	<1	<1
WND-42D	5/3/2001	<1	<1	<1	41	<1	<1	<1	1.6	<1	3.3	2
WND-42D	7/31/2003	<1	<1	<1	53	<1	<1	<1	<1	<1	1.6	<1
WND-42D	12/19/2007	1.4	1.2	<1	66.8	<1	<1	<1	1.2	<1	6	<1
WND-42S	5/3/2001	<1	<1	<1	4.9	<1	<1	<1	<1	<1	<1	<1
WND-42S	7/31/2003	<1	<1	<1	4.2	<1	<1	<1	<1	<1	<1	<1
WND-42S	12/19/2007	1.7	<1	<1	59.4	<1	<1	4	1.3	<1	6.1	<1
WND-43D	5/9/2001	1.2	2.7	1.1	37	<1	<1	<1	1.1	<1	99	6.5
WND-43D	8/18/2004	<1	<1	8.3	21	<1	<1	<1	<1	<1	47	4.5
WND-43D	12/13/2007	<1	<1	3.1	19	<1	1.1	<1	<1	<1	15.6	4.9
WND-43S	5/9/2001	<1	<1	<1	1.7	<1	<1	<1	<1	<1	<1	1.2
WND-43S	8/18/2004	<1	<1	2.1	<1	<1	<1	<1	<1	<1	<1	<1
WND-43S	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-44D	5/8/2001	<1	<1	<1	17	<1	<1	<1	<1	<1	18	2.7
WND-44S	5/8/2001	1.8	<1	2.3	1.3	<1	<1	<1	<1	<1	<1	23
WND-44S	8/20/2004	<1	<1	1.3	14	<1	<1	<1	<1	<1	<1	4.4
WND-45D	5/10/2001	2	7.2	<1	54	<1	<1	<1	1.9	<1	220	3.4
WND-45D	8/11/2004	1.4	3.8	<1	58	<1	<1	<1	1.8	<1	100	1.8
WND-45D	12/12/2007	<1	1.3	<1	62	<1	<1	<1	<1	<1	7.9	1.6
WND-45S	5/10/2001	<1	<1	<1	7.9	<1	<1	<1	<1	<1	26	<1
WND-45S	8/11/2004	<1	<1	<1	5.2	<1	<1	<1	<1	<1	19	<1
WND-45S	12/12/2007	<1	<1	<1	4.4	<1	<1	<1	<1	<1	10.2	<1
WND-46D	5/10/2001	3.3	3.2	<1	65	<1	<1	<1	2.7	1.9	130	3.2
WND-46D	8/20/2004	1.9	2.5	<1	66	<1	<1	<1	1.5	<1	61	1.4

Table 2-4
North Industrial Corridor (NIC) Site
Summary of 2001 - 2007 Groundwater Results

Sample ID	Sample Date	11DCA (µg/L)	11DCE (µg/L)	BEN (µg/L)	C12DCE (µg/L)	CT (µg/L)	CFM (µg/L)	PCE (µg/L)	T12DCE (µg/L)	111TCA (µg/L)	TCE (µg/L)	VC (µg/L)
WND-46D	12/13/2007	1	1.6	<1	55.7	<1	<1	<1	1.3	<1	19.4	1.1
WND-46S	5/10/2001	<1	<1	<1	2.8	<1	<1	<1	<1	<1	8.8	<1
WND-46S	8/20/2004	<1	<1	<1	3.3	<1	<1	<1	<1	<1	8.2	<1
WND-46S	12/13/2007	<1	<1	<1	1.7	<1	<1	<1	<1	<1	3.4	<1
WND-47D	5/9/2001	2.5	4.6	<1	51	<1	<1	7.4	4.7	<1	340	6.1
WND-47D	8/11/2004	1.1	2.9	<1	32	<1	<1	12	1.7	<1	130	<1
WND-47D	12/14/2007	1.4	3.7	<1	58	<1	<1	9.1	1.6	<1	142	3.4
WND-47S	5/9/2001	<1	<1	<1	27	<1	<1	6.8	1.4	<1	180	1.1
WND-47S	8/11/2004	<1	<1	<1	8.6	<1	<1	11	<1	<1	70	<1
WND-47S	12/14/2007	<1	1.3	<1	24.8	<1	<1	10.1	<1	<1	76.5	1
WND-48D	5/8/2001	2.9	7.1	<1	10	<1	<1	<1	<1	12	35	<1
WND-48D	7/31/2003	5.1	4.5	<1	37	<1	<1	<1	<1	3.3	41	2.1
WND-48D	8/20/2004	2.2	1.3	<1	32	<1	<1	<1	<1	<1	31	1.5
WND-48D	12/13/2007	1.1	<1	<1	50.3	<1	<1	<1	<1	<1	21	4.5
WND-48S	5/8/2001	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.2	<1
WND-48S	7/31/2003	2.8	<1	<1	8.1	<1	<1	<1	<1	<1	2.5	<1
WND-48S	8/20/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-48S	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
WND-49D	5/9/2001	2.9	3.8	1.9	47	<1	<1	<1	1	8.6	44	2.1

Notes:
µg/L= micrograms per liter

11DCA = 1,1-Dichloroethane
11DCE = 1,1-Dichloroethene
BEN = Benzene
C12DCE = cis-1,2-dichloroethene
CT = Carbon Tetrachloride
CFM = Chloroform
PCE = Tetrachloroethene
T12DCE = trans-1,2-Dichloroethene
111TCA = 1,1,1-Trichloroethane
TCE = Trichloroethene
VC = Vinyl chloride

Table 2-5
North Industrial Corridor (NIC) Site
Summary of Field MNA Parameters in Groundwater Samples

Well ID	Sample Date	Temperature (^oC)	pH	Conductivity (µS/cm)	*Chemetrics* DO (mg/L)	ORP (mV)	Fe^{2+} (mg/L)	Turbidity (NTU)
DRB-MW-250	12/13/2007	17.4	7.08	817	12.58	-118.5	1.8	600.00
EXC-MW-05B	12/17/2007	16.2	7.13	1034	2.00	51.3	0.2	11.30
EXC-MW-07B	12/17/2007	15.2	7.15	870	2.23	1.4	0.0	31.20
NMW-05D	12/20/2007	15.4	7.23	870	3.72	99.4	0.0	1.43
NMW-05S	12/20/2007	15.9	6.95	737	2.77	97.2	0.0	2.06
NMW-06D	12/13/2007	16.2	7.20	820	3.73	40.1	0.0	1.12
NMW-06S	12/13/2007	17.7	7.21	1578	1.28	54.5	0.0	7.32
NMW-08D	12/12/2007	15.9	7.22	850	2.46	14.3	0.0	1.56
NMW-08S	12/12/2007	16.8	6.97	758	2.32	39.1	0.0	1.75
NMW-10D	12/17/2007	16.2	6.98	885	1.85	-31.7	1.2	7.95
NMW-10S	12/17/2007	16.7	7.05	841	1.83	-46.3	2.2	9.64
NMW-14D	12/14/2007	14.7	7.10	779	4.68	-58.1	2.5	1.33
NMW-14S	12/14/2007	15.1	7.20	735	3.63	-54.9	2.6	3.78
NMW-18D	12/21/2007	14.5	7.56	850	1.46	-67.7	0.3	9.32
NMW-18S	12/21/2007	17.0	7.14	1131	7.39	45.4	0.0	2.52
NMW-19D	12/21/2007	15.6	7.35	1136	2.28	-8.6	0.0	9.32
NMW-23D	12/19/2007	15.5	7.46	932	1.28	-55.3	0.0	3.72
NMW-23S	12/21/2007	17.2	7.33	987	1.54	64.6	0.2	4.87
NMW-25D	12/12/2007	17.6	7.33	1050	5.19	20.1	0.0	3.55
NMW-25S	12/12/2007	18.5	7.47	1032	5.84	62.5	0.0	2.41
NMW-29D	12/12/2007	16.5	7.31	1007	3.71	32.4	0.0	2.10
NMW-29S	12/12/2007	17.5	7.37	1246	4.64	39.3	0.0	2.29
NMW-31D	12/14/2007	15.9	7.36	979	3.51	8.2	0.4	4.82
NMW-31S	12/14/2007	16.5	7.17	857	3.68	49.7	0.2	1.84
NMW-44D	12/13/2007	15.7	7.15	789	1.31	3.8	0.0	2.52
NMW-45D	12/17/2007	14.8	7.14	906	1.13	-19.9	0.4	4.51
NMW-50D	12/19/2007	14.6	7.34	1141	2.70	65.4	0.0	10.80
NMW-51D	12/13/2007	16.5	7.36	1138	4.26	65.8	0.0	2.97
WNC-06D	12/20/2007	16.5	7.31	814	2.69	39.4	0.0	3.11
WNC-16D	12/20/2007	15.2	7.28	809	1.36	-27.4	0.4	4.99
WNC-23D	12/17/2007	15.3	7.62	709	3.44	76.8	0.2	79.60
WNC-32D	12/18/2007	14.3	7.05	853	4.21	51.4	0.0	12.30
WNC-37SR	12/20/2007	15.8	7.36	593	3.67	56.1	0.0	4.90
WND-03S	12/17/2007	16.5	7.17	785	15.32	-103.1	3.1	920.00
WND-04S	12/17/2007	17.2	7.02	835	13.32	82.4	0.2	795.00
WND-06S	12/20/2007	16.5	7.33	769	13.60	68.4	0.4	576.00
WND-14D	12/18/2007	14.9	7.05	890	4.30	87.3	0.0	12.30
WND-14S	12/18/2007	16.5	7.19	447	10.37	113.2	0.2	12.30
WND-21D	12/21/2007	15.9	7.06	872	1.36	-11.7	0.2	22.00
WND-21S	12/21/2007	16.6	6.94	947	2.39	-67.7	2.8	33.10
WND-22D	12/20/2007	14.8	7.26	630	5.68	47.3	0.2	44.40
WND-22S	12/20/2007	16.1	7.09	548	3.83	88.3	0.0	44.40
WND-23S	12/17/2007	16.9	8.07	461		65.1	0.4	992.00
WND-32S	12/18/2007	16.4	6.89	923	1.83	32.8	0.2	54.10
WND-33D	12/12/2007	15.0	7.10	923	12.61	56.7	0.0	950.00

Table 2-5
North Industrial Corridor (NIC) Site
Summary of Field MNA Parameters in Groundwater Samples

Well ID	Sample Date	Temperature (^oC)	pH	Conductivity (µS/cm)	*Chemetrics* DO (mg/L)	ORP (mV)	Fe^{2+} (mg/L)	Turbidity (NTU)
WND-36D	12/20/2007	14.7	7.21	919	2.86	6.8	0.0	49.30
WND-36S	12/20/2007	15.5	7.04	916	5.58	-115.4	3.2	146.00
WND-37DR	12/20/2007	14.4	7.28	825	3.28	52.5	0.0	58.60
WND-39D	12/21/2007	16.5	6.84	899	5.76	109.4	0.0	158.00
WND-39S	12/21/2007	16.9	6.65	460		127.7	0.0	1000.00
WND-40D	12/19/2007	18.5	7.15	924	2.51	39.3	0.2	24.80
WND-41D	12/21/2007	18.4	7.43	791	13.03	64.2	0.0	724.00
WND-42D	12/19/2007	15.2	7.28	931	13.86	-56.7	1.8	922.00
WND-47D	12/14/2007	17.2	7.10	962	6.33	59.7	0.0	132.00
WND-47S	12/14/2007	19.0	7.08	1020	7.53	84.4	0.0	136.00
TW-DRB-MW-11	4/24/2008	16.4	6.69	2190	0.75	31.7	3.4	1000.00
TW-NMW-46D	4/24/2008	16.9	6.96	1093	0.50	29.3	1.6	95.90
TW-WND-40S	4/23/2008	18.5	6.97	1002	0.25	19.0	1.0	30.20

Notes:
mg/L = milligrams per liter
µS/cm = microseimens per centimeter
mV = millivolts
NTU = nephelometric turbidity units
^oC = Degrees Celsius
DO = dissolved oxygen
ORP = oxidation-reduction potential
Fe^{2+} = ferrous iron
NA = Not Applicable

Table 2-6
North Industrial Corridor (NIC) Site
Summary of Metals and Inorganic MNA Parameters in Groundwater Samples

Well ID	Sample Date	Well Depth Zone	Alkalinity, Total (mg/L)	Carbon dioxide (mg/L)	Chloride (mg/L)	Dissolved Organic Carbon (mg/L)	Nitrogen, NO_2 + NO_3 (mg/L)	Sulfate (mg/L)	Volatile Acids, as Acetic Acid (mg/L)	Arsenic (µg/L)	Iron (µg/L)	Manganese (µg/L)
DRB-MW-250	12/13/2007	Shallow	439	474	36.1	4.4	ND	74.4	ND	ND	13800	2350
EXC-MW-05B	12/17/2007	Deep	333	346	46.3	1.4	2.1	330	ND	ND	131	39.6
EXC-MW-07B	12/17/2007	Deep	320	332	55.3	1.9	1.3	198	ND	ND	581	125
NMW-05D	12/20/2007	Deep	424	416	50	1.4	ND	135	ND	ND	ND	7320
NMW-05S	12/20/2007	Shallow	333	377	23.9	2.2	1.6	161	ND	ND	ND	4780
NMW-06D	12/13/2007	Deep	426	443	42.9	4.4	ND	103	ND	ND	ND	585
NMW-06S	12/13/2007	Shallow	388	403	382	5.4	0.91	66.2	ND	16.4	59.9	82.6
NMW-08D	12/12/2007	Deep	399	401	45.5	2.8	0.91	142	ND	ND	ND	436
NMW-08S	12/12/2007	Shallow	338	383	45.3	3.6	0.95	127	ND	ND	67.3	215
NMW-10D	12/17/2007	Deep	403	435	60.6	3.1	ND	132	ND	19	876	472
NMW-10S	12/17/2007	Shallow	379	429	64.2	3	ND	113	ND	ND	1740	548
NMW-14D	12/14/2007	Deep	304	344	65.6	1.6	ND	124	ND	ND	3050	287
NMW-14S	12/14/2007	Shallow	275	311	65.9	1.9	ND	113	ND	ND	2960	301
NMW-18D	12/21/2007	Deep	319	321	80.8	2	ND	139	ND	ND	1230	116
NMW-18S	12/21/2007	Shallow	398	390	97.2	2	1.6	161	ND	ND	ND	25.3
NMW-19D	12/21/2007	Deep	440	457	164	3.6	0.13	117	ND	ND	360	122
NMW-23D	12/19/2007	Deep	315	302	103	1.9	ND	155	ND	ND	858	145
NMW-23S	12/21/2007	Shallow	362	364	97.7	1.5	0.86	169	ND	ND	ND	153
NMW-25D	12/12/2007	Deep	357	350	114	1.8	0.34	192	ND	ND	73.5	104
NMW-25S	12/12/2007	Shallow	392	384	112	1.8	2.3	163	ND	ND	ND	25.5
NMW-29D	12/12/2007	Deep	411	414	83.6	1.8	1.4	182	ND	ND	ND	141
NMW-29S	12/12/2007	Shallow	340	333	197	1.5	9.4	144	ND	ND	ND	14.5
NMW-31D	12/14/2007	Deep	346	348	93.8	1.9	ND	197	ND	ND	188	122
NMW-31S	12/14/2007	Shallow	336	363	75.6	1.6	1.9	125	ND	ND	ND	52.4
NMW-44D	12/13/2007	Deep	306	318	52.1	1.7	6	143	ND	ND	ND	689
NMW-45D	12/17/2007	Deep	411	444	60.3	3	9.8	116	ND	ND	431	1730
NMW-50D	12/19/2007	Deep	413	405	94.7	1.8	1.2	238	ND	ND	62.2	1820
NMW-51D	12/13/2007	Deep	471	474	89	2	0.81	206	ND	ND	ND	480
WNC-06D	12/20/2007	Deep	359	361	57.8	1.4	3.3	113	ND	ND	ND	ND
WNC-16D	12/20/2007	Deep	441	444	32.2	6.4	ND	105	ND	ND	419	1390
WNC-23D	12/17/2007	Deep	91.1	89.3	98.6	2.4	0.93	170	ND	ND	59.8	188
WNC-32D	12/18/2007	Deep	341	368	68.1	1.9	1.5	143	ND	ND	ND	64.9
WNC-37SR	12/20/2007	Shallow	332	376	21	2.9	1.8	66	ND	ND	ND	25.5

Table 2-6
North Industrial Corridor (NIC) Site
Summary of Metals and Inorganic MNA Parameters in Groundwater Samples

Well ID	Sample Date	Well Depth Zone	Alkalinity, Total (mg/L)	Carbon dioxide (mg/L)	Chloride (mg/L)	Dissolved Organic Carbon (mg/L)	Nitrogen, NO_2 + NO_3 (mg/L)	Sulfate (mg/L)	Volatile Acids, as Acetic Acid (mg/L)	Arsenic (µg/L)	Iron (µg/L)	Manganese (µg/L)
DRB-MW-250	12/13/2007	Shallow	439	474	36.1	4.4	ND	74.4	ND	ND	13800	2350
WND-03S	12/17/2007	Shallow	496	515	29.7	2.6	ND	21.4	ND	12.8	15100	1640
WND-04S	12/17/2007	Shallow	342	387	52.5	1.7	1.7	153	ND	ND	1810	1610
WND-06S	12/20/2007	Shallow	387	418	50.2	1.1	4.1	76.6	ND	ND	1060	524
WND-14D	12/18/2007	Deep	353	381	67.3	1.1	0.93	180	ND	ND	ND	26.4
WND-14S	12/18/2007	Shallow	209	237	6.9	3.1	3.3	67.8	ND	ND	419	9.7
WND-21D	12/21/2007	Deep	379	394	44.8	3	2.6	154	ND	ND	ND	82.2
WND-21S	12/21/2007	Shallow	419	502	41	5.1	ND	151	ND	ND	6920	1490
WND-22D	12/20/2007	Deep	274	276	36.2	2.1	0.48	97.7	ND	ND	427	234
WND-22S	12/20/2007	Shallow	269	291	13.1	1.3	0.51	84.8	ND	ND	ND	10.5
WND-23S	12/17/2007	Shallow	185	186	35.5	1.2	0.41	68.3	ND	ND	86.4	15.1
WND-32S	12/18/2007	Shallow	302	361	46.8	2.7	17.9	105	ND	ND	227	4360
WND-33D	12/12/2007	Deep	523	543	47.2	6.1	ND	78.3	ND	ND	255	2930
WND-36D	12/20/2007	Deep	480	499	51.2	6.4	0.49	111	ND	ND	128	1650
WND-36S	12/20/2007	Shallow	568	643	47.1	13.7	0.15	ND	ND	12.4	31700	1680
WND-37DR	12/20/2007	Deep	365	367	47.2	2.3	ND	150	ND	ND	658	146
WND-39D	12/21/2007	Deep	455	491	68.9	4.4	0.54	82.4	ND	ND	799	269
WND-39S	12/21/2007	Shallow	142	196	25.2	1	4.8	25.8	ND	ND	698	21.8
WND-40D	12/19/2007	Deep	394	396	69	2	5.2	117	ND	ND	70.7	88.4
WND-41D	12/21/2007	Deep	325	351	43.1	1.8	13.5	102	ND	ND	891	362
WND-42D	12/19/2007	Deep	373	375	69.4	2	ND	173	ND	ND	1330	165
WND-47D	12/14/2007	Deep	333	346	76.1	2.8	0.91	199	ND	ND	50.1	606
WND-47S	12/14/2007	Shallow	361	390	66.6	1.8	7.5	225	ND	ND	124	528
11	4/24/2008	Shallow	1100	663	230	13	0.51	64.2	ND	ND	9320	483
TW-NMW-46D	4/24/2008	Deep	528	580	67.9	5.6	0.1	41.3	ND	ND	1410	1200
TW-WND-40S	4/23/2008	Shallow	389	432	84.8	1.5	0.68	85.1	ND	ND	544	686

Notes:
mg/ = milligrams per liter
µg/L = micrograms per liter
ND = not detected
NO_2 = Nitrite
NO_3 = Nitrate

Table 2-7
North Industrial Corridor (NIC) Site
Summary of Methane, Ethane, Ethene,and VOCs Results

Station ID	Well Depth Zone	Date Collected	PCE (µg/L)	TCE (µg/L)	C12DCE (µg/L)	VC (µg/L)	11DCE (µg/L)	11DCA (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Methan (µg/L)	Other Detected Compounds
DRB-MW-250	Shallow	12/13/2007	<1	<1	2.1	<1	<1	1.4	<1	<1	815	BEN 9.2
EXC-MW-05B	Deep	12/17/2007	<1	119	19.8	<1	3.8	<1	<1	<1	<1	
EXC-MW-07B	Deep	12/17/2007	<1	101	32.6	1.1	3	1	<1	<1	<1	
NMW-05D	Deep	12/20/2007	<1	1.5	3	<1	<1	<1	<1	<1	64.2	
NMW-05S	Shallow	12/20/2007	3.6	44.3	155	35.3	<1	2.3	<1	<1	<1	T12DCE 1.4
NMW-06D	Deep	12/13/2007	<1	38.5	57.9	<1	4.3	4.3	<1	<1	84.5	T12DCE 1.9
NMW-06S	Shallow	12/13/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-08D	Deep	12/12/2007	<1	202	92.3	8	7.5	2.3	<1	<1	<1	T12DCE 4.0
NMW-08S	Shallow	12/12/2007	<1	63.7	73.4	3	3.7	1.5	<1	<1	<1	T12DCE 2.2
NMW-10D	Deep	12/17/2007	<1	118	96.3	6.1	6.1	2.4	<1	<1	<1	MTBE 1.6, T12DCE 3.5
NMW-10S	Shallow	12/17/2007	<1	102	85.1	4.8	5.3	2.5	<1	<1	58.6	MTBE 2.4, T12DCE 3.0
NMW-14D	Deep	12/14/2007	<1	1.6	104	<1	1.3	<1	<1	<1	<1	T12DCE 1.2
NMW-14S	Shallow	12/14/2007	<1	<1	8.5	<1	<1	<1	<1	<1	<1	
NMW-18D	Deep	12/21/2007	<1	<1	2.3	<1	<1	<1	<1	<1	<1	
NMW-18S	Shallow	12/21/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	
NMW-19D	Deep	12/21/2007	<1	1.9	26.3	<1	<1	<1	<1	<1	12.6	
NMW-23D	Deep	12/19/2007	<1	3.8	3.7	<1	<1	<1	<1	<1	<1	
NMW-23S	Shallow	12/21/2007	<1	117	435	<1	<1	<1	<1	<1	41.9	T12DCE 2.3
NMW-25D	Deep	12/12/2007	<1	2	48.9	<1	<1	<1	<1	<1	<1	
NMW-25S	Shallow	12/12/2007	<1	4.8	28.2	<1	<1	<1	<1	<1	<1	
NMW-29D	Deep	12/12/2007	<1	10.9	23.2	<1	<1	<1	<1	<1	<1	T12DCE 1.9
NMW-29S	Shallow	12/12/2007	<1	4.5	7.4	<1	<1	<1	<1	<1	<1	
NMW-31D	Deep	12/14/2007	93.8	184	61	3.5	1.6	1.7	<1	<1	<1	T12DCE 1.5
NMW-31S	Shallow	12/14/2007	44.2	57.7	25.1	<1	<1	<1	<1	<1	<1	MTBE 1.4
NMW-44D	Deep	12/13/2007	2.4	77.2	21.2	<1	<1	<1	<1	<1	<1	
NMW-45D	Deep	12/17/2007	<1	14.1	11.4	<1	<1	<1	<1	<1	22.1	MTBE 17.8, BEN 3.6
NMW-50D	Deep	12/19/2007	<1	16.9	12.3	<1	<1	<1	<1	<1	<1	
NMW-51D	Deep	12/13/2007	2.1	36.4	33.8	4.6	2.2	3.2	<1	<1	<1	
WNC-06D	Deep	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WNC-16D	Deep	12/20/2007	<1	10.8	2.6	<1	<1	<1	<1	<1	149	
WNC-23D	Deep	12/17/2007	<1	6.5	1.9	<1	<1	<1	<1	<1	518	
WNC-32D	Deep	12/18/2007	3.8	92.2	29.2	<1	<1	<1	<1	<1	<1	
WNC-37SR	Shallow	12/20/2007	<1	42.3	59	5.9	1.8	1.4	<1	<1	<1	T12DCE 3.8
WND-03S	Shallow	12/17/2007	<1	<1	36.4	<1	<1	1.6	<1	<1	6450	EBN 34.8, TOL 5.8, XYLMP 21.5, XYLO 4.2,
WND-04S	Shallow	12/17/2007	<1	131	39.8	<1	2.4	<1	<1	<1	<1	

Table 2-7
North Industrial Corridor (NIC) Site
Summary of Methane, Ethane, Ethene,and VOCs Results

Station ID	Well Depth Zone	Date Collected	PCE (µg/L)	TCE (µg/L)	C12DCE (µg/L)	VC (µg/L)	11DCE (µg/L)	11DCA (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Methan (µg/L)	Other Detected Compounds
WND-06S	Shallow	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-14D	Deep	12/18/2007	11	201	61.7	<1	<1	<1	<1	<1	<1	
WND-14S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-21D	Deep	12/21/2007	<1	139	45.4	1.5	4	<1	<1	<1	<1	T12DCE 1.0
WND-21S	Shallow	12/21/2007	<1	10.8	53.4	<1	1.7	<1	<1	<1	264	
WND-22D	Deep	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-22S	Shallow	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	
WND-23S	Shallow	12/17/2007	<1	3.1	1	<1	<1	<1	<1	<1	56.7	
WND-32S	Shallow	12/18/2007	<1	<1	<1	<1	<1	<1	<1	<1	<1	CFM 3.2
WND-33D	Deep	12/12/2007	<1	5.6	40.2	<1	1.4	2.8	<1	<1	140	
WND-36D	Deep	12/20/2007	<1	27.2	21.8	<1	1.6	1.8	<1	<1	275	BEN 1.7
WND-36S	Shallow	12/20/2007	<1	<1	<1	<1	<1	<1	<1	<1	8980	EBN 33.1, TOL 29.6, XYLMP 98.7, XYLO 10,
WND-37DR	Deep	12/20/2007	<1	108	56.1	6.3	5.5	3.6	<1	<1	245	T12DCE 1.9
WND-39D	Deep	12/21/2007	<1	26.9	42.9	<1	1.2	2.5	<1	<1	146	
WND-39S	Shallow	12/21/2007	<1	21.4	3.4	<1	<1	<1	<1	<1	<1	
WND-40D	Deep	12/19/2007	<1	15.2	34.2	<1	<1	<1	<1	<1	<1	
WND-41D	Deep	12/21/2007	1.6	20.9	4.2	<1	<1	<1	<1	<1	<1	
WND-42D	Deep	12/19/2007	<1	6	66.8	<1	1.2	1.4	<1	<1	<1	T12DCE 1.2
WND-47D	Deep	12/14/2007	9.1	142	58	3.4	3.7	1.4	<1	<1	<1	T12DCE 1.6
WND-47S	Shallow	12/14/2007	10.1	76.5	24.8	1	1.3	<1	<1	<1	<1	
TW-DRB-MW-11	Shallow	4/24/2008	<1	<1	<1	<1	<1	<1	<1	<1	138	MTBE 24
TW-NMW-46D	Deep	4/24/2008	<1	3.4	8.3	<1	<1	<1	<1	<1	349	MTBE 23.7, EBN 1.4, BEN 47.1
TW-WND-40S	Shallow	4/23/2008	<1	4.7	2.2	<1	<1	<1	<1	<1	<1	111TCA 1.1

Notes:
mg/L = milligrams per liter
µg/L = micrograms per liter

BEN = Benzene
11DCA = 1,1-Dichloroethane
11DCE = 1,1-Dichloroethene
C12DCE = *cis* -1,2-Dichloroethene
T12DCE = *trans* -1,2-Dichloroethene
CFM = Chloroform

EBN = Ethylbenzene
MTBE = Methyl tert-butyl ether
PCE = Tetrachloroethene
TOL = Toluene
111TCA = 1,1,1-Trichloroethane
TCE = Trichloroethene

VC = Vinyl chloride
XYLMP = m,p-Xylene
XYLO = o-Xylene

Table 2-8
NIC Site Monitoring Network
RPDs for Original and Duplicate Samples, November 2007

Sample location		Tetrachloro-ethene	Trichloro-ethene	cis-1,2-Dichloro-ethene	Vinyl chloride	Benzene	1,1-Dichloro-ethane	1,1-Dichloro-ethene	trans-1,2-Dichloro-ethene
NMW-02S									
	Original	62.5	1.1	<1	<1	<1	<1	<1	<1
	Duplicate	55.5	1.1	<1	<1	<1	<1	<1	<1
	RPD	12%	0%	----%	----%	----%	----%	----%	----%
NMW-10S									
	Original	<1	102	75.9	4.8	<1	2.5	5.3	3
	Duplicate	<1	102	85.1	4.7	<1	2.5	5.3	3
	RPD	----%	0%	11%	2%	----%	0%	0%	0%
NMW-26D									
	Original	<1	3.4	40.5	<1	<1	<1	<1	<1
	Duplicate	<1	3.4	36.9	<1	<1	<1	<1	<1
	RPD	----%	0%	9%	----%	----%	----%	----%	----%
NMW-35D									
	Original	<1	52.2	94	1.8	<1	1	2.6	2
	Duplicate	<1	45	89.9	1.8	<1	<1	2.4	1.9
	RPD	----%	15%	4%	0%	----%	----%	8%	5%
NMW-51D									
	Original	2.1	35.9	33.3	4.6	<1	3.1	2.2	1
	Duplicate	2.1	36.4	33.8	4.6	<1	3.2	2.2	<1
	RPD	0%	1%	1%	0%	----%	3%	0%	----%
VWRS-MW-09S									
	Original	2.6	16.8	21.4	1.5	<1	2	<1	1.2
	Duplicate	2.9	17.9	24	1.4	<1	1.9	<1	1.4
	RPD	11%	6%	11%	7%	----%	5%	----%	15%
WND-14D									
	Original	10	190	60.1	<1	<1	<1	<1	<1
	Duplicate	11	201	61.7	<1	<1	<1	<1	<1
	RPD	10%	6%	3%	----%	----%	----%	----%	----%
WND-25D									
	Original	<1	5.5	<1	<1	<1	<1	<1	<1
	Duplicate	<1	6.4	<1	<1	<1	<1	<1	<1
	RPD	----%	15%	----%	----%	----%	----%	----%	----%

Table 2-8
NIC Site Monitoring Network
RPDs for Original and Duplicate Samples, November 2007

Sample location		Tetrachloro-ethene	Trichloro-ethene	cis-1,2-Dichloro-ethene	Vinyl chloride	Benzene	1,1-Dichloro-ethane	1,1-Dichloro-ethene	trans-1,2-Dichloro-ethene
WND-25S									
	Original	<1	10.2	<1	<1	<1	<1	<1	<1
	Duplicate	<1	11.2	<1	<1	<1	<1	<1	<1
	RPD	----%	9%	----%	----%	----%	----%	----%	----%
WND-29D									
	Original	<1	1.5	<1	<1	<1	<1	<1	<1
	Duplicate	<1	1.5	<1	<1	<1	<1	<1	<1
	RPD	----%	0%	----%	----%	----%	----%	----%	----%
WND-36D									
	Original	<1	27.2	21.8	<1	1.7	1.8	1.6	<1
	Duplicate	<1	25.8	19.2	1.9	1.6	1.6	1.4	<1
	RPD	----%	5%	13%	----%	6%	12%	13%	----%
WND-37DR									
	Original	<1	107	53.9	6.7	<1	3.3	5.3	1.7
	Duplicate	<1	108	56.1	6.3	<1	3.6	5.5	1.9
	RPD	----%	1%	4%	6%	----%	9%	4%	11%

* Units for VOCs are µg/L.

Table 2-9
North Industrial Corridor (NIC) Site
Summary of Performance Evaluation Sample Results

Sample ID	Submittal Date	Parameter	Result	Units	Certified Value	Lower Control Limit	Upper Control Limit
NBPN-03P	12/14/2007	BEN	17.2	mg/L	15.20	10.00	20.40
		TOL	10.3	mg/L	10.90	7.63	14.40
		EBN	7.1	mg/L	6.79	4.26	9.56
		XYLMP	8.6	mg/L	8.96	4.17	15.20
		C12DCE	19.5	mg/L	16.90	11.00	22.70
		TCE	8.5	mg/L	8.93	5.52	12.80
		VC	8.1	mg/L	9.60	3.84	15.40
NWL-23SP	12/14/2007	BEN	61.8	mg/L	52.50	37.80	66.80
		TOL	68.4	mg/L	65.20	45.20	81.60
		EBN	69.9	mg/L	63.10	43.50	80.10
		XYLMP	57.7	mg/L	52.10	29.20	72.10
		C12DCE	59.9	mg/L	50.80	36.60	67.60
		TCE	55.0	mg/L	53.60	34.00	70.20
		VC	51.4	mg/L	63.20	25.30	101.00
NMW-35DP	12/13/2007	BEN	16.7	mg/L	15.20	10.00	20.40
		TOL	9.8	mg/L	10.90	7.63	14.40
		EBN	6.5	mg/L	6.79	4.26	9.56
		XYLMP	8.5	mg/L	8.96	4.17	15.20
		C12DCE	19.4	mg/L	16.90	11.00	22.70
		TCE	8.0	mg/L	8.93	5.52	12.80
		VC	8.0	mg/L	9.60	3.84	15.40
NMW-35SP	12/13/2007	BEN	56.6	mg/L	52.50	37.80	66.80
		TOL	57.1	mg/L	65.20	45.20	81.60
		EBN	65.3	mg/L	63.10	43.50	80.10
		XYLMP	52.9	mg/L	52.10	29.20	72.10
		C12DCE	55.5	mg/L	50.80	36.60	67.60
		TCE	47.1	mg/L	53.60	34.00	70.20
		VC	44.9	mg/L	63.20	25.30	101.00
NMW-39IP	12/14/2007	BEN	101.0	mg/L	105.00	76.90	132.00
		TOL	126.0	mg/L	130.00	90.10	162.00
		EBN	127.0	mg/L	126.00	87.30	159.00
		XYLMP	104.0	mg/L	104.00	59.30	141.00
		C12DCE	109.0	mg/L	102.00	75.10	135.00
		TCE	104.0	mg/L	107.00	68.10	139.00
		VC	106.0	mg/L	126.00	50.40	202.00
NMW-39DP	12/14/2007	BEN	102.0	mg/L	105.00	76.90	132.00
		TOL	127.0	mg/L	130.00	90.10	162.00
		EBN	130.0	mg/L	126.00	87.30	159.00
		XYLMP	107.0	mg/L	104.00	59.30	141.00
		C12DCE	112.0	mg/L	102.00	75.10	135.00
		TCE	106.0	mg/L	107.00	68.10	139.00
		VC	102.0	mg/L	126.00	50.40	202.00

µg/L= micrograms per liter
BEN = Benzene
C12DCE = cis-1,2-Dichloroethene
EBN = Ethylbenzene
TOL = Toluene
TCE = Trichloroethene
VC = Vinyl chloride
XYLMP = m,p-Xylene

CDM

Table 2-10
North Industrial Corridor (NIC) Site
MNA Scoring Results of 2007-2008 Groundwater Samples

Well ID	Sample Date	Well Depth Zone	Field Parameters										Inorganics								Organics	
			Temperature (^oC)	MNA Value	pH	MNA Value	*Chemetrics* DO (mg/L)	MNA Value	ORP (mV)	MNA Value	Fe^{2+} (mg/L)	MNA Value	Alkalinity, Total (mg/L)	MNA Value[a]	Chloride (mg/L)	MNA Value[a]	Nitrogen, $NO_2 + NO_3$ (mg/L)	MNA Value[c]	Sulfate (mg/L)	MNA Value	Dissolved Organic Carbon (mg/L)	MNA Value[b]
DRB-MW-250	12/13/2007	Shallow	17.4	0	7.08	0	12.58	0	-118.5	2	1.8	3	439	0	36.1	0	0	2	74.4	0	4.4	0
EXC-MW-05B	12/17/2007	Deep	16.2	0	7.13	0	2.00	0	51.3	0	0.2	0	333	0	46.3	0	2.1	0	330	0	1.4	0
EXC-MW-07B	12/17/2007	Deep	15.2	0	7.15	0	2.23	0	1.4	1	0.0	0	320	0	55.3	0	1.3	0	198	0	1.9	0
NMW-05D	12/20/2007	Deep	15.4	0	7.23	0	3.72	0	99.4	0	0.0	0	424	0	50	0	0	2	135	0	1.4	0
NMW-05S	12/20/2007	Shallow	15.9	0	6.95	0	2.77	0	97.2	0	0.0	0	333	0	23.9	0	1.6	0	161	0	2.2	0
NMW-06D	12/13/2007	Deep	16.2	0	7.20	0	3.73	0	40.1	1	0.0	0	426	0	42.9	0	0	2	103	0	4.4	0
NMW-06S	12/13/2007	Shallow	17.7	0	7.21	0	1.28	0	54.5	0	0.0	0	388	0	382	2	0.91	2	66.2	0	5.4	0
NMW-08D	12/12/2007	Deep	15.9	0	7.22	0	2.46	0	14.3	1	0.0	0	399	0	45.5	0	0.91	2	142	0	2.8	0
NMW-08S	12/12/2007	Shallow	16.8	0	6.97	0	2.32	0	39.1	1	0.0	0	338	0	45.3	0	0.95	2	127	0	3.6	0
NMW-10D	12/17/2007	Deep	16.2	0	6.98	0	1.85	0	-31.7	1	1.2	3	403	0	60.6	0	0	2	132	0	3.1	0
NMW-10S	12/17/2007	Shallow	16.7	0	7.05	0	1.83	0	-46.3	1	2.2	3	379	0	64.2	0	0	2	113	0	3	0
NMW-14D	12/14/2007	Deep	14.7	0	7.10	0	4.68	0	-58.1	1	2.5	3	304	0	65.6	0	0	2	124	0	1.6	0
NMW-14S	12/14/2007	Shallow	15.1	0	7.20	0	3.63	0	-54.9	1	2.6	3	275	0	65.9	0	0	2	113	0	1.9	0
NMW-18D	12/21/2007	Deep	14.5	0	7.56	0	1.46	0	-67.7	1	0.3	0	319	0	80.8	2	0	2	139	0	2	0
NMW-18S	12/21/2007	Shallow	17.0	0	7.14	0	7.39	0	45.4	1	0.0	0	398	0	97.2	2	1.6	0	161	0	2	0
NMW-19D	12/21/2007	Deep	15.6	0	7.35	0	2.28	0	-8.6	1	0.0	0	440	0	164	2	0.13	2	117	0	3.6	0
NMW-23D	12/19/2007	Deep	15.5	0	7.46	0	1.28	0	-55.3	1	0.0	0	315	0	103	2	0	2	155	0	1.9	0
NMW-23S	12/21/2007	Shallow	17.2	0	7.33	0	1.54	0	64.6	0	0.2	0	362	0	97.7	2	0.86	2	169	0	1.5	0
NMW-25D	12/12/2007	Deep	17.6	0	7.33	0	5.19	0	20.1	1	0.0	0	357	0	114	2	0.34	2	192	0	1.8	0
NMW-25S	12/12/2007	Shallow	18.5	0	7.47	0	5.84	0	62.5	0	0.0	0	392	0	112	2	2.3	0	163	0	1.8	0
NMW-29D	12/12/2007	Deep	16.5	0	7.31	0	3.71	0	32.4	1	0.0	0	411	0	83.6	2	1.4	0	182	0	1.8	0
NMW-29S	12/12/2007	Shallow	17.5	0	7.37	0	4.64	0	39.3	1	0.0	0	340	0	197	2	9.4	0	144	0	1.5	0
NMW-31D	12/14/2007	Deep	15.9	0	7.36	0	3.51	0	8.2	1	0.4	0	346	0	93.8	2	0	2	197	0	1.9	0
NMW-31S	12/14/2007	Shallow	16.5	0	7.17	0	3.68	0	49.7	1	0.2	0	336	0	75.6	2	1.9	0	125	0	1.6	0
NMW-44D	12/13/2007	Deep	15.7	0	7.15	0	1.31	0	3.8	1	0.0	0	306	0	52.1	0	6	0	143	0	1.7	0
NMW-45D	12/17/2007	Deep	14.8	0	7.14	0	1.13	0	-19.9	1	0.4	0	411	0	60.3	0	9.8	0	116	0	3	0
NMW-50D	12/19/2007	Deep	14.6	0	7.34	0	2.70	0	65.4	0	0.0	0	413	0	94.7	2	1.2	0	238	0	1.8	0
NMW-51D	12/13/2007	Deep	16.5	0	7.36	0	4.26	0	65.8	0	0.0	0	471	0	89	2	0.81	2	206	0	2	0
WNC-06D	12/20/2007	Deep	16.5	0	7.31	0	2.69	0	39.4	1	0.0	0	359	0	57.8	0	3.3	0	113	0	1.4	0
WNC-16D	12/20/2007	Deep	15.2	0	7.28	0	1.36	0	-27.4	1	0.4	0	441	0	32.2	0	0	2	105	0	6.4	0
WNC-23D	12/17/2007	Deep	15.3	0	7.62	0	3.44	0	76.8	0	0.2	0	91.1	0	98.6	2	0.93	2	170	0	2.4	0
WNC-32D	12/18/2007	Deep	14.3	0	7.05	0	4.21	0	51.4	0	0.0	0	341	0	68.1	2	1.5	0	143	0	1.9	0
WNC-37SR	12/20/2007	Shallow	15.8	0	7.36	0	3.67	0	56.1	0	0.0	0	332	0	21	0	1.8	0	66	0	2.9	0
WND-03S	12/17/2007	Shallow	16.5	0	7.17	0	15.32	0	-103.1	2	3.1	3	496	0	29.7	0	0	2	21.4	0	2.6	0
WND-04S	12/17/2007	Shallow	17.2	0	7.02	0	13.32	0	82.4	0	0.2	0	342	0	52.5	0	1.7	0	153	0	1.7	0
WND-06S	12/20/2007	Shallow	16.5	0	7.33	0	13.60	0	68.4	0	0.4	0	387	0	50.2	0	4.1	0	76.6	0	1.1	0
WND-14D	12/18/2007	Deep	14.9	0	7.05	0	4.30	0	87.3	0	0.0	0	353	0	67.3	2	0.93	2	180	0	1.1	0
WND-14S	12/18/2007	Shallow	16.5	0	7.19	0	10.37	0	113.2	0	0.2	0	209	0	6.9	0	3.3	0	67.8	0	3.1	0
WND-21D	12/21/2007	Deep	15.9	0	7.06	0	1.36	0	-11.7	1	0.2	0	379	0	44.8	0	2.6	0	154	0	3	0
WND-21S	12/21/2007	Shallow	16.6	0	6.94	0	2.39	0	-67.7	1	2.8	3	419	0	41	0	0	2	151	0	5.1	0
WND-22D	12/20/2007	Deep	14.8	0	7.26	0	5.68	0	47.3	1	0.2	0	274	0	36.2	0	0.48	2	97.7	0	2.1	0
WND-22S	12/20/2007	Shallow	16.1	0	7.09	0	3.83	0	88.3	0	0.0	0	269	0	13.1	0	0.51	2	84.8	0	1.3	0
WND-23S	12/17/2007	Shallow	16.9	0	8.07	0		0	65.1	0	0.4	0	185	0	35.5	0	0.41	2	68.3	0	1.2	0

Table 2-10
North Industrial Corridor (NIC) Site
MNA Scoring Results of 2007-2008 Groundwater Samples

Well ID	Sample Date	Well Depth Zone	Organics														Dissolved Gases								MNA Score
			Volatile Acids, as Acetic Acid (mg/L)	MNA Value	PCE (µg/L)	MNA Value	TCE (µg/L)	MNA Value	C12DCE (µg/L)	MNA Value	VC (µg/L)	MNA Value	11DCA (µg/L)	MNA Value	BTEX (µg/L)	MNA Value	Carbon dioxide (mg/L)	MNA Value[a]	Ethene (µg/L)	MNA Value	Ethane (µg/L)	MNA Value	Methane (µg/L)	MNA Value	
DRB-MW-250	12/13/2007	Shallow	0	0	0	0	0	0	2.1	2	0	0	1.4	2	9.2	0	474	0	0	0	0	0	815	3	14
EXC-MW-05B	12/17/2007	Deep	0	0	0	0	119	0	19.8	2	0	0	0	0	0	0	346	0	0	0	0	0	0	0	2
EXC-MW-07B	12/17/2007	Deep	0	0	0	0	101	0	32.6	2	1.1	2	1	2	0	0	332	0	0	0	0	0	0	0	7
NMW-05D	12/20/2007	Deep	0	0	0	0	1.5	0	3	2	0	0	0	0	0	0	416	0	0	0	0	0	64.2	0	4
NMW-05S	12/20/2007	Shallow	0	0	3.6	0	44.3	0	155	2	35.3	2	2.3	2	0	0	377	0	0	0	0	0	0	0	6
NMW-06D	12/13/2007	Deep	0	0	0	0	38.5	0	57.9	2	0	0	4.3	2	0	0	443	0	0	0	0	0	84.5	0	7
NMW-06S	12/13/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	403	0	0	0	0	0	0	0	4
NMW-08D	12/12/2007	Deep	0	0	0	0	202	0	92.3	2	8	2	2.3	2	0	0	401	0	0	0	0	0	0	0	9
NMW-08S	12/12/2007	Shallow	0	0	0	0	63.7	0	73.4	2	3	2	1.5	2	0	0	383	0	0	0	0	0	0	0	9
NMW-10D	12/17/2007	Deep	0	0	0	0	118	0	96.3	2	6.1	2	2.4	2	0	0	435	0	0	0	0	0	0	0	12
NMW-10S	12/17/2007	Shallow	0	0	0	0	102	0	85.1	2	4.8	2	2.5	2	0	0	429	0	0	0	0	0	58.6	0	12
NMW-14D	12/14/2007	Deep	0	0	0	0	1.6	0	104	2	0	0	0	0	0	0	344	0	0	0	0	0	0	0	8
NMW-14S	12/14/2007	Shallow	0	0	0	0	0	0	8.5	2	0	0	0	0	0	0	311	0	0	0	0	0	0	0	8
NMW-18D	12/21/2007	Deep	0	0	0	0	0	0	2.3	2	0	0	0	0	0	0	321	0	0	0	0	0	0	0	7
NMW-18S	12/21/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	390	0	0	0	0	0	0	0	3
NMW-19D	12/21/2007	Deep	0	0	0	0	1.9	0	26.3	2	0	0	0	0	0	0	457	0	0	0	0	0	12.6	0	7
NMW-23D	12/19/2007	Deep	0	0	0	0	3.8	0	3.7	2	0	0	0	0	0	0	302	0	0	0	0	0	0	0	7
NMW-23S	12/21/2007	Shallow	0	0	0	0	117	0	435	2	0	0	0	0	0	0	364	0	0	0	0	0	41.9	0	6
NMW-25D	12/12/2007	Deep	0	0	0	0	2	0	48.9	2	0	0	0	0	0	0	350	0	0	0	0	0	0	0	7
NMW-25S	12/12/2007	Shallow	0	0	0	0	4.8	0	28.2	2	0	0	0	0	0	0	384	0	0	0	0	0	0	0	4
NMW-29D	12/12/2007	Deep	0	0	0	0	10.9	0	23.2	2	0	0	0	0	0	0	414	0	0	0	0	0	0	0	5
NMW-29S	12/12/2007	Shallow	0	0	0	0	4.5	0	7.4	2	0	0	0	0	0	0	333	0	0	0	0	0	0	0	5
NMW-31D	12/14/2007	Deep	0	0	93.8	0	184	0	61	2	3.5	2	1.7	2	0	0	348	0	0	0	0	0	0	0	11
NMW-31S	12/14/2007	Shallow	0	0	44.2	0	57.7	0	25.1	2	0	0	0	0	0	0	363	0	0	0	0	0	0	0	5
NMW-44D	12/13/2007	Deep	0	0	2.4	0	77.2	0	21.2	2	0	0	0	0	0	0	318	0	0	0	0	0	0	0	3
NMW-45D	12/17/2007	Deep	0	0	0	0	14.1	0	11.4	2	0	0	0	0	3.6	0	444	0	0	0	0	0	22.1	0	3
NMW-50D	12/19/2007	Deep	0	0	0	0	16.9	0	12.3	2	0	0	0	0	0	0	405	0	0	0	0	0	0	0	4
NMW-51D	12/13/2007	Deep	0	0	2.1	0	36.4	0	33.8	2	4.6	2	3.2	2	0	0	474	0	0	0	0	0	0	0	10
WNC-06D	12/20/2007	Deep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	361	0	0	0	0	0	0	0	1
WNC-16D	12/20/2007	Deep	0	0	0	0	10.8	0	2.6	2	0	0	0	0	0	0	444	0	0	0	0	0	149	0	5
WNC-23D	12/17/2007	Deep	0	0	0	0	6.5	0	1.9	2	0	0	0	0	0	0	89.3	0	0	0	0	0	518	3	9
WNC-32D	12/18/2007	Deep	0	0	3.8	0	92.2	0	29.2	2	0	0	0	0	0	0	368	0	0	0	0	0	0	0	4
WNC-37SR	12/20/2007	Shallow	0	0	0	0	42.3	0	59	2	5.9	2	1.4	2	0	0	376	0	0	0	0	0	0	0	6
WND-03S	12/17/2007	Shallow	0	0	0	0	0	0	36.4	2	0	0	1.6	2	71.5	0	515	0	0	0	0	0	6450	3	14
WND-04S	12/17/2007	Shallow	0	0	0	0	131	0	39.8	2	0	0	0	0	0	0	387	0	0	0	0	0	0	0	2
WND-06S	12/20/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	418	0	0	0	0	0	0	0	0
WND-14D	12/18/2007	Deep	0	0	11	0	201	0	61.7	2	0	0	0	0	0	0	381	0	0	0	0	0	0	0	6
WND-14S	12/18/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	237	0	0	0	0	0	0	0	0
WND-21D	12/21/2007	Deep	0	0	0	0	139	0	45.4	2	1.5	2	0	0	0	0	394	0	0	0	0	0	0	0	5
WND-21S	12/21/2007	Shallow	0	0	0	0	10.8	0	53.4	2	0	0	0	0	0	0	502	0	0	0	0	0	264	0	8
WND-22D	12/20/2007	Deep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	276	0	0	0	0	0	0	0	3
WND-22S	12/20/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	291	0	0	0	0	0	0	0	2
WND-23S	12/17/2007	Shallow	0	0	0	0	3.1	0	1	2	0	0	0	0	0	0	186	0	0	0	0	0	56.7	0	4

Table 2-10
North Industrial Corridor (NIC) Site
MNA Scoring Results of 2007-2008 Groundwater Samples

Well ID	Sample Date	Well Depth Zone	Field Parameters										Inorganics								Organics	
			Temperature (^oC)	MNA Value	pH	MNA Value	*Chemetrics* DO (mg/L)	MNA Value	ORP (mV)	MNA Value	Fe^{2+} (mg/L)	MNA Value	Alkalinity, Total (mg/L)	MNA Value[a]	Chloride (mg/L)	MNA Value[a]	Nitrogen, $NO_2 + NO_3$ (mg/L)	MNA Value[c]	Sulfate (mg/L)	MNA Value	Dissolved Organic Carbon (mg/L)	MNA Value[b]
WND-32S	12/18/2007	Shallow	16.4	0	6.89	0	1.83	0	32.8	1	0.2	0	302	0	46.8	0	17.9	0	105	0	2.7	0
WND-33D	12/12/2007	Deep	15.0	0	7.10	0	12.61	0	56.7	0	0.0	0	523	0	47.2	0	0	2	78.3	0	6.1	0
WND-36D	12/20/2007	Deep	14.7	0	7.21	0	2.86	0	6.8	1	0.0	0	480	0	51.2	0	0.49	2	111	0	6.4	0
WND-36S	12/20/2007	Shallow	15.5	0	7.04	0	5.58	0	-115.4	2	3.2	3	568	0	47.1	0	0.15	2	0	2	13.7	0
WND-37DR	12/20/2007	Deep	14.4	0	7.28	0	3.28	0	52.5	0	0.0	0	365	0	47.2	0	0	2	150	0	2.3	0
WND-39D	12/21/2007	Deep	16.5	0	6.84	0	5.76	0	109.4	0	0.0	0	455	0	68.9	2	0.54	2	82.4	0	4.4	0
WND-39S	12/21/2007	Shallow	16.9	0	6.65	0		0	127.7	0	0.0	0	142	0	25.2	0	4.8	0	25.8	0	1	0
WND-40D	12/19/2007	Deep	18.5	0	7.15	0	2.51	0	39.3	1	0.2	0	394	0	69	2	5.2	0	117	0	2	0
WND-41D	12/21/2007	Deep	18.4	0	7.43	0	13.03	0	64.2	0	0.0	0	325	0	43.1	0	13.5	0	102	0	1.8	0
WND-42D	12/19/2007	Deep	15.2	0	7.28	0	13.86	0	-56.7	1	1.8	3	373	0	69.4	2	0	2	173	0	2	0
WND-47D	12/14/2007	Deep	17.2	0	7.10	0	6.33	0	59.7	0	0.0	0	333	0	76.1	2	0.91	2	199	0	2.8	0
WND-47S	12/14/2007	Shallow	19.0	0	7.08	0	7.53	0	84.4	0	0.0	0	361	0	66.6	2	7.5	0	225	0	1.8	0
TW-DRB-MW-11	4/24/2008	Shallow	16.4	0	6.69	0	0.75	0	31.7	1	3.4	3	1100	1	230	2	0.51	2	64.2	0	13	0
TW-NMW-46D	4/24/2008	Deep	16.9	0	6.96	0	0.50	0	29.3	1	1.6	3	528	0	67.9	2	0.1	2	41.3	0	5.6	0
TW-WND-40S	4/23/2008	Shallow	18.5	0	6.97	0	0.25	0	19.0	1	1.0	0	389	0	84.8	2	0.68	2	85.1	0	1.5	0

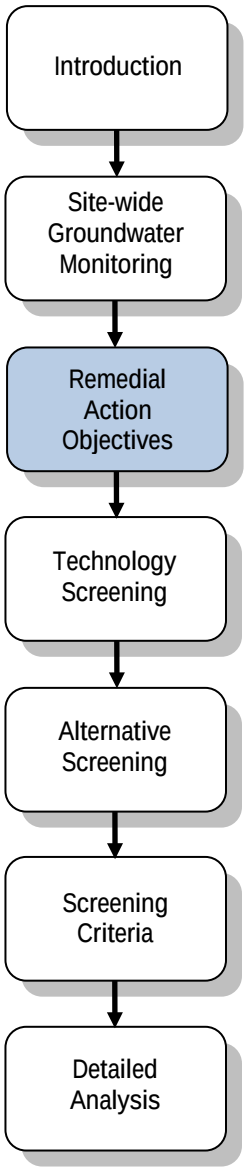
Notes:
^oC = Degrees Celsius
µS/cm = microseimens per centimeter
mg/L = milligrams per liter
µg/L = micrograms per liter
mV = millivolts
NTU = nephelometric turbidity units
NA = Not applicable
MNA = Monitored natural attenuation
DO = Dissolved oxygen
ORP = Oxidation-reduction potential
Fe^{2+} = Ferrous iron
NO_2 = Nitrite
NO_3 = Nitrate
PCE = Tetrachloroethene
TCE = Trichloroethene
C12DCE = *cis*-1,2-Dichloroethene
VC = Vinyl chloride
11DCA = 1,1-Dichloroethane
BTEX = Benzene + toluene + ethylbenzene + xylene
[a](EPA 1998): Table 2.3 lists the range for the contaminated site as > 2xbackground. The background value was obtained by taking an average of the concentrations
[b](ERP 1998): Table 2.3 lists the MNA value for TOC (total organic carbon). Analyzed for DOC (dissolved OC). MNA score calculation assumes the concentration of TOC and DOC are equal.
[c](EPA 1998): Table 2.3 lists MNA value for only NO_3. Analyzed for Nitrogen as $NO_3 + NO_2$. MNA score calculation assumes the concentration of NO_2 is insignificant

Table 2-10
North Industrial Corridor (NIC) Site
MNA Scoring Results of 2007-2008 Groundwater Samples

Well ID	Sample Date	Well Depth Zone	Organics														Dissolved Gases								MNA Score
			Volatile Acids, as Acetic Acid (mg/L)	MNA Value	PCE (µg/L)	MNA Value	TCE (µg/L)	MNA Value	C12DCE (µg/L)	MNA Value	VC (µg/L)	MNA Value	11DCA (µg/L)	MNA Value	BTEX (µg/L)	MNA Value	Carbon dioxide (mg/L)	MNA Value[a]	Ethene (µg/L)	MNA Value	Ethane (µg/L)	MNA Value	Methane (µg/L)	MNA Value	
WND-32S	12/18/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	361	0	0	0	0	0	0	0	1
WND-33D	12/12/2007	Deep	0	0	0	0	5.6	0	40.2	2	0	0	2.8	2	0	0	543	0	0	0	0	0	140	0	6
WND-36D	12/20/2007	Deep	0	0	0	0	27.2	0	21.8	2	0	0	1.8	2	1.7	0	499	0	0	0	0	0	275	0	7
WND-36S	12/20/2007	Shallow	0	0	0	0	0	0	0	0	0	0	0	0	466.4	2	643	0	0	0	0	0	8980	3	14
WND-37DR	12/20/2007	Deep	0	0	0	0	108	0	56.1	2	6.3	2	3.6	2	0	0	367	0	0	0	0	0	245	0	8
WND-39D	12/21/2007	Deep	0	0	0	0	26.9	0	42.9	2	0	0	2.5	2	0	0	491	0	0	0	0	0	146	0	8
WND-39S	12/21/2007	Shallow	0	0	0	0	21.4	0	3.4	2	0	0	0	0	0	0	196	0	0	0	0	0	0	0	2
WND-40D	12/19/2007	Deep	0	0	0	0	15.2	0	34.2	2	0	0	0	0	0	0	396	0	0	0	0	0	0	0	5
WND-41D	12/21/2007	Deep	0	0	1.6	0	20.9	0	4.2	2	0	0	0	0	0	0	351	0	0	0	0	0	0	0	2
WND-42D	12/19/2007	Deep	0	0	0	0	6	0	66.8	2	0	0	1.4	2	0	0	375	0	0	0	0	0	0	0	12
WND-47D	12/14/2007	Deep	0	0	9.1	0	142	0	58	2	3.4	2	1.4	2	0	0	346	0	0	0	0	0	0	0	10
WND-47S	12/14/2007	Shallow	0	0	10.1	0	76.5	0	24.8	2	1	2	0	0	0	0	390	0	0	0	0	0	0	0	6
TW-DRB-MW-11	4/24/2008	Shallow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	663	1	0	0	0	0	138	0	10
TW-NMW-46D	4/24/2008	Deep	0	0	0	0	3.4	0	8.3	2	0	0	0	0	48.5	0	580	0	0	0	0	0	349	0	10
TW-WND-40S	4/23/2008	Shallow	0	0	0	0	4.7	0	2.2	2	0	0	0	0	0	0	432	0	0	0	0	0	0	0	7

Section 3
Remedial Action Objectives

According to the National Contingency Plan (NCP) [40 Code of Federal Register [CFR] 300.430(a)(1)(i)], the goal of the remedy selection process is "*to select remedies that are protective of human health and the environment, maintain protection over time, and minimize untreated waste*." Remedial action objectives (RAOs) are media-specific and source-specific goals achieved through completion of a remedial action that is protective of human health and the environment. These objectives are typically expressed in terms of the contaminant, the concentration of the contaminant, and the exposure route and receptor. They provide the basis for determination of whether protection of human health and the environment is achieved for a remedial alternative.



PRAOs are typically developed by evaluating several sources of information, including results of the BRA and tentatively identified ARARs. During development of the PRAOs, other remedial goals and desires may be considered that have been expressed by various site stakeholders. Although these goals are not considered requirements pursuant to the NCP (40 CFR 300), they may serve to guide the remedial development process. All of these inputs provide the basis for determination of whether protection of human health and the environment is achieved for a remedial alternative.

Preliminary remedial goals (PRGs) are defined as the average concentration of a chemical in an exposure unit associated with a target risk level such that concentrations at or below the PRG do not pose an unacceptable risk. Numerical RGs can be based on existing environmental standards or risk calculations, thus providing crucial targets for successful remedial alternatives to meet.

The following sections present the ARARs, PRAOs, and the PRGs that have been identified for the Site.

3.1 Applicable or Relevant and Appropriate Requirements (ARARs)

The NCP requires that the selected remedy for all remedial actions must attain or exceed the ARARs in environmental and public health laws. The NCP also requires removal actions to attain ARARs to the greatest extent practicable. The distinction between "applicable" and "relevant and appropriate" is critical to understanding the

constraints imposed on remedial alternatives by environmental regulations other than CERCLA.

Identification of ARARs must be done on a site-specific basis and involves a two-part analysis: first, determining whether a given requirement is applicable and second, determining if a requirement that is not applicable is both relevant and appropriate.

3.1.1 Definition of ARARs

Section 121(d) of CERCLA, 42 United States Code (U.S.C.) §9621(d), the NCP, 40 Code of Federal Regulations (CFR) 300 (1990), and guidance and policy issued by the EPA require that remedial actions under CERCLA comply with substantive provisions of ARARs from state and federal environmental laws, and state facility siting laws during and at the completion of the remedial action. ARARs are designated as either "applicable" or "relevant and appropriate," according to EPA guidance. If a state or federal environmental law is determined to be either applicable or relevant and appropriate, compliance with the substantive requirements of that ARAR are mandatory under CERCLA and the NCP. Compliance with ARARs is a threshold criteria that any selected remedy must meet unless a legal waiver is invoked as provided by CERCLA Section 121(d)(4).

3.1.1.1 Applicable Requirements

The NCP final rule for CERCLA defines applicable requirements as:

> *"…those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law 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."*

State requirements are more stringent than federal requirements if the state program has federal authorization and the state requirements are at least as stringent. Applicable requirements must be met to the full extent required by law or be waived by the EPA.

3.1.1.2 Relevant and Appropriate Requirements

If it is determined that a requirement is not applicable to a specific release, the requirement may still be relevant and appropriate to the circumstances of the release. The NCP final rule for CERCLA defines relevant or appropriate requirements as:

> *"…those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or circumstance at a CERCLA site, address*

> *problems or situations sufficiently similar to those encountered at the CERCLA 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 relevant and appropriate."*

Distinguishing a regulation that is relevant and appropriate is determined using best professional judgment, taking into account the purpose of the requirement, medium, substance, and action regulated and use or potential use of affected resources relative to the nature of these factors at a site. In some cases, a requirement may be relevant but not appropriate, given a site-specific circumstance; such a requirement is therefore not an ARAR for a site.

3.1.1.3 Other Requirements To Be Considered (TBC)

In addition to ARARs, To Be Considered (TBC) criteria are evaluated and utilized to determine the necessary level of cleanup for protection of human health or the environment. The TBCs are non-promulgated advisories, regulations, or guidance issued by federal or state government that are not legally binding and are not generally enforceable, but may have specific bearing on all or part of the action. TBCs can be used to determine the necessary level of cleanup for protection of human health or the environment where no specific ARARs exist for a chemical or situation or where such ARARs are not sufficient to be protective.

3.1.1.4 Waivers

CERCLA Section 121(d)(4) authorizes that any ARAR may be waived under one of the six conditions presented in **Table 3-1** if the protection of human health and the environment is assured:

3.1.2 Identification of ARARS

ARARs are defined as chemical-, location-, or action-specific. An ARAR can be one or a combination of all three types of ARARs.

Chemical-specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals that may be found in or discharged to the ambient environment.

Location-specific requirements are restrictions placed upon the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location-specific ARARs relate to the geographical or physical positions of sites, rather than to the nature of contaminants at sites.

Action-specific requirements are usually technology-based or activity-based requirements or limitations on actions taken with respect to hazardous substances, pollutants, or contaminants. A given cleanup activity will trigger an action-specific

requirement. Such requirements do not themselves determine the cleanup alternative but define how chosen cleanup methods should be performed.

Summaries of federal and Kansas chemical-specific, action-specific, and location-specific ARARs and TBCs were compiled using KDHE BER Policy # BER-RS-15 (2005 revision) and supplemented with CDM's own research. The ARARs and TBCs are included in **Tables 3-2a** (federal) and **3-2b** (state) along with a designation denoting the applicability of each ARAR or TBC to the NIC Site. The type of ARAR or TBC (chemical-, location-, or action-specific) is also noted in the tables.

3.2 Preliminary Remedial Action Objectives

The following PRAOs have been developed for contaminated groundwater at the NIC Site for the primary contaminants of concern identified in **Table 1-1**:

- Prevent exposure to groundwater that is contaminated above acceptable risk levels;
- Prevent or minimize further migration of the contaminant plume (source control); and
- Return groundwater to its expected beneficial uses (aquifer restoration).

In determining what constitutes beneficial uses for a particular groundwater, RAOs and RGs should reflect current and future uses of groundwater and exposure scenarios that are consistent with these uses. PRGs, therefore, should be set based on a clear understanding of current groundwater uses as well as a clear determination of future groundwater uses. Generally EPA or State action levels or MCLs are ARARs for groundwater that is determined to be a current or potential future source of drinking water. Action levels/MCLs are not ARARs, however, when groundwater is not currently being used as drinking water and is not considered a future potential source of drinking water.

How quickly RAOs need to be achieved can have a significant impact on the selection of a remedy. For example, if groundwater is not currently used as a drinking water source but is considered a future source of drinking water, then the timing for future use must be taken into account. Consideration needs to be given to alternatives that are available to restore groundwater by the time it is expected to be used as a drinking water supply. EPA guidance states that:

> *"Where the contaminated groundwater is not currently used or an alternative water source is readily available, and there is no near-term future need for the resource, it will likely be appropriate to consider a longer time frame for achieving restoration cleanup levels. Where longer remediation time frames are appropriate, less aggressive remediation methods and/or more passive remediation approaches (such as source control combined with monitored natural attenuation) should be considered." (Rules of Thumb for Superfund Remedy Selection, U.S. EPA, August 1997, p. 20).*

EPA guidance recognizes that groundwater response actions are often implemented in several steps or in a phased approach.

3.3 Preliminary Remedial Goals

EPA MCLs for groundwater are proposed as NIC Site-wide PRGs. For active groundwater treatment systems, ATGs for PRGs are proposed for individual compounds. The proposed ATGs are based on MCLs or KDHE RSK Manual (KDHE 2010) Equation 1 and 2 calculations using 10^{-5} risk levels. The results of the ATG evaluations are that for most of the primary VOCs at the NIC Site, Equation 1 results in a 10^{-5} risk level that is less than the MCLs, with the notable exception of TCE. Equation 1 results in a 10^{-5} risk level of 21 µg/L for TCE; therefore, a TCE ATG of 21 µg/L is proposed as the PRG for active groundwater treatment systems.

Table 3-1
North Industrial Corridor (NIC) Site
ARAR Waivers

Waiver	Description
Interim Measures	The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed. (CERCLA §121(d)(4)(A).)
Greater Risk to Health and the Environment	Compliance with such requirement at the facility will result in greater risk to human health and the environment than alternative options. (CERCLA §121(d)(4)(B).)
Technical Impracticability	Compliance with such requirement is technically impracticable from an engineering perspective. (CERCLA §121(d)(4)(C).)
Equivalent Standard of Performance	The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation through use of another method or approach. (CERCLA §121(d)(4)(D).)
Inconsistent Application of State Requirements	With respect to a state standard, requirement, criteria, or limitation, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criteria, or limitation in similar circumstances at other remedial actions. (CERCLA §121(d)(4)(E).)
Fund Balancing	In the case of a remedial action to be undertaken solely under section 104 using the fund, selection of a remedial action that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration and the availability of amounts from the fund to respond to other sites which present or may present a threat to public health or welfare or the environment, taking into consideration the relative immediacy of such threats. (CERCLA §121(d)(4)(F).)

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
Archaeological and Historic Preservation Act of 1974 - 16 U.S.C. §469 et seq.	Potentially Applicable	Provides for the preservation of historical or archaeological data which might be destroyed or lost as the result of 1) flooding, building of access roads, relocation of railroads and highways, and other alterations of terrain caused by the construction of a dam by government or persons, or 2) alteration of terrain caused by Federal construction projects or federally licensed activity or program.	Will be applicable if construction projects or alteration of terrain at a site have the potential to destroy or modify historical or archaeological materials.		✓	✓
National Historic Preservation Act of 1966 - 16 U.S.C. §470 et seq.	Relevant and Appropriate	Establishes a national registry of historic sites. Provides for preservation of historic or prehistoric resources.	Will be applicable if a site is listed on historic registry and if activities requiring permitting are initiated at a site.		✓	
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 - 42 U.S.C. §9601 et seq. as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986	Applicable	Enacted to provide Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health and the environment. Established a trust fund (i.e., Superfund) to provide for cleanup when no responsible party is identified. Provides for liability of persons responsible for releases of hazardous substances. Established prohibitions and requirements concerning closed and abandoned hazardous waste sites.	Will be applicable if the site is on the EPA National Priorities List (NPL). May be applicable for any site where a release of hazardous substances has occurred.	✓		✓
CERCLA - National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300)	Relevant and Appropriate	Federal government's blueprint for responding to spills or releases of oil and hazardous substances.	May be applicable for any site where a release of hazardous substances has occurred.	✓		✓
CERCLA - 40 CFR 300.440	Applicable	Establishes procedures for planning and implementing offsite response actions.	Formally referred to as the "offsite rule" wherein required to determine compliance status of the disposal facility.		✓	✓
Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 - 42 U.S.C. §11001 et seq.	Applicable	Designated to help local communities protect public health, safety, and the environment from chemical hazards. Enables states and communities to prepare to respond to unplanned releases of hazardous substances. Requires facilities at which hazardous substances are present to report the presence of these materials to emergency responders. Requires companies to report the release of hazardous substances.	Will be applicable if hazardous chemicals are stored or used at a facility.	✓	✓	✓

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
Endangered Species Act 16 U.S.C. §1531-1543	Applicable	Requires that federal agencies insure that any action by the agency is not likely to jeopardize endangered species or adversely modify habitat.			✓	
Endangered Species Act of 1973 - 7 U.S.C. §136; 16 U.S.C. §460 et seq.	Relevant and Appropriate	Provides a program for conservation of threatened and endangered plants and animals and the habitats in which they are found.	Will be applicable if threatened or endangered species, or their habitats are present at or near a site.		✓	
Explosives - 18 U.S.C. §847	Relevant and Appropriate	Regulates commerce in explosives. Requires licensing and permitting, record keeping, and reporting for purchase and use of explosives. Provides standards for storage of explosive materials.	Will be applicable if explosives are purchased, stored, or used at a site.			✓
Federal Hazardous Materials Transportation Law - 49 U.S.C. §5101 et seq.	Relevant and Appropriate	Regulates the transportation of hazardous wastes and hazardous substances by aircraft, railcars, vessels, and motor vehicles. Requires employers to train, test, and maintain training records for all hazmat employees.	Will be applicable if hazardous materials are transported to or from a site.			✓
Clean Air Act (CAA) - 42 U.S.C. §7401 et seq. as amended in 1977 and 1990	Applicable	Regulates air emissions from area, stationary, and mobile sources. Authorizes EPA to establish National Ambient Air Quality Standards.	May be applicable if remedial actions result in emissions of contaminants to the air at volumes above air permitting requirements.	✓	✓	
CAA - Standards of Performance for New Stationary Sources (40 CFR 60)	Applicable	Identifies standards of performance for new stationary sources of air emissions. Provides emission guidelines and compliance times.	Will be applicable for new stationary sources of air emissions.	✓	✓	
CAA - National Emission Standards for Hazardous Air Pollutants (40 CFR 61)	Applicable	Identifies emission standards for specific hazardous air pollutants.	Will be applicable if the identified hazardous air pollutants are emitted from a site in substantial quantities.	✓		✓
CAA - National Emission Standards for Hazardous Air Pollutants for Source Categories including Site Remediation (40 CFR 63)	Applicable	Identifies emission standards for hazardous air pollutants that originate from specific categories of sources including site remediation.	Will be applicable if the identified hazardous air pollutants are emitted from a specific source category that has been identified.	✓		
Flood Control Act of 1944 -16 U.S.C. §460	Relevant and Appropriate	Provides the public with knowledge of flood hazards and promotes prudent use and management of flood plains.	Will be applicable if a site is located on a designated flood plain.		✓	

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
Executive Order on Floodplain Management EO 11988	Applicable	Requires evaluation of potential effects of action on floodplain	Only applicable for remedies in floodplain		✓	
Clean Water Act (CWA) of 1977 - 40 CFR Part 421	Applicable	Limits discharge to POTWs	Applicable if treated water is disposed of at a POTW	✓	✓	✓
CWA - 33 U.S.C §1251 et seq. as amended in 1987	Applicable	Implements a system to impose effluent limitations on, or otherwise prevent, discharges of pollutants into any waters of the United States from any point source	Will be applicable if discharges to streams, rivers, or lakes occur from a site.	✓	✓	✓
CWA - National Pollutant Discharge Elimination System (NPDES) (40 CFR 122)	Applicable	Regulates discharges of pollutants from any point source into waters of the United States	Will be applicable if water from the site will be discharged onto land or into streams, rivers, or lakes.	✓		✓
CWA - Storm Water Discharge Requirements NPDES (40 CFR 122.26)	Potentially Applicable	Provide requirements to obtain a permit to discharge to the stormwater sewer system under the NPDES program.	Will be applicable if the site has stormwater that comes in contact with construction or industrial activity or if the selected remedy involves discharge of treated water to surface waters.	✓		✓
CWA - Federal Water Quality Standards (40 CFR 131)	Potentially Applicable	Establishes methods and requirements for states in the development of ambient water quality criteria for the protection of aquatic organisms and/or the protection of human health.	May be indirectly applicable to surface water remediation and is directly applicable to surface water discharges.	✓		✓
CWA - General Pre-treatment Regulations for Existing and New Sources of Pollution for Publicly Owned Treatment Works (40 CFR 403)	Potentially Applicable	Provides effluent limitations and guidelines for existing sources, standards of performance for new sources, and pre-treatment standards for new and existing sources.	Will be applicable if wastewater from a site is discharged to a POTW.	✓		✓
CWA - Wetlands Protection (40 CFR 22, 40 CFR 230 to 233, and 33 CFR 320 to 330)	Relevant and Appropriate	Allows for permitting of discharge of dredged or fill material to the waters of the United States if no practicable alternatives exists that are less damaging to the aquatic environment. Applicants must demonstrate that the impact to wetlands is minimized.	Will be applicable if designated wetlands are impacted by a remedy.	✓		✓
CWA - Federal Surface Water Quality Requirements - 33 U.S.C. §1251, et seq. as amended in 1987	Applicable	Implements a system to impose effluent limitations on, or otherwise prevent, discharges of pollutants into any waters of the United States from any point source. As provided under Section 303 of the Clean Water Act, 33 U.S.C. § 1313	Will be applicable if treated groundwater is discharged to the Chisholm Creek or the Little Arkansas River.	✓		

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
Executive Order on the Protection of Wetlands EO 1199040 CFR § 6.302(a)	Applicable	Requires avoidance of destruction or loss of wetlands and construction in wetlands.			✓	✓
Safe Drinking Water Act (SDWA) of 1974 - 42 U.S.C. §300f et seq. as amended in 1986	Relevant and Appropriate	Established to protect the quality of drinking water in the United States. Focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. The Act authorized the EPA to establish safe standards of purity and required all owners or operators of public water supply systems to comply with primary (health related) standards.	May be applicable, relevant or appropriate at sites where waters that are used or may potentially be used as drinking water supplies are impacted or threatened.	✓		
SDWA - National Primary Drinking Water Regulations and Implementation (40 CFR 141 and 142)	Applicable	Establishes maximum contaminant levels (MCLs) which are health risk-based standards for public water systems.	Will be applicable at the distribution point (i.e., at the tap). Will be relevant and appropriate for groundwater cleanup at sites where potential drinking water sources (aquifers) are impacted.	✓		✓
SDWA - National Secondary Drinking Water Standards (40 CFR 143)	Applicable	Establishes welfare-based secondary standards for public water systems.	Will be applicable at the distribution point (i.e., at the tap).	✓		✓
SDWA - Underground Injection Control Program (40 CFR 144 to 148)	Applicable	Assures that Underground Injection will not endanger drinking water sources. Provides regulations governing the use of underground injection wells including: identification of the classifications of injection wells; and the permitting, construction, operation, monitoring, testing, and reporting requirements. Also provides requirements for plugging of injection wells.	Will be applicable if underground injection of liquids or air is conducted as part of a site remedy.	✓		✓
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1972 - 7 U.S.C. §136 et seq.	Relevant and Appropriate	Provides Federal control of pesticide distribution, sale, and use. Allows the EPA to study the consequences of pesticide use. Requires users of pesticides to take exams for certification as applicators of pesticides. Pesticide users must register purchases of these materials.	May be applicable if pesticides were distributed, sold, or used at a site.	✓		✓
Fish and Wildlife Conservation Act - 16 U.S.C. §2901 to 2911	Relevant and Appropriate	Action to conserve fish and wildlife, particularly those species that are indigenous to the state.	Will be applicable if significant populations are present at a site or they are affected by site activities.		✓	

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
Fish and Wildlife Coordination Act - 16 U.S.C. §661-667e	Relevant and Appropriate	The Act allows the Departments of Agriculture and Commerce to assist Federal and State agencies to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife.	Will be applicable if significant populations are present at a site or they are affected by site activities.		✓	
Occupational Safety and Health Act (OSHA) of 1970 - 29 U.S.C. §651 et seq.	Applicable	Enacted to ensure worker and workplace safety. Employers are required to provide workers a place of employment that is free from recognized hazards to safety and health.	Applies to workers and workplaces.			✓
OSHA - Occupational Safety and Health Standards (29 CFR 1910)	Applicable	Provides standards for workers and the workplace including: working surfaces; means of egress; ventilation; noise; hazardous materials; personal protective equipment; sanitation; medical services and first aid; fire protection, detection, and suppression; materials handling and storage; machinery and machinery guards; power tools; and welding and electrical equipment. Also requires training for workers.	Will be applicable to workers and workplaces including hazardous waste sites.			✓
OSHA - Safety and Health Regulations for Construction (29 CFR 1926)	Potentially Applicable	Provides standards for construction activities including: work practices; safety equipment; scaffolding and ladders; fall protection; heavy equipment; excavations; concrete and masonry construction; steel erection; tunnels and shafts; demolition; use of explosives; power transmission and distribution; and overhead protection.	Will be applicable to workers and workplaces where construction activities take place.			✓
Resource Conservation and Recovery Act (RCRA) of 1976 - 42 U.S.C. §6901 et seq. as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA) and 1986, the Federal Facilities Compliance Act of 1992, and the Land Disposal Program Flexibility Act of 1996.	Applicable	Enacted to provide control of hazardous waste by imposing management requirements on generators and transporters of hazardous waste and upon owners and operators of treatment, storage, and disposal (TSD) facilities. Also set forth a framework for management of nonhazardous waste. Focuses only on active or future facilities. HSWA requires phasing out land disposal of hazardous waste.	Applies to active hazardous and solid wastes facilities including facilities that treat, store, and dispose of these materials as well as generators and transporters of hazardous wastes.	✓	✓	✓
RCRA - Solid Waste Disposal Facility Criteria (40 CFR 257 - 258)	Relevant and Appropriate	Regulations apply to owners and operators of facilities that treat, store, or dispose of solid wastes	Will be applicable if site activities are analogous to solid waste facility activities.	✓		✓

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
RCRA - Standards for Identification and Listing of Hazardous Waste (40 CFR 261)	Relevant and Appropriate	Provides criteria for identification of hazardous and solid wastes.	Will be applicable for identifying hazardous wastes.	✓		✓
RCRA - Standards Applicable to Generators of Hazardous Waste (40 CFR 262)	Relevant and Appropriate	Regulates the manifesting, pre-transport requirements, and record keeping and reporting for hazardous waste generators.	Will be applicable if hazardous waste is generated at a site.	✓		✓
RCRA - Standards Applicable to Transporters of Hazardous Waste (40 CFR 263)	Relevant and Appropriate	Establishes standards that apply to persons transporting hazardous waste within the United States if the transportation requires a manifest under RCRA.	Will be applicable if hazardous waste is disposed offsite.	✓		✓
RCRA - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264)	Relevant and Appropriate	Regulations apply to owners and operators of facilities that treat, store, or dispose of hazardous waste through the use of surface impoundments, waste piles, incinerators, land treatment units, and landfills.	Will be applicable if site activities are analogous to hazardous waste facility activities.	✓		✓
RCRA - Manifesting, Record Keeping, and Reporting Requirements (40 CFR 264.70 to 264.77)	Relevant and Appropriate	These standards apply to owners and operators of all facilities which treat, store, or dispose of hazardous wastes	Will be applicable if site activities are analogous to hazardous waste facility activities.	✓		✓
RCRA - Releases from Solid Waste Management Units (40 CFR 264.90 to 264.101)	Relevant and Appropriate	Regulations apply to owners or operators of hazardous waste treatment, storage, or disposal facilities.	Will be applicable if solid waste is stored at a site.	✓		✓
RCRA - Closure and Post-Closure Requirements (40 CFR 264.110 to 264.120)	Relevant and Appropriate	Facility owner or operator must close a hazardous waste facility in a way that minimizes the need for further maintenance and maximizes the protection of human health and the environment.	Will be applicable upon the closure and post-closure of a hazardous waste facility.	✓		✓
RCRA - Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 265)	Applicable	Regulations apply to owners and operators of facilities that treat, store, or dispose of hazardous waste.	Will be applicable if site activities are analogous to hazardous waste facility activities.	✓		✓
RCRA - Land Disposal Restrictions (40 CFR 268)	Applicable	Identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise prohibited waste may continue to be land disposed.	Will be applicable depending on the type of waste generated at the site.	✓		✓

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
RCRA - Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (40 CFR 280)	Relevant and Appropriate	Establishes regulations relating to underground storage tanks (UST) including: performance standards; spill control; corrosion protection; record keeping and reporting; release detection; environmental investigations of releases; corrective actions; and closure of UST systems.	Will be applicable if underground storage tanks are or were present at a site and if a petroleum release is present. Also provides for environmental assessment at closure of UST systems.			✓
Resource Conservation and Recovery Act Regulations including Land Disposal Restrictions - 40 CFR Parts 260-270	Relevant and Appropriate	Regulates generation, treatment, storage, and disposal of hazardous waste	Applicable if hazardous treatment residue requires disposal			✓
Resource Conservation and Recovery Act and Regulations	Applicable	Requirements for construction in floodplain and distance from faults are given.	May be applicable for any portion of the site that is a designated floodplain.		✓	
Hazardous Materials Transportation Act - 47 U.S.C. §1801-1808, 40 CFR 107, 171, 177	Potentially Applicable	Regulates transportation of hazardous materials.	May be applicable if remedial actions result is transport of hazardous materials out of the site.			✓
Toxic Substances Control Act (TSCA) of 1976 15 U.S.C. § 2601 et seq.	Relevant and Appropriate	Enacted to give the EPA the ability to track industrial chemicals currently produced or imported into the United States. The EPA screens these chemicals and may require reporting or testing of those that pose an environmental or human-health hazard. the EPA may ban the manufacture and import of those chemicals that pose an unreasonable risk.	Will be applicable if site activities involve handling of toxic substances such as polychlorinated biphenyls (PCBs) or remediation of these substances.	✓		✓
Underground Injection Control - 40 CFR 144	Potentially Applicable	Standards for reinjection of groundwater.	Applicable if groundwater is reinjected.			✓
Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, EPA540-G-89-004, October 1988.	TBC	Provides the methodology that the Superfund program uses to characterize the nature and extent of risk posed by uncontrolled hazardous wastes sites and for evaluating potential remedial alternatives.				✓
Guidance for Quality Assurance Project Plans, EPA240-R-02- 009, December 2002.	TBC	Describes the Quality Assurance Project Plan as four basic element groups covering project management, data generation and acquisition, assessment and oversight, and data validation and usability.				✓

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
Guidance for the Data Quality Objectives Process, EPA600-R-96-055, August 2000.	TBC	Provides a systematic planning process to develop acceptance or performance criteria for collection, evaluation, or use of environmental data.				✓
Risk Assessment Guidance for Superfund, Volume I: Part A EPA540-1-89-002, December 1989; Part B EPA540-R-92-003, December 1991; Part C EPA540-R-92-004, December 1991; Part D EPA540-R-97-033, December 2001; Part E EPA540-R-99-005, July 2004.	TBC	Provide guidelines for conducting a baseline risk assessment.				✓
Development and Evaluation of Consensus Based Sediment Quality Guidelines for Freshwater Ecosystems, 2000, MacDonald, D.D , C.G. Ingersoll, and T.A. Berger. *Archives of Environmental Contamination and Toxicology* 39:20-31.	Not TBC	Identifies Threshold Effect Concentration (TEC) to be used to assess impacts to sediment.		✓		
Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA542-S-02-001, May 2002.	TBC	Identifies methods for sampling groundwater.				✓
Remedial Design/Remedial Action Handbook, EPA540-R-95- 059, June 1995.	TBC	Provides an overview of the remedial design and remedial action processes.		✓		✓
Management of Remediation Waste under RCRA, EPA530-F-98-026, October 1998.	TBC	Describes management of contaminated environmental media, etc.				✓

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
Best Management Practices (BMPs) for Soils Treatment Technologies, EPA530-R-97-007, May 1997.	TBC	Describes various BMPs to be implemented during remedy implementation.				✓
Storm Water Management for Construction Activities EPA832 R-92-005, October 1992.	TBC	Describes stormwater pollution prevention measures.		✓		✓
Guide to Discharging CERCLA Aqueous Wastes to Publicly Owned Treatment Works, EPA OSWER Directive 9330.2- 13FS, March 1991	TBC	Describes applicability and acceptable means of conveyance to a POTW.				✓
Use of Monitoried Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, EPA OSWER Directive 9200.4-17P, April 21, 1999	TBC	Describes EPA's policy regarding the use of monitored natural attenuation for the remediation of contaminated soil and groundwater at sites administered by the EPA's Office of Solid Waste and Emergency Response.		✓		✓
Performance Monitoring of MNA Remedies for VOCs in Ground Water" April 2004. National Risk Management Research Laboratory (NRMRL), Ada, Oklahoma, Publication EPA/600/R-04/027, 92p.	TBC	Describes MNA Performance Monitoring criteria.		✓		✓
National Risk Management Research Laboratory (NRMRL), Ada, Oklahoma, Publication EPA/600/R-04/027, 92p	TBC	Describes EPA's policy regarding the use of monitored natural attenuation for the remediation of contaminated soil and groundwater at sites administered by the EPA's Office of Solid Waste and Emergency Response.		✓		✓

Table 3-2a
North Industrial Corridor (NIC)Site
Summary of Federal ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Federal ARARs						
Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water" October 1998. National Risk Management Research Laboratory (NRMRL), Ada, Oklahoma, Publication EPA/600/R-98/128, NTIS Order Number PB99-130023, 214p	TBC	Presents protocols for evaluating the natural attenuation of chlorinated solvents in groundwater.		✓		✓

TBC = To Be Considered
POTW = Publicly Owned Treatment Works

Table 3-2b
North Industrial Corridor (NIC) Site
Summary of State ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Kansas ARARs						
Kansas Historic Preservation Act - K.A.R. 118-3-1 to 118-3-16	Potentially Applicable	Provides for the protection and preservation of sites and buildings listed on state or federal historic registries.	Will be applicable if a site or building is listed on the state or federal historic registry and if activities requiring permitting are initiated at a site.		✓	✓
Ambient Air Quality Standards and Air Pollution Control - K.A.R. 28-19-1 to 28-19-801	Potentially Applicable	Regulates air emissions from processing operations, indirect heating equipment, and incinerators. Establishes requirements for Attainment and Non-Attainment Areas. Establishes requirements for Stack Heights. Restricts open burning.	Will be applicable if a remedy results in the release of contaminants to the air. Establishes emissions criteria.	✓		✓
Kansas Drinking Water Rules - K.A.R Title 28 Article 15	Potentially Applicable	Establishes health-based standards for public water systems.	No levels have been set for VOCs.	✓		
Water Pollution Control - K.A.R. 28-16-1 to 28-16-154	Potentially Applicable	Provides regulation of sewage discharge. Establishes pre-treatment standards for industry. Designates uses of rivers and streams. Establishes River Basin Quality Criteria and Surface Water Quality Criteria. Provides for the establishment of Critical Water Quality Management Areas.	Will be applicable if water is to be discharged to state waterways.	✓		✓
Kansas Drycleaner Environmental Response Act - K.A.R. 28-68-1 to 28-68-9	Applicable	Enacted to provide funds to assist with assessment and corrective action of former and existing drycleaner facilities. Requires registration of drycleaning facilities and compliance with waste management measures.	May be applicable if a drycleaner operated onsite.			✓
Non-Game, Threatened, or Endangered Species - K.A.R. 115-15-1 to 115-15-4	Potentially Applicable	Identifies Threatened and Endangered Species.	Will be applicable if any of the identified species are present at a site.			✓
Environmental Use Controls - K.S.A. 65-1,221 to 65-1,235	Applicable	An environmental use control " means an institutional control or administrative control, a restriction, prohibition, or control of one or more uses of, or activities on, a specific property, as requested by the property owner at the time of issuance, to ensure future protection of public health and the environment when environmental contamination which exceeds department standards for unrestricted use remains on the property following the appropriate assessment and/or remedial activities as directed by the department pursuant to the secretary's authority".	These restrictions are strictly voluntary as the landowner applies for the restriction to their property to mitigate the risk posed to human health and the environment from contamination at their property (in lieu of active remediation).		✓	

Table 3-2b
North Industrial Corridor (NIC) Site
Summary of State ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Kansas ARARs						
Kansas Antidegradation Policy - State of Kansas - August 6, 2001	Applicable	"EPA's water quality standards regulations require States to adopt and implement an antidegradation policy containing the minimum requirements for such a policy. The antidegradation policy is a component of the Surface Water Quality Standards in the State's overall water quality program. [See K.A.R. 28-16-28c(a)]. The intent of the antidegradation policy is to limit discharges and other activities that will negatively impact water quality, impair designated uses, or threaten to impair designated uses of surface waters. The antidegradation policy provides a baseline level of protection relative to established water quality criteria to all classified surface waters, and a higher level of protection to those waterbodies recognized as unique ecologically, highly valued for its resources, or having high water quality."	Will be applicable where groundwater discharges to surface water bodies with designated uses.	✓	✓	
Explosive Materials - K.A.R. 22-4-1 to 22-4-4	Potentially Relevant and Appropriate	Requires all contractors to obtain explosive storage site permits before moving, storing, or using any explosives or blasting agents at any job site within the state.	Will be applicable if explosives or blasting agents are used or stored at a site.			✓
Asbestos Control - K.A.R. 28-50-1 to 28-50-14	Potentially Relevant and Appropriate	Established the requirements for licensing of businesses and examination and certification of asbestos workers. Established requirement for notification of asbestos projects. Establishes work practices for asbestos projects. Establishes rules for disposal of asbestos containing materials.	Will be applicable if asbestos is handled or removed from a site or encapsulated.	✓		✓
Hazardous Waste Management Standards and Regulations - K.A.R. 28-31-1 to 28-31-16	Applicable	Identifies the characteristics and listing of hazardous waste. Prohibits underground burial of hazardous waste except as granted by the EPA or KDHE. Establishes restrictions on land disposal. Establishes standards for generators or transporters of hazardous waste. Establishes standards for hazardous waste storage, treatment, and disposal facilities.	Will be applicable if hazardous wastes are present, generated, disposed, and/or transported at a site.	✓		✓
Mined Land Reclamation - K.A.R. 47-16-1 to 47-16-11	Not Relevant and Appropriate	Allows for the reclamation of mined land and associated waters.	Will be applicable if mined land or associated waters are to be reclaimed.			✓
Kansas Board of Technical Professions - K.A.R. 66-6-1 through 66-14-12	Applicable	Establishes the requirements for licensing of engineers, land surveyors, geologists, and architects.	Will be applicable if the services of a geologist, engineer, or land surveyor are required for site investigations or remediation.			✓

Table 3-2b
North Industrial Corridor (NIC) Site
Summary of State ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Kansas ARARs						
Water Well Contractor's License; Water Well Construction and Abandonment - K.A.R. 28-30-1 to 28-30-10	Applicable	Establishes the requirements for licensing of drillers. Regulates drilling activities including the construction of wells.	Will be applicable if drilling and/or well construction or abandonment is conducted at a site.			✓
PCB Facility Construction Permit Standards and Regulations - K.A.R. 28-55-1 to 28-55-5	Potentially Relevant and Appropriate	Establishes the requirement for permitting of facilities constructed for the treatment, storage, or disposal of materials containing PCBs. Establishes standards for PCB facilities.	Will be applicable if treatment, storage or disposal of materials containing PCBs occurs.			✓
Agricultural Chemicals, Commercial Fertilizers, Anhydrous Ammonia, and Chemigation - K.A.R. 4-1-1 to 4-1-17, K.A.R. 4-4-1 to 4-4-984, K.A.R. 4-10-1 to 4 10-17, and K.A.R. 4-20-1 to 4-20-15	Relevant and Appropriate	Requires labeling and registration of agricultural chemicals. Provides regulations for storage and secondary containment, transportation and recordkeeping for commercial fertilizers and anhydrous ammonia. Requires permitting and certification of operators of chemigation equipment.	Will be applicable if agricultural chemicals, commercial fertilizers, or anhydrous ammonia are used at site. Will be applicable if chemicals or animal wastes are applied by chemigation.	✓		✓
Pesticides - K.A.R. 4-13-1 to 4-13-65	Relevant and Appropriate	Requires licensing of pesticide businesses and certification of persons that apply pesticides.	Will be applicable if pesticides are present at a site or application of pesticides occurs.			✓
Hydrocarbon Storage Wells and Well Systems - K.A.R. 28-45-1 to 28-45-11	Not Relevant and Appropriate	Establishes a system for permitting of hydrocarbon storage wells. Establishes requirements for construction, operation and monitoring, and plugging of hydrocarbon storage wells.	Will be applicable if hydrocarbon storage wells are present at a site.			✓
Petroleum Products Storage Tanks - K.A.R. 28-44-1 to 28-44-29	Potentially Relevant and Appropriate	Provides requirements for permitting of the installation and operation of underground storage tanks (USTs). Provides requirements for design and construction of storage tanks. Provides a system for licensing contractors who install and test USTs. Requires implementation of methods for detecting releases and reporting releases from USTs.	Will be applicable if petroleum storage tanks are or were present at a site.			✓
Radiation - K.A.R 28-35-1 to 28-35-363	Potentially Relevant and Appropriate	Regulations require registration of radiation producing devices and licensing of sources of radiation. Provides standards for protection against radiation. Provides requirements for industrial radiographic operations and wireline and subsurface tracer studies.	Will be applicable if radiation producing devices or sources of radiation are present at or are used at a site.			✓

Table 3-2b
North Industrial Corridor (NIC) Site
Summary of State ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Kansas ARARs						
Emergency Planning and Right-to- Know - K.A.R. 28-65-1 to 28-65-4	Applicable	Designated to help local communities protect public health, safety, and the environment from chemical hazards. Enables communities to prepare to respond to unplanned releases of hazardous substances. Requires facilities at which hazardous substances are present to report the presence of these materials to emergency responders. Requires companies to report the release of hazardous substances.	Will be applicable if hazardous chemicals are stored or used at a site.	✓	✓	✓
Spill Reporting - K.A.R. 28-48-1 to 28-48-2	Potentially Applicable	Requires reporting of unpermitted discharges or accidental spills. Requires that containment and immediate environmental response measures be implemented. Also provides for technical assistance for mercury-related spills.	Will be applicable if unpermitted discharges or accidental spills occur at a site.			✓
Solid Waste Management - K.A.R. 28-29-1 to 28-29-121 and K.A.R. 28-29-2101 to 28-29 2113	Relevant and Appropriate	Provides standards for management of solid wastes. Establishes administrative procedures. Establishes the requirement for development and submittal of Solid Waste Management Plans.	Will be applicable if solid waste is generated, stored, or disposed at a site.			✓
Kansas Underground Injection Control Regulations - KAR Title 28, Article 47	Potentially Applicable	Controls pressure, flow rate, volume, and quality of injected water.	May be applicable if remedial action chosen has reinjection component.			✓
Underground Injection Control Regulations - K.A.R. 28-46-1 to 28-46-44	Potentially Applicable	Provides regulations governing the use of underground injection wells including: identification of the classifications of injection wells; and the permitting, construction, operation, monitoring, testing, and reporting requirements. Also provides requirements for plugging of injection wells.	Will be applicable if the remedy involves the injection of fluids or air into the subsurface.	✓		✓
Underground Storage, Disposal Wells, and Surface Ponds - K.A.R. 28-13-1 to 28-13-9	Potentially Relevant and Appropriate	Regulates the construction and use of underground storage reservoirs, disposal wells, and surface ponds for the confinement, storage, and disposal of industrial fluids including but not limited to brine. Also pertains to removal of material from surface ponds upon abandonment. Does not include regulations pertaining to oil field activities.	Will be applicable if underground reservoirs, disposal wells, or surface ponds are used for storage or disposal of industrial fluids at a site. Will be applicable if use of a surface pond is discontinued.		✓	✓
Kansas Underground Storage Tank Rules - K.A.R. Title 28 Article 44	Relevant and Appropriate	Corrective action policy establishes petroleum site remediation levels.	Sets soil levels for TPH, BEN and 12DCA and groundwater levels for BTEX, Pb, and 12DCA	✓		✓

Table 3-2b
North Industrial Corridor (NIC) Site
Summary of State ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Kansas ARARs						
Voluntary Cleanup Property Redevelopment Program – K.A.R. 28-71-1 to 28-71-12	Potentially Relevant and Appropriate	Provides a mechanism for property owners, facility operators, prospective purchasers, and local governments to voluntarily address contaminated properties with technical and regulatory guidance from the KDHE. Identifies remedial standards for cleanup of environmental media. Establishes that groundwater cleanup levels shall be based on the most beneficial use of the groundwater (i.e., current and future use).	May be applicable if a site meets the criteria for acceptance into the Voluntary Cleanup Program. Remedial standards established under KAR 28-71-11 are relevant and appropriate for all other sites being managed under KDHE oversight.	✓		✓
Kansas Water Appropriations Act - KSA 82a-701 et. seq	Potentially Applicable	Establishes procedures for the appropriation/distribution of groundwater	According to the KDHE Division of Water Resources, a permit must be obtained for diversion of water whether the use is for remediation or other typical uses. The only time a permit is not required is for domestic wells for a private residence.			✓
Kansas Water Appropriations Act - K.A.R. 5-1-1 through 5-10-6 and K.A.R. 5-50-1 to 5-50-8	Potentially Applicable	Establishes the requirements for obtaining, maintaining, and transferring water appropriations.	Will be applicable if water appropriations are required for groundwater remediation.			✓
Water Well Construction and Abandonment Rules and Regulations - KAR Title 28, Article 30	Applicable	Establishes license requirements for Water Well Contractors, and well installation and abandonment rules and regulations	Wells installed and abandoned on the Site must meet the requirements of this legislation			✓
Construction, Operation, Monitoring and Abandonment of Salt Solution Mining Wells - K.A.R. 28-43-1 to 28-43-11	Not Relevant and Appropriate	Regulates the construction, operation, monitoring, testing and abandonment of salt solution mining wells.	Will be applicable if salt solution mining wells are present.			✓
Consideration for Hydraulic Containment BER-RS-028	TBC	Presents conditions for consideration of hydraulic containment as remedial strategy.				✓

Table 3-2b
North Industrial Corridor (NIC) Site
Summary of State ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Kansas ARARs						
KDHE Bureau of Environmental Remediation (BER), Risk Based Standards for Kansas, RSK Manual, March 1, 2003, as amended (5th Version, October 2010).	TBC	Compiles risk-based cleanup screening goals for contaminants in soil, groundwater, and indoor air.	RSK levels in Appendix A to be used as guidance and potential remedial action levels.	✓		✓
Kansas Vapor Intrusion Guidance. Published by KDHE. June 2007	TBC	Provides guidance on vapor intrusion including soil vapor and indoor air sampling. References standard operating procedures for indoor air, soil vapor, and subslab soil vapor sampling.		✓		✓
Evaluating Future Land Use, KDHE BER Policy #BER-RS-005.	Not TBC	Future land use influences the types and frequencies of exposures that may occur to any residual\contamination remaining on the site and therefore must be considered in making corrective action decisions.				✓
Recommended Remedial Levels for Nitrate in Soil, KDHE BER Policy #BER-RS-012.	TBC	Addresses nitrate and ammonia contamination in the soil from point sources of contamination.		✓		✓
Investigation and Remediation of Salt (Chloride)-Impacted Soil and Groundwater, KDHE BER Policy #BER RS-013A	Not TBC	Provides information on methods for investigating, evaluating, and remediating soil and groundwater contaminated with brine or salt.				✓
Consideration for Remedial Standards, KDHE BER Policy #BER-RS-033.	TBC	Identifies remedial standards and situations where they should be used.		✓		✓
Soil Clean-up Levels for Total Petroleum Hydrocarbons, KDHE BER Policy #BER RS-041.	TBC	Establishes TPH human health and environmental risk-based action levels consistent with the procedures adopted within the Risk-Based Standards for Kansas RSK manual.		✓		✓
Monitored Natural Attenuation, KDHE BER Policy #BER-RS- 042.	TBC	Provides further clarification of additional KDHE BER requirements to the guidance on monitored natural attenuation provided by EPA Directive 9200.4-17P.		✓		✓

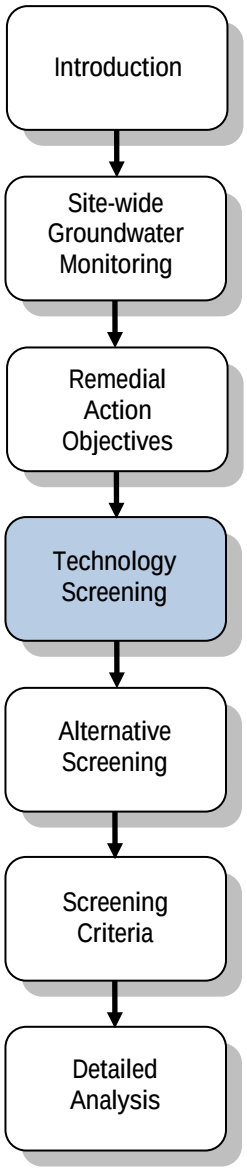
Table 3-2b
North Industrial Corridor (NIC) Site
Summary of State ARARs and TBCs

Statue and Regulatory Citation	ARAR Determination	Description	Comment	Type of ARAR or TBC		
				Chemical	Location	Action
Kansas ARARs						
Considerations for Groundwater Use and Applying RSK Standards to Contaminated Groundwater KDHE BER Policy #BER-RS-045.	TBC	Establishes a mechanism for consistency across BER programs in protecting public health and the environment, in addition to protection of groundwater resources of the State.		✓		✓
Sediment Policy, KDHE BER Policy #BER ARS-045	TBC	Provides a consistent definition and assessment approach for contaminated sediment sites in Kansas.		✓		✓

TBC = To be considered
VOCs = Volatile organic compounds
PCBs = Polychlorinated biphenyls
TPH = Total petroleum hydrocarbons
BEN = Benzene
12DCA = 1,2-Dichloroethane
BTEX = Benzene + toluene + ethylbenzene + xylenes
Pb = Lead

Section 4
Identification of Remedial Technologies and Process Options

Remedial action alternatives (herein referred to as remedial alternatives) are developed from either stand-alone technologies or process options or combinations of technologies or process options and a multi-phase approach is used to develop the remedial alternatives. The purpose of technology, process option, and alternative screening is to reduce the number of remedial alternatives retained for detailed analysis. A multi-phase approach is used to screen the technologies, process options, and alternatives; and this multi-phase approach is described in this and subsequent sections of this document. For this FS, this multi-phase approach involves:



1) Development of GRAs, remedial technologies, and process options that are potentially useful to address the PRAOs identified in Section 3 for contaminated groundwater.

2) Conduct an initial screening of GRAs, technologies, and process options based on technical feasibility at the Site. Technologies and process options that are not technically implementable relative to contaminated groundwater are eliminated from further consideration in this FS.

3) Conduct a qualitative screening of the initially retained process options based on effectiveness, implementability, and relative cost. Technologies and process options that have low effectiveness, low implementability, or high cost relative to contaminated groundwater are also eliminated from further consideration in this FS.

4) Assemble the retained technologies and process options from Step 3 into preliminary remedial alternatives that are potentially viable for remediation of contaminated Site-wide groundwater.

5) Conduct a qualitative screening of the retained alternatives from Step 4 again based on effectiveness, implementability, and relative cost but with additional evaluation criteria.

6) Conduct a detailed analysis of alternatives retained from Step 5.

4.1 General Response Actions

GRAs are initial broad response actions considered to address the PRAOs for contaminated groundwater at a site. GRAs include several remedial categories such

as containment, removal, disposal, and treatment of contamination within a site. Site-specific GRAs are first developed to satisfy the PRAOs for contaminated groundwater and then are evaluated as part of the identification and screening of remedial technologies and process options. The GRAs considered for remediation of site-wide groundwater at the NIC Site include the following:

- No Action – leaves contaminant media in their existing condition with no control or cleanup planned. In accordance with the NCP, this GRA must be considered to provide a baseline against which other options can be compared;
- Institutional Controls – administrative and legal restrictions intended to control or prevent present and future use of contaminated media. Institutional controls are not intended to substitute for engineering aspects of a selected remedy;
- Monitoring – involves physical measures applied to the Site to determine if there is contaminant migration. Monitoring is not intended to substitute for any engineering aspect of a selected remedy and does not physically address contaminants;
- Containment – involvees physical measures applied to contaminant groundwater to control the release of contaminants;
- Collection, Removal, and Disposal – involve a complete or partial removal of contaminant media materials followed by transportation and disposal of the media materials at an onsite/offsite location; and
- Treatment – involves biological, chemical, thermal, and/or physical measures applied to the contaminant groundwater that reduce toxicity, mobility, and/or volume of the contaminants present.

4.2 Identification of Remedial Technologies and Process Options

In this step of the FS process, remedial technology types and process options that are capable of addressing contaminated groundwater are identified and organized under each GRA listed in Section 4.2. These remedial technologies and process options are presented in **Table 4-1**.

4.3 Screening of Remedial Technologies and Process Options for Technical Implementability

The remedial technologies and process options presented in **Table 4-1** were evaluated and screened based on technical implementability. This preliminary screening looked at the suitability of a technology for addressing contaminated groundwater. The

primary source of information used to perform preliminary screening was the Federal Remediation Technologies Roundtable (FRTR) Remediation Technologies Screening Matrix and Reference Guide, Version 4.0 (FRTR 2007). Other sources of information used for preliminary screening include: previous studies and work conducted at the NIC Site; published literature and vendor information; and engineering judgment based on other contaminated groundwater remediation projects.

Under this step of the FS process, a given technology or process option was eliminated from further consideration in this FS on the following bases:

- Technical implementability – A technology or process option was screened when Site conditions or Site characterization data indicated that the technology or process option was incompatible with the type of contaminant involved, the type of contaminated aquifer, or could not be implemented effectively due to physical limitations or constraints at the Site; and

- Some of the process options may be technically implementable on a small-scale basis for a specific location; however, the technical implementability screening and elimination were performed by evaluating use of the process option(s) for contaminated groundwater on a large-scale, Site-wide basis.

Remedial technologies and process options not deemed to be technically implementable relative to contaminated groundwater were eliminated from further consideration. Retained technologies and process options were then carried forward to the second step of the evaluation process as discussed in Section 4.4. The process options for contaminated groundwater eliminated from further consideration in this FS (with the rationale for elimination) are indicated on **Table 4-1** by grey shading.

4.4 Retained GRAs, Remedial Technologies, and Process Options

Based on the results of the screening process, a reduced number of remedial technologies and process options for contaminated groundwater were retained for further evaluation. The following reasoning was used for retention of remedial technologies and process options to address contaminated groundwater at the NIC Site:

- Remedial technologies and process options that have substantial potential and applicability as a stand-alone remedy.

- Remedial technologies and process options that could provide remedial benefits in combination with other remedial technologies but would only have cost-effective application for specific Site elements and particular conditions.

4.5 Qualitative Screening of Remedial Technologies and Process Options for Effectiveness, Implementability, and Relative Cost

The retained process options from the initial screening process are shown unshaded in **Table 4-1** and also listed in **Table 4-2**. Per the NCP guidance, each technology or process option is screened based on effectiveness, implementability, and cost as described in this section. **Table 4-2** also includes a discussion of the assessment for these criteria for each technology or process option.

The evaluation criteria are specified by EPA guidance; however, the degree to which the criteria are weighted against each other are not specified in the guidance. Determination of how the individual evaluation criteria should influence the overall rankings requires engineering judgment. Remedial technologies or process options deemed to have low effectiveness, low administrative implementability, and/or high relative cost for the contaminated medium are eliminated from further consideration in the FS as indicated in **Table 4-2** using grey shading.

Effectiveness

For qualitative screening of initially retained technologies and process options, effectiveness relates to the ability of the remedial alternative to satisfy the following criteria:

- Potential effectiveness in handling the estimated volumes of contaminated media and meeting the goals identified in the PRAOs,
- Potential impacts to human health and the environment during construction and implementation, and
- How proven the remedial technology or process option is with respect to the contaminants and conditions at a site.

The effectiveness of each technology or process option is qualitatively rated as follows:

❍ None
❶ Low
❷ Low to moderate
❸ Moderate
❹ Moderate to high
❺ High

Implementability

Technical implementability was used as an initial screening step to eliminate remedial technologies and process options that were clearly ineffective or unworkable at the NIC Site. The qualitative screening criteria place greater emphasis on the institutional aspects of implementability for each technology or process option; therefore, for

qualitative screening of initially retained technologies and process options, technically implementable technologies and process options are evaluated with respect to both the technical and administrative feasibility of implementing a remedial technology or process option. This includes criteria such as:

- The ability to obtain permits for offsite actions,
- The availability and capacity of treatment, storage, and disposal services, and
- The availability of necessary equipment and skilled workers.

Implementability of each technology or process option is qualitatively rated as follows:

❍ None
❶ Low
❷ Low to moderate
❸ Moderate
❹ Moderate to high
❺ High

Relative Cost

Cost plays a limited role in the screening of remedial technologies and process options; in other words, relative capital and operations and maintenance (O&M) costs are used rather than detailed estimates. Cost analyses for this step in the qualitative screening process are evaluated based on engineering judgment and are ranked relative to other process options in the same technology type.

For this step, each remedial technology or process option was qualitatively evaluated using the estimated relative capital and O&M costs to determine whether the technology or process option should be eliminated from further consideration in this FS or retained for assembly into a remedial alternative.

The cost of each proposed technology or process option is rated on a comparative basis with other technologies and process options using a scale determined from the estimated range of costs for the screened technologies or process options. Cost rating categories are:

$	Low
$$	Low to moderate
$$$	Moderate
$$$$	Moderate to high
$$$$$	High

Table 4-1
North Industrial Corridor (NIC) Site
Screening of Remedial Technologies and Process Options for Technical Implementability

General Response Action	Remedial Technology	Process Option	Description of Response Action	Screening Comments	Retained
No Action	None	No Action	No action would be taken. The source area and groundwater contamination will remain in their existing conditions.	Retained (Required by NCP as stand-alone alternative)	Yes
Institutional Controls	Use Restrictions	Deed Restrictions	Would prevent future site construction activities and subsequent exposure to contaminated groundwater in source areas.	Technically implementable and potentially applicable	Yes
		Government and Proprietary Controls	Groundwater use restrictions would restrict use of groundwater in the zone of contamination.	Technically implementable and potentially applicable	Yes
		Fencing	Limit access to contaminated areas	Not applicable for groundwater contamination	No
	Public Education	Information and Education Programs	Community information and education programs would be undertaken to enhance awareness of potential hazards and remedies.	Technically implementable and potentially applicable	Yes
	Alternate Drinking Water Source	City Water Supply	Provide hook ups to city potable water system	Technically implementable and potentially applicable	Yes
		Bottled Water	Provide alternative drinking water supply (bottled water)	Technically implementable and potentially applicable	Yes
Monitoring	Sampling and Analysis	Groundwater Monitoring	Periodic environmental monitoring to determine extent of contaminant plume	Technically implementable and potentially applicable	Yes
	Site Inspection	Five-Year Site Review	Five-Year Reviews generally are required by CERCLA or program policy when hazardous substances remain on site above levels which permit unrestricted use and unlimited exposure.	Retained per CERCLA	Yes

Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of technical implementability. Remaining (unshaded) remedial technologies/process options have been retained for additional screening in Table 4-2.

Table 4-1
North Industrial Corridor (NIC) Site
Screening of Remedial Technologies and Process Options for Technical Implementability

General Response Action	Remedial Technology	Process Option	Description of Response Action	Screening Comments	Retained
Groundwater Containment	Vertical Barriers	Slurry Wall	Excavated trench at the leading edge of the groundwater plume filled with a low permeable bentonite mixture to contain plume migration	Technically implementable and potentially applicable for portions of the site. This technology has been implemented at a source area.	Yes
		Grout Curtain	Pressure injection of grout through a series of drilled holes along the leading edge of the groundwater plume to form an impermeable barrier	Technically implementable and potentially applicable for portions of the site.	Yes
		Sheet Piling	Lengths of steel or HDPE sheets are connected together and driven into the ground to form an impermeable barrier to groundwater flow	Technically implementable and potentially applicable for portions of the site.	Yes
Groundwater Removal	Collection	Vertical Extraction Well(s)	Removal of groundwater through extraction wells, causing gradient that controls migration of contaminant plume. Series of wells installed to collect groundwater for surface treatment	Technically implementable and potentially applicable	Yes
		Horizontal Extraction Well(s)	Series of laterally installed wells to extract contaminated groundwater for surface treatment	Technically implementable but not applicable for this site.	No
		Interceptor Trench	Collection of groundwater through installation of perforated pipe placed in trenches.	Commercial land use throughout the operable units does not provide area required for installation of the interceptor trench	No

Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of technical implementability. Remaining (unshaded) remedial technologies/process options have been retained for additional screening in Table 4-2.

Table 4-1
North Industrial Corridor (NIC) Site
Screening of Remedial Technologies and Process Options for Technical Implementability

General Response Action	Remedial Technology	Process Option	Description of Response Action	Screening Comments	Retained
Groundwater Removal (continued)	Discharge	Reuse as Non-Potable Water Supply	Use of treated groundwater as non-potable water source (irrigation or industry)	Commercial land use throughout OU does not require irrigation. No industries needing non-potable water supply have been identified.	No
		Reuse for Potable Water Supply	Treated groundwater discharged to potable water supply treatment plant	Technically implementable and potentially applicable	Yes
		Deep well injection	Reinjection of treated groundwater	Technically implementable and potentially applicable	Yes
		Infiltration Galleries/Basins	Gradual infiltration of treated groundwater into soils matrix using galleries or basins	Commercial land use throughout the operable units does not provide area required for installation of either basins or galleries	No
		Discharge to Surface Water Body or Storm Sewer	Discharge of extracted groundwater either directly to a surface water body or to a storm sewer which leads to a surface water body.	Technically implementable and potentially applicable. Requires NPDES permit for discharge.	Yes
		Discharge to Constructed Wetlands	Constructed wetland would treat contaminants by a combination of three mechanisms: adsorption, biodegradation, and volatilization.	Not technically implementable for site application; would require significant land space.	No
		Discharge to publicly owned treatment works (POTW)	Discharge of extracted groundwater to POTW.	Technically implementable and potentially applicable. Discharge permits and discharge fees will be required. Discharge fees may be exorbitant. Receiving POTW may not have the capacity to receive anticipated volume of extracted groundwater.	Yes

Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of technical implementability. Remaining (unshaded) remedial technologies/process options have been retained for additional screening in Table 4-2.

Table 4-1
North Industrial Corridor (NIC) Site
Screening of Remedial Technologies and Process Options for Technical Implementability

General Response Action	Remedial Technology	Process Option	Description of Response Action	Screening Comments	Retained
Groundwater Treatment	Biological Treatment	Ex Situ Biological Degradation	Degradation of contaminants by naturally occurring microorganisms through the addition of nutrients, oxygen, and/or substrates in an engineered reactor.	Not technically implementable for site application. Anaerobic conditions required for biological degradation.	No
Groundwater Treatment (continued)	Biological Treatment (continued)	Natural Attenuation	A variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in the groundwater.	Technically implementable and potentially applicable.	Yes
		In Situ Enhanced Bioremediation	Degradation of contaminants by naturally occurring microorganisms would be stimulated through the addition of substrate to degrade contaminants.	Technically implementable and potentially applicable as a long-term solution; however, need results of sampling to determine what types of microorganisms are present at the site.	Yes
Groundwater Treatment (continued)	Chemical/ Biological Treatment	Reactive Barrier Wall	An in-ground trench would be backfilled with reactive media to provide passive treatment of contaminated groundwater passing through the trench. Depth of application is limited.	Not technically implementable for site application because of the depth to which contamination is present at the site and width of the leading edge of the contaminant plume (more than 1,500 feet).	No

Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of technical implementability. Remaining (unshaded) remedial technologies/process options have been retained for additional screening in Table 4-2.

Table 4-1
North Industrial Corridor (NIC) Site
Screening of Remedial Technologies and Process Options for Technical Implementability

General Response Action	Remedial Technology	Process Option	Description of Response Action	Screening Comments	Retained
		Emulsified Zero-Valent Iron (EZVI)	EZVI involves placing nanoscale zero-valent iron particles into a surfactant-stabilized, biodegradable water-in-oil emulsion. The emulsion is injected into the contaminated zones in the subsurface. Contamination is pulled into the emulsion where the contaminant reacts with the zero-valent iron.	Technically implementable and potentially applicable.	Yes
	Chemical Treatment	Ex Situ UV/Oxidation	Organic contaminants would be destroyed through chemical oxidation/reduction reactions. Used when destruction of contaminants is preferred or when contaminants cannot be removed with granular activated carbon or air stripping.	Technically implementable for site application; however, granular activated carbon or air stripping would be lower cost alternatives for site contaminants.	No
		In Situ Chemical Oxidation	Strong chemical oxidants (e.g., H_2O_2, $KMnO_4$, or O_3) would be injected into the contaminated aquifer to destroy organic contaminants.	Technically implementable and potentially applicable.	Yes
Groundwater Treatment (continued)	Chemical/ Physical Treatment	Surfactant Flushing	A mixture of water and solvents or surfactants would be injected or allowed to infiltrate into the contaminated aquifer to facilitate removal of contaminants through dissolution, displacement, and/or mobilization. The injected solution and contaminants would be extracted downgradient.	Flushing designed for NAPL removal but ineffective for VOC contaminant plumes.	No

Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of technical implementability. Remaining (unshaded) remedial technologies/process options have been retained for additional screening in Table 4-2.

Table 4-1
North Industrial Corridor (NIC) Site
Screening of Remedial Technologies and Process Options for Technical Implementability

General Response Action	Remedial Technology	Process Option	Description of Response Action	Screening Comments	Retained
		Electrokinetics	An electrical potential would be applied across the contaminated zone through the use of electrodes in the ground. Water and ions migrate under the influence of the DC electrical field. The contaminants are either recovered at the electrodes or the process is coupled with other *in situ* processes.	Not technically implementable for site application.	No
	Physical Treatment	Granular Activated Carbon (GAC) Adsorption	Organic contaminants would be removed from groundwater through adsorption onto activated carbon.	Technically implementable and potentially applicable; however, this technology was eliminated from consideration because of the preference for air stripping.	No
		Reverse Osmosis	Membrane separation of water from constituents by pressure-gradient forces.	Technically implementable for site application; however, this technology was eliminated from consideration based on high costs involved with the technology and the disposal requirements for the supernatant.	No
Groundwater Treatment (continued)		Air Stripping	Contaminants would be removed from groundwater to the air through phase transfer mechanisms.	Technically implementable and potentially applicable.	Yes
		Air Sparging/Soil Vapor Extraction (AS/SVE)	Air would be injected through subsurface vertical and/or horizontal wells. Volatile organic contaminants partition into the air stream as it passes through the contaminated groundwater. Technology should be completed by using soil vapor extraction, as previously described in this table.	Technically implementable and potentially applicable.	Yes

Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of technical implementability. Remaining (unshaded) remedial technologies/process options have been retained for additional screening in Table 4-2.

Table 4-1
North Industrial Corridor (NIC) Site
Screening of Remedial Technologies and Process Options for Technical Implementability

General Response Action	Remedial Technology	Process Option	Description of Response Action	Screening Comments	Retained
		In-well Vapor Stripping	Groundwater recirculation wells strip volatile organic contaminants without surface treatment. Stripped contaminants are treated above surface.	Technically implementable and potentially applicable.	Yes

Shading indicates remedial technologies/process options have been eliminated from further consideration based on lack of technical implementability. Remaining (unshaded) remedial technologies/process options have been retained for additional screening in Table 4-2.

Table 4-2
North Industrial Corridor (NIC) Site
Effectiveness, Implementability, and Relative Cost Screening of Potentially Applicable Remedial Technologies/Process Options for Contaminated Groundwater

General Response Action	Remedial Technology	Process Option	Description of Response Action	Effectiveness		Implementability		Relative Cost		Reasons for Elimination of Process Option from Consideration
								Capital Cost	O&M Cost	
No Action	None	No Action	No action would be taken. The groundwater contamination will not be addressed	⓪	No protection of human health or the environment and no compliance with ARARs.	⓪	Easily implemented but is not acceptable to regulatory agencies and does not meet ARARs.	⓪	⓪	Retained (Required by NCP as stand-alone alternative)
Institutional Controls	Use Restrictions	Deed Restrictions	Groundwater use restrictions would restrict use of groundwater in the zone of contamination.	❷	Protects potential human receptors by restricting use of groundwater. Does not physically address contaminants.	❺	Easily implemented using available technical labor resources.	$	$	Retained
		Government and Proprietary Controls	Groundwater use restrictions would restrict use of groundwater in the zone of contamination.	❷	Protects human receptors by restricting use of groundwater. Does not directly affect ecological receptors and does not physically address contamination.	❺	Implemented using legal instruments and labor resources; potential public resistance.	$	$	Retained
	Public Education	Information and Education Programs	Community information and education programs would be undertaken to enhance awareness of potential hazards and remedies.	❷	Protects human receptors by enhancing awareness of potential site hazards and remedies. Does not directly affect ecological receptors and does not physically address contamination.	❺	Easily implemented using available technical and community involvement labor resources.	$	$	Retained
	Alternate Drinking Water Source	City Water Supply	Provide hook ups to city potable water system	❷	Protects potential human receptors by providing alternative source of drinking water. Does not physically address contaminants	❺	Easily implemented using available technical labor resources.	$	$	Retained
		Bottled Water	Provide alternative drinking water supply (bottled water)	❷	Protects potential human receptors by providing alternative source of drinking water. Does not physically address contaminants	❺	Easily implemented using available technical labor resources.	$	$$	Retained
Monitoring	Sampling and Analysis	Groundwater Monitoring	Ongoing environmental monitoring to determine extent of contaminant plume	❷	Provides indication of the nature and extent of groundwater contaminant plume	❺	Easily implemented using available technical labor resources.	$	$	Retained
	Site Inspection	Five-Year Site Review	Evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment.	❶	Provides indication of the nature and extent of groundwater contaminant plume	❺	Easily implemented using available technical labor resources	$	$	Retained (Required per CERCLA). Used in conjunction with groundwater monitoring.

Notes:
1. The screening process for effectiveness, implementability, and relative cost involves a qualitative assessment of the degree to which process options address evaluation criteria presented in Section 4.7. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess process options (for instance, rankings for a process option are not additive).

2. **Shading** indicates remedial technologies/process options have been eliminated from further consideration based on lack of effectiveness, implementability, and/or cost. Remaining (unshaded) remedial technologies/process options have been retained for assembly into remedial action alternatives as discussed in Section 4.8.

Legend for Qualitative Ratings System: The following ratings were used for evaluation and presentation of effectiveness, implementability, and relative cost:

Effectiveness and Implementability		Relative Cost	
⓪	**None**	⓪	**None**
❶	**Low**	$	**Low**
❷	**Low to Moderate**	$$	**Low to Moderate**
❸	**Moderate**	$$$	**Moderate**
❹	**Moderate to High**	$$$$	**Moderate to High**
❺	**High**	$$$$$	**High**

General Response Action	Remedial Technology	Process Option	Description of Response Action	Effectiveness		Implementability		Relative Cost		Reasons for Elimination of Process Option from Consideration
								Capital Cost	O&M Cost	
Groundwater Containment	Vertical Barriers	Slurry Wall	Excavated area around the leading edge of the groundwater plume filled with an impermeable bentonite mixture to contain plume migration	❸	Demonstrated effectiveness of slurry wall installed in OU5.	❸	Can be implemented using available technical labor resources and standard construction equipment. However, heavy commercial land use throughout the OU may negatively impact installation.	$$$$	$$$	Retained. Used in conjunction with groundwater extraction.
		Grout Curtain	Pressure injection of grout through a series of drilled holes along the leading edge of the groundwater plume to form an impermeable barrier	❸	Grout curtain not as effective as a slurry wall, especially in sandy soil matrix	❸	Can be implemented using available technical labor resources and standard construction equipment. However, heavy commercial land use throughout the OU may negatively impact installation.	$$$$	$$	Not retained. Grout curtain is less effective than a slurry wall
		Sheet Piling	Lengths of steel or HDPE sheets are connected together and driven into the ground to form an impermeable barrier to groundwater flow	❸	Sheet piling not as effective, requires time for barrier to "seal"	❷	Can be implemented using available technical labor resources and standard construction equipment. However, heavy commercial land use throughout the OU may negatively impact installation.	$$$$	$	Not retained. Sheet piling is more expensive than other options and more difficult to implement in heavily developed areas.
Groundwater Removal	Collection	Vertical Extraction Well(s)	Removal of groundwater through vertical extraction wells, creating gradient that controls migration of contaminant plume	❺	Will prevent migration of groundwater plume and therefore be protective of the environment. When combined with other options such as slurry walls as well as treatment of extracted groundwater, this is a highly effective containment option	❺	Extraction wells are easily implemented using available technical labor resources and standard construction equipment	$$$	$	Retained
	Discharge	Reuse for Potable Water Supply	Treated groundwater discharged to potable water supply treatment plant	❺	Effective disposal option for treated groundwater.	❷	May require long runs of piping for discharge to a municipal treatment plant. Municipal treatment plants can not typically accept water full time due to fluctuations in demand.	$$	$	Not Retained. Requires citing the treatment plant near existing municipal water treatment plants. Would require discharge to surface water body to maintain consistent operation.

Notes:

1. The screening process for effectiveness, implementability, and relative cost involves a qualitative assessment of the degree to which process options address evaluation criteria presented in Section 4.7. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess process options (for instance, rankings for a process option are not additive).

2. **Shading** indicates remedial technologies/process options have been eliminated from further consideration based on lack of effectiveness, implementability, and/or cost. Remaining (unshaded) remedial technologies/process options have been retained for assembly into remedial action alternatives as discussed in Section 4.8.

Legend for Qualitative Ratings System: The following ratings were used for evaluation and presentation of effectiveness, implementability, and relative cost:

Effectiveness and Implementability		Relative Cost	
❶	**None**	❶	**None**
❷	**Low**	$	**Low**
❸	**Low to Moderate**	$$	**Low to Moderate**
❹	**Moderate**	$$$	**Moderate**
❺	**Moderate to High**	$$$$	**Moderate to High**
	High	$$$$$	**High**

General Response Action	Remedial Technology	Process Option	Description of Response Action	Effectiveness		Implementability		Relative Cost		Reasons for Elimination of Process Option from Consideration
								Capital Cost	O&M Cost	
Groundwater Removal (continued)	Discharge (continued)	Discharge to Surface Water Body/Storm Drain	Discharge of extracted groundwater either directly to a surface water body or to a storm sewer which leads to a surface water body.	❺	Effective disposal option for treated groundwater.	❸	Discharge to Chisholm Creek will require permitting, which negatively impacts implementability	$$	$	Retained
		Discharge to publicly owned treatment works (POTW)	Discharge of extracted groundwater to POTW.	❺	Effective disposal option of treated groundwater to POTW located in vicinity	❸	POTW discharge requires permitting. The age and capacity of the sanitary sewer system used for transported negatively impacts implementability of process option	$$	$	Not retained due to issues with sanitary sewer system capacity
		Deep well injection	Reinjection of treated groundwater	❺	Effective disposal option of treated groundwater.	❸	Injection will require permitting which negatively impacts implementability.	$$$	$	Not retained due to expense and implementability
Groundwater Treatment	Biological Treatment	Natural Attenuation	A variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in the groundwater.	❺	An assessment of data collected on the NIC site has determined that MNA is viable within localized areas. Therefore, MNA is an effective treatment option over time for select areas.	❺	Easily implemented using available technical labor resources. Installation of additional monitoring wells will easily implemented	$	$	Retained
		In Situ Enhanced Bioremediation	Degradation of contaminants by naturally occurring microorganisms would be stimulated through the addition of substrate and nutrients to degrade contaminants.	❺	Site data collection shows locally conditions conducive to anaerobic degradation of contaminants, which is a highly effective method of reduction over time	❹	Introduction of nutrients or bio-organisms is easily implemented using available technical labor	$$$	$$$	Retained
	Chemical/ Biological Treatment	Emulsified Zero-Valent Iron (EZVI)	EZVI involves placing nanoscale zero-valent iron particles into a surfactant-stabilized, biodegradable water-in-oil emulsion. The emulsion is injected into the contaminated zones in the subsurface. Contamination is pulled into the emulsion where the contaminant reacts with the ZVI.	❹	Protects human receptors by reducing concentrations of contaminants in groundwater. Technology provides mass reduction in source areas as well as plume treatment.	❹	Easily implemented with relatively simple, readily available equipment. May require fracturing subsurface formations to disperse emulsified solution.	$$$$	$$$$	Retained

Notes:

1. The screening process for effectiveness, implementability, and relative cost involves a qualitative assessment of the degree to which process options address evaluation criteria presented in Section 4.7. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess process options (for instance, rankings for a process option are not additive).

2. **Shading** indicates remedial technologies/process options have been eliminated from further consideration based on lack of effectiveness, implementability, and/or cost. Remaining (unshaded) remedial technologies/process options have been retained for assembly into remedial action alternatives as discussed in Section 4.8.

Legend for Qualitative Ratings System: The following ratings were used for evaluation and presentation of effectiveness, implementability, and relative cost:

Effectiveness and Implementability		Relative Cost	
❍	None	❍	None
❶	Low	$	Low
❷	Low to Moderate	$$	Low to Moderate
❸	Moderate	$$$	Moderate
❹	Moderate to High	$$$$	Moderate to High
❺	High	$$$$$	High

General Response Action	Remedial Technology	Process Option	Description of Response Action	Effectiveness		Implementability		Relative Cost		Reasons for Elimination of Process Option from Consideration
								Capital Cost	O&M Cost	
Groundwater Treatment (continued)	Chemical Treatment	In Situ Chemical Oxidation	Strong chemical oxidants (e.g., H_2O_2, $KMnO_4$, O_3, or NaS_2O_8) would be injected into the contaminated aquifer to destroy organic contaminants.	❹	Protects human receptors by reducing concentrations of contaminants in groundwater. Technology provides mass reduction in source areas as well as plume treatment.	❷	Requires a broad injection plan with many rounds of injection for plume treatment	$$$$	$$$$	Not Retained. Would require a broad injection plan and continual injection to be effective in the groundwater contaminant plume.
	Physical Treatment	Air Stripping	Contaminants would be removed from groundwater to the air through phase transfer mechanisms.	❹	Protects human receptors by reducing concentrations of contaminants in groundwater. Generally, organic compounds with Henry's constant greater than 0.01 atmospheres - m^3/mol are considered amenable to stripping.	❹	Highly implementable - a tray air stripper is currently being operated at the site for treatment of groundwater extracted from four extraction wells. Off-gas treatment by activated carbon adsorption or catalytic oxidation may be needed.	$$$	$$$	Retained
		Air Sparging/Soil Vapor Extraction (AS/SVE)	Air would be injected through subsurface vertical and/or horizontal wells. Volatile organic contaminants partition into the air stream as it passes through the contaminated groundwater. Technology should be completed by using soil vapor extraction, as previously described in this table.	❹	Protects human receptors by reducing concentrations of contaminants in groundwater. Technology has demonstrated sensitivity to minute permeability changes, which can result in localized stripping between the sparge and monitoring wells.	❸	Easily implemented with readily available equipment.	$$$$	$$$	Retained
		In Well Vapor Stripping	Groundwater recirculation wells strip volatile organic contaminants without surface treatment. Stripped contaminants are treated above surface.	❸	Contaminants are moderately to easy to volatilize and remove, providing a moderately effective means of addressing contaminant impacts on the environment	❸	Easily implemented using available technical labor and equipment. However, heavy commercial land use throughout the OU may negatively impact well installation locations.	$$$	$$$	Retained

Notes:

1. The screening process for effectiveness, implementability, and relative cost involves a qualitative assessment of the degree to which process options address evaluation criteria presented in Section 4.7. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess process options (for instance, rankings for a process option are not additive).

2. **Shading** indicates remedial technologies/process options have been eliminated from further consideration based on lack of effectiveness, implementability, and/or cost. Remaining (unshaded) remedial technologies/process options have been retained for assembly into remedial action alternatives as discussed in Section 4.8.

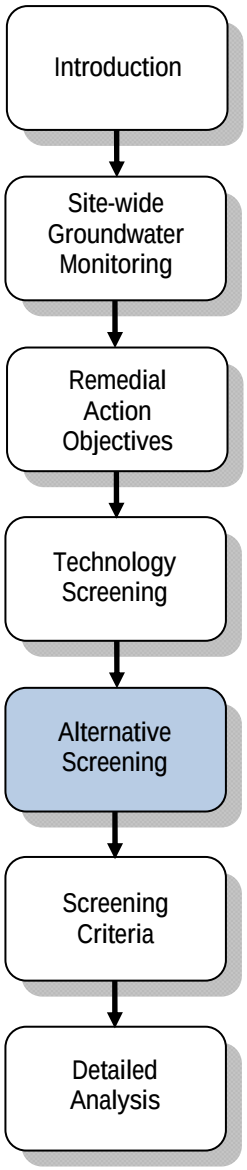
Legend for Qualitative Ratings System: The following ratings were used for evaluation and presentation of effectiveness, implementability, and relative cost:

Effectiveness and Implementability		Relative Cost	
⓪	**None**	⓪	**None**
❶	**Low**	$	**Low**
❷	**Low to Moderate**	$$	**Low to Moderate**
❸	**Moderate**	$$$	**Moderate**
❹	**Moderate to High**	$$$$	**Moderate to High**
❺	**High**	$$$$$	**High**

Section 5
Development and Screening of Remedial Action Alternatives

Section 4 listed several steps used to perform a multi-phase analysis and screening of technologies and process options and discussed Steps 1 through 3 from that list. This section discusses Steps 4 and 5 of that list, in other words:

- The assembly of the retained technologies and process options into preliminary remedial alternatives, and
- The further qualitative screening of the retained alternatives again based on effectiveness, implementability, and relative cost but with additional evaluation criteria.



Remedial alternatives are developed from either stand-alone process options or using combinations of technologies and process options that passed screening as summarized in Section 4 for contaminated groundwater. As stated in Section 1, these remedial alternatives were developed to address Site-wide groundwater contamination. Soil and groundwater source control measures will be implemented through other KDHE regulatory mechanisms. Source control measures being implemented at the Confirmed, Identified, and Suspect Source Areas presented in Section 1 are discussed in **Appendix B**.

The remedial alternatives, in accordance with the guidance from the NCP, are screened by means of a qualitative process using the broad criteria of effectiveness, implementability, and cost. The purpose of alternative screening is to reduce the number of remedial alternatives retained for detailed analysis (in Sections 7 through Section 12). For comparative purposes, remedial alternatives presented in this section primarily assume treatment at the leading edge of a groundwater contaminant plume although some alternatives may be used for in-plume remediation. Alternatives retained in this section may also be combined to address Site-wide groundwater contamination within each GWU.

5.1 Assumptions Affecting Development of Remedial Alternatives

Several fundamental assumptions affected the development of the remedial alternatives evaluated in this FS (other than a "no action alternative"). These assumptions are driven by requirements of the PRAOs identified in Section 3 and Site limitations and constraints that cannot be overcome by using one or more of the remedial technologies or process options described in Section 4. These fundamental

assumptions were taken into consideration during development of remedial alternatives for this FS and include:

- Soil and groundwater contamination remediation alternatives for each GWU will be implemented separately. This FS focuses on Site-wide groundwater contamination; soils are considered source area concerns are therefore not considered in this FS. Separate remedial implementation plans will be prepared for each source area.

Secondary factors such as land use and impacts to communities throughout the Site have also been tentatively identified to aid development of remedial alternatives. Since these considerations vary depending on the remedial approach used in each alternative and GWU, they are discussed in more detail in Sections 7 through 12 for the remedial alternatives retained after the qualitative and detailed assessments.

The remedial alternatives for a site span a range of categories defined by the NCP as follows:

- No action alternative;
- Alternatives that address the principal threats but involve little or no treatment. Protection would be by prevention or control of exposure through actions such as containment and/or engineering and institutional controls;
- Alternatives that, as their principal element, employ treatment that reduces the toxicity, mobility, or volume of the contaminants;
- Alternatives that remove or destroy contaminants to the maximum extent, eliminating or minimizing long-term management;
- Alternatives that include innovative treatment technologies; and
- Alternatives that attain site-specific RAOs within different time periods, using one or more different technologies.

5.2 Description of Remedial Action Alternatives

Remedial alternatives were assembled by combining technologies or process options retained following both the initial screening process and the qualitative screening (described in Section 4). The retained technologies or process options are shown unshaded in **Table 4-2**. These retained technologies or process options were then assembled into remedial alternatives as shown in **Table 5-1**. Fundamental Site assumptions, driven by the PRAO requirements and Site use limitations and constraints, were also considered during development of the remedial alternatives.

The remedial alternatives evaluated for contaminated groundwater at the NIC Site include:

- Alternative 1 – No Action;
- Alternative 2 – Plume Stability Monitoring (PSM);
- Alternative 3 – Monitored Natural Attenuation (MNA);
- Alternative 4 – Anaerobic Bioremediation (EAB)/Enhanced MNA;
- Alternative 5 – Groundwater Extraction and Treatment;
- Alternative 6 – Emulsified Zero-Valent Iron (EZVI);
- Alternative 7 – Slurry Wall Containment;
- Alternative 8 – Air Sparging (AS) and Soil Vapor Extraction (SVE); and
- Alternative 9 – In-Well Vapor Stripping.

These alternatives have been formulated according to the NCP [40 CFR 300.430(e)] and are intended to meet the NIC Site RAOs. Each alternative is presented in the following paragraphs in sufficient detail to allow effective screening by broad criteria. Alternatives retained for detailed analysis are developed in more detail for each GWU in Sections 7 through 12.

Institutional controls administered through the City of Wichita, such as deed restrictions and alternative water supplies, would be utilized until such time as the groundwater data demonstrate the contaminant levels are reduced to drinking water standards under the selected alternative.

5.2.1 Alternative 1 – No Action

The No Action alternative is carried through the FS process as required by the NCP and the KDHE Bureau of Environmental Remediation (BER) Policy #BER-RS-20 to provide a baseline set of conditions against which other remedial actions may be compared. This alternative allows a site to remain in its current state with no remedial actions being implemented outside of separate source control efforts being implemented by responsible parties; these are not considered for this FS. There would be no change in groundwater contaminant concentrations aside from that which occurs naturally because no treatment, containment, or removal of contaminated groundwater is included in this alternative.

Although no remedial action or monitoring is required for this alternative per EPA guidance (EPA 1989), the KDHE currently has a Settlement Agreement with the City that requires some groundwater monitoring. Due to the Settlement Agreement, therefore, the No Action alternative for this FS includes limited groundwater monitoring of the Site GWUs and five-year site reviews. For the NIC Site, this includes groundwater monitoring of select existing wells. Data from each monitoring

event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE. Sample analyses would include the Site COCs discussed in Section 1. Currently existing institutional controls will also be maintained.

Alternatives 2 through 9 assume that source control measures have been implemented as applicable throughout the Site prior to implementation of the remedial alternative.

5.2.2 Alternative 2 – Plume Stability Monitoring

Alternative 2 includes expansion of the existing groundwater monitoring well network by the installation of wells within and at the perimeter of the groundwater contaminant plume(s). Samples would be collected at regular intervals from selected monitoring points and analyzed for the Site COCs discussed in Section 1 and their degradation products. Groundwater monitoring would be implemented at the extent and interior portions of the GWU to determine whether the groundwater plume is stable, shrinking, or expanding. This determination would involve the application of statistical analysis to the results of each well to determine if concentrations are increasing, decreasing, or stable over time (or seasonally fluctuating in a statistically predictable fashion). Changes in groundwater contaminant concentrations may be attributed to dispersion, dilution, sorption, volatilization, chemical or biological stabilization, transformation, or destruction. Biodegradation may play a role in select areas. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE. Five-year reviews are also included in this alternative.

Alternative 2 would be performed in conjunction with the implementation of source control measures at all source areas requiring remediation under regulatory authority. This alternative assumes that source control measures will be effective in cutting off ongoing sources of groundwater contamination.

5.2.3 Alternative 3 –Monitored Natural Attenuation

Under Alternative 3, the existing groundwater contaminant plume would be allowed to naturally attenuate. Natural attenuation is defined in the NCP as "biodegradation, dispersion, dilution, and adsorption" of contaminants in groundwater. The existing groundwater monitoring well network would be expanded by the installation of wells inside the groundwater contaminant plume to provide additional evaluation points. Samples would be collected at regular intervals from all monitoring points and analyzed for COCs and degradation parameters. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE. Five-year reviews are also included in this alternative.

5.2.4 Alternative 4 – Anaerobic Bioremediation/Enhanced MNA

Under Alternative 4, biobarriers (rows of injection wells) would be installed at various locations at the leading edge or within the groundwater contaminant plume to inject nutrient substrate, and possible bioaugmentation materials, into the saturated zone of the aquifer, stimulating bioremediation and enhancing MNA of chlorinated VOCs in groundwater. A pilot study would determine the optimum injection mechanism (gravity feed or low pressure), the injection well configuration, and the need for bioaugmentation.

Periodic groundwater monitoring, both upgradient and downgradient of the biobarriers, and five-year site reviews, would be performed as part of this alternative to determine the rate of degradation and demonstrate the effectiveness of the biobarrier treatment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

5.2.5 Alternative 5 – Groundwater Extraction and Treatment

Under Alternative 5, extraction wells would be installed and placed to minimize plume migration. Typical placement of extraction wells would be along the leading edge of a groundwater plume within a GWU. Extraction wells may also be placed within the groundwater plume to reduce the operational duration of the groundwater treatment system. The number and pumping rate for the extraction wells would be determined via modeling of the GWU's groundwater parameters.

Extracted groundwater would be treated through an air stripper system either at the GilMo Water Treatment Center or at a new treatment plant within the NIC Site. The treated groundwater would be discharged to either the Arkansas River or into Chisholm Creek via a surface water pipeline depending upon the location of the treatment unit. The off-gas from the stripper would either be discharged directly to the atmosphere or be passed through a granular activated carbon (GAC) system prior to discharge into the atmosphere.

Periodic groundwater monitoring, both upgradient and downgradient of the extraction wells, and five-year site reviews, would be performed as part of this alternative to demonstrate the effectiveness of the extraction and treatment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

5.2.6 Alternative 6 – Emulsified Zero-Valent Iron

EZVI involves placing nanoscale ZVI particles into a surfactant-stabilized, biodegradable water-in-oil emulsion. This emulsion is injected into the contaminated zones of the subsurface. Contamination passes through the emulsion where the

contaminant reacts with the ZVI. Through a process known as reductive dehalogenation, the contaminant and its daughter products are degraded into ethene and other less toxic compounds. These by-products are finally broken down through other biological activities in the subsurface.

Alternative 6 consists of injecting EZVI along the leading edge of a groundwater contaminant plume to prevent further migration of the plume. EZVI would be injected perpendicular to the flow of groundwater to form a quasi-permeable reactive barrier to treat contaminated groundwater. A pilot study would determine the proper EZVI formulation and injection spacing. Surface features which would limit or prohibit installation, as well as the width of the plume to be addressed would significantly impact the selection of this alternative.

Periodic groundwater monitoring, both upgradient and downgradient of the reactive barriers, and five-year site reviews, would be performed as part of this alternative to demonstrate the effectiveness of the treatment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

5.2.7 Alternative 7 – Slurry Wall Containment

Under Alternative 7, a slurry wall would be installed on the leading edge of the groundwater contaminant plume to prevent further migration of the plume. The wall would extend to bedrock and would consist of an excavated trench backfilled with a soil/bentonite slurry.

Extraction wells would be installed upgradient of the slurry wall to prevent mounding of groundwater within the slurry wall containment system. Extraction well sizing would be determined through modeling of the GWU's groundwater parameters. Extracted groundwater would be treated through an air stripper system and discharged into Chisholm Creek via a surface water pipeline. The off-gas from the stripper would either be discharged directly to the atmosphere or be passed through a GAC system prior to discharge into the atmosphere.

Periodic groundwater monitoring, both upgradient and downgradient of the slurry wall, and five-year site reviews, would be performed as part of this alternative to demonstrate the effectiveness of the containment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

5.2.8 Alternative 8 – Air Sparging and Soil Vapor Extraction

Under Alternative 8, AS wells would be installed at the downgradient extent of a contaminant plume as a sparge curtain and screened down through the saturated zone. Each AS well would be interconnected with piping from an air blower

designed to provide aeration through each well into the saturated zone. A series of SVE wells would be installed in conjunction with the AS wells to extract vapors from the vadose zone. The SVE wells would be screened in the vadose zone above the aquifer. Each SVE well would be connected to a piping manifold connected to a common extraction blower, providing suction to each SVE well. A pilot study would determine the radius of influence (ROI) of each well and the subsequent spacing of the entire AS/SVE well system. Vapors removed from the SVE well would be transferred to a knockout vessel to remove moisture prior to discharge to the atmosphere. Liquid condensate collected in the knockout vessel may be treated, if necessary, prior to discharge to a storm sewer.

Periodic groundwater monitoring, both upgradient and downgradient of the AS/SVE system, and five-year site reviews, would be performed as part of this alternative to demonstrate the effectiveness of the treatment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

5.2.9 Alternative 9 – In-Well Vapor Stripping

Under Alternative 9, in-well strippers would be installed in wells at the downgradient extent of a contaminant plume. In-well stripping, also referred to as groundwater circulation wells, creates a circulation pattern in the aquifer by drawing water into the bottom of the well and pumping it through the well. VOCs are stripped from the groundwater and either released into the vadose zone or drawn off with a vacuum blower and the "treated" water is reinjected at the top of the aquifer. In-well stripper systems can be operated continuously to remove VOCs from groundwater without the need to pump water to the surface. The in-well stripper creates both vertical and horizontal groundwater flow allowing penetration of low permeability horizontal layers. In-well strippers can be used in conjunction with bioremediation, bioventing, SVE, surfactants, and chemical oxidation to enhance remediation of contaminated aquifers.

Periodic groundwater monitoring, both upgradient and downgradient of the stripper system(s), and five-year site reviews, would be performed as part of this alternative to demonstrate the effectiveness of the treatment system. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

5.3 Qualitative Screening of Remedial Alternatives

Following the initial screening of GRAs, technologies, and process options (Section 4), and the qualitative screening of those GRAs, technologies, and process options, the retained technologies and process options were assembled into remedial alternatives. Per the NCP guidance, each alternative is then to be further screened based on

effectiveness, implementability, and cost using the criteria described below for each category. The purpose of this qualitative screening of remedial alternatives is to reduce the number of alternatives that undergo a more thorough and extensive analysis in subsequent sections of the FS; therefore, remedial alternatives are evaluated more generally in this section than in the detailed analyses. Criteria used for the qualitative screening of the remedial alternatives is described below. The results of the qualitative assessment for each remedial alternative are shown in **Appendix C**.

Effectiveness

For qualitative screening of remedial alternatives, effectiveness relates to the ability of the remedial alternative to satisfy the following criteria:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Short-term effectiveness (during the remedial construction and implementation period);
- Long-term effectiveness and performance (following remedial construction); and
- Reduction of toxicity, mobility, or volume through treatment.

The first two criteria (protection and compliance with ARARs) are referred to as the "threshold criteria" that an alternative must meet to be viable (except the "no action" alternative). The effectiveness of each alternative is qualitatively rated as follows:

❍ None
❶ Low
❷ Low to moderate
❸ Moderate
❹ Moderate to high
❺ High

Implementability

Implementability relates to the technical and administrative feasibility of constructing, operating and maintaining the remedial alternative. Technical feasibility relates to the practical aspects of construction, operation, and maintenance. Administrative feasibility relates to the ability to obtain permits; procure treatment, storage, and disposal services; and procure the needed land, equipment, and expertise.

Technically implementable technologies and process options retained from the initial screening are evaluated with respect to both the technical and administrative feasibility of implementing a remedial alternative. These screening criteria place greater emphasis on the institutional aspects of implementability. These criteria focus on:

- Technical feasibility:
  - Ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete, and
  - Ability to operate, maintain, replace, and monitor technical components after the remedial action is complete.
- Administrative feasibility:
  - Ability to obtain approvals from other agencies,
  - Availability and capacity of treatment, storage, and disposal services, and
  - Availability of property, specific materials and equipment, and technical specialists required for a remedial action.

Implementability of each alternative is qualitatively rated as follows:

❶ None
❶ Low
❷ Low to moderate
❸ Moderate
❹ Moderate to high
❺ High

Relative Cost

Cost estimates prepared for screening remedial alternatives are typically comparative estimates with relative costs. Procedures used to develop cost estimates for qualitative alternative screening are similar to those used for preparing the detailed analyses; however, for the qualitative alternative screening, alternatives and cost components are refined to a lesser degree. Decisions relative to cost among qualitatively screened alternatives are modified as the accuracy of cost estimates improve in the detailed analyses of alternatives.

The focus of qualitative screening estimates is to identify and include items that are essential to each alternative and that control the magnitude of the overall cost. Cost estimates at this step of the FS process are generally determined using cost curves, generic unit costs, vendor information, conventional cost-estimating guides such as R.S. Means, and prior similar estimates modified by site-specific information rather than detailed cost estimates. Both capital and O&M costs are considered in these estimates. Present value analyses are performed to discount all costs to a common base year. This is performed to fairly evaluate expenditures occurring over different time frames.

Because uncertainties with the details of remedial alternatives may remain in this step of the FS process, the costs developed for the qualitative screening of these proposed alternatives are not held to the accuracy required for the detailed analysis of

alternatives (i.e. +50 percent to -30 percent of actual costs). Typical cost accuracy ranges for alternative screening are +100 percent to -50 percent of actual costs.

The cost of each proposed alternative is rated on a comparative basis with other alternatives using a scale determined from the range of costs for the screened alternatives.

$	Low	(less than 2 million dollars)
$$	Low to moderate	(between 2 million and 5 million dollars)
$$$	Moderate	(between 5 million and 10 million dollars)
$$$$	Moderate to high	(between 10 million and 15 dollars)
$$$$$	High	(greater than 15 million dollars)

5.4 Results Summary for Qualitative Screening of Remedial Alternatives

Each alternative developed and described in Section 5.2 was evaluated to determine its overall effectiveness, implementability, and cost using the qualitative ratings system discussed in Section 5.3. **Appendix C** summarizes the results for the qualitative screening of alternatives for the NIC Site along with reasons for retention or elimination of each alternative.

Table 5-2 summarizes the results for the screening of alternatives for the Site. Generally, alternatives that have a low rating for effectiveness and/or implementability coupled with a high cost would be eliminated from further consideration. Remedial alternatives 7, 8, and 9 were eliminated from further consideration in this FS as indicated on **Table 5-2** using grey shading. The primary reasons for the elimination of Alternatives 7, 8, and 9 are costs associated with the effort to address large plume widths and extents relative to the costs of other retained alternatives. Alternatives 7, 8, and 9 may still be applicable to localized areas of the groundwater plumes.

PSM, along with source control measures, may be a viable alternative in areas where the attenuating environmental conditions such as dilution by infiltration, dispersion, advection, adsorption, and possibly aided by a minor biodegradation component, are significant; however, if attenuation factors are not sufficient, PSM may not meet the threshold criteria for protection of human health and the environment. Significant reduction in plume concentrations within GWU2 and GWU6 have been observed; however, insufficient data exists to determine whether plume migration is occurring at the downgradient portions of these two GWUs. Additional monitoring would be necessary to document if attenuation factors are sufficient for PSM for GWU2 or GWU6. Therefore, although PSM may be retained for these GWUs, it may only be implemented in conjunction with other, more aggressive alternatives and not as a stand-alone alternative. PSM is not considered a viable alternative for GWU3 or GWU4 as plume migration has been observed at the downgradient portions of these

groundwater plumes. PSM was not evaluated for GWU1 since conditions are favorable for MNA.

5.5 Remedial Alternatives Retained for Detailed Analysis by GWU

While the alternatives retained in **Table 5-2** are viable alternatives when evaluated on a Site-wide basis, they may not be applicable to each individual GWU. For example, as summarized in Section 2.3.3, numerous analytical parameters collected throughout the Site in 2001 and 2007/8 were used to determine the potential for natural attenuation of COCs and possible anaerobic bioremediation. The temporal distribution of the monitoring data is insufficient to support a definitive conclusion as to MNA's effectiveness, however, and based on this analysis, only GWU1 and GWU5 appear to have adequate evidence to support implementation of Alternatives 3 and 4. The MNA and EAB alternatives are therefore only applicable for detailed analysis in GWU1 and GWU5 and have been retained. Additional temporal MNA data may be collected during the remedial design, as applicable, where the KDHE's CAD accepts MNA and/or EAB as part of the remedial design alternative for one or more of the GWUs within the NIC Site. If accepted, the remedial design work plan would propose a MNA assessment program for those GWUs where MNA is proposed or being evaluated as part of the remedial action.

This FS provides a detailed cost evaluation of GWUs 1, 2, 3, and 4. The detailed cost estimate for GWU2 is being prepared by representatives of the Coleman North GWU and will be included in this FS as Section 8. Detailed FS cost evaluations for GWU5 and GWU6 will be presented under separate cover to the KDHE by the responsible parties within those GWUs and are not included herein. The alternatives selected for detailed analysis for GWU1, GWU3, and GWU4 and the reasons for retention are discussed below. For clarity, the alternatives have been renumbered for each GWU.

GWU1

Alternatives 1, 3, 4, and 5 were retained for detailed cost evaluation for GWU1. Alternatives 4 and 5 were retained as contingencies for GWU1 in the event that MNA alone was determined to be insufficient to fully address the groundwater plume(s). Alternative 6 may be appropriate for GWU1 but was eliminated from detailed cost evaluation since Alternatives 3, 4, and 5 appear to be more viable with less O&M costs. There is, however, concern that Alternative 5 may interfere with TPH recovery efforts within GWU5 and possible chlorinated solvent remediation and containment efforts at the Clean Harbors (former Safety-Kleen) facility at the southern extent of GWU1. The retained alternatives and reasoning are summarized as follows:

- Alternative GWU1-1 – No Action: Required by the NCP;
- Alternative GWU1-2 – Monitored Natural Attenuation: Evidence of MNA based on analytical parameters supports retention of this alternative;

- Alternative GWU1-3 – Enhanced Anaerobic Bioremediation/Enhanced MNA: Evidence of MNA based on analytical parameters supports retention of this alternative; however, the injection of a carbon source, electron donor, or possible bioaugmentation may be necessary to complete the MNA process; and

- Alternative GWU1-4 – Groundwater Extraction (Containment Only), New Treatment Plant, and Discharge to Chisholm Creek: Containment may be necessary to prevent migration of the contaminant plume beyond the Site boundary – 1 well at the leading edge of the plume. Extracted groundwater would be treated at a new treatment plant.

GWU3

Alternatives 1 and 5 were retained for detailed cost analyses for GWU3. Four versions of Alternative 5 are presented in Section 9 for GWU3. Available data within GWU3 indicates that environmental conditions are not suitable for Alternative 3. The size of the GWU3 plume makes costs for Alternatives 4 and 6 prohibitive relative to some of the other alternatives.

- Alternative GWU3-1 – No Action: Required by the NCP;

- Alternative GWU3-2 – Groundwater Extraction (Containment Only) and Discharge after Treatment at the Gilbert-Mosley Groundwater Treatment Plant (GWTP): Containment may be necessary to prevent migration of the contaminant plume beyond the Site boundary – 2 wells at the leading edge of the plume. Extracted groundwater would be treated at an existing treatment plant;

- Alternative GWU3-3 – Groundwater Extraction (Containment Only), New Treatment Plant, and Discharge to Chisholm Creek: Containment may be necessary to prevent migration of the contaminant plume beyond the Site boundary – 2 wells at the leading edge of the plume. Extracted groundwater would be treated at a new treatment plant before discharge;

- Alternative GWU3-4 – Groundwater Extraction (Containment and Interior Extraction), Treatment at Either the Gilbert-Mosley GWTP or a New Treatment Plant,, and Discharge: The size of the GWU may require additional interior extraction to reduce the operational duration of the system – 2 wells at the leading edge of the plume with treatment at an existing treatment plant, 1 well within the plume with treatment at a new treatment plant;

- Alternative GWU3-5 – Groundwater Extraction (Containment and Interior Extraction (Additional Wells)), Treatment at Either the Gilbert-Mosley GWTP or a New Treatment Plant, and Discharge: The size of the GWU may require additional interior extraction to reduce the operational duration of the system – 2 wells at the leading edge of the plume and 3 wells (with 2 contingency wells) within the plume with treatment either at an existing treatment plant or at a new treatment plant.

GWU4

Alternatives 1 and 5 were also retained for detailed cost analyses for GWU4. Three versions of Alternative 5 are presented in Section 10 for GWU4. Available data within GWU4 indicates that environmental conditions are not suitable for Alternative 3. The lack of a consistent plume orientation due to the influence of downtown pumping and the Little Arkansas River system makes the costs associated with Alternatives 4 and 6 too uncertain and most likely cost prohibitive due to the potential size of the area to be addressed relative to the costs of some of the other alternatives.

- Alternative GWU4-1 – No Action: Required by the NCP;
- Alternative GWU4-2 – Groundwater Extraction (Containment Only) and Discharge after Treatment at the Gilbert-Mosley GWTP: Containment may be necessary to prevent migration of the contaminant plume beyond the Site boundary – 1 well at the leading edge of the plume. Extracted groundwater would be treated at an existing treatment plant;
- Alternative GWU4-3 – Groundwater Extraction (Containment Only), New Treatment Plant, and Discharge to Storm Sewer: Containment may be necessary to prevent migration of the contaminant plume beyond the Site boundary – 1 well at the leading edge of the plume. Extracted groundwater would be treated at a new treatment plant before discharge;
- Alternative GWU4-4 – Groundwater Extraction (Containment and Interior Extraction), Treatment at Either the Gilbert-Mosley GWTP or a New Treatment Plant, and Discharge: Containment may be necessary to prevent migration of the contaminant plume beyond the Site boundary – 1 well at the leading edge of the plume and 1 well within the plume with treatment either at an existing treatment plant or at a new treatment plant.

GWUs 2, 5, and 6

Alternatives 1, 3, 4, 5, and 6 may be appropriate and viable for GWU2, GWU5, and GWU6 and are therefore retained in the event that the parties presenting FS documents for these GWUs have chosen one or more of the alternatives for their detailed cost estimating exercises. Additionally, Alternative 2 may be appropriate for GWU2 and GWU6, depending upon the significance of non-biologic attenuation factors.

Table 5-1
North Industrial Corridor (NIC) Site
Remedial Technologies/Process Options Evaluated for Assembly into Remedial Alternatives

General Response Action	Remedial Technology	Process Option	Alternative 1 No Action	Alternative 2 Plume Stability Monitoring	Alternative 3 Monitored Natural Attenuation	Alternative 4 Anaerobic Bioremediation/ Enhanced MNA	Alternative 5 Groundwater Extraction and Treatment	Alternative 6 Emulsified Zero-Valent Iron	Alternative 7 Slurry Wall Containment	Alternative 8 Air Sparging and Soil Vapor Extraction	Alternative 9 In Well Vapor Stripping
No Action	None	No Action	✓								
Institutional Controls	Use Restrictions	Deed Restrictions	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Government and Proprietary Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Public Education	Information and Education Programs	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monitoring	Sampling and Analysis	Groundwater Monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Inspection	Five-year Site Review	✓	✓	✓	✓	✓	✓	✓	✓	✓
Groundwater Containment	Vertical Barriers	Slurry Wall							✓		
Groundwater Removal	Collection	Vertical Extraction Well(s)					✓		✓		
	Discharge	Discharge to Surface Water Body					✓		✓		
Groundwater Treatment	*In situ* Biological Treatment	Monitored Natural Attenuation (MNA)			✓	✓					
		In situ Enhanced Bioremediation				✓					
	In situ Chemical/ Biological Treatment	Emulsified Zero-Valent Iron (EZVI)						✓			
	Physical Treatment	Air Stripping					✓		✓		
		Air Sparging/Soil Vapor Extraction (AS/SVE)								✓	
		In Well Vapor Stripping									✓

Table 5-2
North Industrial Corridor (NIC) Site
Summary of Qualitative Screening of Alternatives

Alternative	Description	Effectiveness	Implementability	Approx. Overall Cost (Present Value Dollars)
1	No Action	⓪	❺	$
2*	Plume Stability Monitoring	⓪-❷	❺	$
3+	Monitored Natural Attenuation	❷	❺	$
4	Anaerobic Bioremediation/Enhanced MNA	❸	❹	$$$
5	Groundwater Extraction and Treatment	❹	❹	$$$
6	Emulsified Zero-Valent Iron	❸	❹	$$$
7	Slurry Wall Containment	❸	❷	$$$$
8	Air Sparging and Soil Vapor Extraction	❹	❸	$$$$
9	In-Well Vapor Stripping	❸	❸	$$$$

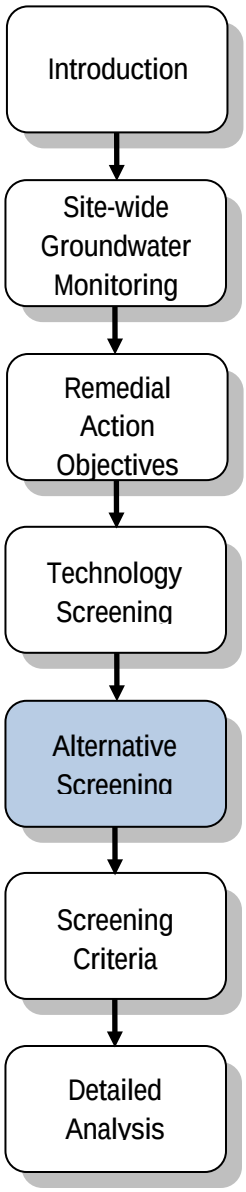
Shading = remedial alternative has been eliminated from further consideration. Alternatives 7, 8, and 9 are eliminated based on cost and lack of technical implementability. Remaining (unshaded) remedial alternatives have been retained for detailed screening.

*Alternative 2 is retained only for GWU2 and GWU6 because there is not sufficient information to evaluate the impact of non-biologic attenuation factors.

+Alternative 3 is retained only for GWU1 and GWU5. Available data indicate other GWUs do not have adequate environmental conditions to support MNA as an alternative.

Section 6
Definitions of Criteria Used in the Detailed Analysis of Alternatives

The remedial alternatives retained after completion of the alternative screening steps described in Sections 4 and 5 are evaluated using nine evaluation criteria. These criteria were developed to address statutory requirements and considerations for remedial actions in accordance with the NCP and additional technical and policy considerations that have proven to be important for selecting among remedial alternatives (EPA 1988). Alternatives are further developed and evaluated in Sections 7 through 12 for GWU1 through GWU6. The following subsections describe the nine evaluation criteria used in the detailed analysis of remedial alternatives and the priority in which the criteria are considered.



6.1 Overall Protection of Human Health and the Environment

Each alternative is assessed to determine whether it can provide adequate protection of human health and the environment (short- and long-term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at a site. Evaluation of this criterion focuses on how site risks are eliminated, reduced, or controlled through treatment, engineered controls, or institutional controls and whether an alternative poses any unacceptable cross-media impacts.

Criteria Used to Evaluate Remedial Alternatives Address Multiple Areas

- Protection of Human Health and Environment
- Compliance with ARARs
- Short-Term Effectiveness
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Implementability
- Cost
- State Acceptance

6.2 Compliance with ARARs

For this criterion, each alternative is evaluated to determine how chemical-, location-, and action-specific ARARs are affected. If the assessment indicates an ARAR will not be met, then the basis for justifying one of the six ARARs waivers (**Table 3-1**) allowed under CERCLA is discussed.

6.3 Short-Term Effectiveness

This criterion reviews the effects of each alternative during the construction and implementation phase of the remedial action until remedial response objectives are met. The short-term impacts of each alternative are assessed, considering the following factors, as appropriate:

- Short-term risks that might be posed to the community during implementation of an alternative;
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
- Potential adverse environmental impacts resulting from construction and implementation of an alternative and the reliability of the available mitigation measures during implementation in preventing or reducing the potential impacts; and
- Time until protection is achieved.

6.4 Long-Term Effectiveness and Permanence

Long-term effectiveness evaluates the likelihood that the remedy will be successful and what permanence that it affords. Factors to be considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their toxicity, mobility, or volume and their propensity to bioaccumulate.
- Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at a site. This factor includes an assessment of containment systems and institutional controls to determine if they are sufficient to ensure that any exposure to human and ecological receptors is within protective levels. This factor also addresses the long-term reliability of management controls for providing continued protection from residuals, the assessment of the potential need to replace technical components of the alternative, and the potential exposure pathways and risks posed should the remedial action need replacement.

6.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Each alternative is assessed for the degree to which it employs technology to permanently and significantly reduce toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by a site. Factors to be considered, as appropriate, include the following:

- The treatment processes that the alternative uses and materials it will treat;
- The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated, including how the principal threat(s) will be addressed;
- The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment;
- The degree to which the treatment is irreversible;
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents; and
- Whether the alternative would satisfy the statutory preference for treatment as a principal element of the remedial action.

6.6 Implementability

The technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation is evaluated under this criterion. The ease or difficulty of implementing each alternative will be assessed by considering the following factors:

- Technical feasibility
    - Technical difficulties and unknowns associated with the construction and operation of a technology
    - Reliability of the technology, focusing on technical problems that will lead to schedule delays
    - Ease of undertaking additional remedial actions, including what, if any, future remedial actions would be needed and the difficulty to implement additional remedial actions
    - Ability to monitor the effectiveness of the remedy, including an evaluation of risks of exposure should monitoring be insufficient to detect a system failure
- Administrative feasibility
    - Activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions)
- Availability of Services and Materials
    - Availability of adequate offsite treatment, storage capacity, and disposal capacity and services

- Availability of necessary equipment, specialists, and provisions to ensure any necessary additional resources
- Availability of services and materials plus the potential for obtaining competitive bids, which is particularly important for innovative technologies
- Availability of prospective technologies

6.7 Cost

Types of costs that are assessed for each alternative include the following:

- Capital costs
- Annual O&M costs
- Periodic costs
- Present value of capital and annual O&M costs

Cost estimates are developed according to *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000). Flexibility is incorporated into each alternative for the location of remedial facilities, the selection of cleanup levels, and the period in which remedial action will be completed. Assumptions of the project scope and duration are defined for each alternative to provide cost estimates for the various remedial alternatives. Important assumptions specific to each alternative are summarized in the description of the alternative. Additional assumptions are included in the detailed cost estimates in **Appendix E**.

The levels of detail employed in making these estimates are conceptual but are considered appropriate for making choices between alternatives. The information provided in the cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. The costs are evaluated with respect to the following categories:

- Capital costs are those expenditures that are required to construct a remedial action. They are exclusive of costs required to operate or maintain the action throughout its lifetime. Capital costs consist primarily of expenditures initially incurred to build or install the remedial action (e.g., construction of a water treatment system and related site work). Capital costs include all labor, equipment, and material costs associated with activities (including contractor markups and overhead and profit), such as mobilization/demobilization; monitoring of site work; installation of extraction, containment, or treatment systems; and disposal. Capital costs also include expenditures for professional/technical services that are necessary to support construction of the remedial alternative.

- Annual O&M costs are those post-construction costs necessary to ensure or verify the continued effectiveness of a remedial action. These costs are estimated mostly on an annual basis. Annual O&M costs include all labor, equipment, and material costs associated with activities such as monitoring (including contractor markups and overhead and profit); operating and maintaining extraction, containment, or treatment systems; and disposal. Annual O&M costs also include expenditures for professional/technical services necessary to support O&M activities.

- Periodic costs are those costs that occur only once every few years (e.g., 5-year reviews or equipment replacement) or expenditures that occur only once during the entire O&M period or remedial time frame (e.g., site closeout or remedy failure/replacement). These costs may be either capital or O&M costs but, because of their periodic nature, it is more practical to consider them separately from other capital or O&M costs in the estimating process.

- The present value of each alternative provides the basis for the cost comparison. The present value cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life. Future O&M and periodic costs are included and reduced by a present value discount rate. The use of discount rates for present value cost analyses is stated in the preamble to the NCP (55 FR 8722) and in the EPA's Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-20, Revisions to Office of Management and Budget [OMB] Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis, 1993. As outlined in *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000), a seven percent real discount rate should be applied over the period of evaluation for each alternative. The real discount rate is defined as:

  Real discount rate = [(1+nominal discount rate)/(1+inflation rate)] – 1

  The nominal discount rate is typically called the nominal interest rate (e.g., on bonds).

  A seven percent real discount rate not considering inflation would yield a nominal discount rate of seven percent. In addition, a seven percent real discount rate considering inflation would result in a nominal discount rate greater than seven percent. Since municipal bond rates in the last 10 years have generally been less than six percent and inflation over the same period has averaged around three percent per year, the seven percent real discount rate is not appropriate to use for FS cost estimating.

  For the NIC Site FS, the net present value will not be calculated with the real discount rate as recommended by *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000); rather an inflation rate of three

percent and a nominal discount (interest) rate of five percent (typical of city bonds) will be applied separately in the determination of net present value.

6.8 State/Support Agency Acceptance

This criterion evaluates the technical and administrative issues and concerns the state/support agency may have regarding each remedial alternative. State/Support agency acceptance is a modifying criterion under the NCP. Assessment of state/support agency acceptance will not be known until the final FS report is submitted to the KDHE and the KDHE issues the *Draft Corrective Action Decision for Interim Groundwater Remediation* (CAD). The draft CAD will provide the State's rationale for alternative selection and acceptance. Thus, state/support agency acceptance is not considered in the detailed evaluation of alternatives presented in this FS.

6.9 Community Acceptance

Community acceptance is also a modifying criterion under the NCP. Assessment of community acceptance will include responses to questions that any interested person in the community may have regarding any component of the remedial alternatives that will be presented in the KDHE's draft CAD for the NIC Site. This assessment will be completed after the KDHE receives public comments on the proposed plan during the public commenting period. Thus, community acceptance is not considered in the detailed evaluation of alternatives presented in this FS.

6.10 Criteria Priorities

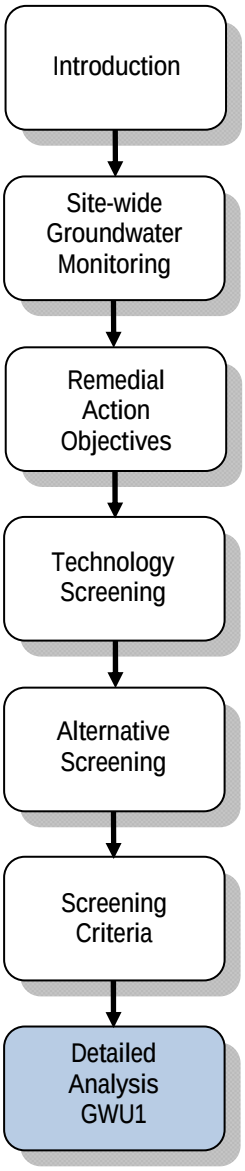
The nine evaluation criteria described above are separated into three groups to establish priority among these criteria during detailed evaluation of the remedial alternatives. These groups are:

- Threshold Criteria – must be satisfied by the remedial alternative being considered as the preferred remedy
    - Overall Protection of Human Health and the Environment
    - Compliance with ARARs
- Balancing Criteria – technical criteria evaluated among those alternatives satisfying the threshold criteria
    - Short-Term Effectiveness
    - Long-Term Effectiveness and Performance
    - Reduction of Toxicity, Mobility, or Volume through Treatment
    - Implementability
    - Cost

- Modifying Criteria – not evaluated in this FS; will be evaluated after comments are received on the FS and proposed plan
    - State Acceptance
    - Community Acceptance

Section 7
Detailed Analysis of Retained Alternatives – Groundwater Unit 1

Remedial alternatives presented in this section are for the area consisting of GWU1 but should also address the downgradient extent of the chlorinated solvent groundwater plume emanating from GWU1 (geographically part of GWU5). GWU1 plus the downgradient chlorinated solvent extent is herein referred to as GWU1. GWU1 alternatives are focused on the chlorinated solvent contamination. Remediation of the refinery-related contaminants in GWU5 is discussed in Section 11.



Alternatives retained in Section 5 for GWU1 undergo detailed analysis in this section. During detailed analysis, each retained alternative is assessed using the two threshold and five balancing criteria presented in Section 6.0. The results of the detailed analysis for each retained alternative are arrayed to perform a comparative analysis, identifying key tradeoffs between alternatives. The detailed analyses for retained alternatives for GWU1 are presented below.

7.1 Secondary Assumptions Affecting Detailed Analysis of Remedial Alternatives

Fundamental assumptions for all remedial alternatives used during alternative development and screening were presented in Section 5. There are, however, also numerous secondary assumptions that affect the detailed analysis of alternatives even though these assumptions are not fundamental controlling considerations. These assumptions are driven mainly by site limitations and constraints that cannot be overcome by using one or more retained remedial technology/process options as described in Section 4. Secondary assumptions affecting the detailed analysis of remedial alternatives for GWU1 include:

- Source control measures are assumed to be implemented at all significantly active source areas for Alternatives GWU1-2, GWU1-3, and GWU1-4.

- The greatest potential for MNA processes is downgradient of GWU1. As noted above, the detailed evaluation for GWU1 includes the downgradient extent of the chlorinated solvent plume emanating from GWU1 which migrates through a significant area of petroleum hydrocarbon contamination. The environmental conditions associated with the petroleum hydrocarbon impact appear to be responsible for the conditions favorable for MNA processes.

- The actual number of groundwater monitoring wells to be installed and established as part of the performance assessment and monitoring program for the selected alternative will be determined during the remedial design phase. However, a number of wells for assessment and monitoring was estimated for each alternative for costing purposes in this FS.

- A period of performance of 70 years has been assigned for GWU1 remedial Alternatives GWU1-1, GWU1-2, and GWU1-3. The periods of performance for Alternatives GWU1-2 and GWU1-3 are based on a combination of assumptions consisting of: types of source control measures implemented at all significant chlorinated solvent source areas and an estimated 10-year transport time for groundwater in the vicinity of K-96 and Hydraulic Street to passively migrate to the northern end of GWU5 where MNA processes are more effective as shown in Attachment F3 of the Groundwater Modeling Report provided as **Appendix F**. It is assumed that seven flushing volumes, combined with natural attenuation effects will reduce the contaminant plume to concentrations below MCLs. Because the duration time of 70 years was identified for Alternatives GWU1-2 and GWU1-3, this time frame was also selected for the No Action alternative (GWU1-1) as well.

- Based on the groundwater modeling report for GWU1 (**Appendix F**), with an active pumping treatment system consisting of one extraction well installed within the plume (Alternative GWU1-4), the contaminant plume would require approximately 35 years of O&M to capture the upgradient groundwater plume for a total of seven flushing volumes. MNA monitoring is assumed to be 42 years. Data supporting the operation time estimate of extraction well NIC#1-1 is provided in the particle capture shown in Groundwater Model Alternative 4 and assumes an operational period of seven flushing volumes. The groundwater model particle tracking in Attachment F3 shows that travel time for groundwater to migrate from 29th Street to the north end of GWU5 is approximately 6 years. Seven flushing volumes for this area would therefore be approximately 42 years. It is assumed that seven flushing volumes, combined with natural attenuation effects will reduce the contaminant plume to concentrations below MCLs.

7.2 Remedial Alternatives Retained for GWU1

The following alternatives were retained for detailed analysis for GWU1:

- Alternative GWU1-1 – No Action;

- Alternative GWU1-2 – Monitored Natural Attenuation;

- Alternative GWU1-3 – Enhanced Anaerobic Bioremediation/Monitored Natural Attenuation; and

- Alternative GWU1-4 – Groundwater Extraction (Containment Only), New Treatment Plant, and Discharge to Chisholm Creek.

7.3 Alternative GWU1-1 – No Action

7.3.1 Alternative Component Description

The No Action alternative is required by the NCP to provide a baseline set of conditions against which other remedial actions may be compared. This alternative allows a site to remain in its current state with no remedial actions being implemented outside of separate source control efforts performed by responsible parties; these source controls are not considered for this FS. There would be no change in groundwater contaminant concentrations aside from that which occurs naturally because no treatment, containment, or removal of contaminated groundwater is included in this alternative. Existing water well ordinances, however, would still be enforced and existing institutional controls would be maintained.

Although no remedial action or monitoring is required for this alternative per EPA guidance (EPA 1989), the KDHE currently has a Settlement Agreement with the City for the NIC Site. Due to the Settlement Agreement, therefore, the No Action alternative for this FS includes limited groundwater monitoring of GWU1 and five-year site reviews. For the NIC Site, this includes groundwater monitoring at 10 well pairs located throughout GWU1.

Sampling and analysis would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 60 years* to monitor the extent of groundwater contamination. Sample analyses would include the Site COCs discussed in Section 1 as well as typical MNA parameters. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination is not treated, contained, or removed in this alternative. Abandonment of monitoring wells is assumed to occur at the end of the *period of performance of 70 years*.

7.3.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU1-1 as determined against criteria factors is provided in **Table D-GWU1-1A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment; however, since no treatment, containment, or removal of contaminated GWU1 groundwater is included in this alternative, this criterion is not met. The overall rating for Alternative GWU1-1 is none (**⓪**).

7.3.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU1-1 as determined against criteria factors is provided in **Table D-GWU1-1B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for

Alternative GWU1-1 against this criterion is none, primarily because concentrations in GWU1 groundwater exceed federal drinking water standards and KDHE Tier 2 action limits (⓪).

7.3.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU1-1 as determined against criteria factors is provided in **Table D-GWU1-1C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment; however, other short-term risks to the community are unchanged by this alternative because no treatment, containment, or removal of GWU1 contaminated groundwater is performed and the time-frame for monitoring is essentially open-ended. This criterion is therefore not met by Alternative GWU1-1 and the overall rating for is therefore none (⓪).

7.3.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU1-1 as determined against criteria factors is provided in **Table D-GWU1-1D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary; however, no containment or removal of contaminated GWU1 groundwater is included in this alternative. Treatment relies on natural attenuation processes and the time required to complete this remedy is expected to exceed the 30 years used as a standard basis for alternative life. This criterion is therefore not met by this alternative and the overall rating for Alternative GWU1-1 is therefore none (⓪).

7.3.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU1-1 as determined against criteria factors is provided in **Table D-GWU1-1E** of **Appendix D**. This alternative does not provide for a GWU1 treatment component outside of natural attenuation which may result in incomplete degradation of chlorinated solvents. In addition, this alternative does not provide for containment or removal of contaminated GWU1 groundwater and therefore does not satisfy the preference for treatment as a principal element of the remedial action. This criterion is not met by this alternative. The overall rating for Alternative GWU1-1 is none (⓪).

7.3.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU1-1F** of **Appendix D**. Groundwater monitoring and maintenance of existing water well ordinances and institutional controls is easily implementable. The overall rating for Alternative GWU1-1 against this criterion is therefore high (❺).

7.3.8 Cost

Evaluation of cost for Alternative GWU1-1 along with a summary breakdown of cost components is provided in **Table D-GWU1-1G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU1-1 against this criterion is low to moderate (**$$**).

7.4 Alternative GWU1-2 – Monitored Natural Attenuation

7.4.1 Alternative Component Description

Under Alternative GWU1-2, the existing groundwater contaminant plume would be allowed to naturally attenuate. Natural attenuation is defined in the NCP as "biodegradation, dispersion, dilution, and adsorption" of contaminants in groundwater. This alternative tracks the VOC concentrations and natural attenuation processes occurring in the GWU1 chlorinated solvent groundwater plume, demonstrating decreasing trends in COC contamination within the GWU1 plume over time. The existing groundwater monitoring well network would be expanded by the installation of wells inside the chlorinated solvent groundwater plume to provide additional evaluation points. Samples would be collected at regular intervals from all monitoring points and analyzed for COCs and degradation parameters. MNA performance criteria will consist of:

- Ongoing reducing, anaerobic groundwater conditions;
- Decreasing overall trends in COC concentrations, recognizing that degradation of parent compounds can result in temporary spikes in daughter compound concentrations; and
- Observed degradation of daughter product C12DCE to VC and the subsequent degradation of VC to ethane and ethane. If the degradation process appears to be stalling at C12DCE, the microbial environment of the aquifer will be evaluated. This evaluation will not be necessary if residual PCE, TCE, and C12DCE concentrations are all below MCLs.

The MNA potential determined for each GWU at the NIC Site was highest in the area downgradient of the GWU1 boundary but within the downgradient extent of the chlorinated solvent plume emanating from GWU1. This is due in part to carbon source contaminants from refinery operations in GWU5. The final GWU1 MNA area will be defined as part of the GWU1 remedial design program. Existing water well ordinances would still be enforced and existing institutional controls would be maintained.

In the event that persistent contaminated groundwater exceeding MCLs is observed during the initial remedial action monitoring on the east side of the East Fork of Chisholm Creek north of 21st Street, a contingency investigation of the nature and extent will be implemented. If the investigation determines the source of the

contamination is not derived from an offsite source area, or will not be addressed by El Paso's or Clean Harbors' source control measures, and is of a nature that requires active remediation as determined by the KDHE, the most likely proposed remedial action would be a localized EAB treatment system. Costs for a potential investigation and localized EAB system are not included in this FS.

Sampling and analysis of VOC parameters at 28 wells throughout the GWU1 groundwater plume and sampling and analysis of MNA parameters at 18 of the 28 wells would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 60 years* to monitor the effectiveness of MNA. Sampling and analysis would also include four surface water monitoring locations. Sample analyses would include the Site COCs discussed in Section 1 as well as typical MNA parameters. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of the monitoring wells is assumed to occur at the end of the *period of performance of 70 years*.

7.4.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU1-2 as determined against criteria factors is provided in **Table D-GWU1-2A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment and MNA assumes degradation of contaminants over time. The overall rating for Alternative GWU1-2 is moderate (❸).

7.4.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU1-2 as determined against criteria factors is provided in **Table D-GWU1-2B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU1-2 against this criterion is moderate (❸).

7.4.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU1-2 as determined against criteria factors is provided in **Table D-GWU1-2C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. Additional monitoring wells allow for better evaluation of trends in COC concentrations. The overall rating for Alternative GWU1-2 is moderate to high (❹).

7.4.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU1-2 as determined against criteria factors is provided in **Table D-GWU1-2D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary. Treatment occurs through existing natural attenuation processes but the time required to complete this remedy is expected to exceed the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU1-2 against this criterion is moderate (❸).

7.4.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU1-2 as determined against criteria factors is provided in **Table D-GWU1-2E** of **Appendix D**. This alternative provides for treatment of GWU1 groundwater through natural attenuation but does not provide for containment or removal of contaminated GWU1 groundwater and therefore does not satisfy the preference for treatment as a principal element of the remedial action. This criterion is only partially met by this alternative. The overall rating for Alternative GWU1-2 is moderate (❸).

7.4.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU1-2F** of **Appendix D**. Groundwater monitoring and maintenance of existing water well ordinances and institutional controls is easily implementable. The overall rating for Alternative GWU1-2 against this criterion is therefore moderate to high (❹).

7.4.8 Cost

Evaluation of cost for Alternative GWU1-2 along with a summary breakdown of cost components is provided in **Table D-GWU1-2G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU1-2 against this criterion is low to moderate (**$$$**).

7.5 Alternative GWU1-3 – Enhanced Anaerobic Bioremediation/ Monitored Natural Attenuation

7.5.1 Alternative Component Description

Alternative GWU1-3 will enhance reductive dechlorination processes within the subsurface to degrade the chlorinated solvent groundwater plume. EAB will be performed using injection wells to deliver electron donor material to the aquifer. Areas of the Site that will be actively treated by EAB will include portions of the groundwater plume with total chlorinated aliphatic hydrocarbon (CAH) concentrations greater than 100 µg/L. Electron donor will be distributed using rows

of injection wells (biobarriers) that are installed perpendicular to the plume axis; each biobarrier will consist of two rows of injection wells. The rows are anticipated to be spaced approximately 25 feet apart, and injection wells within each row to be spaced at approximately 40 feet apart. The wells will generally be offset so that wells in the second row will be positioned at the midpoint of the wells in the first row, creating an overall 20-foot spacing of wells perpendicular to the plume axis.

Four biobarriers would be installed in the approximate locations shown on **Figure 7-1**.

- Biobarrier 1 consists of two parts. Part 1a a lies on the south side of E. 29th Street N, west of the railroad tracks, and is approximately 750 feet in length. This biobarrier will intercept the contaminant plume upgradient of the rail yard, and is expected to contain 37 injection wells installed to depths of approximately 40 feet bgs. Part 1b, approximately 200 feet in length, will be located on the east side of the railroad tracks, approximately 400 feet downgradient of part 1a. This 1b location will intercept the northern plume component that underlies the railroad tracks in the vicinity of part 1a, and is expected to contain 9 injection wells installed to depths of approximately 40 feet bgs.

- Biobarrier 2, approximately 1,200 feet in length, will be located between the two rail yards, parallel to the tree line that is oriented southwest to northeast. The midpoint of Biobarrier 2 is approximately 1,200 feet downgradient of Biobarrier 1a. Biobarrier 2 is expected to consist of 59 injection wells based on a 40-foot spacing between wells; however, the injection wells may need to be placed at an alternate spacing, such as every 48-feet in each row, due to the orientation of the biobarrier. If a 48-foot spacing is used, fewer injection wells would need to be installed. The wells will be installed to depths of approximately 37 ft bgs. Installation of Biobarrier 2 will depend primarily on the ability to gain access to the area located between the two rail yards.

- Biobarrier 3, approximately 1,000 feet in length, will be located near the southern boundary of GWU1, perpendicular to the axis of the plume. This biobarrier will intercept the contaminant plume just upgradient of GWU5. Biobarrier 3 will be located approximately 1,200 feet downgradient of the midpoint of Biobarrier 2, and is expected to contain 49 injection wells installed to depths of approximately 35 ft bgs.

- Biobarrier 4, approximately 600 feet in length, will be located south of the former VIM Trailer facility, perpendicular to the axis of the plume along East 26th Street North. This biobarrier will intercept the contaminant plume downgradient of the former VIM Trailer facility. Biobarrier 4 is expected to contain 29 injection wells installed to depths of approximately 35 ft bgs.

In the event that persistent contaminated groundwater exceeding MCLs is observed during the initial remedial action monitoring on the east side of the East Fork of Chisholm Creek north of 21st Street, a contingency investigation of the nature and

extent will be implemented. If the investigation determines the source of the contamination is not derived from an offsite source area, or will not be addressed by El Paso's or Clean Harbors' source control measures, and is of a nature that requires active remediation as determined by the KDHE, the most likely proposed remedial action would be a localized EAB treatment system. Costs for a potential investigation and localized EAB system are not included in this FS.

Pilot test activities will be used to test injection performance of 1-inch diameter, direct-push technology (DPT)-installed wells versus conventional 2-inch diameter, hollow-stem auger (HSA)-installed wells. Additionally, a comparison of gravity-fed versus pressurized injections may be performed to determine the most effective method of delivering the electron donor. Pilot test injection wells are anticipated to be installed at select locations from the preliminary layout with a maximum of one test well per line. Temporary performance monitoring wells will be installed near each of the pilot test injection points to help determine injection information and ROI for the injection wells. At each pilot test injection location, therefore, one performance monitoring well is anticipated to be installed approximately five feet lateral (cross-gradient) to the injection well and one performance monitoring well is anticipated to be installed approximately 10 feet downgradient of the injection point. Finally, populations of *Dehalococcoides* spp. would be measured prior to and after pilot test activities to determine whether a native population exists that would be capable of completing dechlorination. Pilot testing activities would likely include installation of *two* 1- or 2-inch diameter injection wells, installation of *four* 1-inch diameter performance monitoring wells, injection testing, and associated sampling activities; therefore, a total of approximately 12 field days will be required for pilot testing.

For the remedy, injection wells will be installed of the diameter and spacing determined during the pilot testing. The anticipated electron donor to be used is an emulsified vegetable oil with proven performance at similar sites. The electron donor will be injected into the subsurface at a 2% solution, with an anticipated total volume of approximately 4,275 gallons of 2% solution per well. Microorganisms may also be injected, if needed, into the subsurface, stimulating bioremediation and enhancing natural attenuation of chlorinated VOCs in groundwater.

Injection solutions will be prepared by mixing the emulsified oil amendment with water inside a frac tank; the solution will be homogenized using a pump. The mixed injection solution will be injected into the injection wells at an anticipated injection rate of approximately 20 gpm per well by either gravity-feed or pressurized injections as determined during the pilot testing; an injection manifold will be used to inject into multiple wells at one time. Water required for injections will be transported to each injection area location using tanker trucks; water will be obtained from the City at a City-approved location, possibly a local fire hydrant or from the county filling station located on Ohio Street. It is assumed that bioaugmentation will not be required at the Site; however, this will be confirmed by pilot testing activities. Well installation and development activities are estimated to require approximately 80 field days, assuming two drilling and development crew operating at the Site. Injection activities are

anticipated to require approximately 35 days assuming 10-hour per day operation with two wells injected simultaneously at 20 gpm each.

Groundwater velocities at the NIC Site are estimated at approximately 600 to 700 feet per year, based on particle tracking estimates presented in **Appendix F**. A plume migration rate of 400 feet per year is assumed for the chlorinated solvent plume, which will typically migrate at a rate less than groundwater velocity due to retardation effects. The electron donor has an approximate lifetime of two years in the subsurface; therefore, *two* additional injections would likely be performed after the initial round of injections in order to treat approximately two flushing volumes of the middle reaches of the groundwater plume with total VOC concentrations greater than the threshold 100 µg/L. With active treatment for approximately two flushing volumes within the middle of the principal groundwater plume within GWU1 (based on distances between biobarriers as shown on **Figure 7-1**), the treatment should reduce the remaining contaminants to levels capable of degradation by natural attenuation. Based upon a plume migration rate of 400 feet per year, seven flushing volumes would be achieved in approximately *20* years for the areas addressed by EAB. These seven flushing volumes are anticipated to be sufficient to reduce contaminant levels to below the KDHE Tier 2 action levels for Site COCs and their daughter products.

As part of performance monitoring for the EAB system, at least one monitoring well should be located within 15 to 20 feet downgradient of one of the injection wells in each injection (biobarrier) line. In order to address this requirement, it is anticipated that *10* additional groundwater monitoring well clusters (consisting of one shallow well plus one deep well) will need to be installed and added to the network of existing wells to monitor each injection area; i.e., one cluster of additional monitoring wells would be installed directly upgradient and downgradient of each biobarrier to monitor its performance. A total of 20 additional monitoring wells would therefore be added to the monitoring network; it is assumed that installation and development of the wells would require approximately five days in the field with one drilling and development crew onsite. These wells would be sampled at the same frequency as the existing wells.

Periodic groundwater monitoring, at the *20* wells both upgradient and downgradient of the EAB systems, would be performed as part of this alternative to demonstrate the effectiveness of the EAB treatment system. Sampling and analysis at the *20* wells would be conducted throughout the 10-year expected duration of the EAB systems. Sample analyses would include the Site COCs discussed in Section 1 as well as geochemical and other parameters to monitor the effectiveness of EAB injections.

Sampling and analysis at 13 wells throughout the GWU1 groundwater plume would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 60 years* to monitor the effectiveness of MNA. Sampling and analysis would also include four surface water monitoring locations. Sample analyses would include the Site COCs discussed in Section 1 as well as typical MNA parameters.

Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Maintenance of injection wells is anticipated to be required prior to each injection event for approximately 10% of the wells. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of injection wells was assumed to occur at year 10 following the final completion of the injection activities. Abandonment of monitoring wells was assumed to occur at the end of the *period of performance of 70 years*.

7.5.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU1-3 as determined against criteria factors is provided in **Table D-GWU1-3A** of **Appendix D**. Over time, MNA, supplemented with EAB, will reduce contaminant levels in groundwater to levels below health based cleanup goals; therefore, this alternative is protective of human health and the environment. The overall rating for Alternative GWU1-3 against this criterion is moderate to high (❹).

7.5.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU1-3 as determined against criteria factors is provided in **Table D-GWU1-3B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. Permitting for the injection of the electron donor and/or microorganisms must be obtained from the state agency. Construction of the EAB systems will be compliant with location-specific ARARs; however, this alternative would not technically address the TBC for hydraulic containment of the groundwater plume. The overall rating for Alternative GWU1-3 against this criterion is moderate (❸).

7.5.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU1-3 as determined against criteria factors is provided in **Table D-GWU1-3C** of **Appendix D**. Proper safety protocols will be followed during installation of the system components, waste soils and/or groundwater generated during system installation activities will be appropriately contained, labeled, and disposed of, and substrate and microorganism materials, if used, will be controlled. EAB is expected to have an almost immediate effect on reducing groundwater contaminant concentrations following system startup. The overall rating for Alternative GWU1-3 against this criterion is moderate to high (❹).

7.5.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU1-3 as determined against criteria factors is provided in **Table D-GWU1-3D** of **Appendix D**. The EAB component should help accelerate the degradation process as opposed to an MNA

only option. The EAB system is anticipated to operate a *maximum of 10 years* at the end of which VOC contaminant concentrations in groundwater are expected to be below KDHE Tier 2 action limits. Follow-on MNA groundwater monitoring will be performed to verify that rebound VOC contaminant concentrations do not exceed KDHE Tier 2 action limits. The time period for follow-on groundwater monitoring is expected to extend beyond the 30 years used as a standard basis for alternative life. Since there are no treatment residuals expected and EAB plus MNA will reduce groundwater contamination to acceptable health based levels over time, Alternative GWU1-3 meets this criterion. The overall rating for Alternative GWU1-3 against this criterion is therefore moderate to high (❹).

7.5.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU1-3 as determined against criteria factors is provided in **Table D-GWU1-3E** of **Appendix D**. This alternative does provide a treatment component and will address the statutory preference for treatment as a principal element of remedial action in areas with total VOC concentrations greater than 100 µg/L. VOC contaminant concentrations are expected to be below KDHE Tier 2 action limits following the treatment period and no residual material is anticipated to remain from the treatment process. The overall rating for Alternative GWU1-3 against this criterion is moderate to high (❹).

7.5.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU1-3F** of **Appendix D**. Groundwater monitoring and maintenance of existing water well ordinances and institutional controls is easily implementable. Installation of an EAB system involves standard drilling equipment and installation techniques. Technical personnel are available for O&M and groundwater monitoring. Access to the railroad properties will be the key to implementing this alternative. Historically, access to railroad property has been difficult to obtain. The overall rating for Alternative GWU1-3 against this criterion is therefore moderate (❸).

7.5.8 Cost

Evaluation of cost for Alternative GWU1-3 along with a summary breakdown of cost components is provided in **Table D-GWU1-3G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU1-3 against this criterion is moderate (**$$$**).

7.6 Alternative GWU1-4 – Groundwater Extraction (Containment Only), New Treatment Plant, and Discharge to Chisholm Creek

7.6.1 Alternative Component Description

Alternative GWU1-4 provides MNA monitoring similar to Alternative GWU1-2; however, under GWU1-4, containment of the northern portion of the GWU1 plume would be achieved through operation of one extraction well installed within the plume. The new extraction well would be a 10-inch diameter well, screened from approximately 10 to 40 ft bgs. Based on groundwater modeling, the extraction well (NIC#1-1) would need to have an estimated pumping rate of 50 gallons per minute (gpm) to provide sufficient capture of the groundwater contaminant plume. As noted in Section 7.2 and discussed further in **Appendix F**, the extraction well would operate for a period of 35 years. Extracted groundwater from this well would be piped to a new GWTP constructed within GWU1. Extraction well and piping locations assumed for costing purposes under this alternative are shown on **Figure 7-1**. Most of the new pipe would be installed by directional boring to reduce road resurfacing and impact to traffic. The new GWU1 GWTP would consist of an air stripper unit; treated water would be discharged to the unnamed drainage referred to as the Middle Fork of Chisholm Creek. The GWU1 GWTP is assumed to be located on City-owned property.

MNA would still be applied to the portion of the groundwater plume south of 29th Street as provided for in Alternative GWU1-2.

O&M of the GWU1 GWTP and extraction well was included under this alternative. It was assumed the extraction well would require annual development. For purposes of the detailed analysis it was assumed the extraction well pump would require replacement every five years. Additionally, components of the GWU1 treatment system would be replaced every 30 years.

This alternative also provides for a contingency well (NIC#1-2) to be installed if additional migration control is needed. The location of the contingency extraction well, targeted for an area between the head tower of the former Farmland Elevator and the north end of the former Coastal-Derby refinery, is shown on **Figure 7-1**. Groundwater from the contingency well would be piped to a second new air stripper GWTP within GWU1 prior to being discharged to an available surface water conveyance. Costs for the contingency well and GWTP are not included in this FS.

In the event that persistent contaminated groundwater exceeding MCLs is observed during the initial remedial action monitoring on the east side of the East Fork of Chisholm Creek north of 21st Street, a contingency investigation of the nature and extent will be implemented. If the investigation determines the source of the contamination is not derived from an offsite source area, or will not be addressed by El Paso's or Clean Harbors' source control measures, and is of a nature that requires active remediation as determined by the KDHE, the most likely proposed remedial

action would be a localized EAB treatment system. Costs for a potential investigation and localized EAB system are not included in this FS.

Sampling and analysis of VOC parameters at 28 wells throughout the GWU1 groundwater plume and sampling and analysis of MNA parameters at 18 of the 28 wells would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 32 years* to monitor the effectiveness of the groundwater containment system. Sampling and analysis would also include four surface water monitoring locations. This schedule provides for MNA monitoring of the GWU1 plume for an additional seven years following shut down of the NIC#1-1 extraction well to account for seven flushing volumes between 29th Street and the northern end of GWU5. Sample analyses would include the Site COCs discussed in Section 1 as well as typical MNA parameters. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of the extraction well is assumed to occur at the end of the *period of performance of 35 years*. Decommissioning of the GWU1 GWTP is included in this alternative. Abandonment of the monitoring wells is assumed to occur at the end of the *period of performance of 42 years*.

7.6.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU1-4 as determined against criteria factors is provided in **Table D-GWU1-4A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU1 contaminated groundwater is performed. The overall rating for Alternative GWU1-4 is moderate to high (❹).

7.6.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU1-4 as determined against criteria factors is provided in **Table D-GWU1-4B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU1-4 against this criterion is moderate to high (❹).

7.6.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU1-4 as determined against criteria factors is provided in **Table D-GWU1-4C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU1 contaminated groundwater is performed. The overall rating for Alternative GWU1-4 against this criterion is therefore moderate to high (❹).

7.6.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU1-4 as determined against criteria factors is provided in **Table D-GWU1-4D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary. Treatment, containment, or removal of GWU1 contaminated groundwater is performed; however, the operational duration is greater than the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU1-4 against this criterion is moderate to high (❹).

7.6.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU1-4 as determined against criteria factors is provided in **Table D-GWU1-4E** of **Appendix D**. This alternative provides for a GWU1 treatment component, provides for containment or removal of contaminated GWU1 groundwater, and therefore satisfies the preference for treatment as a principal element of the remedial action. However, because only groundwater extracted for containment of the plume is treated, the overall rating for Alternative GWU1-4 is moderate (❸).

7.6.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU1-4F** of **Appendix D**. Groundwater monitoring, extraction well O&M, and maintenance of existing water well ordinances and institutional controls is readily implementable. The overall rating for Alternative GWU1-4 against this criterion is therefore moderate to high (❹).

7.6.8 Cost

Evaluation of cost for Alternative GWU1-4 along with a summary breakdown of cost components is provided in **Table D-GWU1-4G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU1-4 against this criterion is moderate (**$$$**).

7.7 State/Support Agency Acceptance

State/support agency acceptance is a modifying criterion under the NCP. Assessment of state/support agency acceptance will not be known until the final FS report is submitted to the KDHE and the KDHE issues the draft CAD. The draft CAD will provide the State's rationale for alternative selection and acceptance. Therefore, state/support agency acceptance is not considered in the detailed analysis of alternatives presented in this FS.

7.8 Community Acceptance

Community acceptance is also a modifying criterion under the NCP. Assessment of community acceptance will include responses to questions that any interested person in the community may have regarding any component of the remedial alternatives that will be presented in the KDHE's draft CAD for the NIC Site. This assessment will be completed after the KDHE receives public comments on the proposed plan during the public commenting period. Community acceptance is therefore not considered in the detailed analysis of alternatives presented in this FS.

7.9 Comparative Analysis of Alternatives

This FS evaluated the four retained remedial alternatives discussed in this section against the two threshold criteria and five balancing criteria discussed in Section 6. A summary of the results of the detailed analyses for each remedial alterative (from **Appendix D**) is presented in **Table 7-1** to allow a comparison of the alternatives and identify the key tradeoffs between them.

7.9.1 Overall Protection of Human Health and the Environment

Alternatives GWU1-2, GWU1-3, and GWU1-4 meet this criterion. While current evidence shows all three to be protective of human health and the environment, Alternative GWU1-3 has the potential to be more protective due to the proactive effort in the middle reaches of the GWU-1 plume. Alternative GWU1-4 provides migration control for contamination in the northern portion of the GWU1 plume.

7.9.2 Compliance with ARARs

Alternative GWU1-1 does not comply with ARARs. While Alternatives GWU1-2 and GWU1-3 meet all ARARs, they do not technically meet the TBC for hydraulic containment. Chisholm Creek, however, may function as a hydraulic boundary for the majority of leading edge the GWU1 chlorinated solvent groundwater plume. Alternatives GWU1-2 and GWU1-3 meet this threshold criterion. Alternative GWU1-4 provides for treatment of the chlorinated solvent groundwater plume and also meets this criterion.

7.9.3 Short-term Effectiveness

Alternative GWU1-1 is not effective in the short term because the time frame for the remediation of contaminated groundwater is open ended. Alternatives GWU1-2, GWU1-3, and GWU1-4 can be effective. Alternative GWU1-3 would require the application of EAB; however, this would be largely accomplished on industrial land and would not impact the community significantly. Alternative GWU1-4 would result in impact to the community during implementation because Alternative GWU1-4 includes installation of an extraction well, associated piping, and construction of a new GWTP.

7.9.4 Long-Term Effectiveness and Permanence

Alternative GWU1-1 does not provide a long-term effective or permanent remedy for groundwater at GWU1. Alternatives GWU1-2, GWU1-3, and GWU1-4 will provide a long-term reduction of COCs in groundwater to levels protective of human health. Alternatives GWU1-3 and GWU1-4 would be expected to provide reduction of COCs at a faster rate and are therefore rated slightly higher than GWU1-2 with respect to providing an effective long-term and permanent remedy for GWU1 groundwater.

7.9.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative GWU1-1 does not provide active reduction of contamination. Alternative GWU1-2 provides a reduction in contaminant concentrations over time through natural attenuation processes and implementation of source remediation (under separate source area control programs). Alternative GWU1-3 will provide a reduction of contaminant concentrations in the middle reaches of the plume through EAB. Under Alternative GWU1-3, the downgradient portion of the GWU1 plume will be addressed through the same natural attenuation processes noted for Alternative GWU1-2. Alternative GWU1-4 provides a treatment and migration control component; however, only extracted groundwater would undergo treatment.

7.9.6 Implementability

All alternatives are readily implementable. Alternatives GWU1-2, GWU1-3, and GWU1-4 will require a construction phase to complete monitoring well installation. Alternative GWU1-3 will require installation of the biobarriers and a series of injection efforts. Alternative GWU1-3 would also require the application of EAB on railroad property where access and injection efforts would make GWU1-3 relatively more difficult to implement than Alternatives GWU1-1 or GWU1-2. The overall construction phase for Alternative GWU1-4 is lengthiest due to installation of an extraction well and associated piping plus construction of a new GWTP as well as installing additional monitoring wells.

7.9.7 Cost

Alternatives GWU1-1 and GWU1-2 fall into the low to moderate cost range although Alternative GWU1-1 has the lowest overall cost. Alternatives GWU1-3 and GWU1-4 fall into the moderate cost range although Alternative GWU1-3 has the highest overall cost due to the number and lengths of the proposed biobarriers. As discussed in Sections 7.4, 7.5, and 7.6, the costs for Alternatives GWU1-2, GWU1-3, and GWU-1-4 may increase if persistent contaminated groundwater exceeding MCLs is observed during the initial remedial action monitoring on the east side of the East Fork of Chisholm Creek north of 21st Street, and a contingency investigation of the nature and extent is implemented.

Capital, O&M, periodic, and present value costs for the four alternatives, not including a potential investigation east of Chisholm Creek or remediation of that area, are provided in **Appendix E**; however, these costs are also summarized in **Table 7-1**.

7.10 Recommended Alternative

Four alternatives were evaluated to address GWU1 contaminated groundwater. Alternative GWU1-1 does not provide adequate protection to human health and the environment and does not meet ARARs. Alternative GWU1-2 does not actively treat the contaminated groundwater or contain it within the GWU; however this alternative does provide a reduction in GWU1 groundwater plume contaminant concentrations over time through natural attenuation processes. Alternative GWU1-3 provides a degree of active treatment within the middle reaches of the GWU1 plume but is otherwise similar to Alternative GWU1-2. Alternative GWU1-4 is also similar to GWU1-2 but provides for partial groundwater extraction and treatment. All issues considered, including that current concentrations show effective contaminant reductions within the GWU5 area of the GWU1 downgradient chlorinated solvent groundwater plume, Alternative GWU1-2 is the preferred alternative for GWU1. The final GWU1 MNA area will be defined as part of the GWU1 remedial design program. If GWU1-2 does not provide for reduction of contamination within approximately one flushing volume (5 to 7 years), GWU1-4 will be used as the contingency alternative.

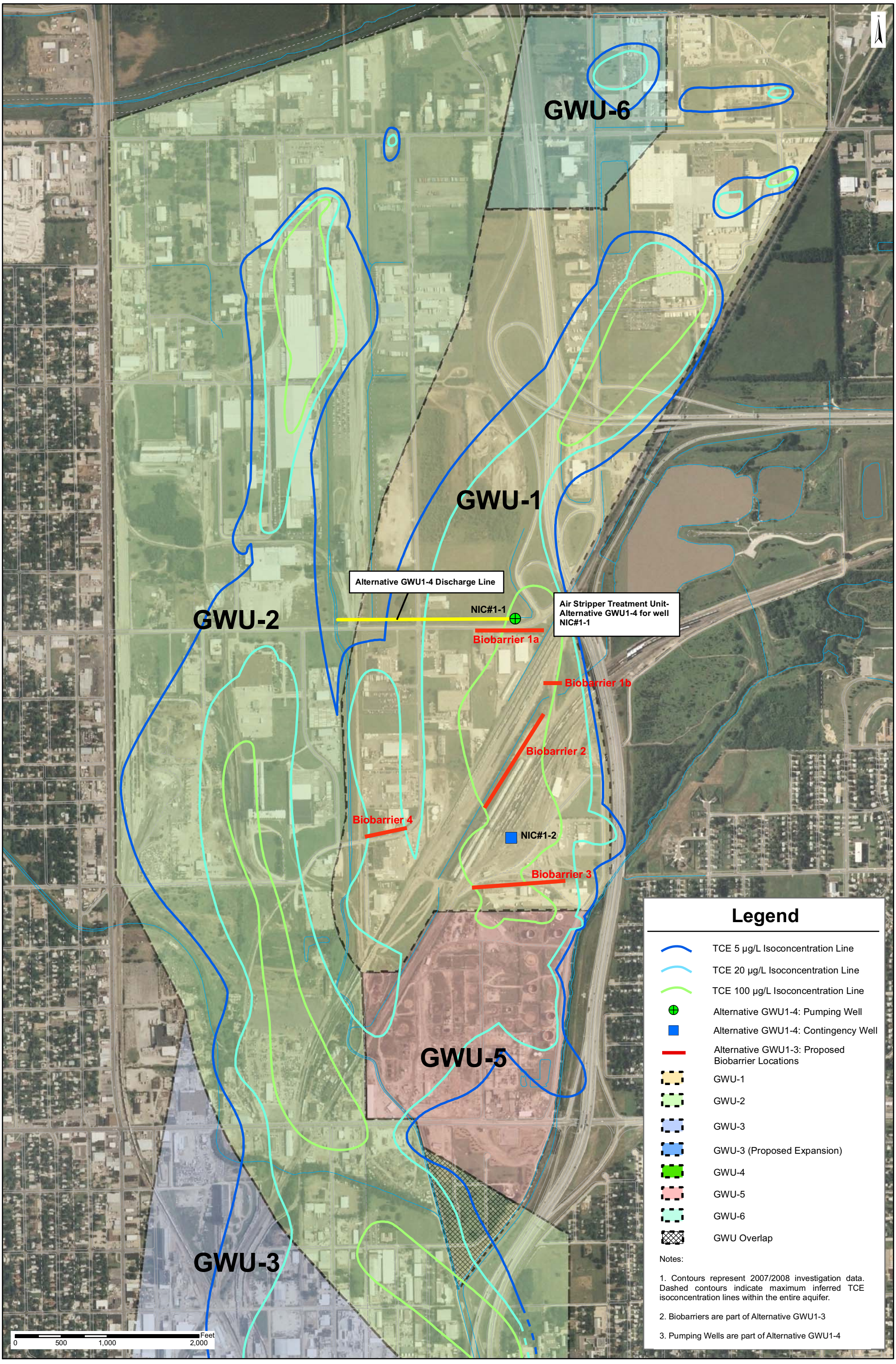


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Figure 7-1
North Industrial Corridor (NIC) Site
Remedial Alternatives GWU1-3 and GWU1-4

Table 7-1
North Industrial Corridor (NIC) Site
Comparative Analysis of Alternatives for GWU1

Remedial Alternative:	Alternative GWU1-1 No Action	Alternative GWU1-2 Monitored Natural Attenuation	Alternative GWU1-3 Enhanced Anaerobic Bioremediation / Monitored Natural Attenuation	Alternative GWU1-4 Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Drainage Ditch
Major Components:	Limited monitoring to support Five-Year Site Reviews	Tracks the natural attenuation process, demonstrating decreasing trends in COC contamination within the groundwater plume over time.	Tracks the natural attenuation process, demonstrating decreasing trends in COC contamination within the groundwater plume over time. Degradation of COCs aided by EAB.	Installation of 1 EW at the leading edge of the groundwater plume. Extracted groundwater would be treated at a new GWTP within GWU1.
Threshold Criteria				
Overall Protection of Human Health and the Environment	⓪ Cleanup objectives would not be achieved	❸ Over time, MNA will reduce contaminant levels	❹ Over time, EAB/MNA will reduce contaminant levels	❹ Containment of the groundwater plume via EWs and treatment will be protective of the environment. Ongoing institutional controls limiting new well installations are protective of human health.
Compliance with ARARs	⓪ Would not comply with ARARs	❸ Would comply with ARARs; however, this alternative will not technically address the TBC for hydraulic containment.	❸ Would comply with ARARs; however, this alternative will not technically address the TBC for hydraulic containment. Permitting for the injection of electron donor must be obtained from the state.	❹ Would comply with ARARs
Balancing Criteria				
Short-Term Effectiveness	⓪ The short term risks are not addressed and the time frame is open ended	❹ Limited construction activities; additional monitoring wells would be installed. Impacted area is industrial. MNA processes locally occurring.	❹ Limited construction activities; injection wells and additional monitoring wells would be installed. Impacted area is industrial. MNA processes locally occurring.	❹ Disruption to the community from installation of water lines and treatment plant.
Long-Term Effectiveness and Permanence	⓪ Future risks to human health and the environment would not be diminished	❸ Over time, MNA will decrease concentrations of all COCs to acceptable risk-based levels.	❹ Over time, EAB/MNA will decrease concentrations of all COCs to acceptable risk-based levels. The EAB component should accelerate the process.	❹ Containment and treatment of contaminated groundwater prevents further migration. Over time the concentrations of contaminants would decrease.
Reduction of Toxicity, Mobility, or Volume through Treatment	⓪ No treatment or reduction in toxicity, mobility, or volume of contaminants	❸ This alternative does not provide a treatment component; however, MNA should reduce contaminant concentrations over time.	❹ This alternative does provide an active treatment component which addresses a portion of the plume. Combined with MNA, EAB should reduce contaminant concentrations over time.	❸ This alternative does provide a limited active treatment component; however, it is not designed to actively treat all contaminated groundwater within GWU1. Treatment would only be applied to groundwater extracted through hydraulic containment. MNA should reduce non-extracted groundwater contaminant concentrations over time.
Implementability	❺ Monitoring is highly implementable	❹ Installation of monitoring wells and MNA monitoring is highly implementable.	❸ Access to railroad property could be an issue. Installation of injection and monitoring wells and MNA monitoring is moderately implementable.	❹ Installation of water lines and treatment systems is very implementable.

Table 7-1
North Industrial Corridor (NIC) Site
Comparative Analysis of Alternatives for GWU1

Remedial Alternative:	Alternative GWU1-1 No Action	Alternative GWU1-2 Monitored Natural Attenuation	Alternative GWU1-3 Enhanced Anaerobic Bioremediation / Monitored Natural Attenuation	Alternative GWU1-4 Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Drainage Ditch
Major Components:	Limited monitoring to support Five-Year Site Reviews	Tracks the natural attenuation process, demonstrating decreasing trends in COC contamination within the groundwater plume over time.	Tracks the natural attenuation process, demonstrating decreasing trends in COC contamination within the groundwater plume over time. Degradation of COCs aided by EAB.	Installation of 1 EW at the leading edge of the groundwater plume. Extracted groundwater would be treated at a new GWTP within GWU1.
Period of Operation (Years)				
Active Treatment	0	0	EAB injections at years 0, 2, 4	Well NIC#1-1 Pumping for 35 years
Monitoring	70	70	70	42
Cost (Dollars)				
	$$	$$$	$$$	$$$
Total Capital Cost[1]	$129,000	$183,000	$3,630,000	$1,356,000
Total Annual O&M Cost[1,2]	$2,674,000	$8,100,000	$5,484,000	$8,709,000
Total Periodic Cost[1,2]	$878,000	$902,000	$2,526,000	$1,208,000
Present Value Cost[1,2]	$2,191,000	$5,532,000	$9,465,000	$8,497,000

EW = Extraction well
GilMo = Gilbert-Mosley
EAB = Enhanced anaerobic bioremediation
TBC = To be considered

GWTP = Groundwater treatment plant
ARARs = Applicable or Relevant and Appropriate Requirements
MNA = Monitored natural attenuation
COCs = Contaminants of concern

Legend for Qualitative Ratings System:

Ratings Categories for Threshold and Balancing Criteria
⓪ None
❶ Low
❷ Low to Moderate
❸ Moderate
❹ Moderate to High
❺ High

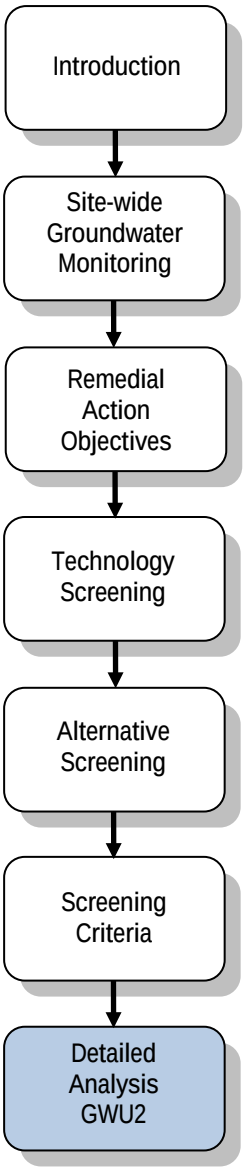
Ratings categories for Cost Criteria (Present Value Cost)

⓪	None	
$	Low	(less than 2 million dollars)
$$	Low to moderate	(between 2 million and 5 million dollars)
$$$	Moderate	(between 5 million and 10 million dollars)
$$$$	Moderate to high	(between 10 million and 15 million dollars)
$$$$$	High	(greater than 15 million dollars)

1 – Capital costs, annual costs, and periodic costs are presented in Appendix E.
2 – Estimated remedial timeframes and associated present value analysis for each remedial alternative are provided in Appendix E.
3 – Costs presented have an expected accuracy range for corrective action study estimates (-30% to +50% of the actual cost of the alternative).

Section 8
Detailed Analysis of Retained Alternatives – Groundwater Unit 2

8.1 Overview by CDM



GWU2 is located in the northwestern quadrant of the NIC Site and includes a number of source areas. A summary of remediation measures to date and planned activities for GWU2 source areas is included in **Appendix B**. Under the NIC Participant Agreement, a representative of GWU2, Shaw Environmental, Inc. (Shaw), representing New Coleman Holdings, Inc., has prepared a Detailed Analysis of Retained Alternatives for GWU2. The document, as produced by Shaw, is included in this section. The document only addresses the chlorinated solvent contaminants in the groundwater within GWU2.

In addition to the chlorinated solvent impacts, GWU2 is also impacted by petroleum hydrocarbon-related contamination associated with facility operations at the former Golden Rule Refinery and former Barnsdall Refinery. The impacts to the GWU2 groundwater from these former refineries are localized and will therefore be addressed under site-specific source investigations and source control measures for these two facilities. No specific remedial actions related to these two facilities will be addressed in this FS; however, the potential impacts of the petroleum hydrocarbon contamination with respect to localized enhanced biodegradation of chlorinated solvents has been taken into consideration.

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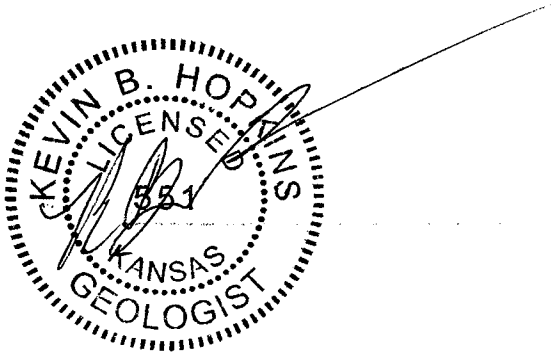

KEVIN B. HOPKINS LPG

8.0 *Detailed Analysis of Retained Alternatives - Groundwater Unit 2*

8.1 Overview of Groundwater Unit 2

Groundwater Unit 2 (GWU2) is located on the northwest quadrant of the North Industrial Corridor (NIC) Site as illustrated in ***Figure 1.2*** The boundary of GWU2 generally follows the groundwater flow direction from the northern NIC Site boundary south, then parallel to the West Fork of Chisholm Creek. South of the intersection of East 25th Street North and Broadway, the GWU2 boundary parallels the West Fork of Chisholm Creek to the southeast toward the confluence with the East Branch of Chisholm Creek. The western boundary of GWU2 follows North Broadway from East 37th Street North to 25th Street North. This boundary then curves to the southeast to 17th Street North. From west to east, GWU2 is approximately one-half mile wide at 29th Street North extending to approximately one mile wide at East 37th Street North.

The geology of GWU2 is consistent with other portions of the NIC Site. The thickness of Hydrostratigraphic Unit 1 ranges from 5 to 20 feet and consists of low-permeable silt and clay with interspersed sands. In this operable unit Hydrostratigraphic Unit 1 is usually not covered with anthropologic features. Therefore, aquifer recharge through infiltration is common in this area.

Hydrostratigraphic Unit 2 consists of a downward coarsening sequence of alluvial deposits ranging in size from fine sand to gravel that is mostly composed of quartz and feldspars. The thickness of Hydrostratigraphic Unit 2, as depicted in the NIC Site cross-sections presented in the RI, ranges from 20 feet near Chisholm Creek to 40 feet down the central axis of GWU2. In general, the thickness of Hydrostratigraphic Unit 2 thins to the east and south.

Hydrostratigraphic Unit 3 and Hydrostratigraphic Unit 4 within GWU2 are typical of the NIC Site. A bedrock contour map of the basal Hydrostratigraphic Unit 4 presented in the RI (***CDM 2004a***) indicates a bedrock high in the vicinity of the boundary between GWU2 and GWU3. The location and strike of the bedrock high mimics the GWU2 groundwater flow direction toward the East Branch of Chisholm Creek (***Plate 2-1***).

The source areas within GWU2 have been identified and characterized as follows:

Confirmed sources with source control measures in place

- Coleman North Operable Unit (Johnson Controls/Evcon Facility) – Chlorinated VOCs, primarily TCE

Other confirmed sources

- Continental Tank Car – Chlorinated VOCs, primarily, 1,1,1-TCA and TCE
- Former Golden Rule Refinery – Petroleum Hydrocarbons and metals
- Former Barnsdall Refinery – Petroleum Hydrocarbons and metals

Identified source areas

- Love Box – Chlorinated VOCs, primarily PCE
- Wichita Brass and Aluminum – Chlorinated VOCs, - 1,1,2,2-TCA
- Compressed Gases – Chlorinated VOCs, primarily 1,1,1-TCA
- Wichita Terminal Elevator – Chlorinated VOCs – CT
- Stockyard Properties 02B – Chlorinated VOCs, primarily TCE
- A&A Auto & Truck Salvage – Chlorinated VOCs, primarily TCE
- National By Products North – Chlorinated VOCs, primarily TCE
- Novick Iron – Metals (lead) and Polychlorinated Biphenyls (PCBs)
- Van Waters & Rogers (VWR) South – Chlorinated VOCs, primarily TCE

Suspect source areas

- Former John's Refinery – Petroleum Hydrocarbons and TCE
- Northern Pipeline Construction – Petroleum Hydrocarbons and TCE

The following are the Site wide groundwater compounds of concern (COCs) for GWU2 identified in **Section 1.5:**

- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- Cis-1,2-dichloroethene (*cis*-1,2-DCE)
- Vinyl Chloride (VC)
- 1,1,1-trichloroethane (1,1,1-TCA)
- 1,1-dichloroethane (1,1-DCA)
- 1,1-dichloroethene (1,1-DCE)

- Carbon Tetrachloride (CT)
- Chloroform
- Benzene

8.2 Assumptions Affecting Detailed Analysis of Remedial Alternatives

The purpose of a Feasibility Study (FS) is to evaluate remedial alternatives and present relevant information for the selection of appropriate remedies. The objectives of this FS are:

- Identify and evaluate the appropriate remedial alternatives based on the information developed and presented in the Remedial Investigation (RI) and Baseline Risk Assessment (BRA).
- Identify potential applicable relevant and appropriate requirements (ARARs), and possible general response actions, technologies, and process options
- Develop and screen remedial action alternatives that protect human health and the environment and meet the remedial action objectives for the Site.
- Evaluate remedial alternatives based on the seven criteria as described in 40 CFR 300.430 (e) (9) (iii) of the National Contingency Plan.
- Recommend the appropriate remedial alternative(s) based on a detailed analysis of the selected alternatives to the criteria discussed in **Section 6.0**.

The focus of this FS is to evaluate remedial alternatives for achieving site Remedial Action Objectives (RAOs) within the context of the physical and chemical characteristics of GWU2. This section evaluates potential remedial technologies with respect to effectiveness, implementability, and costs. The evaluation is based on the following assumptions:

- The Alternative Treatment Goals (ATGs) for TCE proposed elsewhere in this document are accepted by the regulatory agency.
- Measures have or will be implemented at source areas within GWU2 that will control migration of additional COCs into the site-wide groundwater.
- Source control measures are instituted within a reasonable time relative to the implementation of the site-wide Groundwater Remedy.
- The implementation of source area controls in GWU2 and adjacent operable units will not affect the groundwater dynamics of GWU2.
- The period of performance for the various remedial actions are calculated based upon the *flushing* of 7 formation pore volumes. This assumption is made solely for purposes of this FS in order to insure consistency within the Site-Wide FS document.

8.3 Screening of Remedial Alternatives for Groundwater Unit 2

The purpose of the GWU2 FS is to evaluate remedial measures to achieve site RAOs based on the geological, chemical and anthropogenic characteristics of GWU2. This section evaluates the remedial alternatives identified in **Section 5.0** with respect to their effectiveness, implementability, and cost.

In conducting this evaluation, the physical and chemical characteristics of GWU2 were considered. Geology, chemical, and urban modification were key components of this evaluation. Geologic characteristics include mineralogical composition of the aquifer and the spatial relationship of the various hydrostratigraphic units. Chemical characteristics include the fate and transport properties of COCs and the impact of naturally occurring compounds on achieving site RAOs. Anthropogenic characteristics include the area infrastructure (streets and highways, railroad lines, utility corridors), commercial and residential structures, and manmade structures (industrial wells, drainage canals) that may affect the hydraulic properties of the operable unit.

Consideration of the remedial alternatives identified in **Section 5.0** is not limited by the characteristics of the COCs present in GWU2. However, the physical and anthropogenic characteristics of the groundwater unit do limit the effectiveness and implementability of many of these alternatives. The following sections discuss each of the remedial alternatives to be screened and their potential applicability and effectiveness to GWU2. Each alternative is rated on a comparative basis using the rating system presented in **Section 5**.

The following retained remedial alternatives were evaluated for GWU2:

- No Action
- Plume Stability Monitoring
- Enhanced Bioremediation
- Groundwater Extraction and Treatment in various pumping configurations

Alternative GWU2-1: No Action Alternative

Subpart F of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), requires an FS to evaluate the No Action alternative. This alternative is the benchmark used to evaluate the performance of other alternatives. In this alternative, institutional controls (i.e. City prohibition of consumptive use of groundwater) remain in place with controls at source areas being implemented. Groundwater monitoring is conducted solely at areas of source remedial activities. Remediation of site-wide groundwater would be

through source area controls and attenuation processes. Periodic and systematic evaluation of site-wide groundwater would not be conducted. Therefore, improvement or degradation of groundwater quality would not be quantified, and progress towards the RAOs would not be measured. The following tables evaluate the No Action alternative under the appropriate and relevant criteria:

Alternative GWU2-1: No Action– Effectiveness Screening

Effectiveness Criteria	Evaluation Summary (score)
Overall protection of human health and the environment	• The no action alternative does not address or quantify the risks presented by the chemicals of concern in the groundwater. • Rating-0
Compliance with ARARs	• Rating -0
Short-term effectiveness (during the remedial construction and implementation period)	• The short term risks to the community are unchanged by this activity. There are no adverse affects to construction workers or the environment. • Rating-1
Long-term effectiveness and permanence (Following remedial construction)	• Future risks to human health and the environment would not be monitored and evaluated. • Rating-0.
Reduction of toxicity, mobility, or volume through treatment	• No evaluation of the reduction of toxicity, mobility, or volume of contaminants. • Rating-0.

Alternative GWU2-1: No Action – Implementability Screening

Implementability Criteria	Evaluation Summary (score)
Ability to construct, reliably operate, and meet technology-specific regulations for process options until completion of the remedial action.	• No GWU2 remedial actions are implemented • Rating-5
Ability to operate, maintain, replace and monitor technical components	• No GWU2 remedial actions implemented • Rating-5
Ability to obtain permits from other agencies	• No permits required for implementation of alternative • Rating-5
Availability and capacity of treatment, storage, and disposal facility	• No waste generated during implementation of alternative • Rating-5
Availability of property, specific material, equipment, and technical specialists required for a remedial action.	• None required for implementation of alternative • Rating-5
Overall Implementability Rating Based on Lowest Score	**5**

Alternative GWU2-1: No Action- Cost Screening

Evaluation factors for Cost	Generalized Cost (score)
Cost associated with implementation of the alternative including capital, monitoring, operation and maintenance, and closure costs	• Capital Cost: (5) – (Low) • Operation & Maintenance: 5 (Low) • Monitoring Costs: 5 (Low) • Closure Cost: 5 (Low)
Cost Rating	**5**

Screening Decision for Alternative GWU2-1: No Action

The No Action alternative will be retained as required by CERCLA to provide a baseline for comparison to other alternatives.

Alternative GWU2-2: Plume Stability Monitoring

Alternative GWU2-2 is Plume Stability Monitoring or Long Term Monitoring Optimization (LTMO) (EPA 2005). This remedy consists of the periodic collection and analysis of groundwater samples to evaluate the concentrations of COCs in a temporal and geospatial

context. This alternative assumes that source area controls are in place and effective (i.e. no COPC migration beyond the control area) within the groundwater unit. The response of the groundwater within GWU2 to the reduction of contaminant mass resulting from source area controls and other factors is the cornerstone of this remedy. After the completion of a minimum of eight sequentially spaced groundwater sampling events, a statistical analysis of the data would be conducted to evaluate groundwater contamination trends. Objectives of that would be to:

- Determine whether impacted groundwater within GWU2 is migrating.
- Monitor progress toward achieving RAOs.
- Evaluate whether the total mass of COCs in GWU2 groundwater is increasing, decreasing or stable.
- Determine if source controls and attenuation processes are achieving the RAOs and ARARs

RAOs would be accomplished by reducing the contaminant mass entering the groundwater and attenuation processes. Natural attenuation processes include various physical, chemical, and biological processes that reduce the mass, toxicity, mobility, volume, and concentrations of COCs in groundwater. These *in-situ* processes include biodegradation, dispersion, dilution, sorption, volatilization, and transformation of COCs. This alternative includes as a critical component the systematic monitoring of groundwater to evaluate if reductions in COCs are progressing towards RAOs. The implementation of Alternative GWU2-2 requires monitoring wells downgradient of the source areas and wells spatially distributed within GWU2. Groundwater samples would be collected at regular intervals for analysis of COCs.

Analysis of the historic monitoring data in GWU2 indicates dramatic decreases in the concentrations of the COCs in groundwater. Data collected as recently as the fall of 2010 establishes that the area near the southern downgradient boundary of the GWU is below the ATG for TCE and approaching the MCL. Such monitoring data, together with similar observations at the northern end of the GWU suggest that PSM may be shown to be a viable remedial alternative when a more robust data set is developed.

Alternative GWU2-2: Plume Stability Monitoring – Effectiveness Screening

Effectiveness Criteria Alternative GWU2-	Evaluation Summary (score)
Overall protection of human health and the environment	• Over time, source controls in combination with various attenuation processes will reduce contaminant levels to achieve RAOs. • Rating-3
Compliance with ARARs	• COCs are monitored and evaluated to determine effectiveness of source area controls and attenuation processes on downgradient groundwater. • Wastes generated during the installation of monitoring wells, well development and groundwater monitoring would have to be handled in compliance with action specific ARARs. • Rating-4
Short-term effectiveness (during the remedial construction and implementation period)	• Under this alternative, remedial construction would be undertaken with little or no risk to construction workers or the general public as construction activities would be conducted in compliance with a Health and Safety Plan and waste would be handled in compliance with ARARs. • Rating-4
Long-term effectiveness and permanence (Following remedial construction)	• Over time, source control in tandem with attenuation processes will decrease concentrations of COCs to achieve RAOs. • Rating-4
Reduction of toxicity, mobility, or volume through treatment	• Does not provide treatment using constructed remedial systems; source controls and attenuation processes will reduce COPC concentrations. • Rating-3

Alternative GWU2-2: Plume Stability Monitoring – Implementability Screening

Implementability Criteria	Evaluation Summary (score)
Ability to construct, reliably operate, and meet technology-specific regulations for process options until completion of the remedial action.	• The installation of monitoring wells and sampling in this type of aquifer is straightforward. • Rating-5
Ability to operate, maintain, replace and monitor technical components	• Obtaining access to private property for the installation of additional monitoring wells could be a factor in the implementation of this alternative. • Rating-5
Ability to obtain permits from other agencies	• It may be necessary to obtain access to City Right of Way(s) to install new monitoring. Securing these permits is not anticipated to be a problem. • Rating-5
Availability and capacity of treatment, storage, and disposal facility	• Limited amounts of investigative derived waste would be generated during well installation, development and sampling. • Rating-5
Availability of property, specific material, equipment, and technical specialists required for a remedial action.	• Access to private property for the installation and sampling of monitoring wells could be a factor. • Well installation, sampling and waste disposal are straightforward. • Rating-5
Overall Implementability Rating Based on Lowest Score	**5**

Alternative GWU2-2: Plume Stability Monitoring - Cost Screening

Evaluation factors for Cost	Generalized Cost (score)
Cost associated with implementation of the alternative including capital, monitoring, operation and maintenance, and closure costs	• Capital Cost: Low –(5) Low • Operation & Maintenance: – (5) Low • Monitoring Costs:–(5) Low • Closure Cost: –(5) Low
Cost Rating	**5**

Screening Decision for Alternative GWU2-2: Plume Stability Monitoring

Alternative GWU2-2, Plume Stability Monitoring, has been retained for use as a remedial action alterative in GWU2.

Alternative GWU2-3: Enhanced Bioremediation

Enhanced bioremediation is the acceleration of one component of the contaminant attenuation process. Biological de-chlorination activity is promoted by the addition of a carbon substrate that supports specific bacterial inoculums. Because chlorinated compounds are used as electron acceptors during reductive dechlorination, molecular hydrogen must be present in the subsurface. Molecular hydrogen is produced through the fermentation of carbon substrates such as carbohydrates, sugars, alcohols, volatile fatty acids (VFA), and edible oils. A bacterium obtains metabolically useful energy from reductive dechlorination; however, depending on the environment and the presence/absence of suitable microbes the process may be interrupted. During this reductive dechlorination process the chlorinated VOCs are used as an electron acceptor and a chlorine atom is removed and replaced with a hydrogen atom. Reductive dechlorination occurs by sequential dechlorination transforming TCE to DCE to VC to ethene.

The implementation of Alternative GWU2-3 would require installation of an injection well network within GWU2 to establish a barrier treatment zone. The injection of a carbon substrate utilizing the well network provides an environment conducive to anaerobic degradation of chlorinated VOCs. Based on an average groundwater velocity of 1.25 ft per day, the width of the barrier, for complete reductive dechlorination, is seventy-five feet wide parallel to groundwater movement (approximately north to south) with a length of approximately 1200-ft perpendicular to the groundwater flow direction. Pilot testing of this remedial alternative would be required prior to final system design. Based on the groundwater velocity and aquifer thickness it is assumed that reinjection would be required to maintain the effectiveness of the treatment zone. A monitoring well network would also be established to evaluate the effectiveness of Alternative GWU2-3.

Alternative GWU2-3: Enhanced Bioremediation– Effectiveness Screening

Effectiveness Criteria	Evaluation Summary (score)
Overall protection of human health and the environment	• Over time, Enhanced Bioremediation will reduce contaminant levels. • Rating-3
Compliance with ARARs	• Would comply with ARARs. Permitting for the injection of electron donor must be obtained from state agency. • Rating-4
Short-term effectiveness (during the remedial construction and implementation period)	• Limited construction activities; injection wells and additional monitoring wells would be installed. Impacted area is industrial; attenuation processes is locally occurring. • Rating-3
Long-term effectiveness and permanence (Following remedial construction)	• Over time, Enhanced Bioremediation will decrease concentrations of all COCs to acceptable health risk based levels. • Rating-4
Reduction of toxicity, mobility, or volume through treatment	• Provides a treatment component that should reduce contaminant concentrations over time. • Rating-4

Alternative GWU2-3: Enhanced Bioremediation – Implementability Screening

Implementability Criteria	Evaluation Summary (score)
Ability to construct, reliably operate, and meet technology-specific regulations for process options until completion of the remedial action.	• The implementation of bioremediation in an aquifer of this thickness and permeability creates challenges in establishing and maintaining a viable reaction zone • The application of enhanced bioremediation in this aquifer would likely require the installation of an injection well field approximately 75-feet wide and 1200-feet long to maintain the required contact time for adequate degradation. • Access to private property for the installation of additional monitoring wells could limit or delay the implementation of this alternative. • Rating-3
Ability to operate, maintain, replace and monitor technical components	• Property access for system installation and operation could be problematic. • The installation and operation of an enhanced biological system requires significant groundwater monitoring. • Rating-3
Ability to obtain permits from other agencies	• Permits may be required for the installation of shallow monitoring wells and wells in high traffic areas in GWU2. • Injection permits would be required prior to implementation. Permits are not anticipated to be a problem. • Rating-3
Availability and capacity of treatment, storage, and disposal facility	• Limited amounts of waste would be generated during well installation, development and sampling. • Rating-3
Availability of property, specific material, equipment, and technical specialists required for a remedial action.	• Access to private property for the installation and operation of the injection system could be problematic. • Well installation, sampling and waste disposal is straightforward. • Rating-2
Overall Implementability Rating Based on Lowest Score	**2**

Alternative GWU2-3: Enhanced Bioremediation - Cost Screening

Evaluation factors for Cost	Generalized Cost (score
Cost associated with implementation of the alternative including capital, monitoring, operation and maintenance, and closure costs	• Capital Cost: (3) Moderate • Operation & Maintenance: (5) Low • Monitoring Costs: (4) Low • Closure Cost: Medium (4) Low
Cost Rating	**3**

Screening Decision for Alternative GWU2-3: Enhanced Bioremediation

Enhanced bioremediation as a remedial option for GWU2 meets the requirements for effectiveness. However, implementation of this alternative within GWU2 may be difficult based on factors such as property access and aquifer characteristics. Some of the recent literature on this subject also indicates that Enhanced Bioremediation may not be effective at low COC concentrations such as exist in GWU2. Given the rapidly diminishing concentrations in GWU2, this may adversely impact the implementability of this technology. Cost for this alternative is also high. Therefore Alternative GWU2-3 was not retained for further evaluation.

Alternative GWU2-4 (a & b): Groundwater Extraction and Treatment

This alternative includes two potential groundwater extraction and treatment scenarios. Alternative GWU2-4a consists of a single groundwater extraction well. Alternative GWU2-4b adds a second groundwater withdrawal well to the remediation system. In both cases the groundwater extraction alternative utilizes vertical extraction wells to control the migration of, and to remove COCs from, impacted groundwater. Recovered groundwater is treated *ex-situ* using air stripping and subsequently discharged to nearby waterways in accordance with appropriate permits.

Prior to designing the final groundwater extraction and treatment system, testing would be required to determine influent COPC concentrations, total suspended solids (TSS), presence of inorganic compounds and to evaluate pretreatment options. It is anticipated that treated water would be discharged to the Chisholm Creek via a National Pollutant Discharge Elimination System (NPDES) permit. Permitting may be required for treatment system air discharges depending upon groundwater concentrations and pumping rates.

The implementation of Alternative GWU2-4 (a & b) would require the installation of groundwater extraction well(s), the construction of remediation compounds for the system controls and air stripper, and the installation of the system's influent and effluent piping. Based on the current system operating at the Coleman Operable Unit site within GWU2 and the groundwater model constructed for the Site (***Appendix E***), the assumed recovery rate for

a groundwater extraction and treatment system is approximately 150 gallons per minute for scenario 4a and 200 gallons per minute for scenario 4b. A monitoring well network would also be established to evaluate the effectiveness of Alternative GWU2-4(a & b) in GWU2 in attaining the RAOs.

Alternative GWU2-4 (a & b): Groundwater Extraction and Treatment – Effectiveness Screening

Effectiveness Criteria	Evaluation Summary (score)
Overall protection of human health and the environment	• COCs in groundwater would be contained and treated prior to discharge. • Discharge monitoring would be required. • Rating-4
Compliance with ARARs	• Remedial action would be completed by control and removal of COCs in groundwater. • COCs are monitored and evaluated to determine effectiveness of controls on the groundwater within GWU2. • Wastes generated during the installation of monitoring wells, well development and groundwater monitoring would have to be handled in compliance with action specific ARARs. • Rating-4
Short-term effectiveness (during the remedial construction and implementation period)	• Under this alternative, remedial construction workers would be exposed to limited risk from contact with groundwater. Activities would be conducted in compliance with the Health and Safety Plan and waste would be handled in compliance with ARARs. • Rating-4
Long-term effectiveness and permanence (Following remedial construction)	• COCs removed from groundwater through physical processes. • The removal and treatment of COC concentrations has permanence. • Rating-4
Reduction of toxicity, mobility, or volume through treatment	• Mobility would be controlled by the formation of a groundwater capture zone. • Reduction of the volume of COCs would be measurable. • Rating-4

Alternative GWU2-4 (a & b): Groundwater Extraction and Treatment – Implementability Screening

Implementability Criteria	Evaluation Summary (score)
Ability to construct, reliably operate, and meet technology-specific regulations for process options until completion of the remedial action.	• Based on systems already operating in GWU2, groundwater containment at the evaluated well location(s)could be established utilizing a pumping rate of 150 gpm • Groundwater recovery systems are reliable and should meet the regulatory requirements for GWU2. • Rating-4
Ability to operate, maintain, replace and monitor technical components	• Access to private property for the installation of additional monitoring and recovery wells may be problematic. • Technical components are readily available. • The installation and operation of a groundwater recovery and treatment system requires a moderate level of monitoring for optimal system operation. • Rating-4
Ability to obtain permits from other agencies	• Permits could be required for the installation of monitoring wells. • Groundwater recovery would require the approval of a term permit for groundwater withdrawal. • A discharge permit NPDES, or City POTW would be required for the treated water. • Permits are not anticipated to be a problem. • Rating-4
Availability and capacity of treatment, storage, and disposal facility	• Limited amounts of waste would be generated during well installation, development, and sampling. • Rating-5
Availability of property, specific material, equipment, and technical specialists required for a remedial action.	• Access to private property for the installation of remediation system and system piping could create delays in implementation. • Well installation, sampling, and waste disposal are straightforward. • Technical specialist availability not a concern. • Rating-4
Based upon lowest value	**4**

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Alternative GWU2-4 (a & b): Groundwater Extraction and Treatment - Cost Screening

Evaluation factors for Cost	Generalized Cost (High-Medium-Low)
Cost associated with implementation of the alternative including capital, monitoring, operation and maintenance, and closure costs	• Capital Cost: 3 - Medium • Operation & Maintenance 3-Medium • Monitoring Costs: 4 - Low • Closure Cost: 4 - Low
Cost Rating	**3**

Screening Decision for Alternative GWU2-4 (a & b): Groundwater Extraction and Treatment
Alternative GWU2-4 (a & b) satisfies the effectiveness and implementability screening for the use of this remedial alternative in GWU2. Groundwater extraction and treatment can be implemented at a moderate cost level. Groundwater extraction using vertical extraction wells and air stripping is retained for further consideration.

8.4 Remedial Alternatives Retained for GWU2

The next level of analysis of remedial alternatives is designed to provide decision makers with adequate information to select a response action. The objective of this analysis is to select an appropriate remedial action alternative capable of reducing contaminant concentrations, eliminating potential exposure pathways, and achieving cleanup goals in an acceptable time frame in a cost effective and safe manner.

Once again, it is critical to note that for the purposes of evaluating remedial alternatives, it is assumed that all source area controls are in place and operating effectively. Potential deficiencies in the assumed source control system are not addressed in this analysis. Rather, responsible parties and the appropriate regulating agency are assumed to have achieved adequate control of all sources requiring response actions.

CERCLA regulatory guidance requires the evaluation of remedial alternatives that are retained after the initial screening process. The following remedial alternatives have been retained for further evaluation in GWU2:

- Alternative GWU2-1 – No Action
- Alternative GWU2-2 – Plume Stability Monitoring; including:
  - Institutional Controls
  - Groundwater Monitoring
  - Evaluation of plume dynamics including, migration, contaminant mass reduction and progress towards achieving RAOs

- Alternative GWU2-4 (a & b) – Groundwater Extraction and Treatment; including:
  - Institutional Controls
  - Groundwater Monitoring
  - Vertical Extraction Well(s)
  - Air Stripping
  - Treated Water Discharge
  - Evaluation of plume dynamics including, migration, contaminant mass reduction and progress towards the RAOs

8.5 Alternative GWU2-1 – No Action

The No Action Alternative is the benchmark used to evaluate the performance of other alternatives. In this alternative, institutional controls remain in place and controls are implemented at source areas. Groundwater monitoring is conducted solely at the source areas. Improvement of GWU2 groundwater quality would be achieved through source control measures and attenuation. Monitoring of impacted GWU2 groundwater is not conducted; therefore, any improvement or further degradation of water quality is not quantified.

The evaluation of Alternative GWU2-1, No Action, using the seven regulatory criteria is presented above. The cost estimate for implementing the alternative is included in ***Appendix F***. The comparative total Net Present Value (NPV) cost for Alternative GWU2-1 is **$0**.

8.6 Alternative GWU2-2 – Plume Stability Monitoring

Alternative GWU2-2, Plume Stability Monitoring, includes the collection and analysis of groundwater samples to evaluate the concentrations of COCs within impacted areas of GWU2 in a temporal and geospatial context. A key component of Alternative GWU2-2 is monitoring of the progress of GWU2 source area remedial actions and contaminant attenuation processes in achieving the RAOs. Rigorous evaluation of the response of impacted groundwater within GWU2 to the reduction of contaminant mass resulting from remediation of source areas is the cornerstone of this remedy.

Plume stability monitoring requires a robust and valid data set. After the completion of a minimum of eight sequentially spaced groundwater sampling events over the course of two years, a statistical analysis of the groundwater data would be conducted to evaluate trends. Objectives of this evaluation would be to:

- Determine whether impacted groundwater within GWU2 is migrating.

- Evaluate whether the total mass of COCs in GWU2 groundwater is increasing, decreasing or stable.
- Determine whether the implemented source control measures are effective.
- Determine whether impacted groundwater within GWU2 is progressing towards the achievement of RAOs.

Implementation of Alternative GWU2-2 requires monitoring wells downgradient of source controls and additional wells distributed within GWU2. Based on a review of the current monitoring well network, additional monitoring wells would be required to develop an adequate network for this alternative. The proposed monitoring wells would provide groundwater quality data for the COCs at the leading edge of and within the plume. For costing purposes, an additional five deep and shallow monitoring well clusters is assumed.

To minimize waste generation and associated disposal costs, groundwater sampling will be performed using a HydraSleeve passive sampler placed within the screened sections of the monitoring wells. Groundwater samples would be submitted to a State of Kansas approved laboratory for analysis of COCs according to USEPA Method 8260. Groundwater quality measurements would be collected in the field using a down well meter equipped to collect dissolved oxygen (DO), pH, conductivity, oxidation reduction potential (Eh), and temperature.

The evaluation of the monitoring well data would include analysis of plume stability and a projection of the time needed to attain the RAOs. Long Term Monitoring Optimization thus includes the collection of groundwater samples from an established monitoring well network and the statistical analysis of contaminant concentrations over time to evaluate the effectiveness of the remedial actions. Containment flux would also be analyzed using a currently available computer based program such as Natural Attenuation Software (NAS) to determine the time-of-remediation.

Groundwater monitoring would be conducted on a quarterly basis for five years to establish and evaluate trends in the data set. A statistical analysis would be conducted annually after the completion of eight sampling events to evaluate whether concentrations of COCs are stable, decreasing, or increasing within GWU2. This analysis provides a mechanism that would identify plume conditions, identify data gaps in the monitoring network and track the effectiveness of source control measures relative to impacted groundwater trends. This alternative would include preparation of reports on a semi-annual basis for the first five years, with modifications to that schedule anticipated over time. For costing purposes, it was estimated that groundwater samples would be collected from all monitoring locations quarterly for the first five years and semi-annually for the following five years of the remedial action. Annual monitoring would be performed for the subsequent 40 year period,

for a total of 50 years of groundwater monitoring. Surface water samples would be collected and analyzed for VOCs semi-annually during normal and low flow stream conditions of Chisholm Creek for 10 years, and annually during normal or low-flow stream conditions for the subsequent 40 years.

In summary, Alternative GWU2-2 activities and deliverables would consist of the following:

- Preparation of a Monitoring Well Installation Plan.
- Development of a Groundwater Sampling and Analysis Work Plan.
- Preparation of a Statistical Analysis Plan.
- Installation of five additional groundwater monitoring well clusters (deep and shallow).
- Quarterly sampling of 25 deep and shallow monitoring points for five years, with semi-annual sampling for the next five years, followed by annual sampling for an additional 40 years. This schedule may be modified by the statistical analysis discussed above. The location and number of monitoring wells included in this Alternative would be evaluated on an annual basis and adjusted as the impacted groundwater within GWU2 reduces in area.
- Semi-annual monitoring of two surface water locations for 10 years followed by annual monitoring from year 11 to year 50.
- Semi-annual reports would be submitted for the first five years, with annual reporting for the following 45 years.

The cost estimate for implementing the alternative is attached. System installation costs for this alternative are $66,527. The present value total costs for lifetime operation and maintenance, for a fifty year period of implementation, are $1,348,199. The fifty year duration of the remedial activity was developed using data and information specific to GWU2. In general, this Feasibility Study Report incorporates an estimate of the time required to achieve site RAOs/ARARs based on the number of pore volumes exchanged within a given GMU. Solely for the purpose of achieving consistency within this Report as a whole, seven formation pore volumes is utilized as the assumed volume of water required to achieve the RAOs. In fact, the formation pore volumes required to achieve RAOs with respect to impacted groundwater in GWU2 is likely less than seven. Information developed during the RD process will thus presumably support a different pore volume assumption.

8.7 Alternative GWU2-4 (a & b) – Groundwater Extraction and Treatment

The Groundwater Extraction and Treatment Alternative GWU2-4a involves the installation of one vertical groundwater recovery well south of 21st Street North (NIC 2-1 on Figure 9-1) operating at a nominal flow rate of 150 gpm. The objective is to control the migration of groundwater impacted with VOCs above ATG levels up-gradient of the Van Waters and Rogers South facility. Recovered groundwater would be treated ex-situ using an air-stripper with the discharge directed to Chisholm Creek, under a NPDES permit. This alternative also includes the continuation of source and institutional controls, groundwater monitoring, and plume stability monitoring as detailed in ***Section 8.6***.

One groundwater recovery well would be installed on the downgradient edge of the GWU2 plume. This system would be used to provide both mass removal and hydraulic control of contaminant migration in the deep and shallow portions of the aquifer. The groundwater extraction system is expected to operate for a period of 42 years. ***Appendix E*** presents the results of the NIC Site groundwater model particle tracking for this recovery well.

Groundwater Extraction and Treatment Alternative GWU2-4b would consist of the installation of one vertical groundwater recovery well south of 21st Street North (NIC 2-1) and the installation of a second recovery well located near 19th and Mosley (NIC 2-2, Figure 10-1). The combined flow rates of these wells would be 200 gpm. The objective is to control the migration of groundwater impacted above ATG levels both up-gradient and down-gradient of the Van Waters and Rogers South facility, Recovered groundwater would be treated ex-situ using an air-stripper with the discharge directed to Chisholm Creek, under a NPDES permit. This alternative also includes the continuation of source and institutional controls, groundwater monitoring, and plume stability monitoring as discussed in ***Section 8.6***.

This groundwater extraction and treatment system would be used to provide both mass removal and hydraulic control of contaminant migration in the deep and shallow portions of the aquifer. The groundwater extraction system is expected to operate for a period of 42 years. However, the NIC 2-2 well would operate for only 28 years.

A pre-design data acquisition study would be conducted in the area of the proposed recovery well(s) to evaluate hydraulic conductivity, influent concentrations, and groundwater quality. This data would be used to optimize the design of the recovery well(s) and treatment system. For the cost analysis, a fully penetrating groundwater extraction well and a packed-column type air stripper have been assumed. Groundwater would be pumped to the packed-column air-stripper for treatment prior to discharge to Chisholm Creek via underground piping. Effluent samples would be collected on a monthly basis for VOCs and total suspended solids, and quarterly for total residual copper, chlorides, and sulfate.

The monitoring well network for this system consists of the wells described in Alternative GWU2-2 with the addition of a performance monitoring well couplet located down gradient of the recovery system. The monitoring program would be evaluated, and monitoring points modified, based on statistical analysis as concentrations in the plume change over time and if changes in the groundwater flow regime are encountered.

In summary, Alternative GWU2-4 (a & b) activities and deliverables would generally consist of the following:

- Preparation of a Groundwater Extraction Pre-Design Data Acquisition (PDDA) Work Plan.
- Preparation of a Groundwater Monitoring Work Plan.
- Preparation of a Statistical Analysis Plan.
- Preparation of a System Design and Project Implementation Plan.
- Submittal of results of the PDDA study for approval of discharge via a NPDES Permit.
- Design submittal for recovery well and treatment system.
- Installation of groundwater extraction system.
- Operation and maintenance of the groundwater extraction system including electrical use, equipment replacement, effluent sampling and laboratory analysis.
- Quarterly sampling of 50 monitoring points for five years, with semi-annual sampling for the next five years, followed by annual sampling for 32 years. The location and number of monitoring wells included in this alternative would be evaluated on an annual basis and adjusted as the impacted groundwater within GWU2 decreases in size.
- Monthly NPDES reporting and preparation of semi-annual monitoring reports for five years, with annual monitoring reports being submitted to the completion of the project, estimated at 42 years.
- Abandonment of monitoring well network, groundwater recovery well, and associated piping.

The evaluation of Alternative GWU2-4a, Groundwater Extraction and Treatment, against the seven regulatory criteria is presented above. Detailed costs are attached. System installation costs for Alternative 4a (one recovery well) are $419,832. The total present value costs for lifetime operation and maintenance, assuming a 42 year period of remediation, are $3,501,076. Alternative GWU2-4b (two recovery wells), costs are estimated as follows: system installation costs in the amount of $839,665.Total present value costs for lifetime operation and maintenance are of $5,150,041

8.8 Additional Selection Factors

Additional NCP factors are considered in the evaluation and selection of the final remedial action. These factors relate to the acceptance of alternative remedies by the regulating agency and the general public. In accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988), these considerations (regulatory and community acceptance) are not included in this evaluation, as agency and public comments have not yet been received.

An overview of these factors is included in this evaluation.

8.8.1 State (Support Agency) Acceptance

The following assumptions were made with respect to regulatory acceptance:

- Alternative GWU2-2, Plume Stability Monitoring, utilizes remedial actions at source areas and attenuation processes to reduce the volume, toxicity, and mobility of COCs presently impacting the groundwater in GWU2. The assumption of source control is based upon KDHEs' requirement that individual sources within the NIC Site be addressed through the CI/CAS (or equivalent) process. The source groundwater monitoring program would allow KDHE to evaluate these remedial actions and identify any potential risks of residual contamination. The agency's statements to date, however, suggest that Plume Stability Monitoring would not likely be approved as the sole remedy for GMU2 due to the limited existing data set supporting the effectiveness of that remedy. Of course, the collection of additional data through the PDDA and groundwater monitoring activities may well provide the additional data needed to consider Plume Stability Monitoring as a potential sole remedy for GMU2.

- Alternative GWU2-4 (a & b), Groundwater Extraction and Treatment, includes an "active" groundwater remediation component to facilitate reducing the volume and toxicity of COCs in GWU2. The groundwater monitoring program would provide for evaluation of the GWU2 remedial actions, identify any potential risk of residual contamination, and if required, provide relevant information to evaluate possible additional remedial actions. Based on the general acceptance of this alternative to achieve groundwater RAOs and protect human health and the environment, it is assumed that the regulatory agency would find this alternative acceptable.

8.8.2 Community Acceptance

The following assumptions were made with respect to community acceptance:

- Alternative GWU2-2, Plume Stability Monitoring, utilizes source remediation and attenuation processes to achieve a reduction of the volume, toxicity, and mobility of

COCs in GWU2. As this alternative reduces risks associated with impacted groundwater over time and incorporates monitoring that will facilitate determining whether additional remedial actions are warranted, it is assumed that this alternative would be met with community acceptance.

- Alternative GWU2-4 (a & b), Groundwater Extraction and Treatment, utilizes an established remedial technology in combination with source controls and attenuation processes to achieve containment of impacted groundwater and a reduction of the volume and toxicity of COCs in GWU2. As this alternative reduces risks associated with impacted groundwater over time and incorporates monitoring that will facilitate determining whether additional remedial actions are warranted it is assumed that this alternative would be met with community acceptance.

8.9 Comparative Analysis of Alternatives

A comparison of the retained remedial alternatives is presented below. As noted, each criterion was evaluated based on whether it satisfied, partially satisfied, or did not satisfy the criteria. Numerical values were assigned as previously determined in the screening evaluation.

Summary of Criteria Evaluation

Evaluation Criteria	Alternative GWU2-1 No Action	Alternative GWU2-2 Plume Stability Monitoring	Alternative GWU2-4 (a&b) Groundwater Extraction and Treatment
Overall Protection of Human Health and the Environment	0	3	4
Compliance with ARARs	0	4	4
Long Term Effectiveness and Permanence	0	4	4
Reduction of Toxicity, Mobility or Volume through treatment	0	3	4.
Short Term Effectiveness	1	4	3
Implementability	5	5	4
Cost	5	5	4
Totals	11	28	27

Qualitative Analysis

In addition to the quantitative analysis set forth above, the three retained remedial action alternatives were compared using a qualitative evaluation. The alternatives were evaluated according to the criterion discussed in **Section 6.0**:

- Threshold factors:
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Primary balancing factors:
  - Short-term effectiveness
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume through treatment
  - Implementability
  - Cost

8.9.1 Overall Protection of Human Health and the Environment

Alternative GWU2-1, No Action, does not satisfy the criteria for the protection of human health and the environment. Under this alternative, short and long term reduction of COCs would be attained through source control measures and attenuation processes. Institutional controls would be protective of human health by eliminating the use of groundwater as a potable water source. However, without a formal monitoring program it would not be possible to verify whether the no action remedy is protective of the environment.

Alternative GWU2-2, Plume Stability Monitoring, satisfies the threshold factor of overall protection of human health and the environment. Under this alternative, short and long term reduction of COCs would be attained through source control measures and attenuation processes. Institutional controls would protect human health by eliminating the use of groundwater as a potable water source. The groundwater monitoring component of this alternative would provide a mechanism for evaluating plume concentrations and dynamics and provide the information needed to determine whether additional remedial actions are warranted.

Alternative GWU2-4 (a & b), Groundwater Extraction and Treatment, satisfies the threshold factor of overall protection of human health and the environment. Under this alternative, short and long term reduction of COCs would be attained through source control measures, attenuation processes and the removal of COCs from the aquifer through groundwater extraction and treatment. Institutional controls would protect human health by eliminating the use of groundwater as a potable water source. Properly implemented hydraulic controls would prevent migration of the impacted groundwater. The groundwater monitoring component of this alternative would provide a mechanism for evaluating plume concentrations and dynamics and provide the information needed to determine whether additional remedial actions are warranted.

8.9.2 Compliance with ARARs

Alternative GWU2-1 does not satisfy the criteria for the compliance with chemical specific ARARs, as progress toward the RAOs cannot be measured. Action specific ARARs are not applicable to this alternative.

Alternatives GWU2-2 and GWU2-4(a&b) satisfy the criteria for chemical specific ARARs. The action specific, and site specific, ARARs would also be satisfied.

8.9.3 Short Term Effectiveness (In the Construction Phase)

Alternative GWU2-1 satisfies the criteria for short term effectiveness. Remedial actions are not undertaken. This results in no risks during construction to either workers or the general public from construction related activities.

Alternatives GWU2-2 and GWU2-4(a&b) satisfy these criteria. The alternatives involve drilling into contaminated groundwater to install groundwater monitoring or recovery wells and perform groundwater sampling. Risks to both workers and the general public are manageable through site specific health and safety plans.

8.9.4 Long-Term Effectiveness and Permanence

Alternative GWU2-1 does not satisfy this criterion. Remedial actions at source areas would be implemented to address COCs, but groundwater concentrations and the impact of the source remedial actions on impacted groundwater within GWU2 would not be quantified.

Alternatives GWU2-2 and GWU2-4(a&b) implement the remediation of source areas and impacted groundwater within GWU2. Both alternatives provide mechanisms to evaluate impacted groundwater and evaluate progress towards the RAOs in GWU2.

8.9.5 Reduction of Toxicity, Mobility and Volume

Alternative GWU2-1 does not satisfy the criteria for verifiable reduction of the toxicity, mobility, and volume of the COCs in the groundwater within GWU2. Source remediation would either remove or destroy COCs at source areas. Reduction of the contaminant flux into the GWU2 groundwater system would also reduce contaminant mass within the GWU2 groundwater plume. Attenuation processes and source controls would reduce toxicity. However, these remediation processes would not be documented.

Alternative GWU2-2, Plume Stability Monitoring, may satisfy the criteria for the reduction of the toxicity and volume of the COCs in groundwater within GWU2. Source remediation would either remove or destroy COCs at source areas. Reduction of the contaminant flux into the GWU2 groundwater system would also reduce contaminant mass within the GWU2 groundwater plume. Attenuation processes and source controls may reduce toxicity. Alternative GWU2-2 would also incorporate groundwater monitoring and mechanisms for evaluating the effectiveness of this remedy.

Alternative GWU2-4 (a & b), Groundwater Extraction and Treatment, satisfies the criteria for reduction of toxicity and volume of the COCs in groundwater within GWU2. Groundwater withdrawal and *ex-situ* treatment reduces volume and mobility. Source remediation would either remove or destroy COCs in the groundwater at source areas. Reduction of the contaminant flux into the GWU2 groundwater system would also reduce contaminant mass within the GWU2 groundwater plume. Attenuation processes and source controls would further reduce toxicity either by transformation or destruction of a given chemical.

8.9.6 Implementability

Each retained alternative can be implemented using proven technologies. The installation of the monitoring well system in Alternatives GWU2-2 and GWU2-4(a&b) may be complicated by potential access issues. Similarly, the installation and operation of the groundwater recovery system could be impacted by access issues. Alternative GWU2-4(a&b) would also require a Pre-Design Data Acquisition study to insure that the groundwater extraction well(s) are designed and located to optimize plume containment.

8.9.7 Cost

The total present-value cost for Alternative GWU2-1 (No Action) is $0. However, this alternative is not likely to be acceptable to the regulatory agency or the community. The total present-value cost for Alternative GWU2-2 (Plume Stability Monitoring) is $1,348,195. The Alternative GWU2-4a (single groundwater extraction well and treatment system) present-value cost is $3,636,547. Alternative GWU2-4b (two groundwater extraction wells and recovery system) has a present value cost of $5,150,041.

Summary

Although Alternative GWU2-2 and GWU2-4 scored nearly identically using the various criteria required by the National Contingency Plan, (NCP), the KDHE has articulated in various meetings and correspondence that Plume Stability Monitoring is not presently a viable standalone remedy for GWU2. The reason stated for the agency's position is the alleged lack of an adequate data set demonstrating progress towards achieving the RAOs. The NCP requires monitoring of the progress of a given site towards achieving site RAOs and if reasonable progress is not achieved, an identified contingency plan will be implemented. Overall, the evaluation presented in this Section and NCP requirements support the adoption of GWU2-2 (Plume Stability Monitoring) as the preferred remedial alternative, with the contingency of implementing GWU2-4a should adequate progress toward achieving site RAOs not be demonstrated through performance evaluation monitoring.

However, because of KDHE's stated unwillingness to accept Plume Stability Monitoring as a standalone remedy due to the lack of sufficient data demonstrating the effectiveness of the remedy, the single groundwater extraction well and treatment system, with source area remediation and control, plume stability monitoring and institutional controls (GWU2-4a), is presently the recommended remedial alternative for GWU2.

As discussed above, however, recently collected data shows that the concentrations of the COCs within GWU2 are rapidly decreasing due to the impact of source controls and attenuation processes. As no comprehensive well sampling has occurred for almost five years, it can reasonably be assumed based on the observed trend that groundwater

concentrations have decreased even more significantly within GWU2. Groundwater monitoring pursuant to a KDHE source area consent agreement in the vicinity of the Van Waters and Rogers South site in GWU2 clearly reflects this trend. Specifically, groundwater concentrations at Van Waters and Rogers (in the southern portion of GWU2) that exceeded the ATG for TCE in monitoring wells in 2007 are now well below the ATG and approaching the MCLs. Similar significant decreases in TCE concentrations have been documented in the northern portion of GWU2 as a result of source control and attenuation processes.

Prior to final design submittal for GWU2, therefore, it is necessary that current plume concentrations and dynamics be determined in order to re-evaluate as may be appropriate the recommended remedial alternative. As part of remedial design data acquisition, additional monitoring wells should be installed to augment the current well network. Periodic sampling and analysis of this expanded monitoring well network should be performed concurrently with other design data acquisition tasks. Information and data obtained through these remedial design data acquisition efforts will be incorporated into the remedial design analysis to further evaluate and refine as necessary the remedial alternative being recommended at this time, optimize the remedial efforts and more accurately project the time required to achieve the RAOs.

In summary, recommended Alternative GWU2-4a:

- Satisfies both threshold evaluation factors.
- Involves easily manageable risks to on-site workers during installation.
- Incorporates a mechanism to evaluate COC groundwater concentrations and plume dynamics to measure progress toward achieving the RAOs.
- Includes an “active” groundwater extraction and treatment system that augments the rapid decrease in COC concentrations already occurring in GWU2 as a result of source area controls and attenuation processes.
- Provides a mechanism for the cost effective evaluation of remedial action progress and the ability to identify data gaps in the monitoring program and/or possible need for additional remedial action requirements to satisfy the RAOs.
- Incorporates a groundwater extraction and treatment approach that is a feasible and proven technology.

References

EPA May 2005; *Roadmap to Long-Term Monitoring Optimization*, EPA 542-R-05-003, May 2005

Cost Analysis

Cost Analysis
No Action
Alternative 1
GWU2

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
INSTITUTIONAL CONTROLS				n/c	

Cost Analysis
Plume Stability Monitoring
Alternative 2
GWU2

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
MONITORING WELL INSTALLATION					
.					
Direct Capital Cost					
Equipment & Subcontractor Costs					
Monitoring well (10)	400	ft	$ 85	$ 34,000	2" PVC, 5 @ 30' and 5 @ 50'
Work Plans	2	each	$ 5,000	$ 10,000	
Contingency - Direct Capital Costs	15%			$ 5,100	
Subtotal - Direct Capital Costs				$ 49,100	
Indirect Costs					
Well installation					Estimated Time: 8 days
Geologist	60	hrs	$ 82	$ 4,925	
Truck	6	days	$ 45	$ 270	
Mileage	240	miles	$ 0.60	$ 144	
Equipment for well development	1		$ 1,000	$ 1,000	
Engineering	10%			$ 5,544	
Project Management	10%			$ 5,544	
Subtotal - Indirect Capital Costs				$ 17,427	
ESTIMATED INSTALLATION COSTS				**$ 66,527**	
SEMI-ANNUAL MONITORING COSTS (Years 1 thu 5)					
Direct Capital Costs					
Analytical Laboratory VOCs	236	each	$ 100	$ 23,600	50 monitoring wells - quaterly sampling
Reporting	2	each	$ 10,000	$ 20,000	Semi-annual reporting
Contingency - Direct Capital Costs	15%			$6,540	
Subtotal - Direct Capital Costs				$ 50,140	
Indirect Costs					
Technician	260	hrs	$ 51	$ 13,309	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 6,574	
Project Management	10%			$ 6,574	
Subtotal - Indirect Capital Costs				$ 28,746	
ESTIMATED MONITORING COSTS (cost per year)				**$ 78,886**	

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
SEMI-ANNUAL MONITORING COSTS (Years 6 thru 10)					
Direct Capital Costs					
Analytical Laboratory VOCs	118	each	$ 100	$ 11,800	50 monitoring wells - semi-annual sampling
Reporting	2	each	$ 10,000	$ 20,000	Semi-annual reporting
Contingency - Direct Capital Costs	15%			$4,770	
Subtotal - Direct Capital Costs				$ 36,570	
Indirect Costs					
Technician	130	hrs	$ 51	$ 6,655	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 4,551	
Project Management	10%			$ 4,551	
Subtotal - Indirect Capital Costs				$ 18,046	
ESTIMATED MONITORING COSTS (cost per year)				**$ 54,616**	
SEMI-ANNUAL MONITORING COSTS (Years 11 thru 50)					
Direct Capital Costs					
Analytical Laboratory VOCs	59	each	$ 100	$ 5,900	50 monitoring wells - annual sampling
Reporting	1	each	$ 10,000	$ 10,000	Annual reporting
Contingency - Direct Capital Costs	15%			$2,385	
Subtotal - Direct Capital Costs				$ 18,285	
Indirect Costs					
Technician	65	hrs	$ 51	$ 3,327	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 2,390	
Project Management	10%			$ 2,390	
Subtotal - Indirect Capital Costs				$ 10,396	
ESTIMATED MONITORING COSTS (cost per year)				**$ 28,681**	
SYSTEM CLOSURE					
Plug and abandon monitoring wells	2000	feet	$ 10	$ 20,000	50 monitoring wells
Project Management	10%			$ 2,000	
ESTIMATED CLOSURE COST				**$ 22,000**	

Cost Analysis
Groundwater Extraction and Treatment
GWU2
Alternative 4A Well NIC 2-1

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
SYSTEM INSTALLATION					
Direct Capital Cost					
Equipment & Subcontractor Costs					
Recovery well	50	ft	$ 125	$ 6,250	6" PVC, 1 @ 50'
Monitoring well	400	ft	$ 85	$ 34,000	2" PVC, 5 @ 30' and 5 @ 50'
Work Plans	1	ea	$ 50,000	$ 50,000	
Groundwater pump	1		$ 3,500	$ 3,500	130 gpm
Air stripper & controls	1		$ 125,000	$ 125,000	
Groundwater influent line	300	ft	$ 30	$ 9,000	
Concrete pad	1		$ 2,500	$ 2,500	
Crane	1		$ 2,100	$ 2,100	
Set & anchor stripper	1		$ 1,850	$ 1,850	
Construction equipment	1		$ 5,800	$ 5,800	
Electrical	1		$ 5,000	$ 5,000	
Construction mobilization/demobilization	1		$ 1,000	$ 1,000	
Construction per diem	10	days	$ 300	$ 3,000	3 man crew
Pre-treat water equipment	1		$ 1,000	$ 1,000	
Water use permits	1	permit	$ 300	$ 300	
NPDES Permit	1	permit	$ 500	$ 500	
Building permit	1		$ 3,800	$ 3,800	
Recovery well head enclosure	1		$ 1,500	$ 1,500	
Discharge Line	200	ft	$ 30	$ 6,000	
Contingency - Direct Capital Costs	15%			$ 39,315	
Subtotal - Direct Capital Costs				$ 301,415	
Indirect Costs					
Well installation					
Geologist	330	hrs	$ 82	$ 27,086	
Truck	35	days	$ 45	$ 1,575	
Mileage	1200	miles	$ 0.60	$ 720	
Equipment for well development	10		$ 1,000	$ 10,000	
System Installation					
Field Engineer	100	hrs	$ 84	$ 8,374	
Truck	10	days	$ 45	$ 450	
Mileage	400	miles	$ 0.60	$ 240	
Engineering	10%			$ 34,986	
Project Management	10%			$ 34,986	
Subtotal - Indirect Costs				$ 118,417	
ESTIMATED INSTALLATION COSTS				**$ 419,832**	
SYSTEM START-UP					Estimated time: 1 day
Direct Capital Costs					
Electrician	10	hrs	$ 75	$ 750	
Laboratory	2	samples	$ 100	$ 200	
Contingency - Direct Capital Costs	15%			$ 143	
Subtotal - Direct Capital Costs				$ 1,093	
Indirect Costs					
Technician	10	hrs	$ 51	$ 512	
Environmental Engineer	2	hrs	$ 87	$ 174	
Truck	1	day	$ 45	$ 45	
Mileage	40	miles	$ 0.60	$ 24	
Miscellaneous				$ 500	
Engineering	10%			$ 235	
Project Management	10%			$ 235	
Subtotal - Indirect Costs				$ 1,255	
ESTIMATED START-UP COSTS				**$ 2,347**	

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
ANNUAL (O&M) COSTS (42 years)					
Direct Capital Costs					
Electrical	1		$ 19,800	$ 19,800	
Phone service for teledialer	12	mo	$ 100	$ 1,200	
Recovery well service repair and replacement	1		$ 1,000	$ 1,000	
Monitoring well service repair and replacement	1		$ 2,000	$ 2,000	
Motive equipment repair & replacement	1		$ 3,000	$ 3,000	
Water pre-treatment	1		$ 9,800	$ 9,800	
Electrician	24	hrs	$ 75	$ 1,800	
Laboratory	24	samples	$ 100	$ 2,400	
Contingency - Direct Capital Costs	15%			$ 6,150	
Subtotal - Direct Capital Costs				$ 47,150	
Indirect Costs					
Technician	96	hrs	$ 51	$ 4,914	
Environmental Engineer	12	hrs	$ 87	$ 1,044	
Truck	12	days	$ 45	$ 540	
Mileage	480	miles	$ 0.60	$ 288	
Engineering	10%			$ 5,394	
Project Management	10%			$ 5,394	
Subtotal - Indirect Costs				$ 17,573	
ESTIMATED ANNUAL O&M COSTS				**$ 64,723**	
QUARTERLY MONITORING COSTS (Years 1 thu 5)					
Direct Capital Costs					
Analytical Laboratory VOCs	236	each	$ 100	$ 23,600	50 monitoring wells - quaterly sampling
Reporting	2	each	$ 10,000	$ 20,000	Semi-annual reporting
Contingency - Direct Capital Costs	15%			$6,540	
Subtotal - Direct Capital Costs				$ 50,140	
Indirect Costs					
Technician	260	hrs	$ 51	$ 13,309	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 6,574	
Project Management	10%			$ 6,574	
Subtotal - IndirectCosts				$ 28,746	
ESTIMATED MONITORING COSTS (cost per year)				**$ 78,886**	

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
SEMI-ANNUAL MONITORING COSTS (Years 6 thru 10)					
Direct Capital Costs					
Analytical Laboratory VOCs	118	each	$ 100	$ 11,800	50 monitoring wells - semi-annual sampling
Reporting	2	each	$ 10,000	$ 20,000	Semi-annual reporting
Contingency - Direct Capital Costs	15%			$4,770	
Subtotal - Direct Capital Costs				$ 36,570	
Indirect Costs					
Technician	130	hrs	$ 51	$ 6,655	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 4,551	
Project Management	10%			$ 4,551	
Subtotal - Indirect Costs				$ 18,046	
ESTIMATED MONITORING COSTS (cost per year)				**$ 54,616**	
ANNUAL MONITORING COSTS (Years 11 thru 42)					
Direct Capital Costs					
Analytical Laboratory VOCs	59	each	$ 100	$ 5,900	50 monitoring wells - annual sampling
Reporting	1	each	$ 10,000	$ 10,000	Annual reporting
Contingency - Direct Capital Costs	15%			$2,385	
Subtotal - Direct Capital Costs				$ 18,285	
Indirect Costs					
Technician	65	hrs	$ 51	$ 3,327	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 2,390	
Project Management	10%			$ 2,390	
Subtotal - Indirect Costs				$ 10,396	
ESTIMATED MONITORING COSTS (cost per year)				**$ 28,681**	
SYSTEM CLOSURE					
Plug and abandon monitoring wells	2500	feet	$ 10	$ 25,000	50 monitoring wells - 50 feet TD
Abandon recovery well	50	feet	$ 25	$ 1,250	
Abandon horizontal system piping	500	feet	$ 6	$ 3,000	
Remediation equipment and misc				$ 41,983	
Project Management	10%			**$ 6,698**	
ESTIMATED CLOSURE COST				**$ 77,932**	

Cost Analysis
Groundwater Extraction and Treatment
GWU2
Alternative 4b
Wells NIC 2-1 ad NIC 2-2

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
SYSTEM INSTALLATION					
Direct Capital Cost					
Equipment & Subcontractor Costs					
Recovery well	100	ft	$ 125	$ 12,500	6" PVC, 2 @ 50'
Monitoring well	800	ft	$ 85	$ 68,000	2" PVC, 10 @ 30' and 10 @ 50'
Work Plans	2	ea	$ 50,000	$ 100,000	
Groundwater pump	2		$ 3,500	$ 7,000	1@50 gpm and 1@130 gpm
Air stripper & controls	2		$ 125,000	$ 250,000	
Groundwater influent line	600	ft	$ 30	$ 18,000	
Concrete pad	2		$ 2,500	$ 5,000	
Crane	2		$ 2,100	$ 4,200	
Set & anchor stripper	2		$ 1,850	$ 3,700	
Construction equipment	2		$ 5,800	$ 11,600	
Electrical	2		$ 5,000	$ 10,000	
Construction mobilization/demobilization	2		$ 1,000	$ 2,000	
Construction per diem	20	days	$ 300	$ 6,000	3 man crew
Pre-treat water equipment	2		$ 1,000	$ 2,000	
Water use permits	2	permit	$ 300	$ 600	
NPDES Permit	2	permit	$ 500	$ 1,000	
Building permit	2		$ 3,800	$ 7,600	
Recovery well head enclosure	2		$ 1,500	$ 3,000	
Discharge Line	400	ft	$ 30	$ 12,000	
Contingency - Direct Capital Costs	15%			$ 78,630	
Subtotal - Direct Capital Costs				$ 602,830	
Indirect Costs					
Well installation					
Geologist	660	hrs	$ 82	$ 54,173	
Truck	70	days	$ 45	$ 3,150	
Mileage	2400	miles	$ 0.60	$ 1,440	
Equipment for well development	20		$ 1,000	$ 20,000	
System Installation					
Field Engineer	200	hrs	$ 84	$ 16,748	
Truck	20	days	$ 45	$ 900	
Mileage	800	miles	$ 0.60	$ 480	
Engineering	10%			$ 69,972	
Project Management	10%			$ 69,972	
Subtotal - IndirectCosts				$ 236,835	
ESTIMATED INSTALLATION COSTS				**$ 839,665**	
SYSTEM START-UP					Estimated time: 1 day per system
Direct Capital Costs					
Electrician	20	hrs	$ 75	$ 1,500	
Laboratory	4	samples	$ 100	$ 400	
Contingency - Direct Capital Costs	15%			$ 285	
Subtotal - Direct Capital Costs				$ 2,185	
Indirect Costs					
Technician	20	hrs	$ 51	$ 1,024	
Environmental Engineer	4	hrs	$ 87	$ 348	
Truck	2	day	$ 45	$ 90	
Mileage	80	miles	$ 0.60	$ 48	
Miscellaneous				$ 1,000	
Engineering	10%			$ 469	
Project Management	10%			$ 469	
Subtotal - Indirect Capital Costs				$ 2,510	
ESTIMATED START-UP COSTS				**$ 4,695**	

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
ANNUAL (O&M) COSTS (Years 1 thru 28))					
Direct Capital Costs					
Electrical	2		$ 15,000	$ 30,000	
Phone service for teledialer	24	mo	$ 100	$ 2,400	
Recovery well service repair and replacement	2		$ 1,000	$ 2,000	
Monitoring well service repair and replacement	2		$ 2,000	$ 4,000	
Motive equipment repair & replacement	2		$ 3,000	$ 6,000	
Water pre-treatment	2		$ 9,800	$ 19,600	
Electrician	48	hrs	$ 75	$ 3,600	
Laboratory	48	samples	$ 100	$ 4,800	
Contingency - Direct Capital Costs	15%			$ 10,860	
Subtotal - Direct Capital Costs				$ 83,260	
Indirect Costs					
Technician	196	hrs	$ 51	$ 10,033	
Environmental Engineer	24	hrs	$ 87	$ 2,088	
Truck	24	days	$ 45	$ 1,080	
Mileage	960	miles	$ 0.60	$ 576	
Engineering	10%			$ 9,704	
Project Management	10%			$ 9,704	
Subtotal - Indirect Capital Costs				$ 33,184	
ESTIMATED ANNUAL O&M COSTS				**$ 116,444**	
ANNUAL (O&M) COSTS (Years 29 thru 42)					
Direct Capital Costs					
Electrical	1		$ 19,800	$ 19,800	
Phone service for teledialer	12	mo	$ 100	$ 1,200	
Recovery well service repair and replacement	1		$ 1,000	$ 1,000	
Monitoring well service repair and replacement	1		$ 2,000	$ 2,000	
Motive equipment repair & replacement	1		$ 3,000	$ 3,000	
Water pre-treatment	1		$ 9,800	$ 9,800	
Electrician	24	hrs	$ 75	$ 1,800	
Laboratory	24	samples	$ 100	$ 2,400	
Contingency - Direct Capital Costs	15%			$ 6,150	
Subtotal - Direct Capital Costs				$ 47,150	
Indirect Costs					
Technician	96	hrs	$ 51	$ 4,914	
Environmental Engineer	12	hrs	$ 87	$ 1,044	
Truck	12	days	$ 45	$ 540	
Mileage	480	miles	$ 0.60	$ 288	
Engineering	10%			$ 5,394	
Project Management	10%			$ 5,394	
Subtotal - Indirect Costs				$ 17,573	
ESTIMATED ANNUAL O&M COSTS				**$ 64,723**	
QUARTERLY MONITORING COSTS (Years 1 thru 5)					
Direct Capital Costs					
Analytical Laboratory VOCs	236	each	$ 100	$ 23,600	50 monitoring wells - quaterly sampling
Reporting	2	each	$ 10,000	$ 20,000	Semi-annual reporting
Contingency - Direct Capital Costs	15%			$6,540	
Subtotal - Direct Capital Costs				$ 50,140	
Indirect Capital Costs					
Shaw Environmental					
Technician	260	hrs	$ 51	$ 13,309	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 6,574	
Project Management	10%			$ 6,574	
Subtotal - Indirect Capital Costs				$ 28,746	
ESTIMATED MONITORING COSTS (cost per year)				**$ 78,886**	

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Assumptions
SEMI-ANNUAL MONITORING COSTS (Years 6 thru 10)					
Direct Capital Costs					
Analytical Laboratory VOCs	118	each	$ 100	$ 11,800	50 monitoring wells - semi-annual sampling
Reporting	2	each	$ 10,000	$ 20,000	Semi-annual reporting
Contingency - Direct Capital Costs	15%			$4,770	
Subtotal - Direct Capital Costs				$ 36,570	
Indirect Capital Costs					
Shaw Environmental					
Technician	130	hrs	$ 51	$ 6,655	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 4,551	
Project Management	10%			$ 4,551	
Subtotal - Indirect Capital Costs				$ 18,046	
ESTIMATED MONITORING COSTS (cost per year)				**$ 54,616**	
ANNUAL MONITORING COSTS (Years 11 thru 42)					
Direct Capital Costs					
Analytical Laboratory VOCs	59	each	$ 100	$ 5,900	50 monitoring wells - annual sampling
Reporting	1	each	$ 10,000	$ 10,000	Annual reporting
Contingency - Direct Capital Costs	15%			$2,385	
Subtotal - Direct Capital Costs				$ 18,285	
Indirect Capital Costs					
Shaw Environmental					
Technician	65	hrs	$ 51	$ 3,327	
Environmentnal Engineer	16	hrs	$ 87	$ 1,392	
Truck	13	days	$ 45	$ 585	
Mileage	520	miles	$ 0.60	$ 312	
Engineering	10%			$ 2,390	
Project Management	10%			$ 2,390	
Subtotal - Indirect Capital Costs				$ 10,396	
ESTIMATED MONITORING COSTS (cost per year)				**$ 28,681**	
SYSTEM CLOSURE					
Plug and abandon monitoring wells	2500	feet	$ 10	$ 25,000	50 monitoring wells - 50 feet TD
Abandon recovery well	100	feet	$ 25	$ 2,500	
Abandon horizontal system piping	1000	feet	$ 6	$ 6,000	
Remediation equipment and misc				$ 83,966	
Project Management	10%			**$ 10,897**	
ESTIMATED CLOSURE COST				**$ 128,363**	

Cost Analysis Summary
North Industrial Corridor GWU2

		Installation	GW Mon Yrs 1-5	GW Mon Yrs 6-10	GW Mon Yrs 11-30/34/42	System Start-up	System O&M	Closure	**Total**	**Present Value**
Alternative 1	No Action	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -
Alternative 2	Plume Stability Monitoring	$ 66,527	$ 394,429	$ 273,081	$ 1,147,257	$ -	$ -	$ 22,000	**$ 1,903,294**	$1,348,195
Alternative 4a	Groundwater Extraction and Treatment	$ 419,832	$ 394,429	$ 273,081	$ 889,124	$ 2,347	$ 2,718,380	$ 77,932	**$ 4,775,127**	$3,501,076
Alternative 4b	Groundwater Extraction and Treatment 2 Wells	$ 839,665	$ 394,429	$ 273,081	$ 889,124	$ 4,695	$ 3,260,443	$ 128,363	**$ 5,789,801**	$5,150,041

Plume Stability Monitoring
Alternative 2
GWU2

Task	Unit Cost	Unit	Number	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18
Monitoring Well Installation																					
Direct Capital Costs	$49,100	unit	1	$ 49,100																	
Indirect Costs	$17,427	unit	1	$ 17,427																	
Semi Annual Monitoring (Years 1-5)																					
Direct Capital Costs	$50,140	unit	1	$50,140	$50,140	$50,140	$50,140	$50,140													
Indirect Costs	$28,746	unit	1	$28,746	$28,746	$28,746	$28,746	$28,746													
Semi Annual Monitoring (Years 6-10)																					
Direct Capital Costs	$36,510	unit	1	$0	$0	$0	$0	$0	$36,510	$36,510	$36,510	$36,510	$36,510								
Indirect Costs	$18,046	unit	1	$0	$0	$0	$0	$0	$18,046	$18,046	$18,046	$18,046	$18,046								
Annual Monitoring (Years 11-50)																					
Direct Capital Costs	$18,285	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285
Indirect Costs	$10,396	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396
System Closure	$22,000	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

NPV 2% = (3% Inflation with 5% Discount)

Plume Stability Monitoring
Alternative 2
GWU2

Task	Yr 19	Yr 20	Yr 21	Yr 22	Yr 23	Yr 24	Yr 25	Yr 26	Yr 27	Yr 28	Yr 29	Yr 30	Yr 31	Yr 32	Yr 33	Yr 34	Yr 35	Yr 36	Yr 37	Yr 38
Monitoring Well Installation																				
Direct Capital Costs																				
Indirect Costs																				
Semi Annual Monitoring (Years 1-5)																				
Direct Capital Costs																				
Indirect Costs																				
Semi Annual Monitoring (Years 6-10)																				
Direct Capital Costs																				
Indirect Costs																				
Annual Monitoring (Years 11-50)																				
Direct Capital Costs	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285
Indirect Costs	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396
System Closure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

NPV 2% = (3% Inflation with 5% Discou

Plume Stability Monitoring
Alternative 2
GWU2

Task	Yr 39	Yr 40	Yr 41	Yr 42	Yr 43	Yr 44	Yr 45	Yr 46	Yr 47	Yr 48	Yr 49	Yr 50	Net Present Value (2%)
Monitoring Well Installation													
Direct Capital Costs													$49,100
Indirect Costs													$17,427
Semi Annual Monitoring (Years 1-5)													
Direct Capital Costs													$241,060
Indirect Costs													$138,203
Semi Annual Monitoring (Years 6-10)													
Direct Capital Costs													$158,983
Indirect Costs													$78,581
Annual Monitoring (Years 11-50)													
Direct Capital Costs	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$418,541
Indirect Costs	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$237,963
System Closure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$22,000	$8,337
													$1,348,195

NPV 2% = (3% Inflation with 5% Discou

-30%	Present Value	+50%
$943,736	$1,348,195	$2,022,292

Groundwater Extraction and Treatment
Alternative 4a
Well NIC 2-1

Task	Unit Cost	Unit	Number	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13
System Installation																
Direct Capital Costs	$301,415	unit	1	$ 301,415												
Indirect Costs	$118,417	unit	1	$ 118,417												
System Start-Up																
Direct Capital Costs	$1,093	unit	1	$ 1,093												
Indirect Costs	$1,255	unit	1	$ 1,255												
Annual Operation & Maintenance																
Direct Capital Costs	$47,150	unit	1	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150
Indirect Costs	$17,573	unit	1	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573
Quarterly Monitoring (Years 1-5)																
Direct Capital Costs	$50,140	unit	1	$50,140	$50,140	$50,140	$50,140	$50,140								
Indirect Costs	$28,746	unit	1	$28,746	$28,746	$28,746	$28,746	$28,746								
Semi Annual Monitoring (Years 6-10)																
Direct Capital Costs	$36,570	unit	1	$0	$0	$0	$0	$0	$36,570	$36,570	$36,570	$36,570	$36,570			
Indirect Costs	$18,046	unit	1	$0	$0	$0	$0	$0	$18,046	$18,046	$18,046	$18,046	$18,046			
Annual Monitoring (Years 11-42)																
Direct Capital Costs	$18,285	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$18,285	$18,285	$18,285
Indirect Costs	$10,396	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,396	$10,396	$10,396
System Closure	$77,932	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

NPV 2% = (3% Inflation with 5% Discount)

Groundwater Extraction and Tr
Alternative 4a
Well NIC 2-1

Task	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20	Yr 21	Yr 22	Yr 23	Yr 24	Yr 25	Yr 26	Yr 27	Yr 28
System Installation															
Direct Capital Costs															
Indirect Costs															
System Start-Up															
Direct Capital Costs															
Indirect Costs															
Annual Operation & Maintenance															
Direct Capital Costs	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150
Indirect Costs	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573
Quarterly Monitoring (Years 1-5)															
Direct Capital Costs															
Indirect Costs															
Semi Annual Monitoring (Years 6-10)															
Direct Capital Costs															
Indirect Costs															
Annual Monitoring (Years 11-42)															
Direct Capital Costs	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285
Indirect Costs	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396
System Closure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

NPV 2% = (3% Inflation with 5% Discou

Groundwater Extraction and Tr
Alternative 4a
Well NIC 2-1

Task	Yr 29	Yr 30	Yr 31	Yr 32	Yr 33	Yr 34	Yr 35	Yr 36	Yr 37	Yr 38	Yr 39	Yr 40	Yr 41	Yr 42	Net Present Value (2%)
System Installation															
Direct Capital Costs															$301,415
Indirect Costs															$118,417
System Start-Up															
Direct Capital Costs															$1,093
Indirect Costs															$1,255
Annual Operation & Maintenance															
Direct Capital Costs	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$1,357,896
Indirect Costs	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$506,093
Quarterly Monitoring (Years 1-5)															
Direct Capital Costs															$241,060
Indirect Costs															$138,203
Semi Annual Monitoring (Years 6-10)															
Direct Capital Costs															$159,244
Indirect Costs															$78,581
Annual Monitoring (Years 11-42)															
Direct Capital Costs	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$359,067
Indirect Costs	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$204,149
System Closure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$77,932	$34,603
															$3,501,076

NPV 2% = (3% Inflation with 5% Discou

-30%	Present Worth	+50%
$2,450,753	$3,501,076	$5,251,614

Groundwater Extraction and Treatment
Alternative 4b
Wells NIC 2-1 and NIC 2-2

Task	Unit Cost	Unit	Number	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13
System Installation																
Direct Capital Costs	$602,830	unit	1	$602,830												
Indirect Costs	$236,835	unit	1	$236,835												
System Start-Up																
Direct Capital Costs	$2,185	unit	1	$2,185												
Indirect Costs	$2,510	unit	1	$2,510												
Annual O & M (Years 1 thru 28)																
Direct Capital Costs	$83,260	unit	1	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260
Indirect Costs	$33,184	unit	1	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184
Annual O & M (Years 29 thru 42)																
Direct Capital Costs	$47,150	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Indirect Costs	$17,573	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Quarterly Monitoring (Years 1-5)																
Direct Capital Costs	$50,140	unit	1	$50,140	$50,140	$50,140	$50,140	$50,140								
Indirect Costs	$28,746	unit	1	$28,746	$28,746	$28,746	$28,746	$28,746								
Semi Annual Monitoring (Years 6-10)																
Direct Capital Costs	$36,570	unit	1	$0	$0	$0	$0	$0	$50,140	$50,140	$50,140	$50,140	$50,140			
Indirect Costs	$18,046	unit	1	$0	$0	$0	$0	$0	$28,746	$28,746	$28,746	$28,746	$28,746			
Annual Monitoring (Years 11-42)																
Direct Capital Costs	$18,285	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$18,285	$18,285	$18,285
Indirect Costs	$10,396	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,396	$10,396	$10,396
System Closure	$128,363	unit	1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

NPV 2% = (3% Inflation with 5% Discount)

Groundwater Extraction and Tr
Alternative 4b
Wells NIC 2-1 and NIC 2-2

Task	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20	Yr 21	Yr 22	Yr 23	Yr 24	Yr 25	Yr 26	Yr 27	Yr 28	Yr 29
System Installation																
Direct Capital Costs																
Indirect Costs																
System Start-Up																
Direct Capital Costs																
Indirect Costs																
Annual O & M (Years 1 thru 28)																
Direct Capital Costs	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	$83,260	
Indirect Costs	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	$33,184	
Annual O & M (Years 29 thru 42)																
Direct Capital Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$47,150
Indirect Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$17,573
Quarterly Monitoring (Years 1-5)																
Direct Capital Costs																
Indirect Costs																
Semi Annual Monitoring (Years 6-10)																
Direct Capital Costs																
Indirect Costs																
Annual Monitoring (Years 11-42)																
Direct Capital Costs	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285
Indirect Costs	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396
System Closure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

NPV 2% = (3% Inflation with 5% Discou

Groundwater Extraction and Tr
Alternative 4b
Wells NIC 2-1 and NIC 2-2

Task	Yr 30	Yr 31
System Installation		
Direct Capital Costs		
Indirect Costs		
System Start-Up		
Direct Capital Costs		
Indirect Costs		
Annual O & M (Years 1 thru 28)		
Direct Capital Costs		
Indirect Costs		
Annual O & M (Years 29 thru 42)		
Direct Capital Costs	$47,150	$47,150
Indirect Costs	$17,573	$17,573
Quarterly Monitoring (Years 1-5)		
Direct Capital Costs		
Indirect Costs		
Semi Annual Monitoring (Years 6-10)		
Direct Capital Costs		
Indirect Costs		
Annual Monitoring (Years 11-42)		
Direct Capital Costs	$18,285	$18,285
Indirect Costs	$10,396	$10,396
System Closure	$0	$0

NPV 2% = (3% Inflation with 5% Discou

Present Value
OU-2
Groundwater Extraction and Treatment
Alternative 3

Groundwater Extraction and Tr
Alternative 4b
Wells NIC 2-1 and NIC 2-2

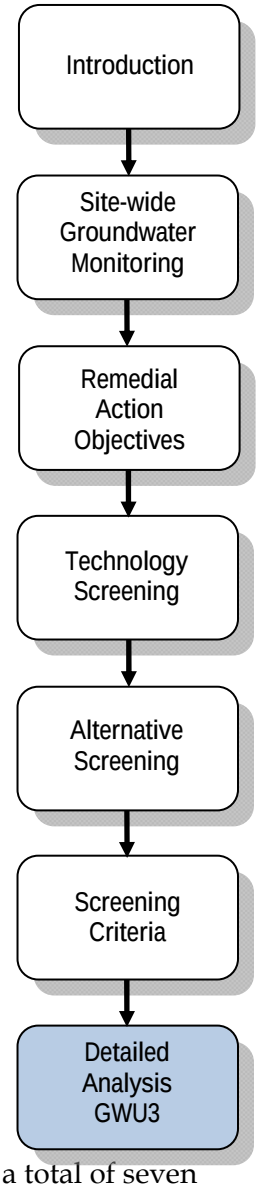
Task	Yr 32	Yr 33	Yr 34	Yr 35	Yr 36	Yr 37	Yr 38	Yr 39	Yr 40	Yr 41	Yr 42	Net Present Value (2%)
System Installation												
Direct Capital Costs												$602,830
Indirect Costs												$236,835
System Start-Up												
Direct Capital Costs												$2,185
Indirect Costs												$2,510
Annual O & M (Years 1 thru 28)												
Direct Capital Costs												$1,807,316
Indirect Costs												$720,322
Annual O & M (Years 29 thru 42)												
Direct Capital Costs	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$47,150	$334,416
Indirect Costs	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$17,573	$124,638
Quarterly Monitoring (Years 1-5)												
Direct Capital Costs												$241,060
Indirect Costs												$138,203
Semi Annual Monitoring (Years 6-10)												
Direct Capital Costs												$218,335
Indirect Costs												$125,175
Annual Monitoring (Years 11-42)												
Direct Capital Costs	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$18,285	$359,067
Indirect Costs	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$10,396	$204,149
System Closure	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$74,324	$33,001
												$5,150,041

NPV 2% = (3% Inflation with 5% Discou

-30%	Present Worth	+50%
$3,605,028	**$5,150,041**	$7,725,061

Section 9
Detailed Analysis of Retained Alternatives – Groundwater Unit 3

Alternatives retained in Section 5 for GWU3 undergo detailed analysis in this section. During detailed analysis, each retained alternative is assessed using the two threshold and five balancing criteria presented in Section 6.0. The results of the detailed analysis for each retained alternative are arrayed to perform a comparative analysis, identifying key tradeoffs between alternatives. The detailed analyses for retained alternatives for GWU3 are presented below.



9.1 Secondary Assumptions Affecting Detailed Analysis of Remedial Alternatives

Fundamental assumptions for all remedial alternatives used during alternative development and screening were presented in Section 5. There are, however, also numerous secondary assumptions that affect the detailed analysis of alternatives even though these assumptions are not fundamental controlling considerations. These assumptions are driven mainly by site limitations and constraints that cannot be overcome by using one or more retained remedial technology/process options as described in Section 4. Secondary assumptions affecting the detailed analysis of remedial alternatives for GWU3 include:

- Source control measures are assumed to be implemented at all significantly active source areas for Alternatives GWU3-2, GWU3-3, GWU3-4, and GWU3-5.

- Based on the groundwater modeling report for GWU3 (**Appendix F**), with an active pumping treatment system consisting of two extraction wells near the NIC southern boundary (Alternatives GWU3-2 and GWU3-3), plus either one in-plume extraction well (Alternative GWU3-4) or three to five in-plume extraction wells (Alternative GWU3-5), the contaminant plume would require a total of approximately 70 years of O&M to capture the upgradient groundwater plume for a total of seven flushing volumes. It is assumed that seven flushing volumes, combined with natural attenuation effects will reduce the contaminant plume to concentrations below MCLs.

- Because the duration time of 70 years was identified for the groundwater extraction alternatives GWU3-2 and GWU3-3, this time frame was also selected for the No Action alternative (GWU3-1) as well.

- The actual number of groundwater monitoring wells to be installed and established as part of the performance assessment and monitoring program for the selected alternative will be determined during the remedial design phase. However, a number of wells for assessment and monitoring was estimated for each alternative for costing purposes in this FS.

9.2 Remedial Alternatives Retained for GWU3

The following alternatives were retained for detailed analysis for GWU3:

- Alternative GWU3-1 – No Action;
- Alternative GWU3-2 – Groundwater Extraction (Containment Only) and Discharge after Treatment at the Gilbert-Mosley GWTP;
- Alternative GWU3-3 – Groundwater Extraction (Containment Only), New Treatment Plant, and Discharge to Chisholm Creek;
- Alternative GWU3-4 – Groundwater Extraction (Containment and Interior Extraction), Treatment at Either the Gilbert-Mosley Treatment Plant or a New Treatment Plant, and Discharge; and
- Alternative GWU3-5 – Groundwater Extraction (Containment and Interior Extraction (Additional Wells)), Treatment at Either the Gilbert-Mosley Treatment Plant or a New Treatment Plant, and Discharge.

9.3 Alternative GWU3-1 – No Action

9.3.1 Alternative Component Description

The No Action alternative is required by the NCP to provide a baseline set of conditions against which other remedial actions may be compared. This alternative allows a site to remain in its current state with no remedial actions being implemented outside of separate source control efforts performed by responsible parties; these source controls are not considered for this FS. There would be no change in groundwater contaminant concentrations aside from that which occurs naturally because no treatment, containment, or removal of contaminated groundwater is included in this alternative. Existing water well ordinances, however, would still be enforced and existing institutional controls would be maintained.

Although no remedial action or monitoring is required for this alternative per EPA guidance (EPA 1989), the KDHE currently has a Settlement Agreement with the City for the NIC Site. Due to the Settlement Agreement, therefore, the No Action alternative for this FS includes limited groundwater monitoring of GWU3 and five-year site reviews. For the NIC Site, this includes groundwater monitoring at 10 well pairs located throughout GWU3.

Sampling and analysis would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 60 years* to monitor the extent of groundwater contamination. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination is not treated, contained, or removed in this alternative. Abandonment of monitoring wells is assumed to occur at the end of the *period of performance of 70 years*.

9.3.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU3-1 as determined against criteria factors is provided in **Table D-GWU3-1A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment; however, since no treatment, containment, or removal of contaminated GWU3 groundwater is included in this alternative, this criterion is not met. The overall rating for Alternative GWU3-1 is none (⓪).

9.3.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU3-1 as determined against criteria factors is provided in **Table D-GWU3-1B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU3-1 against this criterion is none, primarily because concentrations in GWU3 groundwater exceed federal drinking water standards and KDHE Tier 2 action limits (⓪).

9.3. 4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU3-1 as determined against criteria factors is provided in **Table D-GWU3-1C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment; however, other short-term risks to the community are unchanged by this alternative because no treatment, containment, or removal of GWU3 contaminated groundwater is performed and the time-frame for monitoring is essentially open-ended. This criterion is therefore not met by Alternative GWU3-1 and the overall rating for is therefore none (⓪).

9.3.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU3-1 as determined against criteria factors is provided in **Table D-GWU3-1D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary;

however, no containment or removal of contaminated GWU3 groundwater is included in this alternative. Treatment relies on natural attenuation processes and the time required to complete this remedy is expected to exceed the 30 years used as a standard basis for alternative life. This criterion is therefore not met by this alternative and the overall rating for Alternative GWU3-1 is therefore none (⓪).

9.3.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU3-1 as determined against criteria factors is provided in **Table D-GWU3-1E** of **Appendix D**. This alternative does not provide for a GWU3 treatment component outside of natural attenuation which may result in incomplete degradation of chlorinated solvents. In addition, this alternative does not provide for containment or removal of contaminated GWU3 groundwater and therefore does not satisfy the preference for treatment as a principal element of the remedial action. This criterion is not met by this alternative. The overall rating for Alternative GWU3-1 is none (⓪).

9.3.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU3-1F** of **Appendix D**. Groundwater monitoring and maintenance of existing water well ordinances and institutional controls is easily implementable. The overall rating for Alternative GWU3-1 against this criterion is therefore high (❺).

9.3.8 Cost

Evaluation of cost for Alternative GWU3-1 along with a summary breakdown of cost components is provided in **Table D-GWU3-1G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU3-1 against this criterion is low to moderate (**$$**).

9.4 Alternative GWU3-2 – Groundwater Extraction (Containment Only), Discharge after Treatment at the Gilbert-Mosley GWTP

9.4.1 Alternative Component Description

Containment of the GWU3 plume would be achieved through operation of two extraction wells installed near the leading edge of the plume. The new extraction wells would be a 10-inch diameter wells, screened from approximately 10 to 40 ft bgs. Based on groundwater modeling, the extraction wells would need to have a collective estimated pumping rate of 205 gpm (one at 140 gpm and one at 65 gpm) to provide sufficient capture of the groundwater contaminant plume. As noted in Section 9.2 and discussed further in **Appendix F**, one of the extraction wells would operate for a period of 70 years (NIC#3-2), the other extraction well would operate for a period of

56 years (NIC#3-1). Extracted groundwater from these wells would be conveyed to the GilMo GWTP by connecting to a newly installed 8-inch pipe on Santa Fe Street. The majority of the new pipe would be installed with directional boring to reduce road resurfacing and impact to traffic. Extraction well and piping locations assumed for costing purposes under this alternative are shown on **Figure 9-1**. This alternative assumes that pipe jacking would be required in two locations. Extracted groundwater would then be treated through an air stripper system at the GilMo GWTP. The treated groundwater would be discharged to the Arkansas River.

This alternative also assumes ongoing operation of the existing Coleman Downtown pumping wells (RW-5, RW-6, and RW-7). In the event that Coleman shuts down these three pumping wells (with KDHE approval) before the upgradient groundwater reaches levels less than the MCLs, a contingency extraction well may be installed in the vicinity of Santa Fe and 2nd Street (NIC#3-7) to provide ongoing containment.

GilMo GWTP O&M costs proportional to the expected flow rate from GWU3 are included under this alternative. Costs for O&M of the GilMo GWTP were based on historically incurred costs. O&M of the extraction wells was included for this alternative. It was assumed the extraction wells would require annual development.

For purposes of the detailed analysis it was assumed the extraction well pumps would require replacement every five years. Additionally it was assumed that components of the GilMo GWTP would be replaced every 30 years. The cost for the replacement of the GilMo GWTP components was proportional to the expected flow rate from GWU3 compared to the total system flow rate. This cost was based on a previous replacement estimate prepared for the GilMo Site.

Sampling and analysis at 42 wells throughout the GWU3 groundwater plume would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 60 years* to monitor the effectiveness of the groundwater containment system. Sampling and analysis would also include two surface water monitoring locations. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of monitoring and extraction wells is assumed to occur at the end of the *period of performance of 70 years*. Decommissioning of the GilMo GWTP was not included in this alternative.

9.4.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU3-2 as determined against criteria factors is provided in **Table D-GWU3-2A** of **Appendix D**. The existing water well ordinances and institutional controls provide

some protection for public health and the environment. In addition, treatment, containment, or removal of GWU3 contaminated groundwater is performed. The overall rating for Alternative GWU3-2 is moderate to high (❹).

9.4.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU3-2 as determined against criteria factors is provided in **Table D-GWU3-2B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU3-2 against this criterion is moderate to high (❹).

9.4.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU3-2 as determined against criteria factors is provided in **Table D-GWU3-2C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU3 contaminated groundwater is performed. The overall rating for Alternative GWU3-2 against this criterion is therefore moderate to high (❹).

9.4.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU3-2 as determined against criteria factors is provided in **Table D-GWU3-2D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary. Treatment, containment, or removal of GWU3 contaminated groundwater is performed; however, the operational duration is greater than the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU3-2 against this criterion is moderate to high (❹).

9.4.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU3-2 as determined against criteria factors is provided in **Table D-GWU3-2E** of **Appendix D**. This alternative provides for a GWU3 treatment component, provides for containment or removal of contaminated GWU3 groundwater, and therefore satisfies the preference for treatment as a principal element of the remedial action. However, because only groundwater extracted for containment of the plume is treated, the overall rating for Alternative GWU3-2 is moderate (❸).

9.4.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU3-2F** of **Appendix D**. Groundwater monitoring, extraction well O&M, and maintenance of existing water well ordinances and

institutional controls is readily implementable. The overall rating for Alternative GWU3-2 against this criterion is therefore moderate to high (❹).

9.4.8 Cost

Evaluation of cost for Alternative GWU3-2 along with a summary breakdown of cost components is provided in **Table D-GWU3-2G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU3-2 against this criterion is low to moderate to high (**$$$$**).

9.5 Alternative GWU3-3 – Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Chisholm Creek

9.5.1 Alternative Component Description

Alternative GWU3-3 provides the same containment as Alternative GWU3-2; however, under GWU3-3, groundwater pumped from the two extraction wells would be piped to a new GWTP constructed within GWU3 instead of being conveyed to the GilMo GWTP. Extraction well and piping locations assumed for costing purposes under this alternative are shown on **Figure 9-1**. Most of the new pipe would be installed by directional boring to reduce road resurfacing and impact to traffic. The new GWU3 GWTP would consist of an air stripper unit; treated water would be discharged to Chisholm Creek. The GWU3 GWTP is assumed to be located on City-owned property.

O&M of the GWU3 GWTP and extraction wells was included under this alternative. It was assumed the extraction wells would require annual development. For purposes of the detailed analysis it was assumed the extraction well pumps would require replacement every five years. Additionally, components of the GWU3 treatment system would be replaced every 30 years.

Sampling and analysis at 42 wells throughout the GWU3 groundwater plume would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 60 years* to monitor the effectiveness of the groundwater containment system. Sampling and analysis would also include two surface water monitoring locations. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of monitoring and extraction wells is assumed to occur at the end of the *period of performance of 70 years*. Decommissioning of the GWU3 GWTP is included in this alternative.

9.5.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU3-3 as determined against criteria factors is provided in **Table D-GWU3-3A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU3 contaminated groundwater is performed. The overall rating for Alternative GWU3-3 is moderate to high (❹).

9.5.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU3-3 as determined against criteria factors is provided in **Table D-GWU3-3B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU3-3 against this criterion is moderate to high (❹).

9.5.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU3-3 as determined against criteria factors is provided in **Table D-GWU3-3C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU3 contaminated groundwater is performed. The overall rating for Alternative GWU3-3 against this criterion is therefore moderate to high (❹).

9.5.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU3-3 as determined against criteria factors is provided in **Table D-GWU3-3D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary. Treatment, containment, or removal of GWU3 contaminated groundwater is performed; however, the operational duration is greater than the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU3-3 against this criterion is moderate to high (❹).

9.5.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU3-3 as determined against criteria factors is provided in **Table D-GWU3-3E** of **Appendix D**. This alternative provides for a GWU3 treatment component, provides for containment or removal of contaminated GWU3 groundwater, and therefore satisfies the preference for treatment as a principal element of the remedial action. However, because only groundwater extracted for containment of the plume is treated, the overall rating for Alternative GWU3-3 is moderate (❸).

9.5.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU3-3F** of **Appendix D**. Groundwater monitoring, extraction well O&M, and maintenance of existing water well ordinances and institutional controls is readily implementable. The overall rating for Alternative GWU3-3 against this criterion is therefore moderate to high (❹).

9.5.8 Cost

Evaluation of cost for Alternative GWU3-3 along with a summary breakdown of cost components is provided in **Table D-GWU3-3G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU3-3 against this criterion is moderate to high (**$$$$**).

9.6 Alternative GWU3-4 – Groundwater Extraction (Containment and Interior Extraction), Treatment at Either the Gilbert-Mosley GWTP or a New Treatment Plant, and Discharge

9.6.1 Alternative Component Description

Alternative GWU3-4 provides the same leading edge containment as Alternative GWU3-2 including conveyance of extracted groundwater to the GilMo GWTP for treatment; however, Alternative GWU3-4 also provides additional treatment via one in-plume extraction well. Groundwater from the in-plume extraction well would be piped to a new GWTP constructed within GWU3. The new GWU3 GWTP would consist of an air stripper unit; treated water would be discharged to Chisholm Creek. Most of the new pipe would be installed by directional boring to reduce road resurfacing and impact to traffic. The GWU3 GWTP is assumed to be located on City-owned property. Extraction well and piping locations assumed for costing purposes under this alternative are shown on **Figure 9-1**.

Under Alternative GWU3-4, one of the leading edge extraction wells would pump at 140 gpm (NIC#3-1) and be expected to operate for 56 years and the other leading edge extraction well (NIC#3-2) would pump at 65 gpm and be expected to operate for 70 years. The in-plume extraction well (NIC#3-3A) would pump at 110 gpm and be expected to operate for 70 years. GilMo GWTP O&M costs proportional to the expected flow rate from GWU3 are included under this alternative. Costs for O&M of the GilMo GWTP were based on historically incurred costs. O&M of the new GWU3 GWTP and three extraction wells was included for this alternative. It was assumed each extraction well would require annual development.

For purposes of the detailed analysis it was assumed the extraction well pumps would require replacement every 5 years. Additionally, it was assumed that components of the new GWU3 GWTP and components of the GilMo GWTP would be replaced every 30 years. The cost for the replacement of the GilMo GWTP components was proportional to the expected flow rate from GWU3 compared to the

total system flow rate. This cost was based on a previous replacement estimate prepared for the GilMo Site.

Sampling and analysis at 42 wells throughout the GWU3 groundwater plume would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 60 years* to monitor the effectiveness of the groundwater containment system. Sampling and analysis would also include two surface water monitoring locations. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of monitoring and extraction wells is assumed to occur at the end of the *period of performance of 70 years*. Decommissioning of the GWU3 GWTP is included in this alternative; however, decommissioning of the GilMo GWTP was not included.

9.6.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU3-4 as determined against criteria factors is provided in **Table D-GWU3-4A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU3 contaminated groundwater is performed. The overall rating for Alternative GWU3-4 is moderate to high (❹).

9.6.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU3-4 as determined against criteria factors is provided in **Table D-GWU3-4B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU3-4 against this criterion is moderate to high (❹).

9.6.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU3-4 as determined against criteria factors is provided in **Table D-GWU3-4C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU3 contaminated groundwater is performed. The overall rating for Alternative GWU3-4 against this criterion is therefore moderate to high (❹).

9.6.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU3-4 as determined against criteria factors is provided in **Table D-GWU3-4D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary.

Treatment, containment, or removal of GWU3 contaminated groundwater is performed; however, the operational duration is greater than the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU3-4 against this criterion is moderate to high (❹).

9.6.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU3-4 as determined against criteria factors is provided in **Table D-GWU3-4E** of **Appendix D**. This alternative provides for a GWU3 treatment component, provides for containment or removal of contaminated GWU3 groundwater, and therefore satisfies the preference for treatment as a principal element of the remedial action. The overall rating for Alternative GWU3-4 is moderate (❸).

9.6.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU3-4F** of **Appendix D**. Groundwater monitoring, extraction well O&M, and maintenance of existing water well ordinances and institutional controls is readily implementable. The overall rating for Alternative GWU3-4 against this criterion is therefore moderate to high (❹).

9.6.8 Cost

Evaluation of cost for Alternative GWU3-4 along with a summary breakdown of cost components is provided in **Table D-GWU3-4G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU3-4 against this criterion is high (**$$$$$**).

9.7 Alternative GWU3-5 – Groundwater Extraction (Containment and Interior Extraction (Additional Wells)), Treatment at Either the Gilbert-Mosley GWTP or a New Treatment Plant, and Discharge

9.7.1 Alternative Component Description

Alternative GWU3-5 provides the same leading edge containment as Alternative GWU3-2 including conveyance of extracted groundwater to the GilMo GWTP for treatment; however, Alternative GWU3-5 also provides additional treatment via three in-plume extraction wells. Groundwater from the in-plume extraction wells would be piped to a new GWTP constructed within GWU3. The new GWU3 GWTP would consist of an air stripper unit; treated water would be discharged to Chisholm Creek. Most of the new pipe would be installed by directional boring to reduce road resurfacing and impact to traffic. The new GWU3 GWTP is assumed to be located on City-owned property. Extraction well and piping locations assumed for costing purposes under this alternative are shown on **Figure 9-1**.

Under Alternative GWU3-5, one of the leading edge extraction wells would pump at 140 gpm (NIC#3-1) and be expected to operate for 35 years and the other leading edge extraction well (NIC#3-2) would pump at 60 gpm and be expected to operate for 63 years. The in-plume extraction wells would pump and be expected to operate as follows: one at 100 gpm for 28 years (NIC#3-3B), one at 50 gpm for 42 years (NIC#3-5), and one at 50 gpm for 70 years (NIC#3-4). Pumping rates and operational durations for the two contingency wells (NIC#3-6 and NIC#3-7) were not considered. GilMo GWTP O&M costs proportional to the expected flow rate from GWU3 are included under this alternative. Costs for O&M of the GilMo GWTP were based on historically incurred costs. O&M for the new GWU3 GWTP and all extraction wells was included for this alternative. It was assumed each extraction well would require annual development.

For purposes of the detailed analysis it was assumed the extraction well pumps would require replacement every 5 years. Additionally, it was assumed that components of the new GWU3 GWTP and components of the GilMo GWTP would be replaced every 30 years. The cost for the replacement of the GilMo GWTP components was proportional to the expected flow rate from GWU3 compared to the total system flow rate. This cost was based on a previous replacement estimate prepared for the GilMo Site.

This alternative also provides for the installation of two additional contingency in-plume extraction wells. One of the contingency wells (NIC#3-6) would be installed in the event that surface water monitoring in Chisholm Creek shows contaminant levels attributable to NIC Site groundwater exceeding the designated use concentration limits within the creek. The other contingency well (NIC#3-7) would be installed in the event that Coleman shuts down the three Coleman Downtown pumping wells (RW-5, RW-6, and RW-7) (with KDHE approval) before the upgradient groundwater reaches levels less than the MCLs. Costs associated with these two contingency wells were not included in this FS.

Sampling and analysis at 42 wells throughout the GWU3 groundwater plume would be conducted *quarterly for the first two years*, *semiannually for eight years*, then *annually for an additional 60 years* to monitor the effectiveness of the groundwater containment system. Sampling and analysis would also include two surface water monitoring locations. Sample analyses would include the Site COCs discussed in Section 1. Data from each monitoring event would be compiled and appropriate text, tables, figures, and time trends would be generated and included in reports to the KDHE.

Maintenance of monitoring wells (e.g., replacement of well vaults) was assumed to occur *every 10 years*. Five-year site reviews would also be a component of this alternative because groundwater contamination would remain onsite. Abandonment of monitoring and extraction wells is assumed to occur at the end of the *period of performance of 70 years*. Decommissioning of the GWU3 GWTP is included in this alternative; however, decommissioning of the GilMo GWTP was not included.

9.7.2 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative GWU3-5 as determined against criteria factors is provided in **Table D-GWU3-5A** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU3 contaminated groundwater is performed. The overall rating for Alternative GWU3-5 is moderate to high (❹).

9.7.3 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative GWU3-5 as determined against criteria factors is provided in **Table D-GWU3-5B** of **Appendix D**. The complete list of ARARs used in this evaluation is provided in Section 3. The overall rating for Alternative GWU3-5 against this criterion is moderate to high (❹).

9.7.4 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative GWU3-5 as determined against criteria factors is provided in **Table D-GWU3-5C** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. In addition, treatment, containment, or removal of GWU3 contaminated groundwater is performed. The overall rating for Alternative GWU3-5 against this criterion is therefore moderate to high (❹).

9.7.5 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness for Alternative GWU3-5 as determined against criteria factors is provided in **Table D-GWU3-5D** of **Appendix D**. The existing water well ordinances and institutional controls provide some protection for public health and the environment. These will continue to be maintained as long as necessary. Treatment, containment, or removal of GWU3 contaminated groundwater is performed; however, the total operational duration is greater than the 30 years used as a standard basis for alternative life. The overall rating for Alternative GWU3-5 against this criterion is moderate to high (❹).

9.7.6 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of the reduction of toxicity, mobility, or volume through implementation of Alternative GWU3-5 as determined against criteria factors is provided in **Table D-GWU3-5E** of **Appendix D**. This alternative provides for a GWU3 treatment component, provides for containment or removal of contaminated GWU3 groundwater, and therefore satisfies the preference for treatment as a principal element of the remedial action. The overall rating for Alternative GWU3-5 is moderate (❸).

9.7.7 Implementability

Evaluation of implementability for this alternative as determined against criteria factors is provided in **Table D-GWU3-5F** of **Appendix D**. Groundwater monitoring, extraction well O&M, and maintenance of existing water well ordinances and institutional controls is readily implementable. The overall rating for Alternative GWU3-5 against this criterion is therefore moderate to high (❹).

9.7.8 Cost

Evaluation of cost for Alternative GWU3-5 along with a summary breakdown of cost components is provided in **Table D-GWU3-5G** of **Appendix D**. Detailed costs are provided in **Appendix E**. The overall rating for Alternative GWU3-4 against this criterion is high (**$$$$$**).

9.8 State/Support Agency Acceptance

State/support agency acceptance is a modifying criterion under the NCP. Assessment of state/support agency acceptance will not be known until the final FS report is submitted to the KDHE and the KDHE issues the draft CAD. The draft CAD will provide the State's rationale for alternative selection and acceptance. Therefore, state/support agency acceptance is not considered in the detailed analysis of alternatives presented in this FS.

9.9 Community Acceptance

Community acceptance is also a modifying criterion under the NCP. Assessment of community acceptance will include responses to questions that any interested person in the community may have regarding any component of the remedial alternatives that will be presented in the KDHE's draft CAD for the NIC Site. This assessment will be completed after the KDHE receives public comments on the proposed plan during the public commenting period. Community acceptance is therefore not considered in the detailed analysis of alternatives presented in this FS.

9.10 Comparative Analysis of Alternatives

This FS evaluated the five retained remedial alternatives discussed in this section against the two threshold criteria and five balancing criteria discussed in Section 6. A summary of the results of the detailed analyses for each remedial alterative (from **Appendix D**) is presented in **Table 9-1** to allow a comparison of the alternatives and identify the key tradeoffs between them.

9.10.1 Overall Protection of Human Health and the Environment

Alternatives GWU3-2, GWU3-3, GWU3-4, and GWU3-5 meet this criterion. Alternatives GWU3-4 and GWU3-5 are the most protective of the alternatives proposed for GWU3 because they add the interior plume pumping and treatment for additional treatment.

9.10.2 Compliance with ARARs

Alternative GWU3-1 does not comply with ARARs. Alternatives GWU3-2, GWU3-3, GWU3-4, and GWU3-5 meet all ARARs providing the GilMo extraction wells capture the modeled 10% plume leaving the NIC Site. In the event that Coleman shuts down the three downgradient Coleman Downtown pumping wells (RW-5, RW-6, and RW-7) (with KDHE approval) before the upgradient groundwater reaches levels less than the MCLs, a contingency extraction well (NIC#3-7) may be installed in the vicinity of Santa Fe and 2nd Street to provide ongoing containment.

9.10.3 Short-term Effectiveness

Alternative GWU3-1 is not effective in the short term because the time frame for the remediation of contaminated groundwater is open ended. All four groundwater extraction alternatives (GWU3-2 through GWU3-5) proposed for GWU3 are effective in the short term; however, each has a construction component that would impact the community during implementation. Alternatives GWU3-2, GWU3-4, and GWU3-5 would install the longest run of piping in order to connect to the GilMo GWTP while Alternative GWU3-3 consists of piping for the new GWU3 GWTP only. Alternatives GWU3-4 and GWU3-5 would result in additional impact to the community during implementation because Alternatives GWU3-4 and GWU3-5 include construction of a new GWTP in addition to construction for connecting to the existing GilMo GWTP.

9.10.4 Long-Term Effectiveness and Permanence

Alternative GWU3-1 does not provide a long-term effective or permanent remedy for groundwater at GWU3. Alternatives GWU3-2, GWU3-3, GWU3-4, and GWU3-5 provide long-term containment of the GWU3 groundwater plume and therefore provide the most effective long-term and permanent remedy for GWU3 groundwater.

9.10.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative GWU3-1 does not provide any reduction of contamination. Alternatives GWU3-2, GWU3-3, GWU3-4, and GWU3-5 provide a treatment component; however, only extracted groundwater would undergo treatment.

9.10.6 Implementability

All five alternatives proposed for GWU3 groundwater are readily implementable; however, Alternatives GWU3-2, GWU3-3, GWU3-4, and GWU3-5 require a construction phase and would therefore be relatively more difficult to implement than Alternative GWU3-1. The overall construction phase for Alternative GWU3-3 is longer than that of Alternative GWU3-2 because a new GWTP is constructed under Alternative GWU3-3. The overall construction phase for Alternative GWU3-4 is longer than that of Alternatives GWU3-2 and GWU3-3 due to construction of a new GWTP as well as installing piping to the existing GilMo GWTP. The overall construction phase for Alternative GWU3-5 is lengthiest due to installation of

additional wells and associated piping plus construction of a new GWTP as well as installing piping to the existing GilMo GWTP.

9.10.7 Cost

Alternative GWU3-1 has the lowest overall cost. Alternatives GWU3-2 and GWU3-3, which include costs for extraction well, GWTP, and associated piping installation, fall into the moderate to high cost range. Alternatives GWU3-4 and GWU3-5 require the installation of additional extraction wells and fall into the high cost range. Alternative GWU3-5 contains the most extraction wells and therefore has the highest cost.

As discussed in **Appendix F**, the addition of one extraction well in the interior of the GWU3 groundwater contaminant plume (GWU3-4) has little impact on the duration of operation of the two leading edge containment extraction wells, apparently because of the direction of groundwater flow in the south-central and southeastern portions of GWU3. Installing additional in-plume wells, such as proposed under GWU3-5, does appear to provide a minor reduction of the duration of operation for the two leading edge containment extraction wells (approximately seven years). Because of the strong influence of Chisholm Creek on groundwater flow in GWU3, most of the groundwater plume captured by the one in-plume extraction well appears to eventually migrate to Chisholm Creek, i.e., only a portion of the groundwater plume captured by the one in-plume extraction well appears to migrate to the western leading edge containment well. In the event that surface water monitoring in Chisholm Creek shows contaminant levels attributable to NIC Site groundwater exceeding the designated use concentration limits within the creek, a contingency extraction well (NIC#3-6) may be installed in the vicinity of Indiana and 13th Street to provide additional migration control.

Capital, O&M, periodic, and present value costs for the five alternatives are provided in **Appendix D**; however, these costs are also summarized in **Table 9-1**.

9.11 Recommended Alternative

Five alternatives were evaluated to address GWU3 contaminated groundwater. Alternative GWU3-1 does not provide adequate protection to human health and the environment and does not meet ARARs. Alternatives GWU3-2, GWU3-3, GWU3-4, and GWU3-5 involve plume containment. Alternatives GWU3-2 and GWU-3-3 provide for plume containment near the leading edge, extraction, and treatment. Alternative GWU3-2 uses the existing GilMo GWTP to treat extracted groundwater while Alternative GWU3-3 uses a newly constructed GWTP to treat extracted groundwater. Alternatives GWU3-4 and GWU-3-5 use both the existing GilMo GWTP and a newly constructed GWTP to treat extracted groundwater but also include provisions for interior plume extraction and treatment. The additional in-plume extraction well under Alternative GWU3-4 provides no significant net benefit in the reduction time of the containment wells; however, under Alternative GWU3-5 which has three in-plume extraction wells, the overall duration of operation for the leading edge containment wells is reduced from 70 years to 63 years. Alternative

GWU3-2 is the least expensive of the four active remedial alternatives. Alternative GWU3-4 is the enhanced preferred alternative for GWU3.

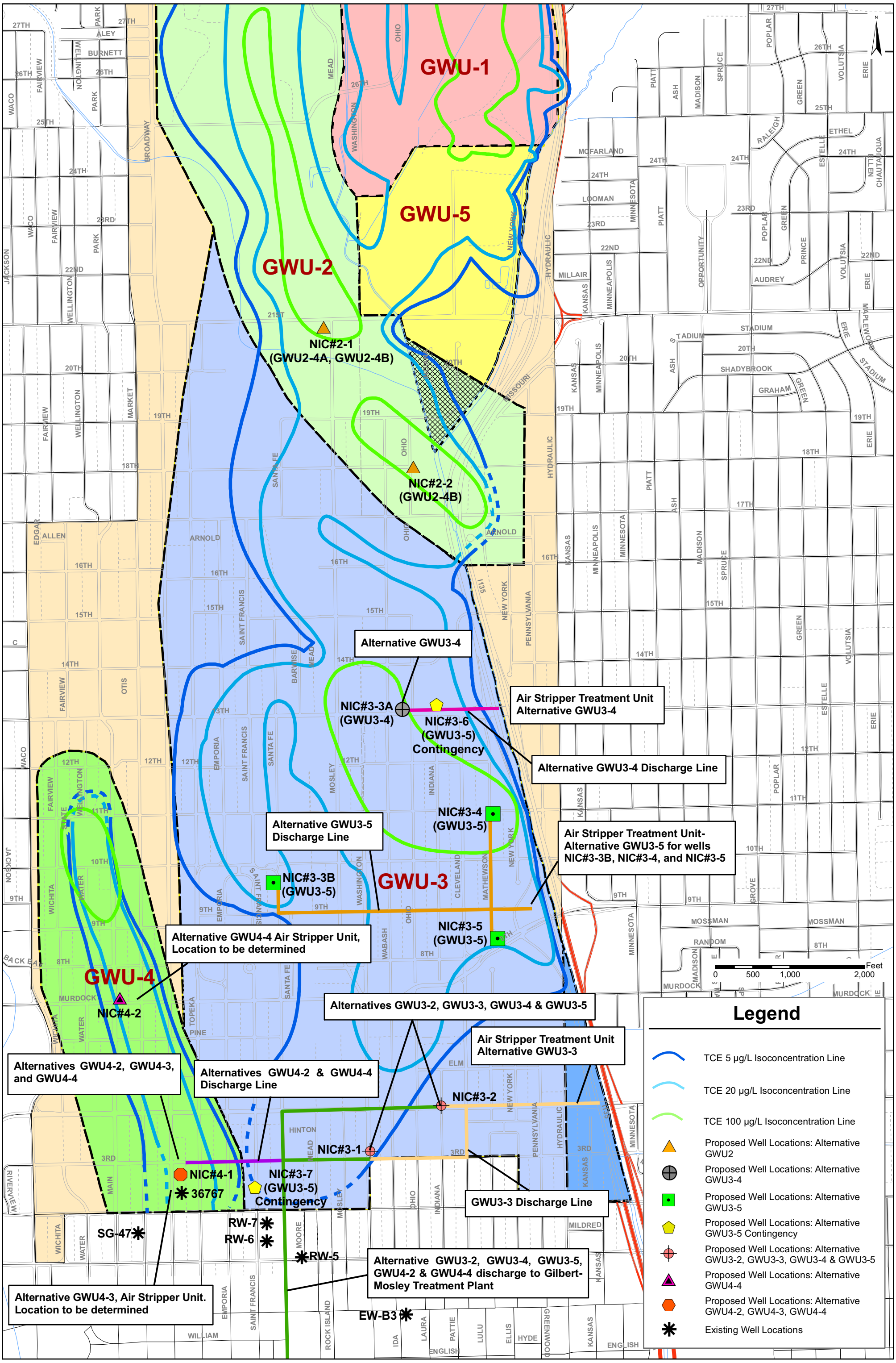


Figure 9-1
North Industrial Corridor (NIC) Site
GWU2, GWU3, and GWU4 Pumping Alternatives and Treatment Systems

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Table 9-1
North Industrial Corridor (NIC) Site
Comparative Analysis of Alternatives for GWU3

Remedial Alternative:	Alternative GWU3-1 No Action	Alternative GWU3-2 Groundwater Extraction (Containment Only), Discharge after Treatment at GilMo GWTP	Alternative GWU3-3 Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Chisholm Creek	Alternative GWU3-4 Groundwater Extraction (Containment and Interior Extraction), New Treatment Plant, Discharge to Creek and GilMo GWTP	Alternative GWU3-5 Groundwater Extraction (Containment and Interior Extraction), New Treatment Plant, Discharge to Creek and GilMo GWTP
Major Components:	Limited monitoring to support Five-Year Site Reviews	Installation of 2 EWs at the leading edge of the groundwater plume. Extracted groundwater would be conveyed to the GilMo GWTP for treatment.	Installation of 2 EWs at the leading edge of the groundwater plume. Extracted groundwater would be treated via an air stripper system at a new GWTP within GWU3 then discharged to Chisholm Creek.	Installation of 2 EWs at the leading edge of the groundwater plume and 1 EW in-plume. Extracted groundwater would be would be conveyed to the GilMo GWTP for treatment or treated at a new GWTP within GWU3.	Installation of 2 EWs at the leading edge of the groundwater plume and 3 to 5 EWs in-plume. Extracted groundwater would be would be conveyed to the GilMo GWTP for treatment or treated at a new GWTP within GWU3.
Threshold Criteria					
Overall Protection of Human Health and the Environment	⓪ Cleanup objectives would not be achieved	❹ Containment of the groundwater plume via EWs and treatment will be protective of the environment. Ongoing institutional controls limiting new well installations are protective of human health.	❹ Containment of the groundwater plume via EWs and treatment will be protective of the environment. Ongoing institutional controls limiting new well installations are protective of human health.	❹ Containment and interior pumping of the groundwater plume via EWs and treatment will be protective of the environment. Ongoing institutional controls limiting new well installations are protective of human health.	❹ Containment and interior pumping of the groundwater plume via EWs and treatment will be protective of the environment. Ongoing institutional controls limiting new well installations are protective of human health.
Compliance with ARARs	⓪ Would not comply with ARARs	❹ Compliant with all ARARs providing the GilMo EWs capture the modeled 10% plume leaving the NIC Site	❹ Compliant with all ARARs providing the GilMo EWs capture the modeled 10% plume leaving the NIC Site	❹ Compliant with all ARARs providing the GilMo EWs capture the modeled 10% plume leaving the NIC Site	❹ Compliant with all ARARs providing the GilMo EWs capture the modeled 10% plume leaving the NIC Site
Balancing Criteria					
Short-Term Effectiveness	⓪ The short term risks are not addressed and the time frame is open ended	❹ Some disruption from installation of water lines from EWs to the tie-in location with the GilMo GWTP piping.	❹ Disruption to the community from installation of water lines and treatment plant.	❹ Disruption to the community from installation of water lines and treatment plant.	❹ Disruption to the community from installation of water lines and treatment plant.
Long-Term Effectiveness and Permanence	⓪ Future risks to human health and the environment would not be diminished	❹ Containment and treatment of contaminated groundwater prevents further migration. Over time the concentrations of contaminants would decrease.	❹ Containment and treatment of contaminated groundwater prevents further migration. Over time the concentrations of contaminants would decrease.	❹ Containment and treatment of contaminated groundwater prevents further migration. Over time the concentrations of contaminants would decrease. Interior extraction and treatment could reduce the overall time needed to achieve RAOs.	❹ Containment and treatment of contaminated groundwater prevents further migration. Over time the concentrations of contaminants would decrease. Interior extraction and treatment could reduce the overall time needed to achieve RAOs.
Reduction of Toxicity, Mobility, or Volume through Treatment	⓪ No treatment or reduction in toxicity, mobility, or volume of contaminants	❸ This alternative does provide a treatment component; however, it is not designed to treat all contaminated groundwater within GWU3. Treatment would only be applied to groundwater extracted through hydraulic containment.	❸ This alternative does provide a treatment component; however, it is not designed to treat all contaminated groundwater within GWU3. Treatment would only be applied to groundwater extracted through hydraulic containment.	❸ This alternative does provide a treatment component; however, it is not designed to treat all contaminated groundwater within GWU3. Treatment would only be applied to groundwater extracted through interior pumping and hydraulic containment.	❸ This alternative does provide a treatment component; however, it is not designed to treat all contaminated groundwater within GWU3. Treatment would only be applied to groundwater extracted through interior pumping and hydraulic containment.

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Table 9-1
North Industrial Corridor (NIC) Site
Comparative Analysis of Alternatives for GWU3

Remedial Alternative:	Alternative GWU3-1 No Action	Alternative GWU3-2 Groundwater Extraction (Containment Only), Discharge after Treatment at GilMo GWTP	Alternative GWU3-3 Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Chisholm Creek	Alternative GWU3-4 Groundwater Extraction (Containment and Interior Extraction), New Treatment Plant, Discharge to Creek and GilMo GWTP	Alternative GWU3-5 Groundwater Extraction (Containment and Interior Extraction), New Treatment Plant, Discharge to Creek and GilMo GWTP
Major Components:	Limited monitoring to support Five-Year Site Reviews	Installation of 2 EWs at the leading edge of the groundwater plume. Extracted groundwater would be conveyed to the GilMo GWTP for treatment.	Installation of 2 EWs at the leading edge of the groundwater plume. Extracted groundwater would be treated via an air stripper system at a new GWTP within GWU3 then discharged to Chisholm Creek.	Installation of 2 EWs at the leading edge of the groundwater plume and 1 EW in-plume. Extracted groundwater would be would be conveyed to the GilMo GWTP for treatment or treated at a new GWTP within GWU3.	Installation of 2 EWs at the leading edge of the groundwater plume and 3 to 5 EWs in-plume. Extracted groundwater would be would be conveyed to the GilMo GWTP for treatment or treated at a new GWTP within GWU3.
Implementability	❺ Monitoring is highly implementable	❹ The GilMo GWTP has the capacity to accommodate the estimated flow rates required for capture of the GWU3 groundwater plume in this alternative.	❹ Installation of water lines and treatment systems is very implementable.	❹ Installation of water lines and treatment systems is very implementable. Tthe GilMo GWTP has the capacity to accommodate the estimated flow rates required for capture of the 2 southern EWs.	❹ Installation of water lines and treatment systems is very implementable. Tthe GilMo GWTP has the capacity to accommodate the estimated flow rates required for capture of the 2 southern EWs.
Period of Operation (Years)					
Active Treatment	0	Well NIC#3-1 - 56 yrs, 140 gpm Well NIC#3-2 - 70 yrs, 65 pgm	Well NIC#3-1 - 56 yrs, 140 gpm Well NIC#3-2 - 70 yrs, 65 gpm	Well NIC#3-1 - 56 years, 140 gpm Well NIC#3-2 - 70 yrs, 65 gpm Well NIC#3-3A - 70 yrs, 110 gpm	Well NIC#3-1 - 35 yrs, 140 gpm Well NIC#3-2 - 63 yrs, 60 gpm Well NIC#3-3B - 28 yrs, 100 gpm Well NIC#3-4 - 70 yrs, 50 gpm Well NIC#3-5 - 42 yrs, 50 gpm
Monitoring	70	70	70	70	70
Cost (Dollars)					
	$$	$$$$	$$$$	$$$$$	$$$$$
Total Capital Cost[1]	$122,000	$1,557,000	$1,872,000	$2,631,000	$3,218,000
Total Annual O&M Cost[1,2]	$2,674,000	$14,620,000	$16,776,000	$21,074,000	$21,585,000
Total Periodic Cost[1,2]	$889,000	$2,216,000	$2,422,000	$3,364,000	$3,606,000
Present Value Cost[1,2]	$2,192,000	$11,304,000	$12,784,000	$16,422,000	$25,776,000

EW = Extraction well
GilMo = Gilbert-Mosley
RAOs = Remedial action objectives

GWTP = Groundwater treatment plant
ARARs = Applicable or Relevant and Appropriate Requirements
GPM = gallons per minute

Legend for Qualitative Ratings System:

Ratings Categories for Threshold and Balancing Criteria
- ⓪ None
- ❶ Low
- ❷ Low to Moderate
- ❸ Moderate
- ❹ Moderate to High
- ❺ High

Ratings categories for Cost Criteria (Present Value Cost)

⓪	None	
$	Low	(less than 2 million dollars)
$$	Low to moderate	(between 2 million and 5 million dollars)
$$$	Moderate	(between 5 million and 10 million dollars)
$$$$	Moderate to high	(between 10 million and 15 million dollars)
$$$$$	High	(greater than 15 million dollars)

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Table 9-1
North Industrial Corridor (NIC) Site
Comparative Analysis of Alternatives for GWU3

Remedial Alternative:	Alternative GWU3-1 No Action	Alternative GWU3-2 Groundwater Extraction (Containment Only), Discharge after Treatment at GilMo GWTP	Alternative GWU3-3 Groundwater Extraction (Containment Only), New Treatment Plant, Discharge to Chisholm Creek	Alternative GWU3-4 Groundwater Extraction (Containment and Interior Extraction), New Treatment Plant, Discharge to Creek and GilMo GWTP	Alternative GWU3-5 Groundwater Extraction (Containment and Interior Extraction), New Treatment Plant, Discharge to Creek and GilMo GWTP
Major Components:	Limited monitoring to support Five-Year Site Reviews	Installation of 2 EWs at the leading edge of the groundwater plume. Extracted groundwater would be conveyed to the GilMo GWTP for treatment.	Installation of 2 EWs at the leading edge of the groundwater plume. Extracted groundwater would be treated via an air stripper system at a new GWTP within GWU3 then discharged to Chisholm Creek.	Installation of 2 EWs at the leading edge of the groundwater plume and 1 EW in-plume. Extracted groundwater would be would be conveyed to the GilMo GWTP for treatment or treated at a new GWTP within GWU3.	Installation of 2 EWs at the leading edge of the groundwater plume and 3 to 5 EWs in-plume. Extracted groundwater would be would be conveyed to the GilMo GWTP for treatment or treated at a new GWTP within GWU3.

1 – Capital costs, annual costs, and periodic costs are presented in Appendix E.
2 – Estimated remedial timeframes and associated present value analysis for each remedial alternative are provided in Appendix E.
3 – Costs presented have an expected accuracy range for corrective action study estimates (-30% to +50% of the actual cost of the alternative).