Corrective Measures Study Report

Occidental Chemical Corporation Facility
Wichita, Kansas
EPA ID #KSD007482029

Glenn Springs Holdings, Inc.

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Acronyms and Abbreviations

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirements
ASI	Asbestos Surface Impoundment
BER	Bureau of Environmental Remediation
bgs	below ground surface
Cal/OSHA	California Division of Occupational Safety and Health Administration
CAO	Corrective Action Objective
CIG	Community Involvement Group
CLM	Chloromethanes
CM	Corrective Measure
CMA	Corrective Measure Alternative
CMS	Corrective Measures Study
COC	Contaminant of Concern
COPC	Chemical of Potential Concern
CRA	Conestoga-Rovers & Associates
CSM	Conceptual Site Model
CY.	cubic yards
DNAPL	Dense Non-Aqueous Phase Liquid
EPA	Environmental Protection Agency
FIRST	Facilities Investigation Remedy Selection Track
GHD	GHD Services, Inc.
gpm	gallons per minute
GSH	Glenn Springs Holdings, Inc.
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments
HVAC	Heating, Ventilation and Air Conditioning
ICM	Interim Corrective Measures
ISCO	In Situ Chemical Oxidation
KDHE	Kansas Department of Health and Environment
MCL	Maximum Contaminant Level
MPP	Macro Porous Polymer
NAPL	Non-aqueous Phase Liquid
OCC	Occidental Chemical Corporation
OEL	Occupational Exposure Limit
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PEL	Permissible Exposure Limit
PPE	Personal Protective Equipment
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RSL	Regional Screening Level
SF.	square feet

Acronyms and Abbreviations (continued)

SWMU	Solid Waste Management Unit
TC	Threshold Criteria
THQ	Target Hazard Quotient
TR	Target Risk
TSVC	Target Soil Vapor Concentrations
TWA	Time Weighted Average
U.S.	United States
VCI	Voluntary Cleanup Investigation
VCRU	Vent Capture and Recovery Unit
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound
WACC	Weighted Average Cost of Capital
ZVI	Zero-Valent Iron

1. Introduction

This Resource Conservation and Recovery Act (RCRA) Corrective Measures Study (CMS) Report was prepared by GHD Services, Inc. (GHD) on behalf of Glenn Springs Holdings, Inc. (GSH) for the Occidental Chemical Corporation (OCC) Wichita, Kansas, Facility (Site or Wichita Facility or Facility) located at 6200 S. Ridge Road, Wichita, Sedgwick County, Kansas (United States [U.S.] Environmental Protection Agency [EPA] ID #KSD007482029), **Figure 1**. This Report was prepared in accordance with Part II of the Facility's 2007 RCRA/Hazardous and Solid Waste Amendments (HSWA) operating permit (Permit) (Kansas Department of Health and Environment (KDHE) & U.S. EPA, 2007), RCRA regulations at 40 CFR 264.100 (Corrective Action), and relevant guidance documents (U.S. EPA, 1994; U.S. EPA, 2013), including the RCRA Facilities Investigation Remedy Selection Track (FIRST) (U.S. EPA, 2015).

This CMS Report identifies and screens corrective measure technologies, develops and evaluates corrective measure alternatives (CMAs) and provides justification under the RCRA Corrective Action Plan (U.S. EPA, 1994) for the Facility's Process Area, Non-Process Area, and Landfill Area, hereinafter referred to as the CMS Study Area (**Figure 2**), and in accordance with the RCRA FIRST principles. A RCRA FIRST analysis of Region 3 and Region 7 Site data concluded that the CMS work plan-review-approval part of a remedy selection takes an average of nearly six years (U.S. EPA, 2015). The corrective measure identification and selection process for the Wichita Facility as outlined in this report proposes to significantly improve upon that typical timeframe, despite the relative Site complexity. In part, the remedy selection process will be achieved through the recognition of existing effective Interim Corrective Measures (ICMs) for soil, groundwater, vapor intrusion (VI) and the closed Landfill as components of the final remedy to address long-term Corrective Action Objectives (CAOs) for an active chemical facility and will align with the RCRA FIRST principles. **Figure 3** presents the streamlined approach to the CMS for the Wichita Facility.

This CMS Report is based on the Site investigation information obtained during the RCRA Facility Investigation (RFI) performed from 2009 to 2014 (Conestoga-Rovers & Associates (CRA), 2014d; CRA, 2014a; CRA, 2014b), the Human Health Risk Assessment (HHRA) (GHD, 2017a), and the CMS Work Plan (GHD, 2015a).

1.1 Overview

The Wichita Facility has been an active chemical plant since 1952 and is located in a rural industrial and agricultural area. The Facility manufactures, stores, and ships a variety of chemicals. These chemicals include, but are not limited to, a number of the Contaminants of Concern (COCs) identified during the various investigations at the Facility, including currently and historically manufactured chemicals, e.g., pentachlorophenol and perchloroethylene. The current Facility layout is presented on **Figure 2**. Land use at the Facility is currently restricted to industrial use. The Facility is fenced and the ground surface within the Facility is primarily covered by pavement, buildings, and other operational features that are necessary for the Facility chemical manufacturing operations. A comprehensive discussion of the Facility's operational history and waste disposal practices is summarized in the Comprehensive RCRA Facility Investigation Summary Report (CRA, 2014d) and the Phase II Groundwater RFI (CRA, 2014a) and is not replicated here.

OCC acquired the Wichita Facility from Vulcan Chemical in 2005. Following renewal of the Permit in 2007, an RFI Schedule of Work was agreed upon by U.S. EPA and GSH in 2008 in order to address revised HSWA requirements identified in Part II of the Permit, including investigation of over 150 Solid Waste Management Units (SWMUs) and Areas of Concern (AOC). The conclusions of the RFI identified a subset of SWMUs and AOC locations requiring further analysis in the HHRA and CMS (**Figure 4**). Whereas the average timeframe for an RFI for U.S. EPA sites (including Region 7) is approximately 10 years (U.S. EPA, 2015), the RFI for the OCC Wichita Facility was completed and approved in a little over six years following establishment of the Permit Schedule of Work. Substantial ICMs for soil, groundwater and VI were completed during the same time.

Details of the investigation, monitoring and interim remediation activities, to date, within the CMS Study Area are presented in the key reports listed below.

- Comprehensive RCRA Facility Investigation Summary Report, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, Conestoga-Rovers and Associates (CRA), December 2014.
- Phase II On-Site Groundwater Investigation RCRA Facility Investigation (RFI) Summary Report, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, CRA, February 2014.
- Phase II On-Site Groundwater Investigation RCRA Facility Investigation (RFI) Supplemental Report, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, CRA, June 2014.
- Human Health Risk Assessment, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, GHD, May 2017.
- Interceptor Well System, Interim Corrective Measure Effectiveness Evaluation, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, CRA, February 2010.
- On-Site Vapor Intrusion Investigation, Assessment, and Interim Corrective Measures Implementation, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, CRA, September 2009.
- Operation and Maintenance Plan for On-Site Vapor Intrusion Interim Corrective Measures at the Control Laboratory, Technical Center and Administration Building, Revision 1, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, CRA, October 2010.
- Alternatives/Modifications to Encapsulation. Submitted to Kansas Department of Health and Environment in Response to Item 2 of the January 28, 1986 Administrative Order, p.9-11, Vulcan Chemicals, July 1986.
- Engineer’s Report: Closed Landfill Evaluation, Chloralkali/Chlorosolvent Manufacturing Plant, Wichita, Kansas, Canonie Environmental, March 1988.
- RFI Summary Report, Alpha Cake Landfill, Hex Waste Pits and Brine Ponds, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, CRA, January 2011.

- Interim Corrective Measures Implementation Report for Asbestos Surface Impoundment SWMU, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, Weston Solutions, August 2008.
- Semi-Annual Groundwater Monitoring Report, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas, GHD, March 2017.

1.2 Corrective Action Objectives and CMS Evaluation Criteria

The CAOs for the Facility are intended to provide short-term and long-term protection of human health and the environment to the extent practicable. The CMS CAOs are intended to be specific to the affected media (i.e. soil, groundwater, and soil vapor) without overly restricting the potential remedial technology available. The CAOs are based on potential complete exposure pathways identified in the HHRA as well as threshold criteria identified in Part II, Section C.8.(4) of the Permit. The CAOs for soil, groundwater, and soil vapor are listed below:

Soil CAOs:

- Control sources of releases that may pose a threat to human health or the environment in the Process Area and Landfill Area
- Prevent exposure exceeding the approved cleanup goals by a potential receptor (including ingestion, inhalation, and dermal adsorption) with COCs in soil in the Process Area and Landfill Area
- Reduce or eliminate the potential for COCs in soil to migrate to groundwater in the Process Area and Landfill Area

Groundwater CAOs:

- Attain cleanup standards set by, or risk-based standards approved by, U.S. EPA where practicable in the Process Area, Non-Process Area, Landfill Area, and Off-Site.
  - The first priority of this CAO will be to reduce the areas of impacted groundwater that have originated from to OCC plant to within the boundaries of the plant.
  - The second priority for this CAO will be to reduce the volume of Site-related dense non-aqueous phase liquids (DNAPL) in the subsurface to the extent practicable.
  - The final priority for this CAO will be the long-term management of any impacted groundwater areas or DNAPL source materials in order to prevent exposure by human or ecological receptors at levels above the approved cleanup goals.
- Control sources of releases that may pose a threat to human health or the environment in the Process Area, Non-Process Area, Landfill Area and Off-Site
- Prevent exposure exceeding the approved cleanup goals by a potential receptor (including ingestion, inhalation, and dermal adsorption) with COCs in the Process Area, Non-Process Area, Landfill Area, and Off-Site

Soil Vapor CAOs:

- Prevent exposure exceeding the approved cleanup goals by a potential receptor with COCs in soil gas in the Process Area

Based on the CAOs, CMAs (which include existing ICMs) were evaluated based on the extent to which the CMA meets the CAO and against the four threshold and five balancing criteria listed in the Permit and the three balancing criteria from RCRA FIRST.

The threshold criteria are:

- Protection of human health and the environment
- Attainment of media cleanup standards set by, or risk-based standards approved by, U.S. EPA
- Controlling the sources of releases to reduce or eliminate further releases that may pose a threat to human health or the environment
- Compliance with applicable standards for management of wastes

The balancing criteria are:

- Long-term reliability and effectiveness
- Reduction of toxicity, mobility, or volume of wastes
- Short-term effectiveness
- Implementability
- Community acceptance
- Agency acceptance
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
- Cost

The results of the comparative evaluations of the CMAs, based on the achievement of the CAOs and the above criteria, are used to present the alternative which can most effectively accomplish the CMS objectives. Details regarding how these goals will be achieved will be provided in the Corrective Measures Implementation Plan.

1.3 Report Organization

The purpose of this CMS Report is to present the selection criteria and methodology by which GSH will evaluate and select corrective measures alternatives to address COCs impacts in environmental media (soil, groundwater, and soil vapor) at the Site in accordance with Part II Section C.9 of the Facility's RCRA Permit. This report contains the following sections:

- Section 1 - Introduction
- Section 2 - Current Conditions
- Section 3 - Media Cleanup Standards
- Section 4 - Identification, Screening and Development of Corrective Measure Alternatives
- Section 5 - Evaluation of Corrective Measure Alternatives
- Section 6 - Recommendation by Permittee for a Final Corrective Measure Alternative
- Section 7 - Public Involvement Plan

- Section 8 - References

2. Current Conditions

2.1 Conceptual Site Model

A detailed discussion of the Conceptual Site Model (CSM) is provided in the Phase II On-Site Groundwater Investigation RCRA Facility Investigation (RFI) Summary Report, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas (CRA, 2014b). A summary of the CSM is presented here. Details related to the CSM have not changed since the completion of the RFIs.

In the CSM there are four generally discrete sand units, S1 through S4 (oldest to youngest), separated by a sequence of clays and silts, C1 through C4 (oldest to youngest), unconformably deposited and overlying the Wellington Formation (bedrock) (CRA, 2014b). These sequences of alternating layers of sand and clay are representative of alluvial flood plain deposits with the possible exception of the upper parts of the surficial C4 clay layer that are windblown deposits.

The C4 clay layer is the uppermost stratigraphic unit in the area and is believed to be windblown loess consisting of silt and clay ranging in thickness from just over 10 feet to nearly 25 feet.

The S4 sand layer consists of discontinuous, unconfined perched water occurring at approximately 15 to 30 feet below ground surface (bgs). The wells screened in the S4 discontinuous perched water areas are not hydraulically connected and have limited reliability to transport contaminants beyond their extent. The monitoring wells screened in this unit are often dry and some have remained so since their installation.

The C3 clay layer ranges in thickness from just a few feet to nearly 20 feet thick and is nearly continuous beneath the Site.

The S2/S3 sand is a semi-confined continuous water-bearing unit occurring approximately 40 to 50 feet bgs. The S2/S3 water-bearing unit is a series of hydraulically interconnected sand units that exhibit similar hydrogeologic characteristics throughout the Site. Groundwater flow in the vicinity of the Site in the S2/S3 is generally toward the southeast and the gradient is influenced by groundwater extraction from interceptor wells installed in this unit as part of the Groundwater ICM.

The C2 clay layer appears to be present between the S2 and S3 sand layers in the northern portion of the Site and thins out toward the south and is discontinuous beneath the Site.

The C1 clay layer is generally continuous beneath the Site and ranges in thickness from 8 feet to nearly 20 feet.

The S1 sand is semi-confined and is the lowermost water-bearing unit (approximately 80-100 feet bgs) which overlies the shale bedrock surface (Wellington unit). The S1 water-bearing unit is a nearly continuous sand unit that pinches out to the east and west of the Facility. Groundwater flow in the S1 is generally toward the southeast and the gradient is influenced by groundwater extraction from interceptor wells installed in this water-bearing unit as part of the Groundwater ICM.

2.1.1 Groundwater

Site-related chemicals are present in groundwater in concentrations that exceed the Maximum Contaminant Level (MCL) drinking water standards in the two main water-bearing units at the Site (**Figures 5-14**). OCC has installed and continues to operate a Groundwater ICM in these water-bearing units: the S2/S3 and the S1. The pumping rates employed at the Interceptor Wells prevent migration of impacted groundwater via hydraulic containment and through recovery and treatment. The impacted groundwater is pumped through activated carbon for treatment and then is either discharged to a National Pollutant Discharge Elimination System (NPDES)-permitted outfall; disposed via the Facility's deep well injection or used as process water at the Facility.

The initial Groundwater Interceptor Well IW29 was operational in 1978 and followed by IW30, IW31 and IW32 in 1979 as part of a groundwater management plan (Wilson & Company, 1978). The Interceptor Well System has been periodically upgraded and augmented. The system upgrades/augmentations include the following:

- 1983 - Interceptor Well IW35A was installed
- 1986 through 1996 - Replaced Interceptor Wells IW29, IW30, IW31, IW32, and IW35A
- 1996 - Interceptor Well IW35B was installed
- 2003 - Interceptor Well System augmented with four wells, including IW36 (located on-Site) and off-Site Interceptor Wells IW40, IW41, and IW42
- 2010 - A Groundwater Interceptor Well Effectiveness Evaluation for ten interceptor wells (IW29, IW30, IW31, IW32, IW35A, IW35B, IW36, IW40, IW41, IW42) was completed (CRA, February 2010) and recommended installation of two additional interceptor wells in the S2/S3 to collect and contain groundwater impacted with carbon tetrachloride
- 2011-2012 - Two interceptor wells (IW-43 and IW-44) were installed
- 2011-2012 - 12 hydraulic monitoring piezometers were installed to help define flow conditions and the hydraulic effects of the pumping operations
- 2013 - A second Groundwater Effectiveness Evaluation was completed and recommended installation of two additional interceptor wells (IW-45 and IW-46) with hydraulic monitoring piezometers at both locations
- 2015 - OCC completed construction of a groundwater treatment system as part of the Groundwater ICM
  - The system collects groundwater from IW-40, IW-43, IW-44, IW-45 and IW-46
  - Treats the groundwater via activated carbon system
  - Treated water is either pumped to the Facility for use in chemical production, discharged via the NPDES-permitted outfall, or is disposed via the Facility's deep well injection
- 2017 - Groundwater treatment system is being upgraded to include a pre-treating air stripper to minimize activated carbon use in the system

A focused Effectiveness Evaluation of the Groundwater ICM was performed in 2017 and concluded the existing system is effective. The results of the Effectiveness Evaluation are presented in **Appendix A**.

2.1.2 Soil Vapor

The Facility is an active chemical manufacturing facility and as such the Facility and its workers follow health and safety procedures to prevent exposure beyond allowable standards. These health and safety procedures include, but are not limited to: (1) compliance with Occupational Safety and Health Administration (OSHA) Hazard Communication Standard (29 CFR 1910.1200) by providing information to workers regarding chemicals at the Facility; and (2) use of personal protective equipment (PPE) to eliminate or limit potential exposure.

There is a potential for constituents in the subsurface (groundwater, soil, DNAPL) to volatilize and migrate through the subsurface and into indoor air at the Facility. However, the constituents identified in the subsurface are also part of the Facility operations in certain areas. The potential migration of constituents in the subsurface is influenced by the vadose zone geology and the characteristics (e.g., building construction, building use, existing ICM, etc.). VI ICMs were established in 2011 at certain Facility buildings and OCC has completed the quarterly inspection and reporting requirements outlined in the Interim Corrective Measures Operations and Maintenance Plan for the Administration Building, Technical Center and Control Building (CRA, 2011a) to document that the performance standards established to eliminate the potential for significant vapor intrusion are being met. Because of the existing ICM at these buildings, there is no potential for significant vapor intrusion into these structures. There is a potential for vapor intrusion into other Facility structures. This evaluation of the potential for vapor intrusion and determination of whether potential migration could be significant is discussed in the HHRA and summarized in Section 2.2 below.

2.1.3 DNAPL

The DNAPL source areas at the Site are associated with historical waste disposal practices. The chemical makeup and areal extent of DNAPL within the Site have been determined (CRA, 2014d; CRA, 2014a; CRA, 2014b). DNAPL was observed extending through the saturated zone in four areas at the Site: Eastern Hex Area, Northwestern Hex Area, Landfill Hex Area, and CT and Perc Area during the RFIs. The primary compounds that occur with DNAPL at the Site are carbon tetrachloride, chloroform, perchloroethylene pentachlorophenol, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, and benzene hexachloride. **Figure 15** presents the areas that exhibit indications of DNAPL. The Landfill ICM was designed and constructed to contain the wastes in place (e.g., Alpha Cake). The dissolved phase concentrations originating from the identified DNAPL sources are addressed on an ongoing basis by the Groundwater ICM.

The conceptual model for the Site is that released DNAPL traveled into the subsurface vertically along density gradients until a change in soil hydraulic conductivity caused horizontal migration. DNAPL moved horizontally until either the field capacity of the soil was reached, the edge of the lower conductivity seam was encountered, or the capillary pressure of the lower conductivity seam was exceeded. After the DNAPL stabilized in the subsurface, constituents in the DNAPL dissolved into groundwater according to Raoult's Law. Once in groundwater, the contaminant mass traveled along hydraulic gradients in the dissolved phase, as well as sorbing onto organic matter in the soil matrix and diffusing into secondary porosity in less conductive seams in the soil column. The existing Groundwater ICM captures the dissolved contaminant flux emanating from the DNAPL, sorbed mass, and mass in secondary porosity. Groundwater modeling and groundwater monitoring data indicate that the dissolved phase flux originating from DNAPL at the Site is currently captured

by the groundwater interceptor well system (Section 4.1.2). There are no completed exposure pathways between the DNAPL and any Site receptor, given the presence of capping and the operation of the Groundwater ICM. Furthermore, the DNAPL plumes are not expanding beyond their current boundaries, given the presence of the groundwater interceptor system.

With respect to the DNAPL present at the Site, the CMS has been streamlined to facilitate media-specific remedy selection following the principles outlined in the U.S. EPA's RCRA Corrective Action Plan Final and RCRA FIRST Toolbox. This methodology evaluates existing ICMs and potential remedial technologies to expedite final corrective measure alternative selection and implementation at the Site. The CMS Work Plan outlined a limited CMS to evaluate corrective measure alternatives for DNAPL at the Site.

A Mobility and Recoverability Pilot Study (Pilot Study) was performed using the protocol presented in Appendix A of the CMS Work Plan, the results of which are presented in **Appendix B** of this report. The Pilot Study results indicated a limited amount of DNAPL could be recovered manually from a recovery well screened through DNAPL under a natural gradient. The rate of recovery attenuated significantly over a short time, but reached relatively constant DNAPL recovery rate of approximately 27 gallons per day with a rapid decline in recovery rate after about 5 hours of sustained recovery. To sustain this rate, the DNAPL recovery had to be pulsed with a daily recovery period, resulting in a rate on the order of approximately 15 gallons per day. Based on case studies at other sites (**Appendix B**), the rate of recovery of DNAPL is expected to continue to decrease with time, likely reaching asymptotic levels within less than one year; however, the long-term asymptotic recovery rate is not known with accuracy. Hence, despite the likelihood that only a very small fraction of the DNAPL present is likely mobile, the performance of long-term DNAPL recovery from available locations within the active facility was recommended to better characterize long-term attenuation of the recovery rate with time.

This Site is an active chemical manufacturing plant with large portions of the ground surface largely covered by pavement (concrete, asphalt or gravel), tanks, buildings, roads, railroads, process lines and other infrastructure. Additionally, the subsurface has numerous process-related utility corridors (process piping, electrical, communications, etc.). Therefore, full implementation of remedial technologies which may require large scale surface or subsurface disturbance (such as tightly spaced injection wells, recovery trenches, or large-scale excavation) generally would not be feasible.

2.2 Human Health Risk Assessment

The HHRA for the Site was conducted in accordance primarily with the U.S. EPA Risk RAGS, Parts A, B, D, E, and F (U.S. EPA 1989, 1991a, 2001, 2004, and 2009) and other U.S. EPA guidance (U.S. EPA, 2000, 2005, 2014a), as stated in the U.S. EPA approved Work Plan (CRA, 2014c).

The purpose of the HHRA was to determine whether releases of chemicals to environmental media could pose unacceptable risks to human health under specific exposure conditions in each of the Exposure Areas (Process Area, Non-Process Area and Landfill Area) (**Figure 2**). The HHRA also provides information to support risk management decisions concerning the need for further evaluation of corrective measures based upon current and reasonably anticipated future land use.

Soil (including surface and subsurface soil), soil vapor, and groundwater were quantitatively evaluated within the HHRA assuming workers do not comply with existing worker protection measures, OSHA right to know or PPE requirements, as follows:

Exposure Area	Media	Potential Receptor	Potential Complete Pathway
Process Area	Soil	• Industrial/Commercial Worker • Construction/Utility Worker • Trespasser • Maintenance Worker	Ingestion Dermal Contact Inhalation
	Groundwater	• Future Industrial/Commercial Worker	Ingestion Dermal Contact Inhalation
	Soil Vapor	• Industrial/Commercial Worker	Inhalation
Non-Process Area	Groundwater	• Future Industrial/Commercial Worker	Ingestion Dermal Contact Inhalation
	Soil Vapor	• Industrial/Commercial Worker	Inhalation
Landfill Area	Soil	• Construction/Utility Worker • Maintenance Worker • Trespasser	Ingestion Dermal Contact Inhalation
	Soil Vapor	• Maintenance Worker	Inhalation
Off-Site	Groundwater	• Future Resident	Ingestion Dermal Contact Inhalation
	Soil Vapor	• Resident	Inhalation

Chemicals of Potential Concern (COPCs) were identified in soil and groundwater through comparison of the media concentrations to the applicable risk-based screening levels. GSH (or OCC) will put in place an institutional control to prevent future groundwater use for potable purposes.

2.2.1 Soil Vapor and Indoor Air

A subsequent soil vapor and indoor air investigation was undertaken in accordance with the "Vapor Intrusion Investigation Work Plan" (VI Work Plan) (GHD, 2016) that the U.S. EPA approved on September 22, 2016. This soil vapor investigation addresses the potential for VI associated with Facility-related volatile COCs that may migrate into buildings within the exposure areas at the Site identified by the Human Health Risk Assessment (GHD, 2017).

The 2016 VI Investigation Work Plan (GHD, 2016) identified and evaluated on-Site structures to determine where there was a potential for significant vapor intrusion. The following summarizes the initial identification of on-Site structures as part of the VI investigation:

- 236 structures were identified at the Site and included in the evaluation of potentially significant VI
- 190 of these 236 structures were determined to be routinely unoccupied structures and were excluded from further evaluation
- 46 structures were further evaluated as part of the VI Work Plan to document their characteristics

The characteristics of these 46 structures were compiled and evaluated per the VI investigation. This further evaluation identified that seven of these occupied structures had characteristics, e.g., elevated off the ground or having only three walls, that precluded additional evaluation for potential VI.

The remaining 39 structures identified through the implementation of the VI Work Plan included the three occupied buildings where ICMs for soil vapor are already in place. These three buildings are the Administration Building, Control Laboratory, and Technical Center (**Figure 16**), which have a soil vapor ICM installed to minimize the potential for building occupants to be exposed to chemicals present or potentially present in soil gas beneath the buildings. Therefore, these three buildings were not further evaluated as part of the VI investigation.

For the remaining 33 structures, a soil VI investigation was completed in 2017 and the information was incorporated into the HHRA. The VI investigation was conducted to assess the potential for significant VI into certain industrial buildings located on the Site from volatile organic compounds (VOCs) identified in soil and groundwater. The VI investigation included collecting samples (soil vapor) for laboratory analyses and building-specific data to provide multiple lines of evidence for the VI evaluation. The data from the VI investigation were used to evaluate whether the volatile COPCs identified in the approved VI Work Plan were present in soil vapor adjacent to the buildings at sufficient concentrations that could pose a potential threat to indoor air quality.

The HHRA compared the detected concentrations in soil gas to Generic Soil Vapor Screening Criteria. The Generic Soil Vapor Screening Criteria were calculated from U.S. EPA's Vapor Intrusion Screening Level (VISL) calculator using a generic default soil gas attenuation factor (based on residential buildings), commercial/industrial exposure assumptions, and a target cancer risk of $1x10^{-6}$, $1x10^{-5}$, and $1x10^{-4}$ and a hazard quotient (HQ) of 0.1. Reasonable anticipated future use of the Site does not include residential use.

2.2.1.1 Additional Soil Vapor Evaluation

As discussed in the HHRA, occupational exposure limits are the applicable indoor air standards at this Site, which is an operating chemical manufacturing facility. Therefore, the following criteria were used to further refine the 36 structures considered in this CMS:

1. Regulatory Limits – enforceable occupational exposure limits, i.e., OSHA Permissible Exposure Limit (PEL)

2. Recommended Limits – non-enforceable occupational exposure limits, i.e., California Division of Occupational Safety and Health Administration (Cal/OSHA) 8-hour Time Weighted Average (TWA) values

The Cal/OSHA 8-hour TWA values are the most conservative of the occupational inhalation exposure limits used in the evaluation of soil vapor data in the HHRA. U.S. EPA (especially in Region 5) has established a precedent at other active manufacturing facilities where OSHA monitoring and controls are active, e.g., where chemicals are used. At these other sites, which include the Allison Transmission (EPA ID IND006413348. 2014 Updated RCRA Corrective Action Corrective Measures Proposal and 2015 Statement of Basis, Indianapolis, Indiana) and Rolls-Royce Facilities (EPA ID IND000806836 and IND094469913. 2015 Updated Corrective Measures Proposal and 2015 Statement of Basis, Indianapolis, Indiana) and the Kokomo Bypass Facility (EPA ID IND000806851. 2015 Corrective Measures Proposal and 2016/2017 Statement of Basis, Kokomo, Indiana). U.S. EPA has agreed that monitoring and/or mitigation of the potential for VI from the same chemicals covered in the OSHA Right-to-Know program is inappropriate. Therefore, at these sites U.S. EPA has prepared its Statement of Basis to acknowledge that Corrective Measures are not necessary at these sites under the current land and groundwater use; however, institutional controls are necessary there to ensure that 1) the OSHA program remains active and current or 2) the potential for significant VI be re-evaluated and addressed as appropriate if the Site is no longer in compliance with the relevant portions of OSHA. Because the Wichita Facility is an active chemical manufacturing facility, occupational exposure limits are appropriate and are used in the evaluation of potential technologies and Corrective Measures.

The data from the 36 structures identified through the implementation of the VI Work Plan were compared to the occupational inhalation criteria identified above. From this occupational exposure limit screening, shown in **Tables 2.1 and 2.2**, four buildings in addition to the three with the current VI ICMs have the potential for significant VI.

Detected concentrations in soil vapor were higher than the Cal/OSHA criteria at four sampling locations (SG-1, SG-16, SG-18, and SG-19). The buildings adjacent to these sample locations and the description of the operations in these buildings are summarized in **Table 2.3.**

Table 2.3 Locations and Buildings where Soil Vapor Exceeded Applicable Screening Criteria

Sample Location	Associated Building	Building Description
SG-1	58 – Process Area	Warehouse / PCS Group Offices
SG-16	51 – Process Area	VCRU Control Room
SG-18	31 – Process Area	Drum Filling Warehouse
SG-19	10 – Process Area	CLM II Control Room

The additional evaluation in this CMS further investigates the building-specific data for these buildings to determine how the building construction and/or use influences the potential for significant VI.

2.2.1.2 Additional Structure Evaluation

As discussed above and as summarized in **Table 2.3**, Buildings 10, 31, 51, and 58 are the four buildings where the adjacent soil vapor data exceeds the VI screening criteria based on

occupational exposure limits. As part of the VI investigation, the physical characteristics of each of these buildings were documented to identify whether there was a potential for VI from the subsurface into indoor air that could result in vapor intrusion-related exposure. The characteristics of these four buildings are further evaluated in this CMS to assess the potential for significant VI exposure. The characteristics evaluated for each building include:

- Type of Structure
- Adjacent Surface Material(s)
- Building Utility Locations
- Exterior Construction
- Building Siting
- Building Ventilation
- Building Protrusions

The building description and building characteristics for each of these four buildings, which are part of the active chemical manufacturing operations, are presented in **Table 2.4**. As shown in this table, the operations in these four buildings include warehousing of chemicals, filling drums with manufactured chemicals, and control rooms to support chemical manufacturing within the Facility. Each of these buildings can contain small to significant amounts of the same chemical(s) detected in soil vapor during the course of normal operations because these buildings are utilized by employees to store, package, and manufacture the same chemicals that are manufactured at the Facility at concentrations above the occupational exposure limit (OEL)-based vapor intrusion criteria. These indoor sources can include chemical storage, materials/clothing that were also used in chemical manufacturing or storage areas, chemicals from outdoors that exchange with indoor air, or other sources of chemicals. Therefore, additional indoor air sampling to determine the existence of soil vapor intrusion may be inconclusive. Therefore, other building characteristics (discussed below) were further evaluated to determine what, if any, Corrective Measures (CMs) should be considered at these four buildings.

All four of these building are constructed of concrete or cinder block with poured concrete floors that could allow vapor migration into indoor air through cracks. The floors of each of these buildings are at least 10 inches thick and significant cracks through the entirety of the slabs are unlikely. The Facility conducts routine safety inspections in each of the buildings at the Site since they are part of the chemical manufacturing process. Routine safety inspections are used to identify and address work area hazards such as uneven or significantly cracked floors. The integrity of the floors in each of the four buildings was evaluated via visual inspection during a field survey performed on July 21, 2017. This survey did not identify significant displacement or cracks in the floors or the floor/wall interface. The concrete floors in Buildings 10, 31, and 58 are coated with either an epoxy or anti-slip surface; this type of coating further impedes potential vapor migration from the subsurface into these buildings by filling and sealing any minor cracks in the floor.

The surface cover around all four buildings is concrete pavement, except for a small section of gravel that is adjacent to the northwest portion of Building 51.

Buildings 31 and 58 (the warehouses), are ventilated through a combination of natural ventilation via large bay garage doors which are open during typical operations and mechanical ventilation

through heating, ventilation, and air conditioning (HVAC) near the offices and restrooms. The large garage doors increase the building ventilation rate well above the conservatively low generic mechanical ventilation rate inherent in the attenuation factor used at U. S. EPA's recommendation in the HHRA and the screening in this CMS. The high ventilation rate that occurs routinely in these buildings eliminates the potential for any significant accumulation of vapors via vapor intrusion in indoor air. Therefore, Buildings 31 and 58 were eliminated from further evaluation in this CMS.

Buildings 10 and 51 (the control rooms), are mechanically ventilated through existing HVAC systems and all of the exterior windows are sealed. There is a potential for vapor intrusion into Building 10 and Building 51, which are both utilized as control rooms for their respective chemical manufacturing processes, since the ventilation rates within these structures are unknown and, there is a high likelihood that the indoor air will mix with outdoor air during routine operations since these two buildings sit within the active manufacturing areas. However, the potential for a complete indoor air pathway due to soil vapor intrusion is low in these buildings since the floors consist of 10-inch thick epoxy-covered concrete which are intact.

Since there is a greater likelihood that the indoor air will be mixed with outdoor air (since the structures sit within the active manufacturing areas). Buildings 10 and 51 will be further evaluated in this CMS.

2.2.2 Off-Site Vapor Intrusion Exposure Pathway

The off-Site vapor intrusion exposure pathway was evaluated in the HHRA and determined that there were no concerns resulting from vapor intrusion from impacted off-Site groundwater (Section 3.3.1).

2.2.3 HHRA Conclusions

The HHRA concluded that the ICMs, worker protection protocols, and administrative controls that are currently in place are effectively interrupting exposure pathways for the potential receptors. The selection and implementation of Final Corrective Measures within each of the Exposure Areas at the Site will be necessary to interrupt potential receptor exposures to soil and groundwater.

2.3 Off-Site Sources

Two other properties adjacent to this Facility have active site investigations: the former Arkema Facility and the Gavilon Grain Facility (**Figure 17**). A voluntary cleanup investigation (VCI) was undertaken by Arkema under the oversight of the KDHE in two phases. These activities were summarized in a Comprehensive VCI Summary Report (ERM, 2010). Based on the generated data, the summary report recommended that a focused feasibility study be developed to address impacted media.

In 2014, the KDHE completed two groundwater investigations at and near the Gavilon Grain Facility (north of the OCC Facility). The results of the KDHE's investigation confirmed a separate carbon tetrachloride groundwater contamination source emanates from the Gavilon Grain Facility {KDHE, September 2014). Gavilon has since also entered into the KDHE Voluntary Cleanup Program and is currently in the process of conducting an investigation of impacts relating to its operations. The nature and extent of this source has not yet been fully delineated. The Facility's monitoring wells in the vicinity of this second source are gauged and sampled semi-annually and

the Facility's off-Site interceptor well recovery system collects and treats the impacted groundwater associated with this separate source (**Figures 7 and 8**).

2.4 Interim Corrective Measures

A number of Interim Corrective Measures (ICMs) have been initiated and are currently operating at the Wichita Facility. These ICMs will continue to be operated as ICMs and will be incorporated as final Corrective Measure Alternatives. The ICMs at the Site are summarized below.

2.4.1 Groundwater Interceptor Well System

The Groundwater ICM consists of 14 interceptor wells screened in separate sand aquifers beneath the Facility and surrounding areas. The locations of the interceptor wells in the shallow water-bearing unit (S2/S3) and the deeper water-bearing unit (S1) are shown on **Figures 18** and **19**, respectively. The interceptor wells operate in the two aquifers to maintain capture zones to prevent the migration of contaminants (CRA, 2010c) including all or a portion of the separate groundwater plume with the Gavilon Grain Facility. The ongoing effectiveness of the Groundwater ICM is monitored through the semi-annual groundwater gauging and sampling events.

Recovered groundwater from interceptor wells IW-40, IW-44, IW-45, and IW-46 are currently pumped to the IW Recovery and Treatment Facility on Hoover Road where the groundwater is currently treated by two parallel trains of two carbon beds in series. The facility has a design flow capacity of 600 gpm. The treated groundwater is discharged to the plant feed for production use; however, the NPDES permit also allows discharge to a permitted outfall on a tributary to Cowskin Creek, to Pond #2 in the Prairie Wetland Conservation Area, or for agricultural irrigation use. Installation of a system to provide pretreatment using an air stripper and bag filters prior to the carbon units has been completed and permitted and is currently under testing. This will allow for the addition of extracted groundwater from IW-43 to the treatment facility by April 2018. Recovered groundwater from the other interceptor wells (excluding IW-41 and IW-42) is pumped to the Plant Deep Well Disposal.

Recovered groundwater from interceptor wells IW-41 and IW-42 are pumped through forcemains to separate treatment facilities that each consist of two carbon beds in series. Each facility can treat a maximum of 100 gpm. The treated groundwater is discharged to a KDHE-permitted surface water outfall on a tributary to Cowskin Creek or used to irrigate adjacent agricultural properties.

2.4.2 Vapor Intrusion Mitigation System

A 2009 evaluation of the VI pathway for the Administration, Control Laboratory, and Technical Center (R&D Laboratory) buildings (**Figure 20**) indicated that compounds present (or potentially present) in underlying soil gas necessitated an ICM to address any potential concern. The VI ICM minimizes the potential for building occupants to be exposed to chemicals that are present or potentially present in soil gas beneath the building by operating the HVAC equipment to induce a positive pressure inside the building (CRA, 2009c). The HVAC equipment in the Administration Building was upgraded in 2010, and pressure monitors were installed in the Administration Building, Technical Center, and the Control Laboratory. The Wichita Facility completes quarterly inspection and monitoring of the VI ICM and provides the information in Quarterly Corrective Action Reports (CRA, 2010d).

2.4.3 Landfill Area Cap

The Alpha Cake Landfill, Hex Waste Pits, and the Brine Ponds (Landfill Area) collectively comprise approximately 40 acres at the southeast portion of the Site (**Figure 20**) and were closed in 1977 (Vulcan, 1986). The closure includes a two-foot thick compacted clay cap covered with four feet of soil fill material (Canonie, 1988; CRA, 2011c). As documented in the 1988 Canonie Environmental Engineer's Report, Closed Landfill Evaluation, Chloralkali/Chlorosolvent Manufacturing Plant (Canonie, 1988), a comprehensive barrier exists to prevent both direct contact and stormwater infiltration. Additionally, the clay soils comprising the Landfill cap have low hydraulic conductivities that serve as a hydraulic barrier to underlying soils (CRA, 2011c). The perimeter of the Landfill Area is surrounded by a chain-link fence. Periodic inspections as well as maintenance and repairs are performed on the final cap as necessary.

2.4.4 Asbestos Surface Impoundment Cap

The approximate location of the former Asbestos Surface Impoundment (ASI) is located in the southern portion of the Site shown on **Figure 20** and was used between 1952 and 1977 to dispose diaphragm cell regeneration wastes. In 1977, the plant began disposal of asbestos-containing wastes at off-Site licensed disposal facilities and use of the ASI was discontinued. Subsequent construction in the vicinity of the ASI resulted in covering and filling the ASI with soil, gravel, and concrete pavement. During routine maintenance activities in June 2005, asbestos-containing materials were identified in a gravel area in the vicinity of the No. 4 Cooling Tower (Weston, 2008). The Wichita Facility implemented an ICM by capping the ASI with concrete. The concrete provides an impervious surface and allows for machinery to be utilized in the area during cooling tower maintenance. Much of the surrounding area consists of asphalt or concrete. The Wichita Facility has a preventative maintenance program that requires routine inspection of concrete areas to monitor and confirm durability and sustainability.

3. Media Cleanup Standards

3.1 Soil

Tables 3.1, 3.2 and 3.3 identify the surface soil locations with soil concentrations for the COCs that were above industrial soil Regional Screening Levels (RSLs) (U.S. EPA, 2017) (target risk [TR] of 1×10^{-6} and target hazard quotient [THQ] of 1), in the Process, Non-process, and Landfill Areas, respectively. The soil COCs with concentrations above the industrial soil RSLs were considered to be COPCs and evaluated within the HHRA (GHD, 2017a) for the Site. The HHRA determined that risk estimates for the industrial/commercial worker in the Process Area and trespasser in the Landfill Area were above the U.S. EPA's limits for corrective action. In the Process Area pentachlorophenol in surface soil results in a cancer risk estimate above 1×10^{-4}. In the Landfill Area, alpha-hexachlorocyclohexane (alpha-BHC) in surface soil results in a cancer risk estimate above 1×10^{-4}.

Within the HHRA, a range of soil cleanup goals were developed using the U.S. EPA RSL calculator and the industrial/commercial worker and trespasser exposure assumptions. For each of these chemicals, two cleanup goals were calculated to assist in the development of corrective measures alternatives in the CMS.

Soil cleanup goals were calculated for both of these carcinogenic chemicals at a target cancer risk limit of 1 x 10^{-4} and THQ of 1. The cleanup goals are presented in the table below.

Table 3.4 Cleanup Goals

Medium	COPC	Exposure Area	Receptor	Risk Level	Cleanup Goal
Surface Soil	Pentachlorophenol	Process Area	Industrial/commercial Worker	1E-04	441 mg/kg
	alpha-BHC	Landfill	Trespasser	1E-04	458 mg/kg

As presented in **Table 3.5**, only one surface soil location (PA-54) within the Process Area has a concentration above the cleanup goal developed in the HHRA and provided above for pentachlorophenol. **Figure 21** shows the location of PA-54 within the Process Area.

Within the Landfill Area, only one surface soil location (P5SA) has a soil concentration of alpha-BHC above the cleanup goal developed in the HHRA, as shown in **Table 3.6**. This location is presented on **Figure 22**.

3.2 Groundwater

Groundwater elevation contour maps for the S2/S3 and S1 water-bearing units are presented on **Figures 18 and 19**, respectively. MCL or RSL (if no MCL is present) for indicator COCs (beta-BHC, carbon tetrachloride, hexachlorobutadiene, hexachloroethane, and perchloroethylene) have been utilized to prepare COC isoconcentration maps based upon the May 2017 semi-annual groundwater event (GHD, 2017b) for the S2/S3 and S1 water-bearing units (see **Figures 5-14**).

The Groundwater ICM is the existing groundwater remedial technology that has been successfully implemented at the Wichita Facility. The locations of the interceptor wells are presented on **Figure 23**. The interceptor/extraction wells operate to maintain cones of depression within the aquifers containing impacted groundwater to prevent migration of dissolved contaminants from the subsurface. The Groundwater ICM, which will be evaluated as a final corrective measure alternative, was evaluated for effectiveness as part of the CMS Work Plan and the results of the effectiveness evaluation are included in **Appendix A.**

3.3 Soil Vapor

Soil vapor has been investigated within the CMS Study Area (Process Area, Non-Process Area, and Landfill Area) from 2007 through 2011 (Shaw, 2008a; Shaw, 2008b; CRA, 2009c; CRA, 2010b; CRA, 2011a), and again in 2016 (GHD, 2016). Additionally, off-Site soil vapor in, and adjacent to, occupied residential structures down-gradient of the Facility was investigated 2008-2011 and again 2016/2017 (Shaw, 2008a; Shaw, 2008b; CRA, 2011b; GHD, 2016).

3.3.1 Off-Site Soil Vapor

Appendix F of the HHRA (GHD, 2017a) summarized historic and recent soil vapor sampling and compared the results to calculated Target Soil Vapor Concentrations (TSVCs). **Figure 24** presents the off-Site soil vapor sample locations. The HHRA concluded that the groundwater impacts located

approximately 24 feet bgs are not resulting in vapor intrusion concerns off-Site; therefore, off-Site soil vapor will not be considered further in this CMS.

3.3.2 On-Site Soil Vapor

Soil vapor within the CMS Study Area was investigated in the vicinity of the Administration, Control Laboratory, and Technical Center (R&D Laboratory) buildings during the RFI (CRA, 2014d) and an evaluation of the VI pathway indicated that compounds present (or potentially present) in underlying soil gas necessitated an ICM to address any potential concern (CRA, 2011). The VI ICM is discussed in Section 2.4.2 above and additional detail follows in Sections 4, 5, and 6.

Additional soil vapor investigation activities were performed within the CMS Study Area in 2016 (GHD, 2016), and the results are discussed in the HHRA (GHD, 2017a) and summarized below. The purpose of the VI investigation was to assess the potential for significant vapor intrusion to occur into the various industrial buildings at the Site from VOC impacted soil and groundwater at the Site. A step-wise approach was utilized to select the buildings within each exposure area that could potentially be evaluated further as part of the vapor intrusion investigation, details of the evaluation are presented in the VI Work Plan (GHD, 2016). A total of 26 soil probe locations were installed in the Process Area, Non-Process Area, and Landfill Area (**Figures 25, 16, and 26**) to assess the buildings that were retained for screening.

The soil vapor screening indicated VOCs were present in soil gas at all locations (**Figures 25, 16, and 26**) and the results are presented in **Table 3.7**. The HHRA compared the measured soil vapor concentrations to soil vapor criteria from the U.S. EPA's OSWER VISL Calculator (Version 3.5.1, May 2016 RSLs) and the results are presented in **Table 3.7**. These generic soil vapor criteria were developed based on an industrial/commercial worker exposure scenario, TR for carcinogens of 1×10^{-6}, 1×10^{-5}, and 1×10^{-4}, and THQ of 0.1 for non-carcinogens. The HHRA concluded that there was a potential for soil vapor concentrations that may result in unacceptable vapor intrusion in structures within the Process Area, Non-Process Area, and Landfill Area. Potentially complete exposure pathways for specific buildings were not evaluated or quantified during the HHRA and are evaluated in this CMS.

As part of this CMS, soil vapor criteria based on TR of 1×10^{-5} and THQ of 1 are used to demonstrate whether any mitigative measure is required to provide the necessary protection of the health of the workers, as necessary. These criteria are not cleanup goals for indoor air or soil vapor, but are screening levels that will be used as an initial threshold for determining whether the selected CM is operating or that additional CM are necessary.

3.4 DNAPL

The chemical makeup and areal extent of DNAPL within the Facility have been determined through the Site RFIs. DNAPL has been observed extending through the saturated zone in four areas at the Site: Eastern Hex Area, Northwestern Hex Area, Landfill Hex Area, and CT and Perc Area. The primary compounds that occur with DNAPL at the Site are carbon tetrachloride, chloroform, perchloroethylene, pentachlorophenol, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, and benzene hexachloride. Figure 15 presents the horizontal and vertical extent of areas that exhibit indications of DNAPL. The Landfill ICM was designed and constructed to contain the wastes in place (e.g., Alpha Cake). The dissolved phase concentrations originating from

the identified DNAPL sources are addressed on an ongoing basis by the Groundwater ICM. As residual DNAPL is present at depth, there is not any direct exposure to this media, therefore no cleanup goals have been developed; however, U.S. EPA guidance (U.S. EPA, 1997) states that "EPA generally expects that the quantity of free phase NAPL (i.e., "free product") should be reduced to the extent practicable and that an appropriately designed containment strategy should be developed for NAPLs that cannot be removed from the subsurface." The guidance also states, "Where significant quantities of potentially mobile DNAPL are identified, extraction should be considered in conjunction with containment. Extraction of potentially mobile DNAPLs will increase the long term reliability of the containment remedy as well as remove source material from the aquifer." DNAPL mass and volume are difficult to estimate, and it is unlikely that better than an order of magnitude estimate is possible. OCC has estimated that an order-of-magnitude volume of DNAPL present in the subsurface is approximately 4 million gallons (Appendix B).

A pilot study to evaluate DNAPL mobility and potential recoverability was performed as part of implementation of the CMS Work Plan and the results are presented in Appendix B. The mobility and recoverability pilot study results will be used to screen potential applicable technologies and develop corrective measure alternatives in Sections 4 and 5.

4. Identification, Screening, and Development of Corrective Measure Alternatives

This section identifies, describes, and provides a screening evaluation of corrective measure technologies (including existing ICMs) relevant to the identification and development of Site-specific CMAs and in accordance with the RCRA FIRST principles. The selected corrective measure alternative(s) will be the alternative(s) that can most effectively accomplish the CMS objectives. The following sections outline the CMS approach in more detail.

A summary of potential ARARs is presented in **Table 4.1.** The table was prepared based on KDHE Bureau of Environmental Remediation (BER) Policy BER-RS-015 (KDHE, 2005).

Several ICMs were initiated and are currently operating at the Site including the Groundwater Interceptor Well System, Vapor Intrusion Mitigation System, Landfill Area Cap, and ASI Cap. These ICMs are discussed in Section 2.4. Significant portions of the Process Area are covered by concrete, asphalt, or gravel. The Landfill Area Cap consists of 2 feet of clay and 4 feet of overlying fill (CRA, 2009e). The ASI is capped with concrete and asphalt. The Landfill Area Cap and ASI Cap are inspected on a routine basis and maintained. The existing Landfill Area Cap, ASI Cap, and impervious surface covers in the Process Area effectively eliminate direct exposure pathways to impacted soils beneath the covers, where present. Seeps have been observed intermittently at the toe of the southern perimeter of the Landfill Area. The existing covers or existing covers with modifications (e.g., Landfill Area Cap with seep collection) are components of the CMAs that are discussed in Section 4.2.

4.1 Identification and Screening of Technologies/Actions

As presented in the CMS Work Plan, the purpose of this section is to describe the applicability of the specific technology types, including process options identified for the CMS Study Area.

Identified technologies (including existing ICMs) are evaluated to determine whether the technology is feasible to implement at the Site. Technologies and ICMs which pass this screening are retained and carried forward to develop corrective measure alternatives. The corrective measures technologies are summarized in **Table 4.2**. The table presents a description of the potential technologies and relative costs. The corrective measure technologies are described below.

4.1.1 Soil

Soil ICMs are in place and complete in the Landfill Area and the ASI (**Figure 20**). Since this Site is an active chemical facility, large portions of the Site soils are covered with impervious or low permeability caps (**Figure 21**). Existing and proposed soil remedial technologies which are relevant to the Site include excavation, capping, seep collection, engineering controls, institutional controls, and monitoring. These technologies for soil are summarized below.

4.1.1.1 Excavation and On-Site Consolidation

Soil excavation is an effective means of source and residual contaminant removal where surface and shallow soil impacts exist. Soil excavation typically involves the use of standard earth-moving equipment such as tracked excavators and front end loaders. On-Site consolidation involves placement of excavated materials in a centralized location with similar materials.

Advantages of excavation and on-Site consolidation include:

- Complies with standards for management of waste
- May be implemented readily and effectively
- Consolidates similarly impacted material on the Facility property
- Involves less transportation of materials than off-Site disposal
- Is more cost-effective than excavation and off-Site disposal

Disadvantages of excavation and on-Site consolidation include:

- Requires additional measures (e.g., capping) to protect human health and the environment
- Will not reduce toxicity, mobility, or volume of impacted materials
- May generate emissions (Federal Remediation Technologies Roundtable (FRTR), 2017)
- May pose a safety hazard due to work with heavy equipment and materials, and exposure to impacted materials, the elements, and biological hazards

This technology may be used in conjunction with other technologies to protect human health and the environment. Excavation and on-Site consolidation is applicable to the complete range of contaminants and is potentially applicable for surface soil above cleanup goals that is not currently covered.

Excavation and on-Site consolidation will be included as part of CMAs for further evaluation in the CMS.

4.1.1.2 Excavation and Off-Site Disposal

Soil excavation is an effective means of source and residual contaminant removal where surface and shallow soil impacts exist. Soil excavation typically involves the use of standard earth-moving equipment such as tracked excavators and front end loaders. Excavated materials are transported to an off-Site disposal facility.

Advantages of excavation and off-Site disposal include:

- Provides off-Site disposal at a facility designed to protect human health and the environment
- Prevents exposure exceeding the approved cleanup goals by a potential receptor
- Contains the impacted materials to prevent potential exposures
- Reduces or eliminates the potential for COCs in soil to migrate to groundwater
- Complies with standards for management of waste

Disadvantages of excavation and off-Site disposal include:

- May generate emissions (FRTR, 2017)
- May pose a safety hazard due to work with heavy equipment and materials, and exposure to impacted materials, the elements, and biological hazards
- Requires off-Site transportation of excavated materials
- Is less cost effective than excavation and on-Site consolidation

Excavation and off-Site disposal is applicable to the complete range of contaminants and is potentially applicable for surface soil above cleanup goals that is not currently covered. Excavation and off-Site disposal involves more risks and is typically more costly than other equally effective technologies or alternatives. Areas of consolidation already exist at the Site that are capped and have been demonstrated to be effective in protecting human health and the environment.

This technology will not be evaluated further in the CMS.

4.1.1.3 Capping

Capping is an effective containment technology, which controls hazards by eliminating routes of exposure and reducing contaminant migration via isolation and elimination of vertical water infiltration. Capping typically involves engineered covers that are constructed of clean fill, compacted clay, asphalt, or concrete over impacted soil with standard earthmoving and construction equipment.

Advantages of capping include:

- Provides containment that is designed to protect human health and the environment
- Prevents exposure exceeding the approved cleanup goals by a potential receptor
- Contains the impacted materials to prevent potential exposures
- Reduces or eliminates the potential for COCs in soil to migrate to groundwater

Disadvantages of capping include:

- May generate emissions during construction
- May pose a safety hazard due to work with heavy equipment and materials, and exposure to impacted materials, the elements, and biological hazards
- Requires long-term maintenance
- Can be costly to construct

This technology may be used in conjunction with other technologies to protect human health and the environment. Capping is applicable to the complete range of contaminants and is potentially applicable for surface soil above cleanup goals that is not currently covered. There is available area to consolidate the excavated materials on Site in the SWMU area with similarly impacted materials.

Capping will be included as part of CMAs for further evaluation in the CMS.

4.1.1.4 Seep Collection

Seeps have occasionally been observed along the southern and southeastern edges of the Landfill Area. The seeps appear only following extended periods of rainfall and are thought to be rainwater that is migrating horizontally within the cap and discharging at the toe of slope of the cap. Seep collection typically involves the installation of underground, perforated drains in a permeable bedding to collect seep water. The seep water is commonly collected at a sump or manhole and pumped to a location for treatment and disposal.

Advantages of seep collection include:

- Provides hydraulic containment that is designed to protect human health and the environment
- Collects the seep water to prevent migration
- Reduces or eliminates the potential for COCs in soil to migrate to groundwater
- Complies with standards for management of waste
- May be implemented readily and effectively

Disadvantages of seep collection include:

- May pose a safety hazard due to work with heavy equipment and materials, and exposure to impacted materials, the elements, and biological hazards
- Requires long-term operation and maintenance

This technology may be used in conjunction with other technologies to protect human health and the environment. Seep collection is applicable to the complete range of contaminants and is potentially applicable for seep water that is occasionally observed along the southern and southeastern edges of the Landfill Area. The collected seep water would be pumped via forcemain to on-Site, deep well injection points.

Seep collection will be included as part of CMAs for further evaluation in the CMS.

4.1.1.5 Engineering Controls

Engineering Controls are an effective technology, often used in conjunction with other remedial technologies, which restricts potential receptor access to impacted areas. Engineering Controls can include fences, walls, security services, and surveillance. Engineering controls in the form of fences, security services, and surveillance exist at the Site.

Advantages of engineering controls include:

- Provides barriers and security that are designed to protect human health and the environment
- Restricts potential exposures to impacted media
- Complies with standards for management of waste
- May be implemented readily and effectively
- Is often cost-effective

Disadvantages of engineering controls include:

- Will not reduce toxicity, mobility, or volume of impacted materials
- Requires long-term implementation or maintenance

Engineering controls are applicable to the complete range of contaminants and are potentially applicable for non-Process Areas where the engineering controls (e.g., fences) would not interfere with active facility operations. In Process Areas, engineering and safety controls are in place for worker safety.

This technology will be included in a potential CMA for further evaluation in the CMS.

4.1.1.6 Institutional Controls

Institutional controls are non-engineered instruments such as administrative and legal controls that can minimize potential human exposure to impacted media. The Facility implements administrative controls that are a condition of employment for the workers and contractors at the Site. The administrative controls that are applicable to soil include:

- Soil handling permits (no intrusive work without prior review and approval by Facility Management)
- Routine safety inspections and related (follow-up) maintenance activities
- OSHA Right-to-Know briefings
- Work permits (which include PPE requirements) for maintenance activities related to soil activities

Additionally, the Facility has a current Deed Restriction in place (Figure I-1 of the RCRA Permit) that limits activities within certain areas of the Facility. The Site is zoned for industrial use and would be deed-restricted for future industrial use, consistent with the HHRA.

Advantages of institutional controls include:

- Provides deed notifications, use restrictions, and facility permit requirements that are designed to protect human health and the environment
- Restricts potential exposures to impacted media
- Complies with standards for management of waste
- May be implemented readily and effectively
- Is often cost-effective

Disadvantages of institutional controls include:

- Will not reduce toxicity, mobility, or volume of impacted materials
- Restricts future use of the land without additional corrective action

This technology may be used in conjunction with other technologies to protect human health and the environment, but not alone since it will not meet the threshold criteria. Institutional controls are applicable to the complete range of contaminants and are potentially applicable to the Site to augment existing controls.

Institutional controls will be included as part of CMAs for further evaluation in the CMS.

4.1.1.7 Inspection

Inspection consists of activities required to inspect/verify and maintain the effectiveness of an implemented remedial measure.

Advantages of inspection include:

- Provides inspection of corrective measures to protect human health and the environment
- May be implemented readily and effectively
- Is often cost-effective in identifying potential issues

Disadvantages of inspection include:

- Will not reduce toxicity, mobility, or volume of impacted materials

This action may be used in conjunction with other technologies to protect human health and the environment. Inspection is applicable to a wide range of remedial technologies and is potentially applicable for the Site.

Inspection will be included as part of CMAs for further evaluation in the CMS.

4.1.2 Groundwater

This CMS includes a third Groundwater Interceptor Well ICM Effectiveness Evaluation (2017 Groundwater ICM Evaluation) and the results are presented in **Appendix A**. The 2017 Groundwater ICM Evaluation assesses the current Groundwater Interceptor Well ICM system by reviewing the capture zones of existing interceptor wells, indicator COC trends in monitoring wells, and the

current groundwater monitoring program (sampling locations and regime). The 2017 Groundwater ICM Evaluation considered the following:

- The efficacy of the current pump and treat ICM as the final Corrective Measure for groundwater at the Site
- Groundwater chemistry trends and changes since the 2013 Groundwater Interceptor Well Effectiveness Evaluation
- Potential for installing another interceptor well in the vicinity of MW145S2/S3 to facilitate containment and treatment of b-BHC impacted groundwater
- Streamlining the future groundwater chemistry and hydraulic monitoring regime

The 2017 Groundwater Interceptor Well Evaluation concludes that the existing Groundwater Interceptor ICM is effective; but the current ICM will be modified to include an additional interceptor well IW47 to be installed in the S2/S3. Therefore, this modified ICM will be proposed as a final CMA for groundwater at the Site and will incorporate the following technologies: groundwater extraction, air stripping, carbon adsorption, monitoring, and institutional controls.

4.1.2.1 Groundwater Extraction

Groundwater extraction is a form of hydraulic containment. Extracted groundwater is often treated and then discharged or re-injected.

Advantages of groundwater extraction include:

- Provides hydraulic containment that is designed to protect human health and the environment
- May help control impacted groundwater to reduce or eliminate potential exposures
- May remove mass of impacted groundwater
- Complies with standards for management of waste

Disadvantages of groundwater extraction include:

- May take a long time to attain cleanup standards
- May require long-term operation and maintenance

This technology may be used in conjunction with other technologies to protect human health and the environment. Groundwater extraction is applicable to the complete range of contaminants and is applicable to the Site.

Groundwater extraction will be included as part of CMAs for further evaluation in the CMS.

4.1.2.2 Air Stripping

Air stripping involves the mass transfer of volatile contaminants from groundwater to air. Air stripping is a form of physical treatment where VOCs are partitioned from groundwater by increasing the surface area of the impacted groundwater by exposing it to air. Common aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.

Advantages of air stripping include:

- Provides physical treatment that is designed to protect human health and the environment
- Removes mass of impacted groundwater
- Complies with standards for management of waste

Disadvantages of air stripping include:

- May suffer from fouling and biofouling
- Is energy intensive
- May require long-term operation and maintenance

This technology may be used in conjunction with other technologies to protect human health and the environment. Air stripping is applicable to many volatile contaminants and is potentially applicable to the Site to augment other technologies.

Air stripping will be included as part of CMAs for further evaluation in the CMS.

4.1.2.3 Carbon Adsorption

Granular activated carbon is used to treat groundwater. Groundwater is pumped through vessels containing granular activated carbon (GAC). Dissolved organic contaminants adsorb to the carbon. The GAC must be regenerated periodically when the concentration of contaminants adsorbed on the GAC reaches a limit. The GAC vessels must be backwashed periodically to remove accumulated solids in the GAC units.

Advantages of GAC include:

- Provides treatment that is designed to protect human health and the environment
- Removes mass of impacted groundwater
- Complies with standards for management of waste

Disadvantages of GAC include:

- May suffer from carbon breakthrough
- May suffer from solids accumulation
- May require long-term operation and maintenance

This technology may be used in conjunction with other technologies to protect human health and the environment. GAC is applicable to many organic contaminants and is potentially applicable to the Site to augment other technologies. GAC will be included as part of CMAs for further evaluation in the CMS.

4.1.2.4 Monitoring

Monitoring consists of activities required to sample and monitor the effectiveness of an implemented corrective measure.

Advantages of monitoring include:

- Provides monitoring of corrective measures to protect human health and the environment
- May be implemented readily and effectively
- Is often cost-effective

Disadvantages of monitoring include:

- Will not reduce toxicity, mobility, or volume of impacted materials

This action may be used in conjunction with other technologies to protect human health and the environment. Monitoring is applicable to a wide range of remedial technologies and is potentially applicable for the Site. Monitoring will be included as part of CMAs for further evaluation in the CMS.

4.1.2.5 Institutional Controls

Institutional controls are non-engineered instruments such as administrative and legal controls that can minimize potential human exposure to impacted media. The Facility implements administrative controls which are a condition of employment for the workers and contractors at the Site. The administrative controls that are applicable to groundwater, including maintenance activities related to soils, include:

- Soil handling permits (no intrusive work without prior review and approval by Facility Management)
- Routine safety inspections and related (follow-up) maintenance activities
- OSHA Right-to-Know briefings
- Work permits (which include PPE requirements) for maintenance activities related to soil activities

Additionally, the Facility has a current Deed Restriction in place (Figure I-1 of the RCRA Permit) that limits activities within certain areas of the Facility. The Site is zoned for industrial use and would be deed-restricted for future industrial use, consistent with the HHRA. Groundwater use at the will also be deed-restricted.

Advantages of institutional controls include:

- Provides deed notifications, use restrictions, and facility permit requirements that are designed to protect human health and the environment
- Restricts potential exposure to impacted media
- Complies with standards for management of waste
- May be implemented readily and effectively
- Is often cost-effective

Disadvantages of institutional controls include:

- Will not reduce toxicity, mobility, or volume of impacted materials

- Restricts future use of the land without additional corrective action

This technology may be used in conjunction with other technologies to protect human health and the environment. Institutional controls are applicable to the complete range of contaminants and are potentially applicable to the Site to augment existing controls.

Institutional controls will be included as part of CMAs for further evaluation in the CMS.

4.1.3 Soil Vapor

4.1.3.1 Institutional Controls

Institutional controls are non-engineered instruments such as administrative and legal controls that can minimize potential human exposure to impacted media. The Facility implements administrative controls which are a condition of employment for the workers and contractors at the Site. The administrative controls that are applicable to soil vapor include:

- Routine safety inspections and related (follow-up) maintenance activities
- OSHA Right-to-Know briefings
- Work permits (which include PPE requirements) for maintenance activities related to soil activities

Additionally, the Facility has a current Deed Restriction in place (Figure I-1 of the RCRA Permit) that limits activities within certain areas of the Facility. The Site is zoned for industrial use and would be deed-restricted for future industrial use, consistent with the HHRA. An inspection and monitoring plan for soil vapor will be completed in the future.

Advantages of institutional controls include:

- Provides deed notifications, use restrictions, and facility permit requirements that are designed to protect human health and the environment
- Restricts potential exposure to impacted media
- Complies with standards for management of waste
- May be implemented readily and effectively
- Is cost-effective

Disadvantages of institutional controls include:

- Will not reduce toxicity, mobility, or volume of impacted materials

This technology may be used in conjunction with other technologies to protect human health and the environment. Institutional controls are applicable to the complete range of contaminants and are potentially applicable to the Site to augment existing controls.

Institutional controls will be included as part of CMAs for further evaluation in the CMS.

4.1.3.2 Monitoring

Monitoring represents periodic sampling of Site media to monitor Site contaminants. Monitoring results in no direct remediation of Site contaminants.

Advantages of monitoring include:

- Provides monitoring of corrective measures to protect human health and the environment
- May be implemented readily and effectively
- Is often cost-effective

Disadvantages of monitoring include:

- Will not reduce toxicity, mobility, or volume of impacted materials

This action may be used in conjunction with other technologies to protect human health and the environment. Monitoring is applicable to a wide range of remedial technologies and is potentially applicable for the Site.

Monitoring will be included as part of CMAs for further evaluation in the CMS.

4.1.3.3 Inspection

Inspection consists of activities required to inspect/verify and maintain the effectiveness of an implemented remedial measure.

Advantages of inspection include:

- Provides inspection of corrective measures that protect human health and the environment
- May be implemented readily and effectively
- Is often cost-effective in identifying potential issues

Disadvantages of inspection include:

- Will not reduce toxicity, mobility, or volume of impacted materials

This action may be used in conjunction with other technologies to protect human health and the environment,. Inspection is applicable to a wide range of remedial technologies and is potentially applicable for the Site.

Inspection will be included as part of CMAs for further evaluation in the CMS.

4.1.3.4 Pressurization

Pressurization is a modification of a building HVAC system to supply more air than is directly exhausted at the makeup air units. The operational objective of building pressurization is to create a downward pressure differential between the building interior and the subsurface. Once the system is established, any cracks or penetrations in the building floor will limit the transfer of air from the subsurface into the building due to the downward pressure differential. The pressure differential should cause exfiltration of building air through various escape paths in the building envelope. Building pressurization may be accomplished using normal HVAC systems. By supplying more air

than is directly exhausted at the makeup air units, the building develops a slight positive pressure provided that the building envelope is sealed sufficiently.

The building pressurization system will also require ongoing operation, maintenance, and monitoring to ensure the effectiveness of the system.

Advantages of pressurization include:

- Provides physical treatment using existing equipment that is designed to protect human health and the environment
- Prevents exposure to soil gas in exceedance of the cleanup goals
- May help control impacted soil vapor to reduce or eliminate potential exposures
- Complies with standards for management of waste
- Does not add significant costs to normal building operations

Disadvantages of pressurization include:

- Requires long-term operation and maintenance

This technology may be used alone or in conjunction with other technologies to protect human health and the environment. Pressurization is applicable to volatile contaminants and is potentially applicable to the Site to mitigate potential VI into buildings.

Pressurization will be included as part of CMAs for further evaluation in the CMS.

4.1.4 DNAPL

4.1.4.1 Institutional Controls

Institutional controls are non-engineered instruments such as administrative and legal controls that can minimize potential human exposure to impacted media. The Facility implements administrative controls that are a condition of employment for the workers and contractors at the Site. The administrative controls that are applicable to DNAPL include:

- Restrictions related to the use of groundwater from the S2/S3 and S1 water-bearing units
- OSHA Right-to-Know briefings
- Work permits (which include PPE requirements) for maintenance activities related to groundwater monitoring wells and interceptor wells

Additionally, the Facility has a current Deed Restriction in place (Figure I-1 of the RCRA Permit) that limits activities within certain areas of the Facility. The Site is zoned for industrial use and would be deed-restricted for future industrial use, consistent with the HHRA.

Advantages of institutional controls include:

- Provides deed notifications, use restrictions, and facility permit requirements that are designed to protect human health and the environment
- Restricts access to sources of releases to prevent further releases

- Complies with standards for management of waste
- May be implemented readily and effectively

Disadvantages of institutional controls include:

- Will not reduce toxicity, mobility, or volume of impacted materials
- Restricts future use of the land without additional corrective action

This technology may be used in conjunction with other technologies to protect human health and the environment, but not alone since it will not meet the threshold criteria. Institutional controls are applicable to the complete range of contaminants and are potentially applicable to the Site to augment existing controls. Institutional controls will be included as part of CMAs for further evaluation in the CMS.

4.1.4.2 Groundwater ICM

Site wide impacted groundwater is being captured through the continued implementation of the current Groundwater ICM. The DNAPL is effectively controlled by capturing the groundwater impacted by flux from the DNAPL. Additionally, DNAPL mass is being reduced by dissolution into groundwater that is captured. Disposal of the impacted groundwater is via treatment and discharge (Section 2.4.1).

Advantages of groundwater ICM include:

- Prevents further migration of impacted groundwater thus protecting human health and the environment outside the treatment area
- Reduces volume of impacted materials towards attainment of media cleanup standards
- Controls source of releases to reduce or eliminate further releases
- Complies with standards for management of waste
- Already implemented and effective

Disadvantages of groundwater ICM include:

- Does not directly remove DNAPL (i.e., relies on dissolution)
- Requires long-term operation and maintenance

Applicability to the Site is based on effective containment of the DNAPL and the anticipated dissolution rate of the DNAPL being an order of magnitude greater than the direct recovery rate of DNAPL mass (based on pilot study and case study data), given the large volume and associated surface area of the DNAPL at the Site.

Groundwater ICM will be included as part of CMAs for further evaluation in the CMS.

4.1.4.3 DNAPL Recovery from Vertical Recovery Wells

Vertical recovery wells are installed to create a preferential pathway for a media to be collected (via pumping) from the subsurface. Vertical recovery wells can only be installed in accessible locations that will not interfere with ongoing operations; therefore, installation is limited to discrete locations

within the DNAPL-impacted areas. Nested recovery wells could be installed within a portion of each of the DNAPL impacted areas. The DNAPL would be pumped from the nested recovery points to enhance mass removal. Once DNAPL recovery from a vertical recovery well becomes asymptotic, either a new vertical well will be installed (if an available location can be found); or DNAPL recovery will either be continued (if the recovery rate is sufficiently high even at the asymptotic rate) or discontinued and the recovery system abandoned. Recovered groundwater and DNAPL will be separated and recovered groundwater will be disposed via the Facility deep well injection system and recovered DNAPL will be disposed at a permitted off-Site disposal facility.

Advantages of DNAPL recovery from vertical recovery wells include:

- Directly removes DNAPL
- Reduces volume of impacted materials towards attainment of media cleanup standards
- Complies with standards for management of waste

Disadvantages of DNAPL recovery from vertical recovery wells include:

- Effectiveness is expected to be limited

This technology may be used in conjunction with other technologies to protect human health and the environment and reduce the volume of mass. It is potentially applicable to some areas of the Site that are accessible for well installation. Based on the pilot study results, the potential for long-term DNAPL recovery is likely to be limited (very low) and therefore the addition to groundwater capture may only marginally improve the effectiveness of the collection system. If significant rates of direct DNAPL recovery cannot be maintained over time, that improvement may be negligible. It is anticipated that DNAPL recovery will become asymptotic within the first year of operation. The remaining DNAPL that could not be treated would still need to be contained. However, this technology is available and easily implementable, and may somewhat enhance mass removal of the groundwater ICM.

DNAPL recovery from vertical recovery wells will be included as part of CMAs for further evaluation in the CMS.

4.1.4.4 DNAPL Recovery by Enhanced Vertical Recovery Wells

Enhanced vertical recovery technology involves increasing the mobility of DNAPL to the recovery point by up-gradient groundwater injection, vertical recovery well extraction (i.e., multiphase pumping), or application of vacuum at the vertical recovery wells (i.e., multiphase extraction). Any attempt to flood the up-gradient portion of DNAPL impacted area must be matched with side-gradient and down-gradient hydraulic control to ensure impacted groundwater with higher concentrations does not migrate to areas of lower concentrations. DNAPL and impacted groundwater could be collected using pumps or vacuum enhanced pumps from groups of recovery points. The effluent could be allowed to pass through a density separator, followed by off-Site disposal of the DNAPL fraction. The recovered water would require treatment before discharge.

Advantages of DNAPL recovery by enhanced vertical recovery wells include:

- Directly removes DNAPL
- Reduces volume of impacted materials towards attainment of media cleanup standards

- Complies with standards for management of waste

Disadvantages of DNAPL recovery by enhanced vertical recovery wells include:

- Phases need separation through a treatment system
- Effectiveness is expected to be limited; although better than DNAPL recovery from vertical recovery
- Significantly more complicated with only a marginal improvement in effectiveness over DNAPL recovery from vertical recovery wells alone

This technology may be used in conjunction with other technologies to protect human health and the environment and reduce the volume of mass. It is potentially applicable to some areas of the Site that are accessible for well installation; however, the feasibility to place wells and trenching at the active facility would limit the volume treated. Long-distance trenching is not an option within the Process Area, and as such, a separate liquid ring pump would be needed at each cluster of recovery points. The long-term management of this technology includes maintenance (pumping system, recovery well network, air treatment equipment, groundwater treatment equipment), and disposal (DNAPL and effluent). Remedial system failures and system fouling are possible. Based on the pilot study results, the potential for long-term DNAPL recovery is likely to be limited. Additional DNAPL recovery using vacuum enhancement in addition to groundwater capture may only marginally improve the effectiveness of the system. If significant rates of direct DNAPL recovery cannot be maintained over time, that improvement may be negligible. It is anticipated that DNAPL recovery will become asymptotic within the first year of operation. The remaining DNAPL that could not be treated would still need to be contained.

Based on the above, this technology is impractical to implement at an active facility in a manner that can address all the separate DNAPL areas at various depths and locations with varying geology. The placement of wells and trenches would be disruptive to facility operations, and the presence of existing structures and utilities makes full implementation impractical. Given this technology is more complicated, would require more infrastructure and maintenance, and would only be marginally more effective than the DNAPL recovery from vertical recovery technology, the benefit to cost would be low and therefore it will not be evaluated further in the CMS.

4.1.4.5 DNAPL Recovery Using Co-Solvent Injection and Recovery

DNAPL recovery using co-solvent injection and recovery technology involves the installation of nested injection/recovery points within a portion of the DNAPL area and injecting and recovering the co-solvent and dissolved chemical mass. Conceptually, co-solvents increase the saturation concentration of many constituents in DNAPLs, sometimes from 10 to more than 1000 times, meaning much more dissolved contaminant mass can be recovered per pore volume extracted. This helps to improve one of the major limitations of pump and treat systems, that is the amount of chemical mass that dissolves into water is often very small as compared to the amount of mass present, which requires long-term operation and maintenance. A Macro Porous Polymer (MPP) system would be required to recover the DNAPL from the co solvent / groundwater mixture. The captured DNAPL would be recovered from the MPP unit by steam regeneration and require off-Site disposal. Recovered water would require treatment before discharge.

Advantages of DNAPL recovery using co-solvent injection and recovery include:

- Increases the mass recovery rate via extraction by increasing the amount of dissolved mass
- Reduces volume of impacted materials towards attainment of media cleanup standards
- Complies with standards for management of waste

Disadvantages of DNAPL recovery using co-solvent injection and recovery include:

- Does not directly removes DNAPL
- Does not protect human health and the environment
- Does not fully prevent further migration of DNAPL
- Does not fully control source of releases to reduce or eliminate further releases
- Phases need separation through a treatment system
- Effectiveness is expected to be limited; although better than DNAPL recovery from vertical recovery alone
- More complicated and would require more treatment and maintenance than DNAPL recovery from vertical recovery
- Additional health and safety concerns with respect to storage and handling the solvent

Co-solvent extraction has been used at several sites to enhance DNAPL recovery from vertical recovery wells, but this technology is much less frequently used than the previously discussed technologies. One limitation for a co-solvent to be effective is that there must be physical contact between the co-solvent and DNAPL; meaning that the co-solvent must be able to flow past the DNAPL impacted area, making this method less reliable in low permeability formations, where residual amounts of the DNAPL is present at the Site. Another limitation is if the DNAPL itself limits groundwater flow where it is present, the co-solvent extraction will not be as effective. The ability to place wells and trenching at the active facility would limit the volume treated and ability to hydraulically control the system. Multiple MPP units would be required due to the inability to construct trenching to a central location due to the active nature of the Site, resulting in this methodology having a low benefit to cost ratio. Additionally, hydraulic control is critical, such that the injected co-solvent does not escape the capture radius of the system. The pH of the subsurface must be monitored, because poorly buffered aquifers can experience a dramatic reduction in pH, when ethyl lactate degrades to ethanol and lactate. Upon degradation, ethyl lactate's byproducts will act as electron donors, thereby increasing the level of biological attenuation, which will concomitantly increase the dissolution rate of the DNAPL.

Based on the above, this technology is impractical to implement at an active facility in a manner that can address all the separate DNAPL areas at various depths and locations with varying geology. The placement of wells would be disruptive to facility operations, and the presence of existing structures and utilities makes full implementation impractical. Given that this technology is more complicated, would require more infrastructure, operation, and maintenance, and would likely be only a little more effective than the DNAPL recovery from vertical recovery technology, the benefit to cost would be low and therefore it will not be evaluated further in the CMS.

4.1.4.6 DNAPL Recovery Using Horizontal Recovery Wells

This technology is similar to DNAPL Recovery Using Vertical Recovery Wells, except that horizontal wells would be used to avoid some of the difficulties associated with numerous vertical recovery points at an active facility. Groundwater and DNAPL would be recovered through horizontal wells installed at the base of the conductive zones containing DNAPL in each of the separate DNAPL impacted areas. Pumping would draw water and DNAPL toward the horizontal well. Blank pipe would be installed at the low point(s) in the horizontal well to allow the accumulation of DNAPL, which otherwise could flow back out of the horizontal well if the low point were not immediately underlain by a low permeability unit. Disposal of recovered DNAPL would be off-Site.

Advantages of DNAPL recovery from horizontal recovery wells include:

- Directly removes DNAPL
- Reduces volume of impacted materials towards attainment of media cleanup standards
- Complies with standards for management of waste

Disadvantages of DNAPL recovery from horizontal recovery wells include:

- Difficult to install horizontal wells to accurately intersect the DNAPL layers
- Effectiveness is expected to be limited

DNAPL, unless pooled, would not be easily recovered in the presence of water, due to density and viscosity differences. Not all DNAPL impacted areas could be reached even using multiple horizontal wells, given the limited operational space and the utility corridors that would limit the installation. In areas where horizontal well installation is possible, the horizontal wells could be installed length wise through the DNAPL impacted area, but the radius of influence along the width of each horizontal well is likely to be less than 20 feet. Hence, multiple horizontal wells would need to be installed along the width of each DNAPL impacted area and within each vertical zone in that area, which may not be feasible.

DNAPL recovery using horizontal recovery wells is less widely used than vertical well technology, and is rarely utilized in deep (>50 feet bgs) collection conditions. This technology is less reliable than vertical well recovery over long periods due to the potential for well fouling (and the expense of well replacement) and the potential that the screened interval does not properly intersect the DNAPL. The screened interval of the horizontal well may intersect higher transmissive zones where little DNAPL exists, and due to the length of the screened interval, this is where most of the fluid, mostly groundwater and not DNAPL, would be preferentially recovered. Another concern is that the horizontal well could act as a conduit to spread DNAPL along the well length. While the use of horizontal wells may allow more DNAPL to be targeted and potentially recovered, the potential for collecting mostly groundwater and mobilizing DNAPL obviates this potential effectiveness. Based on the Pilot Study results, the potential for long-term DNAPL recovery is likely to be limited due to geologic conditions and the depths of the DNAPL pools and therefore the expected additional effectiveness would be limited. The remaining DNAPL that could not be treated would still need to be contained.

Based on the above, this technology is impractical to implement at an active facility in a manner that can address all the separate DNAPL areas at various depths and locations with varying geology.

The placement of wells would be disruptive to facility operations, and the presence of existing structures and utilities makes full implementation impractical. Given this technology is more complicated than vertical well technology, would require more infrastructure and maintenance, and would potentially be marginally more effective than the DNAPL recovery from vertical recovery technology, the benefit to cost would be lower and therefore it will not be evaluated further in the CMS.

4.1.4.7 DNAPL Remediation Using In Situ Abiotic/Biotic Reduction

In situ biotic/abiotic treatment is considered an innovative technology and would typically be used on small sites. This technology involves the in situ destruction of DNAPL by either bioremediation from an added amendment or abiotic dechlorination using an injected amendment capable of lowering the oxidation-reduction potential (ORP). Abiotic and biotic reduction are separate processes but occur under the same conditions, and one rarely occurs without the other. Therefore, these two technologies are discussed together in this section. The amendment when combined with a fortified emulsified oil containing a slow release electron donor can maintain a very low ORP, which facilitates anaerobic biodegradation. Chlorinated compounds are often good electron acceptors, and zero-valent iron (ZVI) can provide electrons to chlorinated compounds, resulting in abiotic dechlorination. In many subsurface environments, the ORP is too high to support biotic or abiotic reductive dehalogenation. An electron donor such as ZVI can be added to lower the ORP, and the addition of the appropriate emulsified oil can provide electrons and carbon (in slow release form for biomass). Due to the difficulty of distributing ZVI, a grid of direct push points is commonly used to apply the initial dose. While micelles that contain ZVI can be pumped into a transmissive formation, this technology has few field proven applications, and cannot easily be used in lower transmissive soils. An oil-ZVI mixture could be injected using direct push technology in a limited number of areas of the Site due to the presence of various structures. Typically, pilot testing is necessary to determine the optimal injection quantities. Reapplications would be required approximately every five to 10 years. The long-term management of this alternative, above what is required for the ICM, includes periodic reinjections of the oil-ZVI mixture.

Advantages of DNAPL remediation using in situ abiotic/biotic reduction include:

- Directly treats DNAPL
- Reduces volume of impacted materials towards attainment of media cleanup standards
- Complies with standards for management of waste

Disadvantages of DNAPL remediation using in situ abiotic/biotic reduction include:

- Requires balancing of injected material to promote optimal conditions
- Does not fully control source of releases to reduce or eliminate further releases
- Effectiveness is limited in lower transmissive soils
- Large scale application has not been proven
- Larger number of injection points

Based on the above, this technology is impractical to implement at an active facility over a large area in a manner that can address all the separate DNAPL areas at various depths and locations

with varying geology. The direct push injection points will be less disruptive to Site activities since there would be no permanent installations; however, permanent monitoring points may need to be added that would be disruptive. The presence of existing structures and utilities makes full implementation impractical. However, partial implementation of this technology may be considered in some localized DNAPL-impacted areas. The variation of the hydrogeology would make it difficult to maintain optimal conditions, thus limiting effectiveness. The uncertainties of implementation and unproven effectiveness of this technology on a large scale at an active facility could result in escalating costs and for diminishing returns. The remaining DNAPL that could not be treated would still need to be contained. Treatment is not expected to have a significant measurable effect on remedial timeframe for the Site. Therefore, it will not be evaluated further in the CMS.

4.1.4.8 DNAPL Remediation Using In Situ Bioremediation

This technology involves in situ degradation of DNAPL by natural processes involving microorganisms. Chlorinated compounds are often good electron acceptors. In many subsurface environments, the ORP is too high to support reductive dehalogenation (or the microbial dechlorination of constituents composing the DNAPL). An electron donor can be added to lower the ORP, as well as adding organic carbon to provide for biomass and the nutrients nitrogen, phosphorus, and micronutrients. The addition of organic or inorganic compounds to cause indigenous microorganisms to effect bioremediation is referred to as biostimulation, and it can be accomplished by the addition of lactate for rapid, but not sustained, lowering of the ORP. Alternatively, the addition of a slow-release, emulsified oil substrate would allow longer-term electron donor release. Specific organisms known to be efficient at reductive dehalogenation for the COCs can be added, and this process is known as bioaugmentation. The most efficient method is the use of emulsified oil along with nutrient addition and bioaugmentation.

The key element in the design of a bioremediation system is distribution of the electron donor. Due to the difficulty of distributing emulsified oil, a grid of direct push points is commonly used to apply the initial dose. An emulsified oil could be injected using direct push technology in a limited number of areas of the Site due to the presence of various structures. Typically, pilot testing is necessary to determine the optimal injection quantities. Reapplications would be required approximately every 5 to 10 years.

Advantages of DNAPL remediation using in situ bioremediation include:

- Directly treats DNAPL
- Reduces volume of impacted materials towards attainment of media cleanup standards
- Complies with standards for management of waste

Disadvantages of DNAPL remediation using in situ bioremediation include:

- Requires balancing of injected material to promote optimal conditions
- Does not fully control source of releases to reduce or eliminate further releases
- Effectiveness is limited in lower transmissive soils
- Large scale application has not been proven
- Larger number of injection points difficult in plant environment

In situ bioremediation is considered a reasonably well understood technology. It has similar limitations to DNAPL remediation using in situ abiotic/biotic reduction. Additionally, it is not known whether strains of microorganisms can degrade the specific mixture of DNAPL at the Site under current Site conditions. The reliability and long-term effectiveness is less well known, especially in lower transmissive seams in the aquifer. Treatment is not expected to have a significant measurable effect on remedial timeframe for the Site.

Based on the above, this technology is impractical to implement at an active facility over a large area in a manner that can address all the separate DNAPL areas at various depths and locations with varying geology, similar to the previous technology. There are also similar uncertainties of implementation and unproven effectiveness of this technology on a large scale at an active facility could result in escalating costs and for diminishing returns. The remaining DNAPL that could not be treated would still need to be contained. However, partial implementation of this technology may be considered in some localized DNAPL-impacted areas. Therefore, it will not be evaluated further in the CMS.

4.1.4.9 DNAPL Remediation Using Thermal Treatment

This technology involves DNAPL recovery through heating the aquifer in conjunction with vapor extraction in the vadose/unsaturated zone. There are a number of methods available to apply thermal treatment, which include steam injection, hot water injection, electrical resistive heating, and radio frequency heating. In general, the increase in temperature increases the amount of contaminant that can be mobilized by increasing solubility, decreasing viscosity, and/or increasing the Henry's Law coefficient.

Steam injection involves sparging steam into the aquifer at multiple points throughout the impacted areas, by which means DNAPL mass is volatilized into the sparged steam. These vapors are then collected in the vadose zone near the surface.

Hot water injection involves pumping hot water into the aquifer at multiple points throughout the impacted areas. The introduction of hot water increases the solubility and viscosity of the DNAPL and allows more mass to partition into the hot water to be extracted. The concept of flooding the aquifer requires the ability to maintain very good hydraulic control, in order not to mobilize DNAPL.

Both electrical resistive heating and radio frequency heating elevate the temperature of the aquifer above the boiling point of the DNAPL and of the water, resulting in the movement of vaporized DNAPL to vapor collection wells placed within the vadose zone of the area to be heated.

Advantages of DNAPL remediation using thermal treatment include:

- Directly treats DNAPL
- Reduces volume of impacted materials towards attainment of media cleanup standards
- Complies with standards for management of waste

Disadvantages of DNAPL remediation using thermal treatment include:

- Large scale application has not been proven
- Larger number of heating points

- Best suited for open space
- High energy usage (carbon footprint)
- Vapor or groundwater collection and treatment is required

The effectiveness of steam injection would be limited because of the complex geology through which vapors would have to travel prior to reaching the unsaturated zone. The layering that separates the flow zones and the presence of structures precludes the ability to collect vapors at the surface. Furthermore, sufficient depth of homogeneous material is needed below the area to be sparged (without intervening lower transmissive seams that would cause preferential pathways) in order for the radius of influence to be sufficient at the depth to be treated. Preferential pathways limit the effectiveness of this technology at this Site. The number of sparge wells required to treat a sufficient volume of DNAPL would require a gridded sparge well network, which is impractical at the Site due to numerous Site structures.

Hot water injection has similar limitation to steam injection and the added need for hydraulic control within the treatment area to prevent contaminant migration adding to the overall cost. Additionally, treatment of the extracted water would be necessary. Similar to steam injection, implementation is impractical at the Site due to numerous Site structures.

Six phase heating is rarely used in areas with overlying operations and the presence of utilities due to safety concerns with the electrification of the subsurface. Thus, a system could only be applied over a very small part of the Site where no facilities or utilities are located, which would have minimal added benefit and added safety concerns. Treatment is not expected to have a significant measurable effect on remedial timeframe for the Site.

Based on the above, these technologies are impractical to implement at an active facility over a large area in a manner that can address all the separate DNAPL areas at various depths and locations. The placement of heating points would be disruptive to facility operations, and the presence of existing structures and utilities makes full implementation impractical (e.g., these technologies are not easily or safely implemented below occupied buildings). The remaining DNAPL that could not be treated would still need to be contained. The benefit to cost would be low due to the high costs of operation and maintenance. Therefore, these technologies will not be evaluated further in the CMS.

4.1.4.10 DNAPL Remediation Using In Situ Chemical Oxidation

This technology involves chemical oxidants used to destroy DNAPL in situ through direct oxidation. Chemical oxidants are distributed in the DNAPL impacted area, and after the natural oxidant demand of the aquifer is overcome, the chemical oxidants directly contact the surface of the DNAPL and oxidize the boundary layer, as well as any aqueous constituents in transmissive zones where the oxidant can be delivered. The key to proper application is distribution of the oxidant. Several chemical oxidants have been widely used, namely ozone, hydrogen peroxide, sodium permanganate, and potassium permanganate. Ozone is a gas that is sparingly soluble. The injection of hydrogen peroxide along with iron (Fenton's reaction), sodium permanganate or potassium permanganate can provide a powerful oxidant. In Situ Chemical Oxidation (ISCO) technologies are still considered relatively innovative (although they have a good application history

and record of accomplishment at petroleum sites), with few successful DNAPL demonstration sites to date. This technology is generally used at small sites.

Advantages of DNAPL remediation using ISCO include:

- Directly treats DNAPL
- Reduces volume of impacted materials towards attainment of media cleanup standards
- Complies with standards for management of waste

Disadvantages of DNAPL remediation using ISCO include:

- Large scale application has not been proven
- Larger number of injection points
- Best suited for small sites
- Natural oxidant demand of the aquifer will use the chemicals preferentially

As in the case of steam sparging discussed above, this technology is poorly suited for complex geologies, and a fairly broad depth (without lower transmissive seams) is needed below the DNAPL in order for the radius of influence of the injection wells to allow distribution, and preferential pathways limit the effectiveness of this technology. Hydrogen peroxide degrades fairly rapidly in the subsurface and so distribution requires numerous closely spaced injection wells, which would be difficult given the building locations. A concern is that Fenton's reaction can be violent, and it should not be implemented below active facilities on a broad scale for reasons of safety. Injection of sodium permanganate and potassium permanganate have the same distribution issues as hydrogen peroxide. Chemical oxidants in general as a class lack effectiveness for DNAPLs. Chemical oxidants are by their nature hydrophilic and can only destroy DNAPL at contacted surfaces. Given the distribution of DNAPL in complex media, this is rarely possible. Generally, chemical mass in the higher transmissive zones is rapidly destroyed, and rebound occurs after flux from the DNAPL is reestablished from the lower transmissive zones. Despite good initial results, numerous studies have indicated poor performance of chemical oxidants at DNAPL sites with complex geologies over the long term because of untreated mass resulting in back diffusion.

This technology could only be safely implemented over a small area of the Site due to the current activities. Treatment over a large area is not expected to have a significant measurable effect on remedial timeframe for the Site. However, partial implementation of this technology may be considered in some localized DNAPL-impacted areas.

Based on the above, these technologies are impractical to implement at an active facility over a large area in a manner that can address all the separate DNAPL areas at various depths and locations with varying geology. The gridded injection points will be disruptive to Site activities, and the presence of existing structures and utilities makes implementation impractical (e.g., for some of the oxidants, these technologies are not easily or safely implemented below occupied buildings) in most areas. The remaining DNAPL that could not be treated would still need to be contained. Therefore, this technology will not be evaluated further in the CMS.

4.2 Corrective Measure Alternative Development

This CMS has been streamlined to facilitate media-specific remedy selection following the principles outlined in the U.S. EPA's RCRA Corrective Action Plan Final and RCRA FIRST Toolbox. This methodology evaluates existing ICMs and potential remedial technologies to expedite final corrective measure alternative selection and implementation at the Site. The CMS Work Plan identified a limited CMS or no CMS for each of the media at the Site (**Figure 3**). The CMA development path for each media is summarized below:

- Soil – Limited CMS – utilize existing ICMs which are proven and effective remedies suitable as a final remedy and utilize proven and effective technologies to address additional areas identified in the HHRA which require corrective action
- Groundwater – Limited CMS – utilize the existing ICM which is a proven and effective remedy suitable as a final Corrective Measure and supplement with additional measures to reduce the size of dissolved plumes to within the plant boundaries where practicable
- Soil Vapor – Limited CMS – evaluate the existing ICM which is proven and effective as a final remedy and utilize proven technologies to address additional areas identified in the HHRA which require corrective action
- DNAPL – Limited CMS – utilize the results of the pilot study to evaluate a limited set of potential remedial technologies

Detailed discussion of the CMA development for each media is presented in the following sections.

4.2.1 Soil

The existing surface covers throughout the facility including the SWMU area provide for an effective system of remedial technologies addressing the soil CAOs (control sources of releases, reduce/eliminate potential migration to groundwater, and prevent exposure exceeding the approved cleanup goals) over most of the facility. The existing surface covers include asphalt and concrete areas (i.e., impervious covers) and a landfill cap consisting of two feet of clay soils with low hydraulic conductivities, which serves as a hydraulic barrier to underlying soils, covered by four feet of protective soil material.

The Facility has plans in place to address potential releases in the Process Area and the existing impervious surfaces will prevent stormwater infiltration and subsequent downward migration of COCs in shallow soil to groundwater. The Landfill is inactive eliminating the potential for future releases in this area.

The potential migration of COCs from soil to groundwater via soil leaching in the Process Area is reduced/eliminated by the presence of the existing impervious covers and storm water drainage system (surface contours and collection systems) which prevent the vertical migration of surface water and ponding, respectively. In the Landfill Area, the low hydraulic conductivity clay prevents vertical migration of surface water and the slopes/contours of the cover soils promote horizontal surface water drainage away from the Landfill to prevent ponding. In both cases, potential contact with COCs in soil is prevented. Current conditions below and surrounding the Landfill, which has been closed since 1977, do not indicate leaching of contaminants to groundwater based on the ongoing groundwater monitoring program. It is noted that seeps have occasionally been observed

along the southern and southeastern edges of the Landfill Area. These appear only following extended periods of rainfall and are thought to be rainwater that is migrating horizontally within the cap and discharging at the toe of slope of the cap. It is unlikely that these seeps are in contact with COCs. However unlikely because of their source and infrequency, these seeps may present a point of exposure and are creating maintenance issues with the landfill cap.

The HHRA identified two locations where COCs exceed the approved cleanup goals. One location (PA 54) is located in the Process Area and is below concrete, effectively preventing potential exposure. The second location (P5SA) is located south of the Landfill and not below an existing cover system.

As evidenced above, current conditions effectively address the soil CAOs except at location P5SA and potentially for the seeps. These locations will be addressed by corrective measures.

The CMA for soil is discussed below and presented on **Figure 27**.

4.2.1.1 Soil CMA S1 – Excavation, Consolidation, Cover, Seep Collection and On-Site Discharge, and Inspection

The soil CMA S1 consists of the following:

- Excavation of impacted surface soils above risk-based standards (TR of 1 x 10^{-4} and THQ of 1) to a depth of 2 feet bgs, if the surface of the impacted area is not already covered
- Consolidation of excavated impacted soils to an appropriate area of the Site (e.g., the Landfill Area)
- Backfilling of the excavation area with clean soil, grading, and seeding with native species
- Construction of a cover (2 feet of compacted clay overlain by seeded topsoil) over the consolidated materials and graded to ensure with positive drainage
- Maintenance of existing fence, including posting of signs, around consolidation area
- Installation of a seep collection system at the southern toe of the Landfill Area that consists of a perforated drain pipe surrounded by a gravel bedding wrapped in a liner/sheeting
- Pumping of collected seep water from a collection sump via a forcemain to an existing on-Site deep well injection point
- Performing quarterly mowing, inspections, maintenance (including repair and replacement of cover, seep collection system, fence, and signs) and documentation, as needed
- Implementation of a soil handling/management procedures using a plant permit

4.2.1.1.1 *ASI*

The existing cover in the ASI consists of approximately 10,000 square feet (SF.) of concrete cover that was installed as an ICM. The ASI Cap is inspected on a routine basis and maintained.

4.2.1.1.2 *Process Area*

The existing cover in the Process Area in the vicinity of surface soil location PA-54 is a concrete slab with a surface area of approximately 2,000 SF. that is surrounded by gravel.

4.2.1.1.3 *Landfill Area*

The proposed CMA for the Landfill Area includes:

The excavation area will be backfilled with clean soil, graded, and seeded with native species. A cover that is comprised of 2 feet of compacted clay overlain by seeded topsoil will be constructed over the consolidated, impacted surface soils. The cover will be graded for positive drainage. The existing fence in the Landfill Area will be maintained and posted with signs. The remedial approach will be:

- Excavation of an estimated 3,000 cubic yards (CY.) of impacted surface soil to the south of the Landfill Area in the vicinity of surface soil location P5SA
- Consolidation of the 3,000 CY. of impacted surface soil within the Landfill Area
- Backfill of the excavated area with clean soil, graded, and seeded with native species
- Construction of a cover (2 feet of compacted clay overlain by seeded topsoil) over the consolidated materials with positive drainage
- Maintenance of existing fence including posting of signs
- Installation and maintenance of a seep collection system as described below

The installation of the 2,200-foot, seep collection system includes the excavation of an estimated 800 CY. of material for the collection trench along the southern toe of the Landfill Area. The collection trench would be keyed into the interface between the topsoil and clay of the existing cover system. A 30-mil poly continuous sheeting would be installed along the bottom, sidewall, and top of trench. The seep collection system would consist of a 12-inch diameter, perforated HDPE pipe placed in a 1/2-inch, clean washed gravel bedding. The poly would be covered on top with 3 inches of gravel. A 3-foot by 3-foot by 3-foot concrete collection sump with a pump would be installed as part of the seep collection system. The excavated material may be consolidated with the 3,000 CY. excavated near P5SA or used as backfill at the Site, as appropriate. Details related to this corrective measure alternative are presented on **Figure 28**.

4.2.1.1.4 *General Discussion*

The cover system with soil handling/management procedures would be protective of human health and the environment by effectively eliminating direct contact exposure for Site receptors. The cover system would minimize infiltration through the impacted consolidated surface soils and reduce the potential migration of COPCs from covered soil to groundwater. Containment would eliminate the completed pathway and exposure above the risk-based standards (TR of 1×10^{-4} and THQ of 1).

Quarterly inspection and repair, as necessary, would generate a minimal amount of energy use and materials use. Minimal waste would be generated through the inspection and repair, as necessary. The consolidated, impacted soil would be non-hazardous so management of wastes would not be an issue. Regular review and inspection can be implemented either coincident with other Site activities or by Site personnel. The CMA can be completed using readily available equipment and materials, so the length of time to implement is short.

4.2.2 Groundwater

The existing Groundwater ICM has been in place since 1997 (Groundwater Model Calibration Corrective Measures Study, Camp Dresser & McKee, 1997). The number of wells and pumping rates have changed over time based on field observations. The Groundwater ICM is an effective system of remedial technologies, which currently includes 14 groundwater recovery wells, and a network of 170 monitoring wells and piezometers. Statistical analysis of groundwater concentrations has shown downward trends in several off-Site wells. The effectiveness of the Groundwater ICM was evaluated as part of this CMS (**Appendix A**) and the results of the evaluation are incorporated into CMA G1, which consists of the following:

- Maintain institutional controls at the Site including deed recordation associated with the Facility's RCRA Permit
- Continue groundwater recovery and treatment operations with the existing 14 recovery wells
- Install one new interceptor well (IW-47) near MW-145S2/S3 to address recent increasing concentrations of beta-BHC
- Evaluation of additional measures to reduce the size of plumes originating from the OCC facility to within the facility boundaries
- Update the monitoring well regime to remove 21 monitoring wells
  - Eleven wells in the S4
  - Five wells in the S2/S3
  - Four wells in the S1
- Updated monitoring frequency and COC parameter list per the recommendations in **Appendix A**

The groundwater recovery system is protective of human health by effectively eliminating direct contact by a potential receptor. Additionally, the system contains the dissolved-phase constituents and prevents further migration via the capture and treatment. Recovered groundwater is treated via granular activated carbon and/or disposed via the Facility's deep well injection system; therefore, additional waste management is not an issue.

This alternative would have a minimal environmental footprint as the bulk of the system has already been constructed. Operation of the system generate a moderate amount of energy use and materials use. Installation of the additional recovery well will be a short duration. The system is anticipated to operate for at least the next 25 years and will be monitored on a semi-annual, annual, and biennial frequency to ensure the system is operating as designed. However, continued release of VOCs from non-OCC sources makes determining the length of time necessary to meet CAOs difficult. The effectiveness of the recovery system will be evaluated on a periodic basis to ensure the recovery system is operating efficiently. The corrective measure alternative groundwater are presented on **Figure 29**.

4.2.3 Soil Vapor

The CMA for soil vapor is discussed below and presented on **Figure 30**.

4.2.3.1 Soil Vapor CMA V1 – Process Area Buildings 10 and 51: Existing Vapor Intrusion ICM, and Building Inspection

The soil vapor CMA V1 consists of the following:

- Building pressurization including operation, monitoring, and maintenance, if required
- Development and implementation of an inspection and monitoring plan to monitor the condition of the buildings, if required
- Inspection and documentation of the current condition of the floor and walls in contact with the ground within each of these control rooms to confirm no significant unsealed cracks, openings, floor penetrations are present that would allow for migration of vapors from the subsurface into indoor air, if required
- Review of plans for possible changes to the building envelope (windows, doors, vents, etc.) and work orders to determine what changes could increase the potential for vapor intrusion, if required
- Inspection of the floors and walls that are in contact with the ground to identify any new significant unsealed cracks, openings, floor penetrations, if required
- Repair and/or seal significant unsealed cracks, openings, floor penetrations, if required

4.2.3.1.1 Administration Building, Technical Center, and Control Laboratory

The existing soil vapor ICM consists of building pressurization to prevent the migration of soil gas into the structures. The proposed CMA for the Administrative Building, Technical Center, and Control Laboratory includes:

- Building pressurization
- Operation and Monitoring
- Maintenance

This CMA was previously evaluated (CRA, 2009c) and selected for its ability to protect human health and reduce the mobility of VOCs in soil gas. The system has been operational since 2010 and its effectiveness is monitored on a quarterly basis. The HHRA confirmed the system is operating as designed and is interrupting the potential exposure pathway for indoor air.

This alternative would have a minimal environmental footprint because the infrastructure for the ICM is already in place. The ICM has some increased energy use over possible passive alternatives, but the overall energy use is lower than historic use because the Facility upgraded its HVAC system in 2012-2013. Negligible amounts of materials will be required, and negligible to no waste will be generated through the continued operation and monitoring.

4.2.3.1.2 Process Area: Buildings 10 and 51

The proposed CMA for Buildings 10 and 51 includes:

- Develop and implement an inspection and monitoring plan to monitor the condition of the buildings.

- Inspect and document the current condition of the floor and walls in contact with the ground within each of these control rooms to confirm no significant unsealed cracks, openings, floor penetrations are present that would allow for migration of vapors from the subsurface into indoor air.
- Review- plans for possible changes to the building envelope (windows, doors, vents, etc.) and work orders to determine what changes could increase the potential for vapor intrusion.
- Inspect- the floors and walls, which are in contact with the ground to identify any new significant, unsealed cracks, openings, floor penetrations.

Repair and/or seal significant unsealed cracks, openings, floor penetrations.

This alternative would have a minimal environmental footprint. Inspection and repair, as necessary, will generate a minimal amount of energy use and materials use. Negligible to no waste will be generated through the inspection and repair, as necessary.

4.2.4 DNAPL

4.2.4.1 DNAPL CMA D1 - Vertical Recovery Wells and CMA G1

The DNAPL CMA D1 consists of the following:

- Continued operation of the groundwater interceptor well system (CMA G1)
- Installation and operation of nested vertical recovery wells
- Deed restrictions for groundwater use
- Annual- system effectiveness evaluations

This alternative will incorporate containment (groundwater interceptor well system) with mass removal (nested or individual vertical recovery wells) in DNAPL-impacted areas at the Facility. Nested vertical recovery wells will be installed in areas where DNAPL is present in both the S2/S3 unit and S1 unit. DNAPL would be collected using local pumping systems located near each set of nested or individual DNAPL recovery points (**Figure 31**). The Facility is an active plant and the location of numerous recovery wells will be difficult to implement at the Site. Seven nested DNAPL recovery wells (i.e., one recovery well in the S2/S3 and one recovery well in the S1 at each nested location) and three individual DNAPL recovery wells (i.e., one recovery well in the S2/S3) will be installed in accessible locations that will not interfere with Facility operations (**Figure 31**). Each recovery well will be 6 inches in diameter and have up to 3 feet of blank casing at the bottom, creating a sump. The screened interval for each set of nested recovery wells will be set at the base of the more hydraulically conductive unit containing DNAPL, and care will be taken to create a seal between hydraulically conductive units. A typical vertical recovery well construction detail is presented on **Figure 32**. A downwell pump will be used to pump DNAPL generally no more than 20 to 40 feet to an enclosed area containing a control panel and a drum to collect the pumped DNAPL. Two interface probes will be installed in each recovery well such that one probe will cause the pump to shut off when the level of DNAPL in the well is near the bottom of the recovery well, while the other probe will turn the pump on when the DNAPL increases to a level above a predetermined depth in the recovery well. A third probe will be installed in the DNAPL collection drum as a high

shutdown control. The DNAPL collection drums will be emptied on a regular basis and the DNAPL will be disposed of properly.

The 10 nested recovery points were placed at low spots within the monitored zone of the DNAPL-impacted area as shown on **Figure 31**. After the 10 nested DNAPL recovery points are installed, DNAPL will be recovered daily from each point for one year or until DNAPL recovery decreases to asymptotic levels. As discussed above, based on other case studies, the DNAPL recovery rate is expected to attenuate with time; hence, the rate of recovery will be monitored over time. If, during this time, the recovery rate decreases asymptotically due to daily recovery, the schedule for DNAPL recovery at the 10 points will be adjusted to a lower frequency. Depending on the magnitude of the asymptotic recovery rate, DNAPL recovery will continue, the recovery period between attempts to recover DNAPL would be reduced, or DNAPL recovery would be discontinued. Collected DNAPL will be drummed and disposed of properly. The system could be fully implemented within six months.

5. Evaluation of Corrective Measure Alternatives

5.1 Threshold and Balancing Criteria

5.1.1 Threshold Criteria

The CM alternatives will be compared to the threshold criteria outlined in the facility's Permit (KDHE & U.S. EPA, 2007). The threshold criteria are summarized below.

- Protection of human health and the environment
- Attainment of media cleanup standards set by, or risk-based standards approved by, EPA
- Controlling the sources of releases to reduce or eliminate further releases that may pose a threat to human health or the environment
- Compliance with applicable standards for management of wastes

To be selected as a corrective measure alternative, the corrective measure must meet the threshold criteria.

5.1.2 Balancing Criteria

The CM alternatives will be compared to the balancing criteria outlined in the facility's Permit (KDHE & U.S. EPA, 2007) and the RCRA FIRST balancing criteria. A brief discussion of the balancing criteria is presented below.

5.1.2.1 Long-Term Reliability and Effectiveness

This criterion requires that the selected corrective measure alternative have long-term reliability and effectiveness. To establish the degree of certainty that the remedy will prove successful, each corrective measure alternative was evaluated to assess the following factors over a 30-year timeframe:

- Magnitude of residual risks

- Type and degree of long-term management required
- Exposure potential of humans and environmental receptors to remaining wastes
- Long-term reliability of the engineering and institutional controls
- Potential need for replacement of the remedy

5.1.2.2 Reduction of Toxicity, Mobility, or Volume

This criterion requires that the selected corrective measure alternative reduce toxicity, mobility, and volume. Each corrective measure alternative is assessed to understand the degree to which toxicity, mobility, or volume of hazardous wastes (including hazardous constituents) are reduced by the alternatives at the Site. The following factors were considered:

- The treatment processes that the remedies employ and materials that are treated
- Amount of hazardous wastes (including hazardous constituents) that would be destroyed or treated
- The degree to which the treatment is irreversible
- The residuals that will remain following treatment while considering the persistence, toxicity, mobility and propensity of hazardous constituents to bio-accumulate

5.1.2.3 Short-Term Effectiveness

This criterion requires that the selected corrective measure alternative has short-term effectiveness. To assess the short-term effectiveness of each corrective measure alternative, the following factors were considered:

- Magnitude of reduction of existing risks
- Short-term risks that might be posed to the community, workers, or the environment during implementation of the remedy, including potential threats to human health and the environment associated with excavation, transportation, re-disposal, or containment
- Time until full protection is achieved

5.1.2.4 Implementability

This criterion requires that the selected corrective measure alternative be implementable. The ease or difficulty of implementing each corrective measures alternative was assessed by considering the following types of factors:

- Degree of difficulty associated with constructing the technology
- Expected operational reliability of the technology
- Need to coordinate/obtain necessary approvals and permits from other agencies
- Availability of necessary equipment
- Available capacity and location of needed treatment, storage, and disposal services

5.1.2.5 Community Acceptance

This criterion estimates the relative support of the community for the CMAs.

5.1.2.6 State Acceptance

This criterion estimates the relative support of the state agency for the CMAs. This criterion includes technical and administrative concerns regarding the CMAs.

5.1.2.7 Compliance with ARARs

This criterion requires that the corrective measure alternative be compliant with ARARs. ARARs are defined as chemical-specific, location-specific, or action-specific.

Chemical-specific ARARs address chemical or physical characteristics of compounds or substances at sites. Chemical-specific ARARs commonly specify acceptable concentrations for Site media.

Location-specific ARARs are restrictions related to the geographical or physical location of the Site rather than the nature of the contamination at the Site.

Action-specific ARARs are activity-based or technology-based restrictions related to hazardous materials. Action-specific ARARs direct how remediations are performed.

To Be Considered (TBC) criteria (e.g., advisories, guidance, or regulations) may be evaluated to determine the appropriate level of remediation. Potential ARARs are presented in **Table 4.1**.

5.1.2.8 Cost

This criterion requires that the selected corrective measure alternative be cost-effective. Cost estimates, where applicable, include the following:

- Engineering and planning
- Construction
- Health and safety measures
- Permitting
- Operation and Maintenance

The cost estimates were compiled utilizing guidance established in the U.S. EPA's *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (U.S. EPA, 2000). Facility-specific costs where possible (i.e. inspections/maintenance currently performed by employees or contractors); regional experience with similar projects (seep collection and consolidation, well installation, etc.), and vendor pricing (materials and equipment). Costs were compiled into three categories:

- Capital costs – those costs anticipated to be expended upon initiation of the CMA
- Annual O&M costs – those costs associated with annual inspections, maintenance, and repairs

- Periodic costs – those costs anticipated to occur at a specific time or interval in the future (i.e. 5-year evaluation, equipment replacement, etc.) and separate from Annual O&M costs

The capital, O&M and recurring/periodic cash outflows for each year of the CMA were compiled in constant dollars. The present value of the CMA was calculated assuming each CMA would last 30 years and the discount rate is 7.4 percent. The discount rate is based on OCC's weighted average cost of capital (WACC) as of May 2017 (OCC, 2017) and is consistent with U.S. EPA's *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (U.S. EPA, 2000).

The information in these cost estimates is based on the best available information regarding the anticipated scope of the corrective measure alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the alternative. These are order-of-magnitude engineering cost estimates that are expected to be within –30 to +50 percent of the actual project cost.

Each of the soil remedial technologies were evaluated using the nine criteria outlined in the Permit (KDHE & U.S. EPA, 2007). All of the remedial technologies were screened against these criteria and scored numerically in each category from very unfavorable (1 point) to very favorable (5 points). The comparative evaluations and scoring were based on GHD's past experience, published literature, and data generated during the RFI investigations. The screening results for each of the remedial technologies and exposure control measures are presented in **Table 5.1**. Costs estimates for the CMAs are presented in **Appendix C**. A summary of the CMAs is presented in **Table 5.2**.

5.2 Soil

In Section 4, potential remedial technologies for the impacted soils were identified. The Soil CMA is appropriate and effective for the surface soil conditions encountered at specific locations of the Site. **Table 5.1** shows the relative ranking of the CMA for the threshold and balancing criteria. The CMA with the highest total score from the comparative analysis is typically the most effective and efficient CMA for the specific treatment objective and the conditions encountered.

5.2.1 Soil CMA S1: Excavation, Consolidation, Cover, Seep Collection and On-Site Discharge, and Inspection (Landfill Area)

Each of the 12 threshold and balancing criteria for the soil CMA is discussed below.

(a) ***Protect Human Health and the Environment:*** Favorable – The CMA will control exposure to impacted soil and limit infiltration and potential contaminant migration including from soil to groundwater. The CMA will protect human health and the environment.

(b) ***Attain Cleanup Objectives:*** Favorable – The CMA will not treat the soil but combined with the administrative controls will protect human health and the environment by eliminating direct contact exposure pathways. The CMA will control sources of release and reduce or eliminate the migration of COCs in soil to groundwater.

(c) ***Source Control:*** Favorable – The CMA will limit disturbance of the covered soils and limit infiltration, and therefore, limit potential future releases including from soil to groundwater.

(d) ***Comply with Applicable Standards for Waste Management:*** Favorable – The impacted soils will be contained in the existing ACI, Process Area, and Landfill Area. The collected seep water from the Landfill Area will be discharged to the deep well injection point or the facility's process water system.

(e) ***Long-term Reliability and Effectiveness:*** Favorable – Residual risks are low. Long-term inspection and maintenance are required for this CMA. Exposure potential to the remaining impacted soil is low. Long-term reliability of the engineering and institutional controls for this CMA is favorable. Routine replacement of components of this CMA is anticipated.

(f) ***Reduction of Contaminant Toxicity:*** Unfavorable - The CMA will not treat the soil but combined with the administrative controls will eliminate direct contact exposure pathways.

(g) ***Short-term Effectiveness:*** Neutral – The CMA eliminates the direct exposure pathways. The CMA potentially presents short-term exposure and injury risks during excavation, consolidation, cover construction, and seep collection system construction. Full protection can be completed within months.

(h) ***Implementability:*** Favorable – The CMA can be constructed with readily available equipment and materials. The CMA technologies are reliable. Minimal approvals or permits are anticipated. The impacted soils will be moved to the Landfill Area that has volume capacity. The seep water will be transferred via forcemain to an on-Site deep well injection point or the facility's process water system that have capacity.

(i) ***Community Acceptance:*** Favorable – A similar cover component of the CMA has already been implemented as an effective ICM in the ASI and Landfill Area. The cover and seep collection system are accepted technologies that are protective of human health and the environment.

(j) ***Agency Acceptance:*** Favorable – A similar cover component of the CMA has already been implemented as an effective ICM in the ASI and Landfill Area. The cover and seep collection system are accepted technologies that are protective of human health and the environment.

(k) ***Compliance with ARARs***: Favorable – Similar components of the CMA were implemented in the ASI and Landfill Area as effective ICM and in compliance with ARARs. The seep collection system will pump via forcemain to an on-Site deep well injection point or the facility's process water system, similar to other systems at the Site and in compliance with ARARs.

(l) ***Costs:*** Neutral - Costs were based primarily on regional experience with similar projects (seep collection and consolidation) and facility experience (inspection and maintenance), project-specific vendor pricing (materials and equipment), and reference cost data. Capital costs for excavation, consolidation, cover, and seep collection system installation range from low to relatively high, but the operation and maintenance costs are relatively low. The estimated 30-year present value cost of the CMA is $1,035,500.

5.3 Groundwater

In Section 4, potential remedial technologies for the impacted groundwater were identified. The Groundwater CMA is appropriate and effective for the subsurface conditions encountered at the Site.

Table 5.1 shows the relative ranking of the CMA for the threshold and balancing criteria. The highest total score from the comparative analysis is typically the most effective and efficient remedial technology for the specific treatment objective and the conditions encountered.

5.3.1 Groundwater CMA G1: Modification and Continued Operation of Existing Groundwater Interceptor Well System

Each of the 12 threshold and balancing criteria for the groundwater CMA is discussed below.

(a) ***Protect Human Health and the Environment:*** Favorable – The CMA will control exposure to impacted groundwater and limit potential contaminant migration. The CMA will protect human health and the environment.

(b) ***Attain Cleanup Objectives:*** Neutral – The CMA typically will not achieve MCLs but combined with administrative controls will protect human health and the environment by eliminating direct contact exposure pathways. The CMA will control sources of release.

(c) ***Source Control:*** Favorable – The CMA will increase hydraulic control and mass removal, and therefore, reduce potential future releases.

(d) ***Comply with Applicable Standards for Waste Management:*** Favorable – The treated water from the IW system is discharged by an approved permit for surface water recharge, irrigation, or process water.

(e) ***Long-term Reliability and Effectiveness:*** Neutral – Residual risks are low. Long-term operation, maintenance, and monitoring are required for this CMA. Exposure potential to the remaining impacted groundwater is low. Long-term reliability of the engineering and institutional controls for this CMA is neutral. Major components of this CMA may require replacement over a 30-year lifespan.

(f) ***Reduction of Contaminant Toxicity:*** Neutral - The CMA uses activated carbon to treat the groundwater prior to discharge. Contaminant removal efficiencies for activated carbon are high. The treatment is permanent but the carbon needs to be replaced or regenerated. The CMA can reduce high levels of VOCs but typically not suitable for removing low levels of VOCs.

(g) ***Short-term Effectiveness:*** Favorable – The CMA reduces the mass of contaminants. The majority of the CMA already exists as an effective ICM, so short-term risks are minimal. The CMA potentially presents short-term exposure and injury risks during drilling and construction. Full protection can be completed within months.

(h) ***Implementability:*** Favorable – The CMA can be constructed with readily available equipment and materials. The CMA typically requires pump tests, multiple extraction points within a formation, and a network of observation wells to demonstrate hydraulic control. The CMA technologies are reliable. No additional approvals or permits are anticipated. The treated water from the IW system is discharged by an approved permit for surface water recharge, irrigation, or process water that have available capacity.

(i) ***Community Acceptance:*** Favorable – The CMA technology was implemented as an effective ICM at the Site. The CMA uses accepted technology that is protective of human health and the environment.

(j) ***Agency Acceptance:*** Favorable – The CMA technology was implemented as an effective ICM at the Site. The CMA uses accepted technology that is protective of human health and the environment.

(k) ***Compliance with ARARs***: Favorable – Similar components of the CMA were implemented as an effective ICM and in compliance with ARARs.

(l) ***Costs:*** Unfavorable - Costs were based primarily on regional experience with similar projects and facility experience (operation and maintenance), vendor pricing (recovery wells), and reference cost data. The capital costs for Interceptor Well installation and operation are relatively low. The operation and maintenance costs are relatively high for pumping and treating. The estimated 30-year present value cost of the CMA is $18,393,100.

5.4 Soil Vapor

In Section 4, potential remedial technologies for soil vapor were identified. The Soil Vapor CMAs is appropriate and effective for the soil vapor conditions encountered at specific locations of the Site. **Table 5.1** shows the relative ranking of the CMA for the threshold and balancing criteria. The highest total score from the comparative analysis is typically the most effective and efficient remedial technology for the specific treatment objective and the conditions encountered.

5.4.1 Soil Vapor CMA V1: Existing ICM and Building Inspection

The existing ICMs and the CMAs are evaluated assuming Administrative Control will also be in place. Each of the 12 threshold and balancing criteria for the soil vapor CMA is discussed below.

(a) ***Protect Human Health and the Environment:*** Favorable – The CMA will control exposure to impacted soil vapor and limit potential contaminant migration. The CMA will protect human health and the environment.

(b) ***Attain Cleanup Objectives:*** Neutral – The CMA will not treat the soil vapor but monitoring and administrative controls will protect human health and the environment by ensuring that future on-Site populations will not be significantly exposed via vapor intrusion. The CMA will reduce or eliminate inhalation by a potential receptor of COCs in soil gas.

(c) ***Source Control:*** Neutral – The CMA will limit exposure to soil vapor in indoor spaces, and therefore, limit potential releases.

(d) ***Comply with Applicable Standards for Waste Management:*** Very Favorable – The CMA will generate no air emissions, and therefore, no waste will need to be managed.

(e) ***Long-term Reliability and Effectiveness:*** Favorable – Residual risks are low. Long-term inspection, maintenance, and monitoring are required for this CMA but are minimal and reliable. Exposure potential to the remaining impacted soil vapor is low. Long-term reliability of the engineering and institutional controls for this CMA is favorable. Routine replacement of components of this CMA is anticipated.

(f) ***Reduction of Contaminant Toxicity:*** Unfavorable - The CMA will not treat the soil vapor but monitoring and administrative controls will protect human health by ensuring that future on-Site populations will not be significantly exposed via vapor intrusion.

(g) ***Short-term Effectiveness:*** Favorable – The CMA eliminates the direct exposure pathways. The CMA already exists as an effective ICM, so short-term risks are minimal and full protection already exists.

(h) ***Implementability:*** Very Favorable – The CMA already exists as an effective ICM and is reliable. No additional approvals, permits, equipment, or treatment/storage/disposal services are required.

(i) ***Community Acceptance:*** Favorable – The CMA was implemented as an effective ICM. The CMA uses accepted technology that is protective of human health and the environment.

(j) ***Agency Acceptance:*** Favorable – The CMA was implemented as an effective ICM. The CMA uses accepted technology that is protective of human health and the environment.

(k) ***Compliance with ARARs***: Favorable – The CMA was implemented as an effective ICM and in compliance with ARARs.

(l) ***Costs:*** Favorable – Costs were based primarily on regional experience with similar projects and facility experience (replacement costs). The capital costs are low as an inspection and monitoring plan will be required. Operation and maintenance costs for inspection, repairs, monitoring and documentation are low. The estimated 30-year present value cost of the CMA is $175,400.

5.5 DNAPL

In Section 4, potential remedial technologies for DNAPL were identified. The DNAPL CMA is appropriate and effective for the conditions encountered at the Site. **Table 5.1** shows the relative ranking of the CMA for the threshold and balancing criteria. The highest total score from the comparative analysis is typically the most effective and efficient remedial technology for the specific treatment objective and the conditions encountered.

5.5.1 DNAPL CMA D1: Groundwater ICM, Administrative, and Vertical Recovery Wells

Each of the 12 threshold and balancing criteria for the DNAPL CMA is discussed below

(a) ***Protect Human Health and the Environment:*** Favorable – The CMA will control exposure to dissolved phase DNAPL and limit potential migration. The CMA will protect human health and the environment.

(b) ***Attain Cleanup Objectives:*** Neutral – The CMA typically will not achieve MCLs but combined with administrative controls will protect human health and the environment by limiting potential exposure. The CMA will control sources of release and reduce the volume of Site-related DNAPL in the subsurface to the extent practicable.

(c) ***Source Control:*** Favorable – The CMA will increase hydraulic control and mass removal including DNAPL, and therefore, reduce potential future releases.

(d) ***Comply with Applicable Standards for Waste Management:*** Favorable – the treated water from the IW system is discharged by an approved permit for surface water recharge, irrigation purposes or process water.

(e) ***Long-term Reliability and Effectiveness:*** Neutral – Residual risks are low. Long-term operation, maintenance, and monitoring are required for this CMA. Exposure potential to the remaining impacted DNAPL is low. Long-term reliability of the engineering and institutional controls for this CMA is neutral. Based on the Pilot Study results, the potential for long-term DNAPL recovery is likely to be limited at this active facility. Major components of this CMA may require replacement over a 30-year lifespan.

(f) ***Reduction of Contaminant Toxicity:*** Neutral - The CMA uses off-Site treatment for the recovered DNAPL. Based on the Pilot Study results, the potential for long-term DNAPL recovery is likely to be limited at this active facility. The treatment is permanent. The CMA can reduce high levels of DNAPL and VOCs but typically not suitable for removing residual DNAPL and low levels of VOCs.

(g) ***Short-term Effectiveness:*** Favorable – The CMA reduces the mass of contaminants. The majority of the CMA already exists as an effective ICM, so short-term risks are minimal. The CMA potentially presents short-term exposure and injury risks during drilling and construction. Full protection can be completed within years.

(h) ***Implementability:*** Favorable – Additional effort will be needed to install additional DNAPL recovery wells. The CMA can be constructed with readily available equipment and materials. The CMA was tested as a Pilot Study, and it has been proven to be implementable and reliable. The CMA typically requires pump tests, multiple extraction points within a formation, and a network of observation wells to demonstrate hydraulic control. The CMA technologies are reliable. No additional approvals or permits are anticipated. Collected DNAPL will be disposed at an off-Site facility. Capacity is not anticipated to be an issue. This CMA technology is not capable of removing residual DNAPL.

(i) ***Community Acceptance:*** Favorable – The CMA technology was implemented as an effective Pilot Study at the Site. The CMA uses accepted technology that is protective of human health and the environment.

(j) ***Agency Acceptance:*** Favorable – The CMA technology was implemented as an effective Pilot Study at the Site. The CMA uses accepted technology that is protective of human health and the environment.

(k) ***Compliance with ARARs***: Favorable – The CMA was implemented as a Pilot Study and in compliance with ARARs.

(l) ***Costs:*** Unfavorable – Costs were based primarily on regional experience with similar projects and project-specific vendor pricing (interceptor wells, well abandonment, and disposal costs). The capital and operation and maintenance costs are relatively high for the installation and operation of the vertical recovery wells and off-Site disposal of the collected DNAPL. The estimated 30-year present value cost of the CMA is $3,249,000.

6. Recommendation by Permittee for a Final Corrective Measure Alternative

The selected CMAs presented above are based on the ability of the recommended CMAs to achieve the CAOs, with the remaining evaluation criteria balanced to provide the most effective overall alternative while considering protection of human health and the environment, attainment of media cleanup objectives, control of sources of potential release, reliability, reduction in toxicity/mobility or volume, short-term effectiveness, implementability, community and agency acceptance, cost effectiveness, and compliance with ARARs. Where institutional controls are included as a part of a proposed remedy, their present form includes environmental media-management controls consisting of permits and operating guidelines in place by the Facility; their future form will include limiting future access to soil and groundwater in the DNAPL-impacted areas and providing management guidelines for impacted soils. A summary of the screening results for the CMAs is presented in **Table 5.2**.

6.1 Soil

Based on the evaluation in Section 5, the recommended CMA for soil includes.

- CMA S1 (ASI) - Existing Cover and Inspection (ASI): This existing effective CMA eliminates potential exposure pathways and is protective of human health and the environment. This CMA is recommended based on its protectiveness of human health and the environment, compliance with waste management standards, short-term effectiveness, implementability, community and agency acceptance, and cost-effectiveness.
- CMA S1 (Process Area) - Existing Cover and Inspection (Process Area): This existing effective CMA eliminates potential exposure pathways and is protective of human health and the environment. This CMA is recommended based on its protectiveness of human health and the environment, compliance with waste management standards, short-term effectiveness, implementability, community and agency acceptance, and cost effectiveness.
- CMA S1 (Landfill Area) – Excavation, Consolidation, Cover, Seep Collection and On-Site Discharge, Inspection, and Maintenance (Landfill Area): This existing effective CMA eliminates potential exposure pathways and is protective of human health and the environment. This CMA is recommended based on its protectiveness of human health and the environment, compliance with waste management standards, implementability, and community and agency acceptance.

6.2 Groundwater

Based on the evaluation in Section 5, the recommended CMA for groundwater includes.

- CMA G1 – Modification and Continued Operation of Existing Groundwater Interceptor Well System: This effective CMA, that partially exists, provides hydraulic control and reduces contaminant mass and is protective of human health and the environment. This CMA is recommended based on its protectiveness of human health and the environment, control of sources of potential release, compliance with waste management standards, short-term effectiveness, implementability, and community and agency acceptance.

6.3 Soil Vapor

Based on the evaluation in Section 5, the recommended CMA for soil vapor includes:

- CMA V1 – Administrative Building, Technical Center and Laboratory: This existing effective CMA is protective of human health and the environment. This CMA is recommended based on its protectiveness of human health and the environment, compliance with waste management standards, long-term reliability, short-term effectiveness, implementability, and community and agency acceptance.
- CMA V1 – Process Area Buildings 10 and 51 – Inspection: This existing effective CMA is protective of human health and the environment. This CMA is recommended based on its protectiveness of human health and the environment, compliance with waste management standards, long-term reliability, short-term effectiveness, implementability, and community and agency acceptance, and cost effectiveness.

6.4 DNAPL

Based on the evaluation in Section 5, the recommended CMA for DNAPL includes:

- CMA D1 – Groundwater ICM, Administrative Controls, and Vertical Recovery Wells: This effective CMA, that was pilot-tested, is protective of human health and the environment. This CMA is recommended based on its protectiveness of human health and the environment, control of sources of potential release, compliance with waste management standards, reduction in toxicity/mobility or volume of waste, short-term effectiveness, implementability, and community and agency acceptance.

The Pilot Study (**Appendix B**) and case studies indicated that the DNAPL recovery rate is low and likely to further attenuate after less than a year of implementation.

6.5 CMS Implementation Schedule

A schedule depicting implementation of each of the proposed Final Corrective Measures is presented on **Figure 33**. A brief description of the duration of each of the proposed CMAs is presented below.

6.5.1 Soil CMA

The corrective measure for the Asbestos Surface Impoundment has already been implemented. OCC will continue with annual inspections and maintenance/repairs (as necessary) of the concrete pad that overlies the remnants of the former ASI.

The corrective measure has already been implemented for the soil in the vicinity of soil sample location PA-54, OCC will continue with annual inspections and maintenance/repairs (as necessary) of the concrete surface, which overlies the soil, sample location.

The estimated duration to implement CMA S3 is approximately 6 months. Implementation will begin upon approval of the CMS Report with design and procurement activities. The duration for excavation and consolidation activities at P5SA will last approximately two months. Once the work at P5SA is complete, the seep collection trench will be installed. The estimated duration for the

seep collection trench is one month. Additional activities at CMA S3 will include quarterly inspections, mowing and periodic maintenance/repairs.

6.5.2 Groundwater CMA

Design, permitting and procurement related to the new interceptor well (IW-47) will begin upon approval of the CMS Report and will last approximately 60 days. Installation and system startup/testing of IW-47 is anticipated to last approximately 30 days. Once the new interceptor well is installed and operational, the construction completion report will be prepared.

The revised monitoring network sampling plan will be developed to outline the monitoring well abandonment program and the revised sampling and gauging regime. After the revised sampling plan is approved, the monitoring well abandonment program will begin. Monitoring wells will be abandoned in the S4, S2/S3 and S1 units. The well abandonment program duration is anticipated to be approximately 60 days.

The monitoring network program will be implemented after approval of the sampling plan and will occur semi-annually, annually, and biannually.

6.5.3 Soil Vapor CMA

Administrative Building, Technical Center, and Control Laboratory

The corrective measure for the Administration Building, Technical Center and Control Laboratory has already been implemented; therefore, OCC will continue with quarterly monitoring and reporting of the existing pressure monitoring system and periodic maintenance/repairs as necessary.

Buildings 10 and 51

The corrective measure for Buildings 10 and 51 will include annual inspections and routine maintenance/repairs as necessary.

6.5.4 DNAPL CMA

The final design and procurement related to installation of the seven nested vertical recovery wells (seven wells in the S2/S3 unit and seven adjacent wells in the S1 units) and three individual vertical recovery wells (S2/S3 unit) will begin upon approval of the CMS Report. The installation and system testing of the recovery wells will last approximately 60 days; annual monitoring and reporting will commence once the wells are operational.

7. Public Involvement Plan

OCC and GSH actively engage the community through regular Community Involvement Group (CIG) meetings. The CIG meetings review conditions at the Facility, community concerns and upcoming activities and includes members of the OCC Management Team and representatives from U.S. EPA and KDHE. OCC engages the CIG at least one month per year to review the status of the Facility's RCRA Program. OCC will continue involving the public by making the CMS Report and EPA's Statement of Basis available for public review. Additionally, OCC and GSH will continue the CAG meetings during CMS Implementation.

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Figures

Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas
South FIPS 1502 Feet

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

FACILITY LOCATION

FIGURE 1

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA010.mxd

Source: USDA NAIP 2010

0 200 400 600
Feet

Coordinate System:
NAD 1983 StatePlane Kansas
South FIPS 1502 Feet

N

GHD

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WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

FACILITY LAYOUT AND
CMS STUDY AREA

FIGURE 2

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA011.mxd

Wichita CMS Alignment
With RCRA FIRST Remedy Selection Process

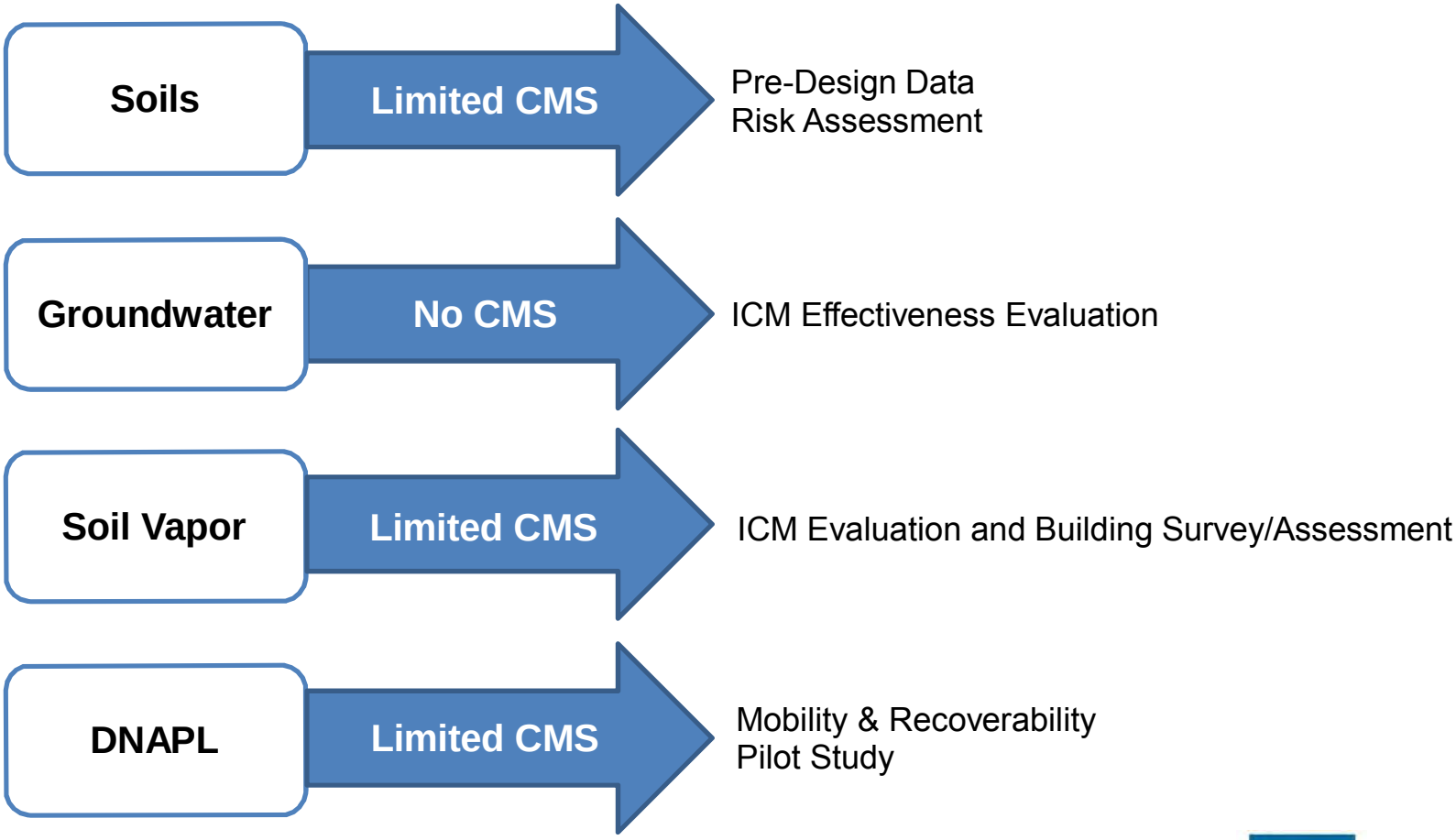
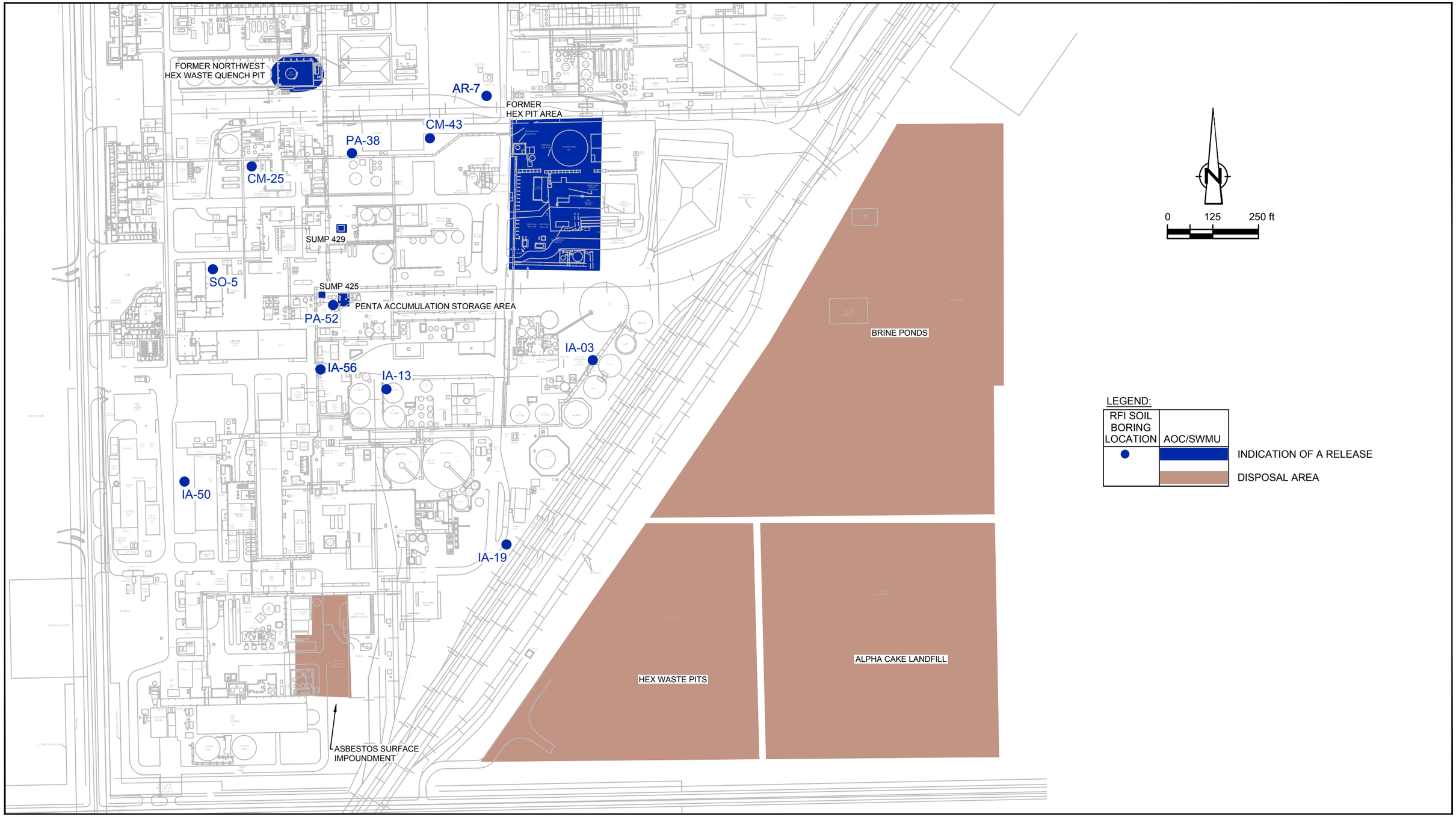


Figure 3



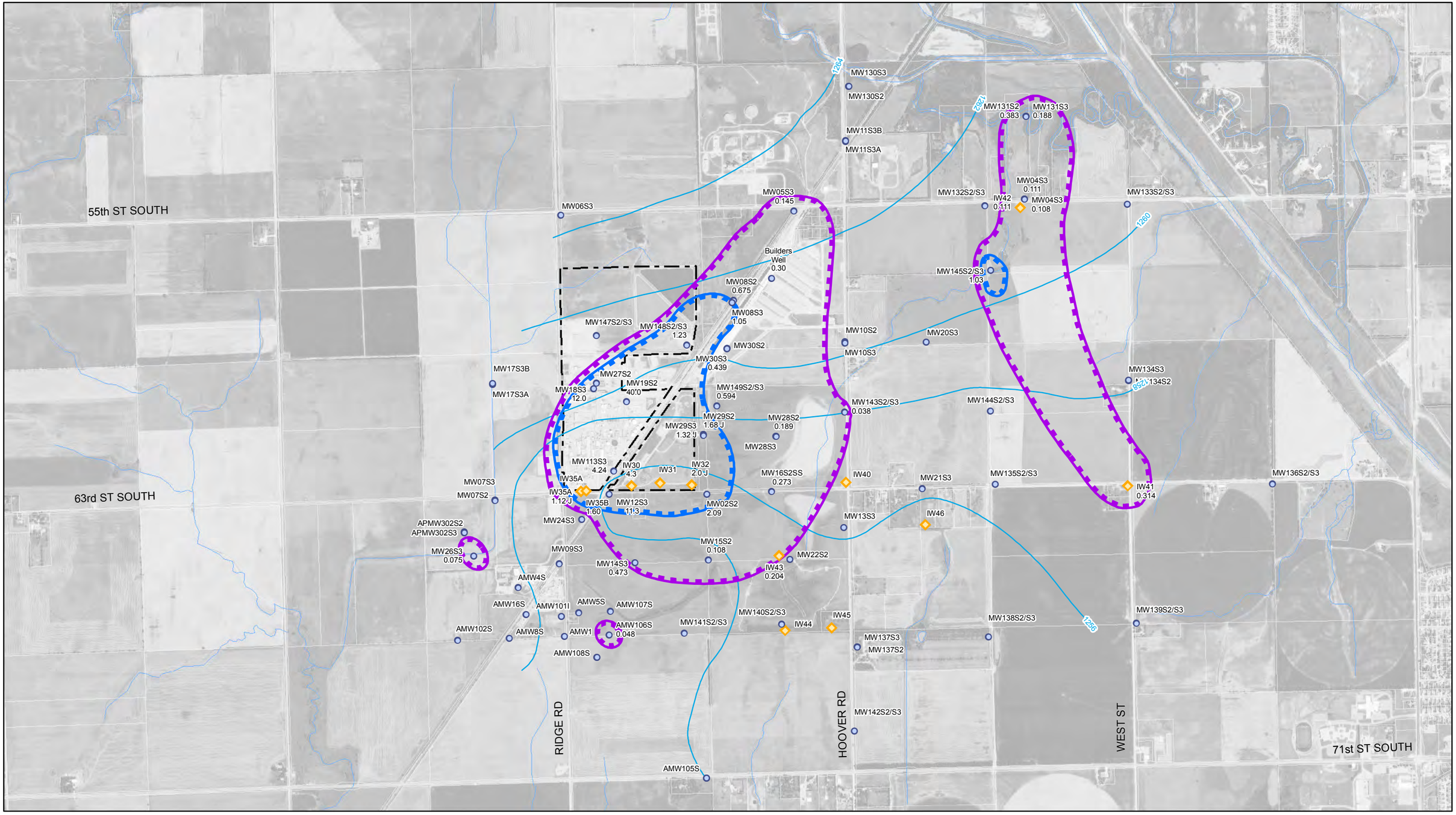
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Jul 21, 2017

POTENTIAL RELEASE AREAS

figure 4

CAD File: P:\drawings\11137000s\11137148\11137148-REPORT\11137148-D23103(003)\11137148-D23103(003)GN\11137148-D23103(003)GN-WA005.dwg



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contours - Intermediate (S2/S3) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

0.025 1.0

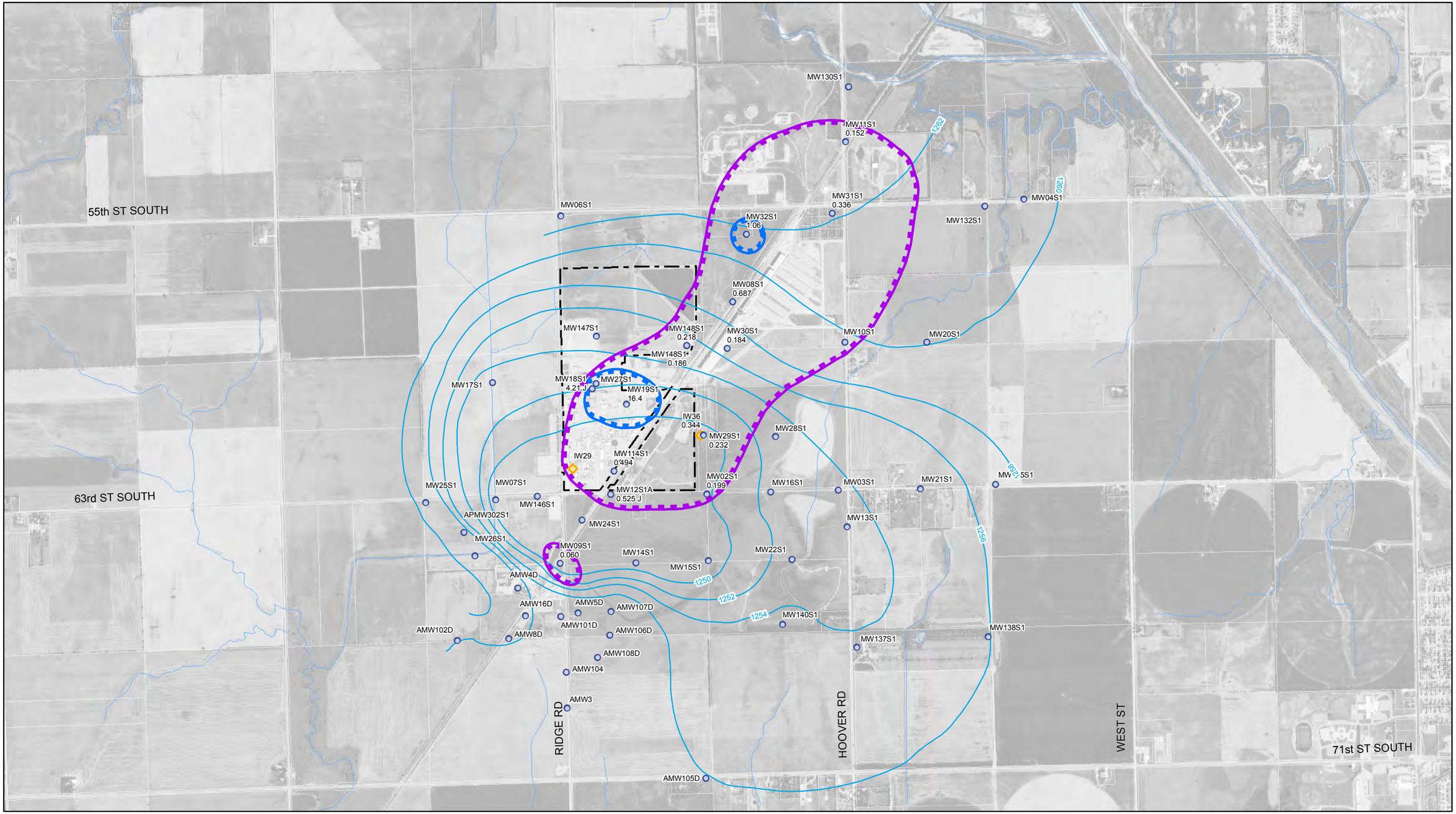
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

S2/S3 BETA BHC ISOCONCENTRATION CONTOURS - MAY 2017

FIGURE 5

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA021.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contours - Deep (S1) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

0.025 1.0

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
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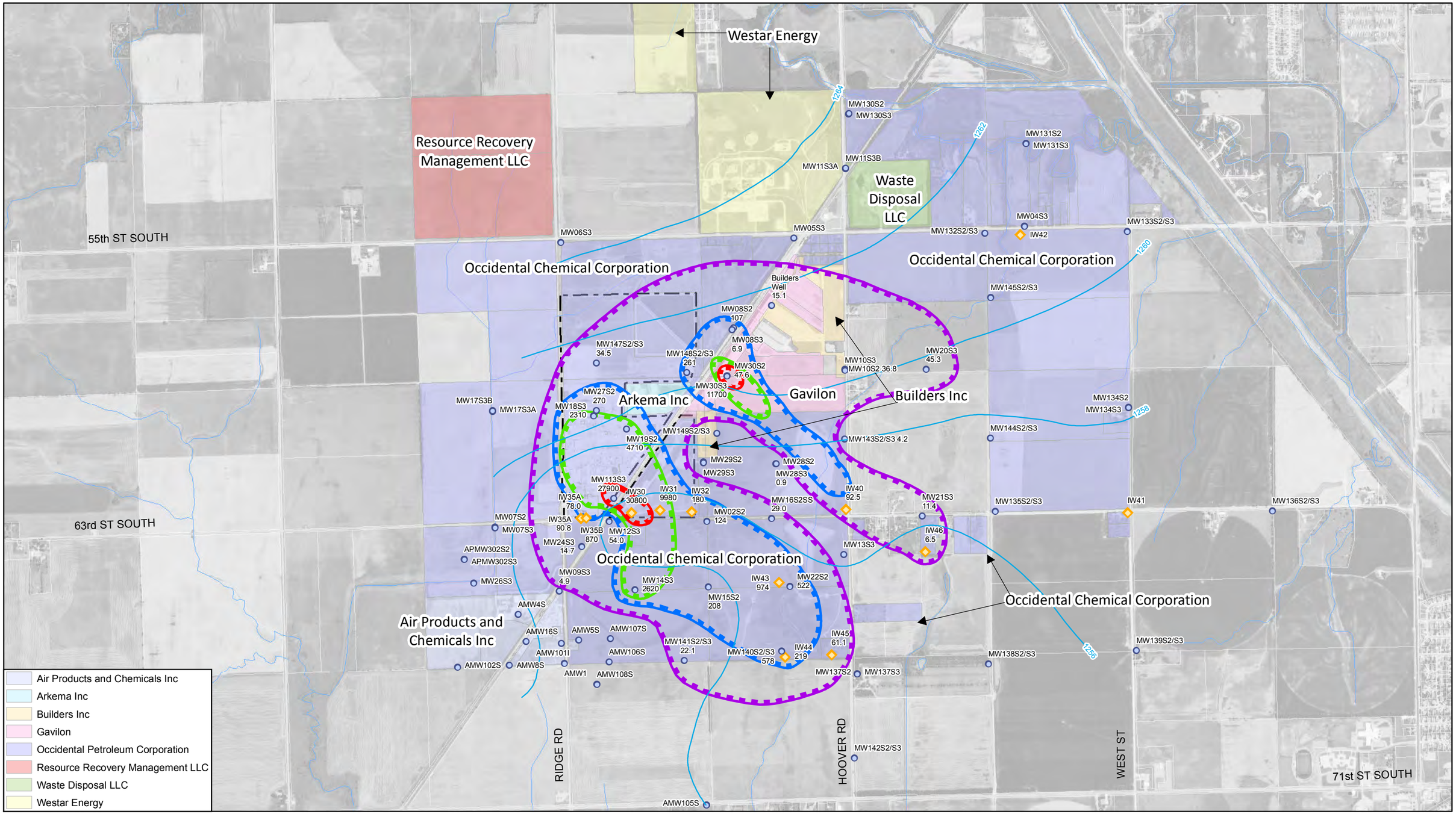
S1 BETA BHC ISOCONCENTRATION CONTOURS - MAY 2017

FIGURE 6

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA022.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- S2/S3 Monitoring Well
- S2/S3 Interceptor Well
- Groundwater Contours - Intermediate (S2/S3) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

5.0 100 1,000 10,000

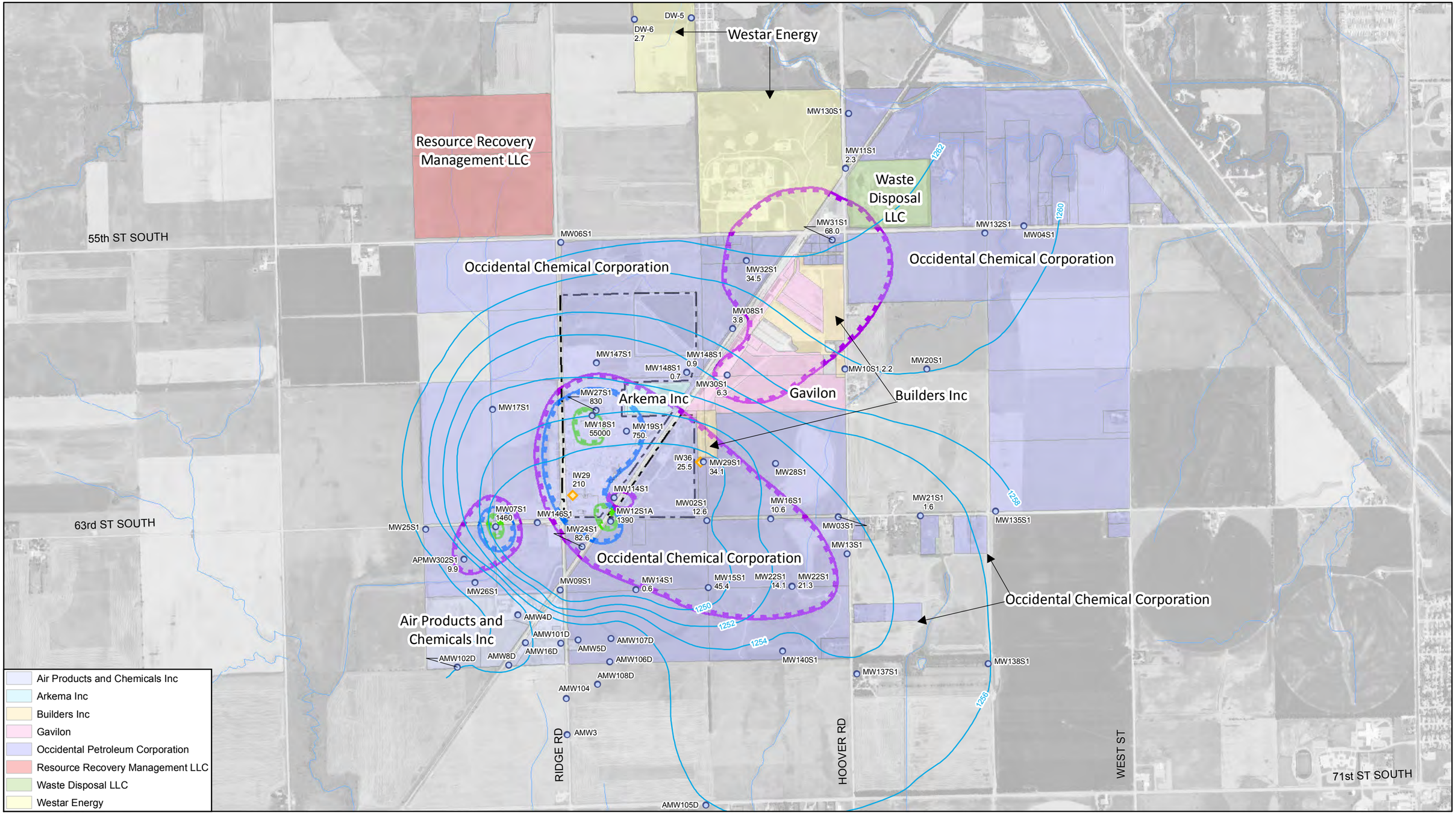
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 16, 2017

CARBON TETRACHLORIDE ISOCONCENTRATION CONTOURS IN S2/S3 GROUNDWATER AS OF MAY 2017

FIGURE 7

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA016.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- S1 Monitoring Well
- S1 Interceptor Well
- Groundwater Contours - Deep (S1) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

5.0 100 1000

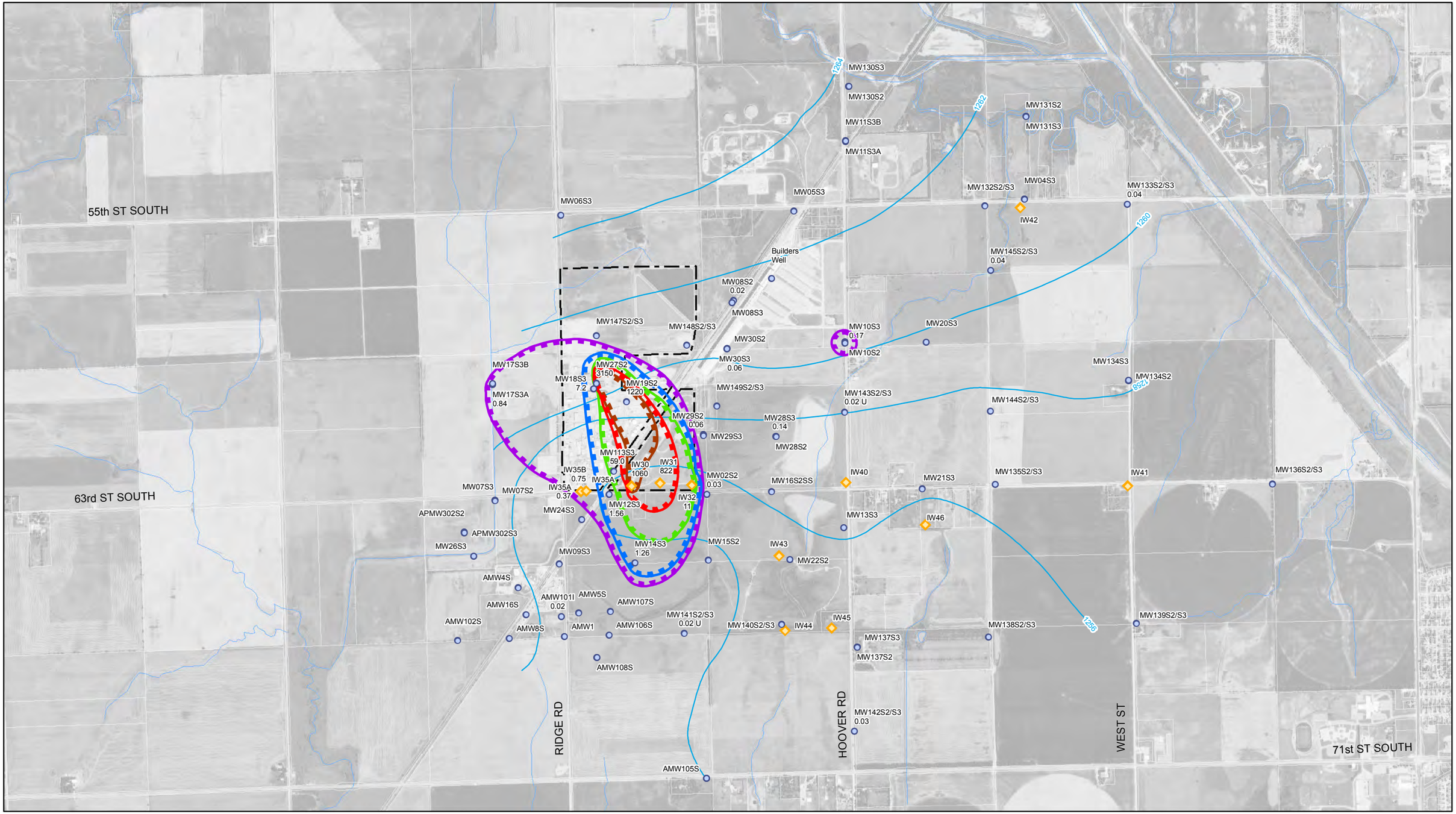
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 16, 2017

CARBON TETRACHLORIDE ISOCONCENTRATION CONTOURS IN S1 GROUNDWATER AS OF MAY 2017

FIGURE 8

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA017.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contours - Intermediate (S2/S3) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

0.14 1.0 10 100 1000

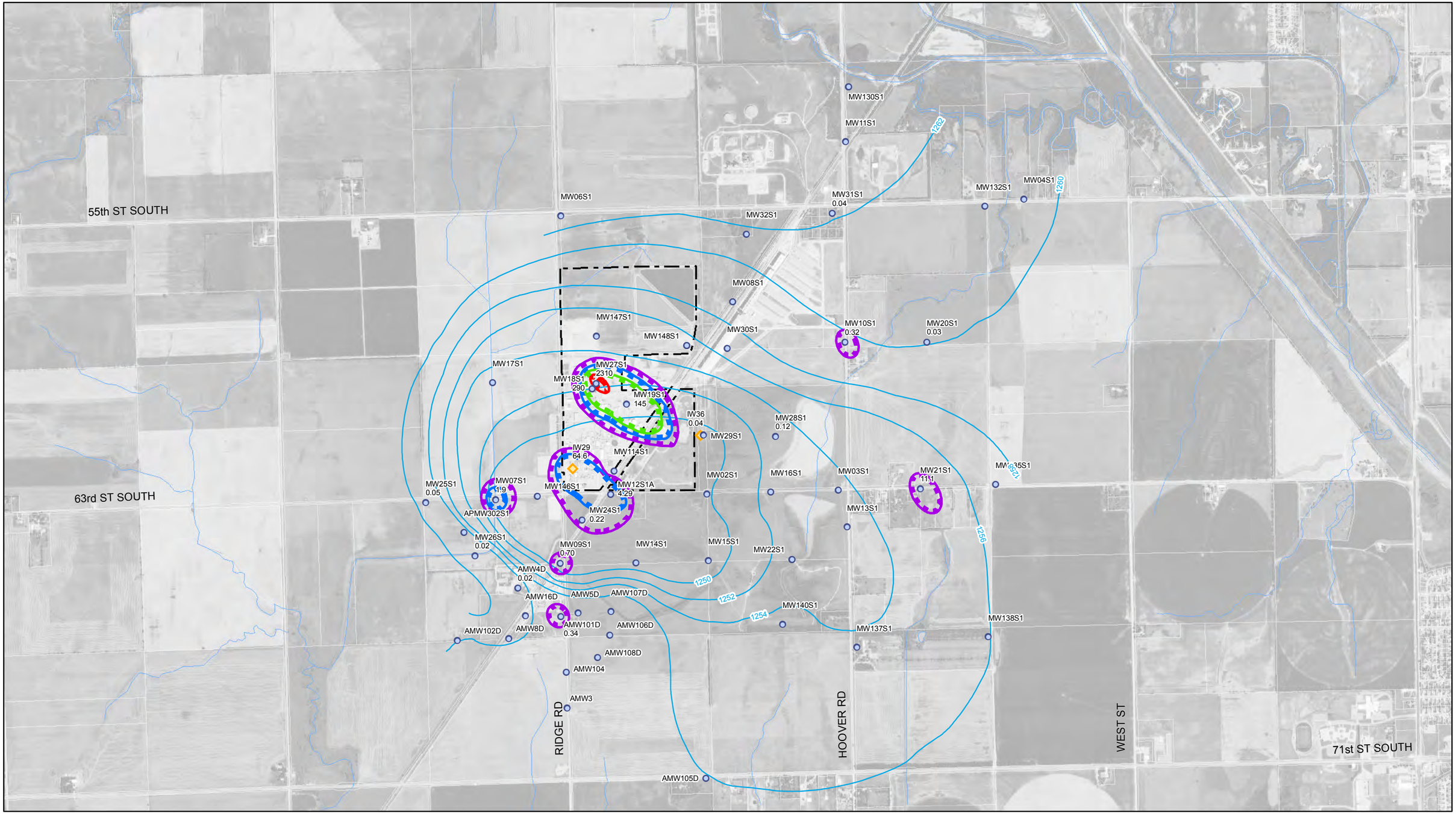
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

HEXACHLOROBUTADIENE ISOCONCENTRATION CONTOURS IN S2/S3 GROUNDWATER AS OF MAY 2017

FIGURE 9

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA023.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contours - Deep (S1) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

0.14 1.0 100 1000

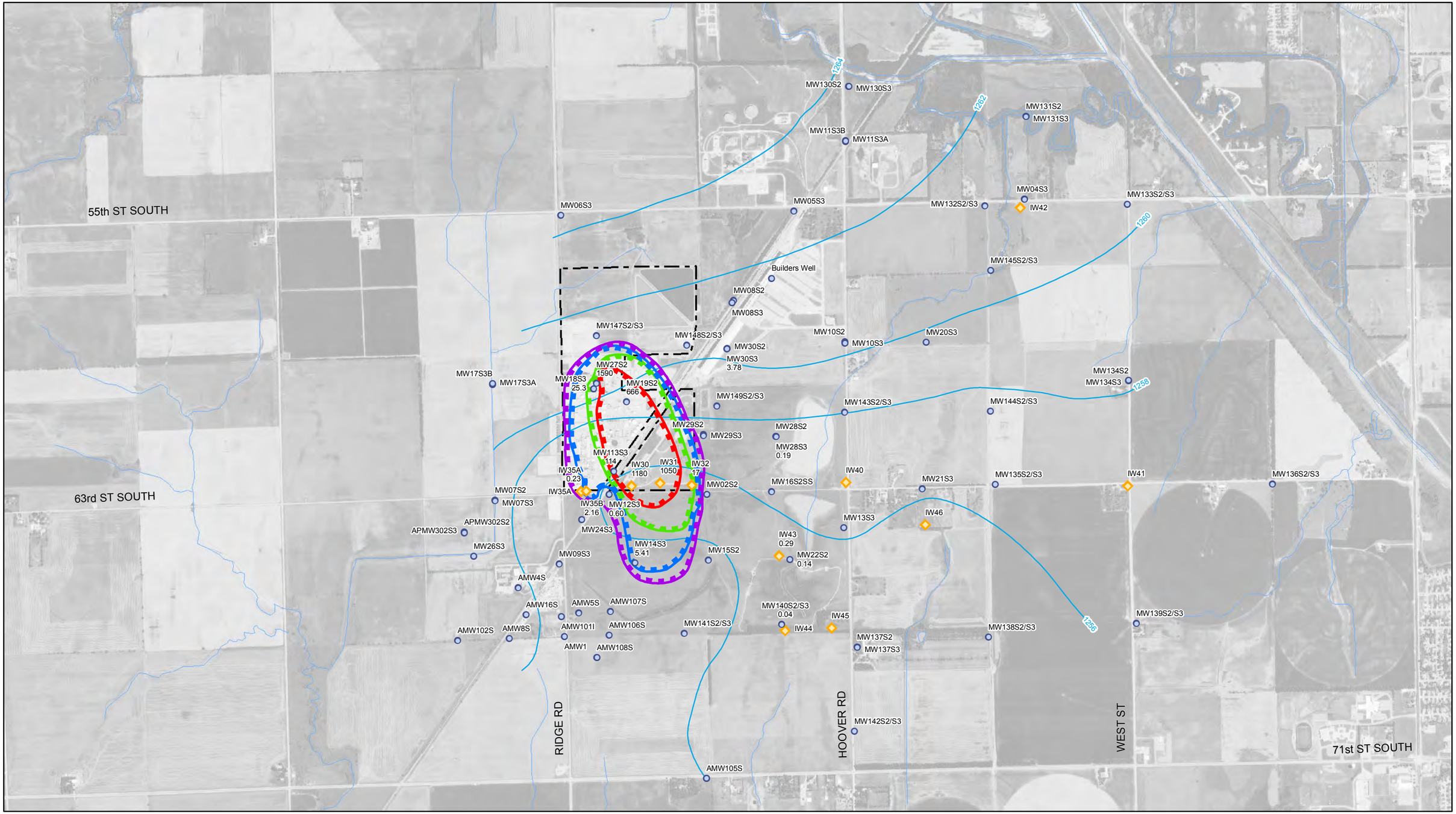
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

HEXACHLOROBUTADIENE ISOCONCENTRATION CONTOURS IN S1 GROUNDWATER AS OF MAY 2017

FIGURE 10

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA024.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contours - Intermediate (S2/S3) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

0.33 1.0 10 100

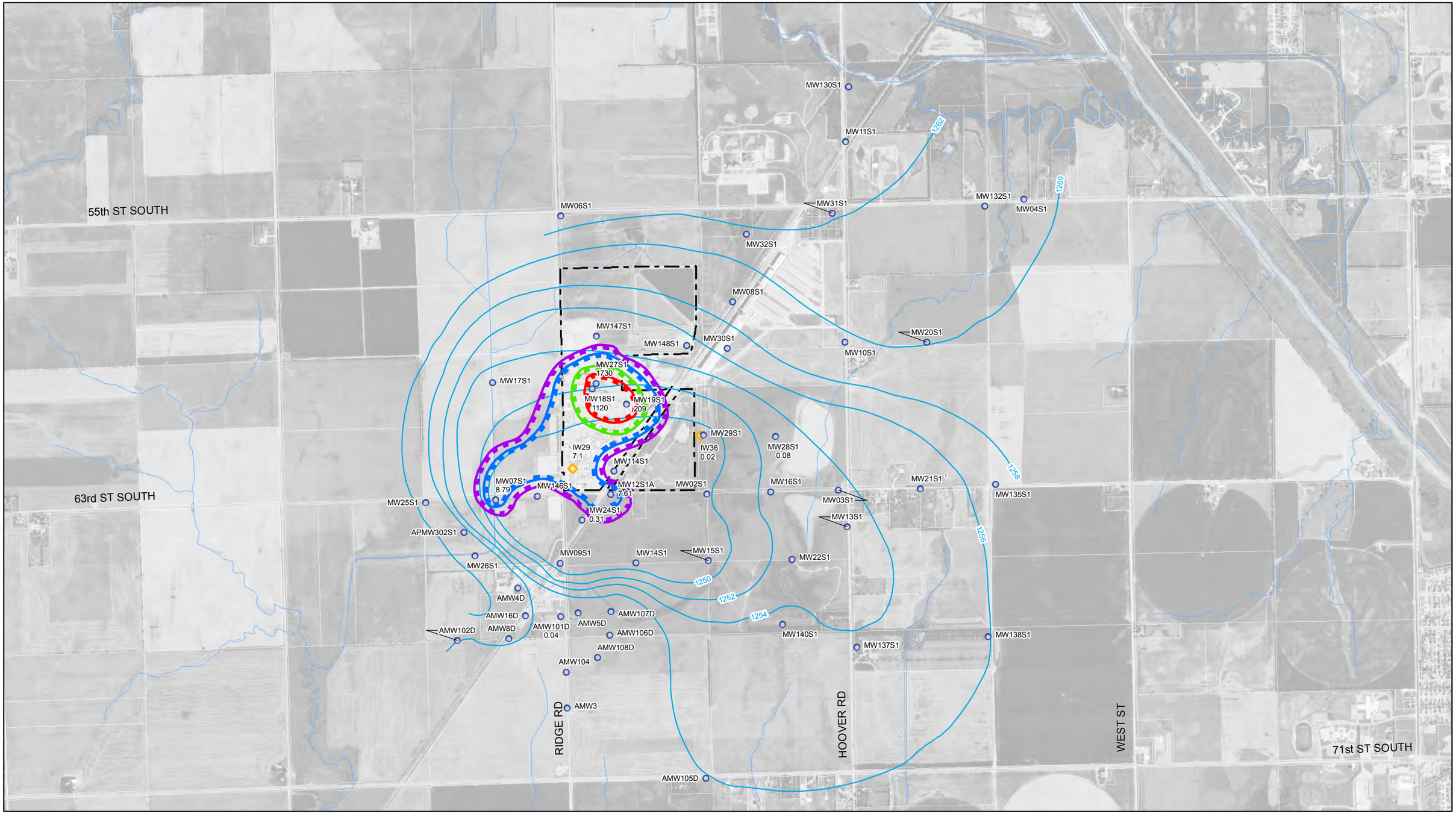
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

HEXACHLOROETHANE ISOCONCENTRATION CONTOURS IN S2/S3 GROUNDWATER AS OF MAY 2017

11137148-D23103
Aug 14, 2017

FIGURE 11

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA025.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contours - Deep (S1) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

0.33 1.0 10 100

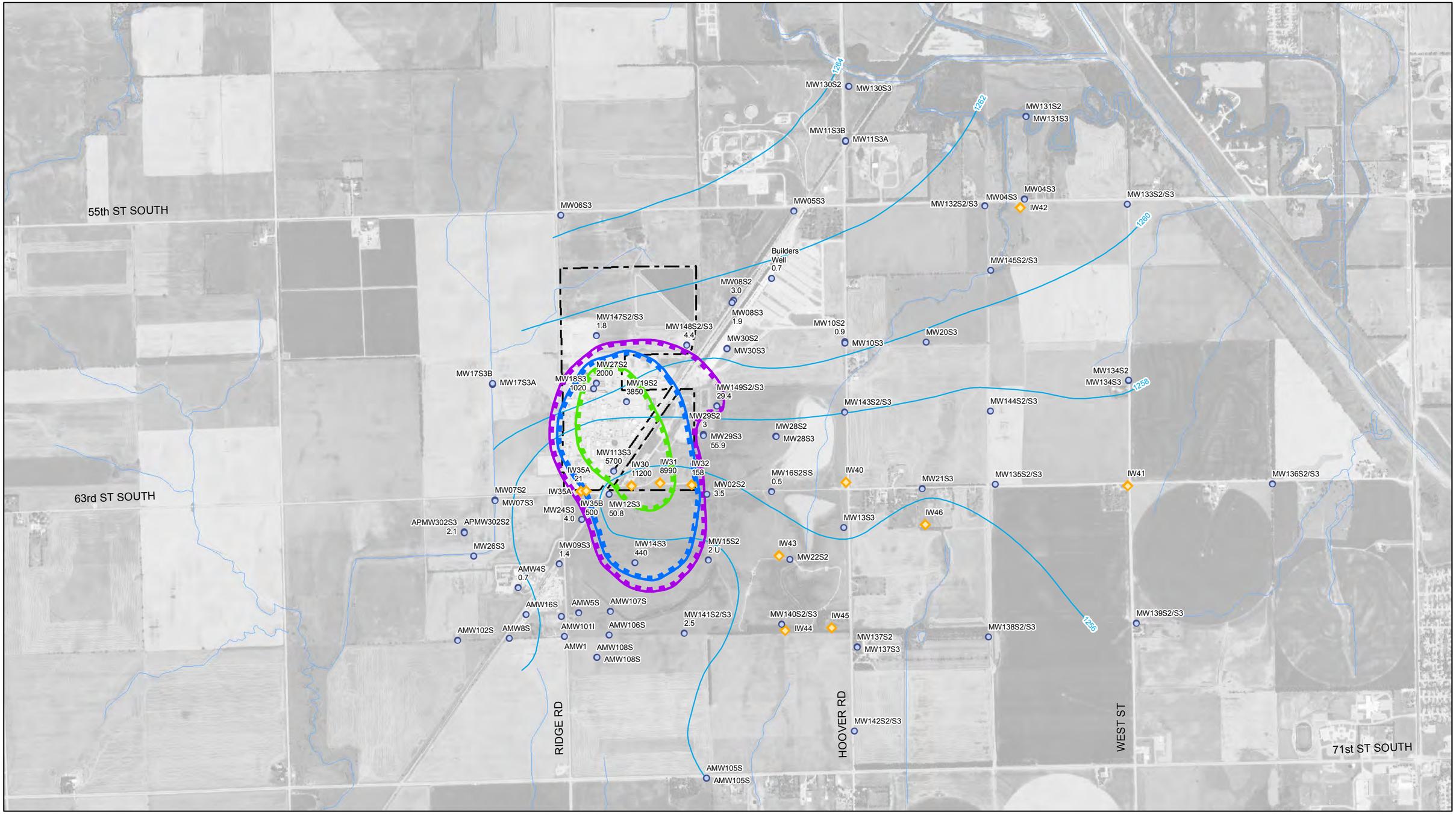
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

HEXACHLOROETHANE ISOCONCENTRATION CONTOURS IN S1 GROUNDWATER AS OF MAY 2017

11137148-D23103
Aug 14, 2017

FIGURE 12

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA026.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contours - Intermediate (S2/S3) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

5.0 100 1000

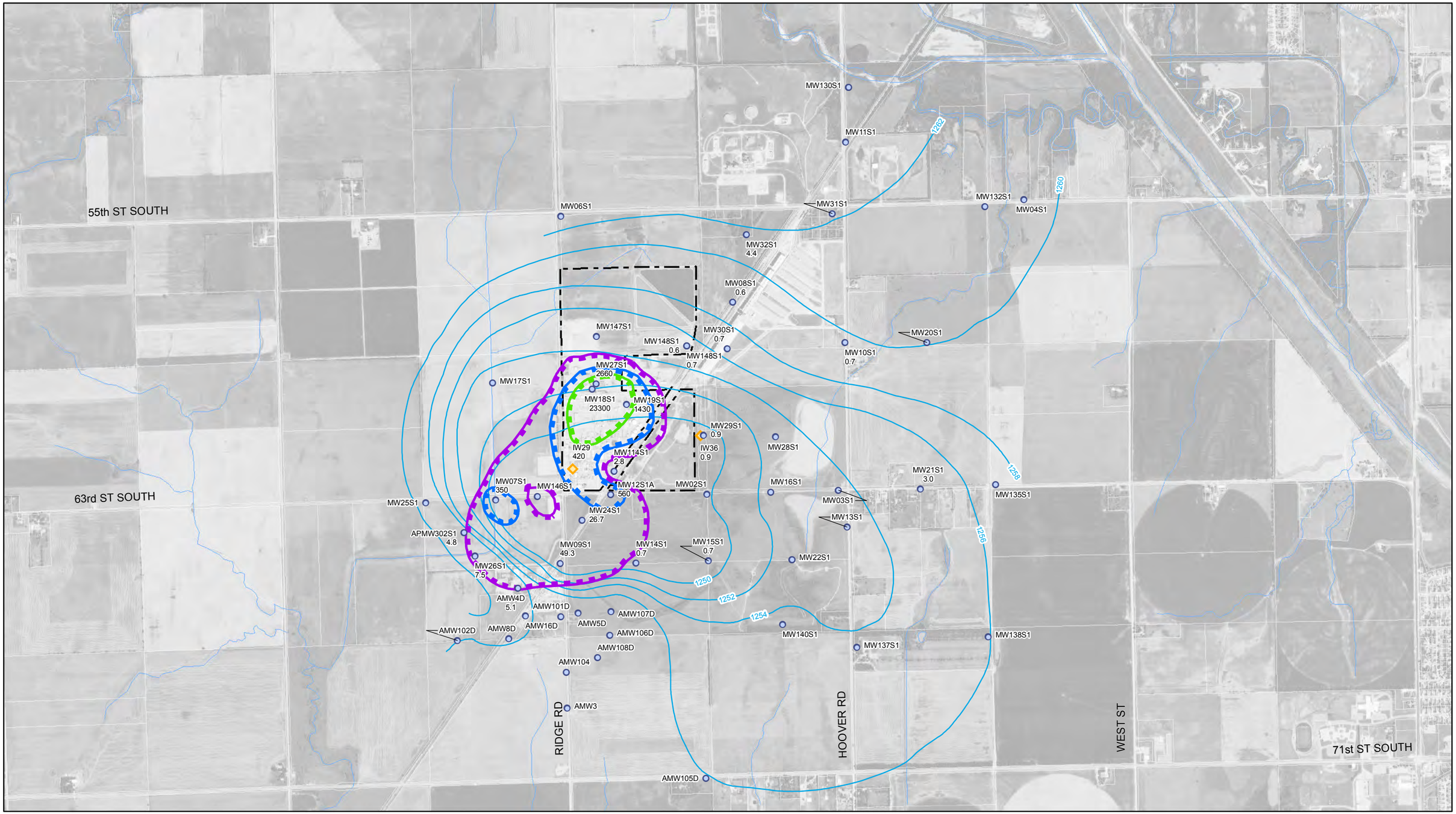
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

PERCHLOROETHYLENE ISOCONCENTRATION CONTOURS IN S2/S3 GROUNDWATER AS OF MAY 2017

11137148-D23103
Aug 14, 2017

FIGURE 13

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA027.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contours - Deep (S1) Screened Sand Unit Interval
- Approximate Facility Boundary

Isoconcentration (ug/l) *Only detected concentrations are shown

5.0 100 1000

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
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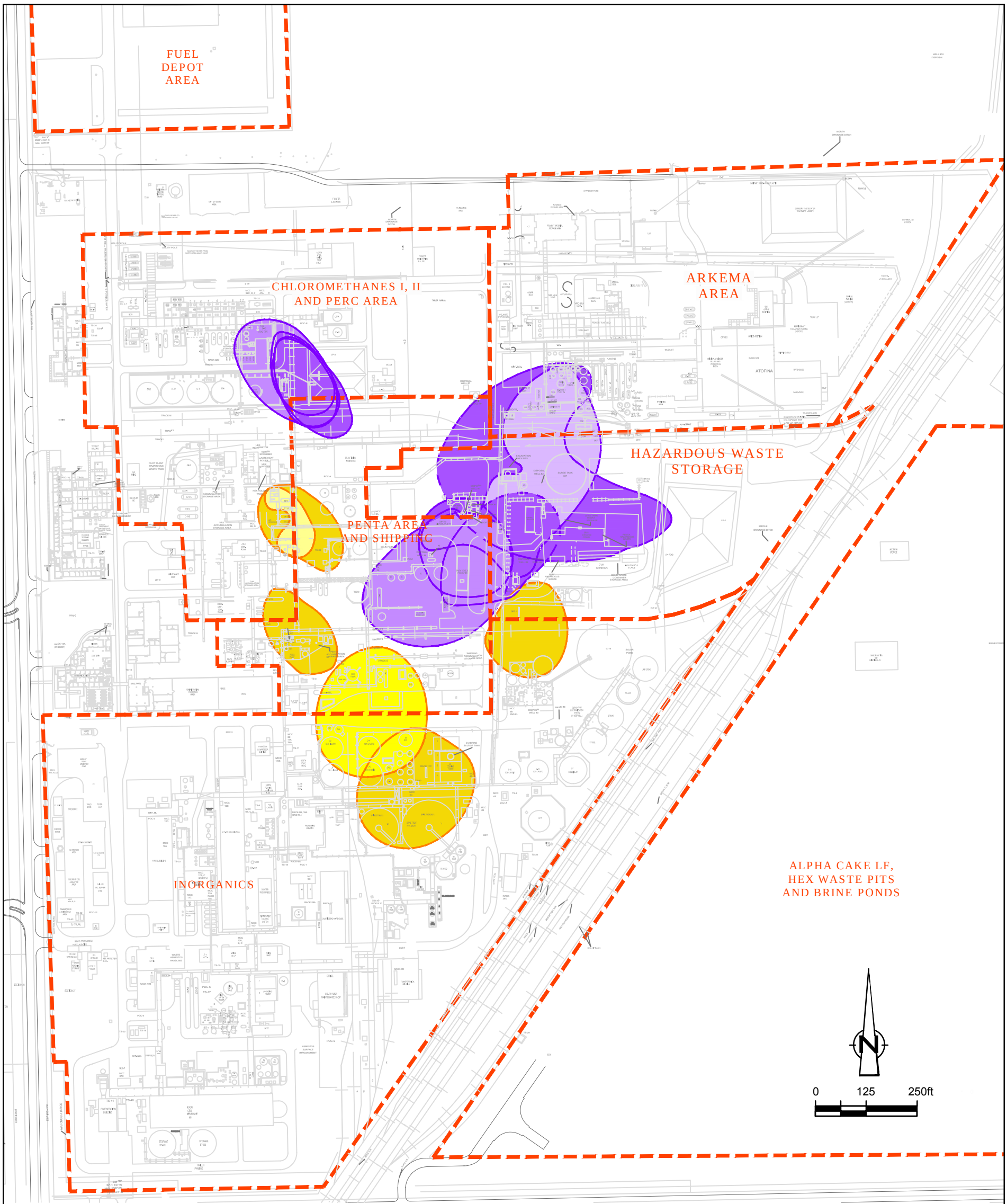
PERCHLOROETHYLENE ISOCONCENTRATION CONTOURS IN S1 GROUNDWATER AS OF MAY 2017

FIGURE 14

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA039.mxd



LEGEND

STUDY AREAS

PRIMARY CONSTITUENTS INCLUDE HEXACHLORINATED COMPOUNDS IN S1 AQUIFER LIMIT

PRIMARY CONSTITUENTS INCLUDE CARBON TETRACHLORIDE OR PERCHLOROETHYLENE (PERC) IN S1 AQUIFER LIMIT

PRIMARY CONSTITUENTS INCLUDE HEXACHLORINATED COMPOUNDS IN S2/S3 AQUIFER LIMIT

PRIMARY CONSTITUENTS INCLUDE CARBON TETRACHLORIDE OR PERCHLOROETHYLENE (PERC) IN S2/S3 AQUIFER LIMIT

PRIMARY CONSTITUENTS INCLUDE HEXACHLORINATED COMPOUNDS IN S4 AQUIFER LIMIT

PRIMARY CONSTITUENTS INCLUDE CARBON TETRACHLORIDE OR PERCHLOROETHYLENE (PERC) IN S4 AQUIFER LIMIT

GHD

figure 15

ESTIMATED DNAPL COMBINED VERTICAL AND HORIZONTAL LIMITS
OCCIDENTAL CHEMICAL CORPORATION
Wichita, Kansas

11137148-D23112(002)GN-WA018 JUL 21, 2017

SOURCE:
- OCC DRAWING NO. 27-1-5-16117_E; PLANT MAP FACILITY SITING ANALYSIS.
- NAIP, 2010.

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103

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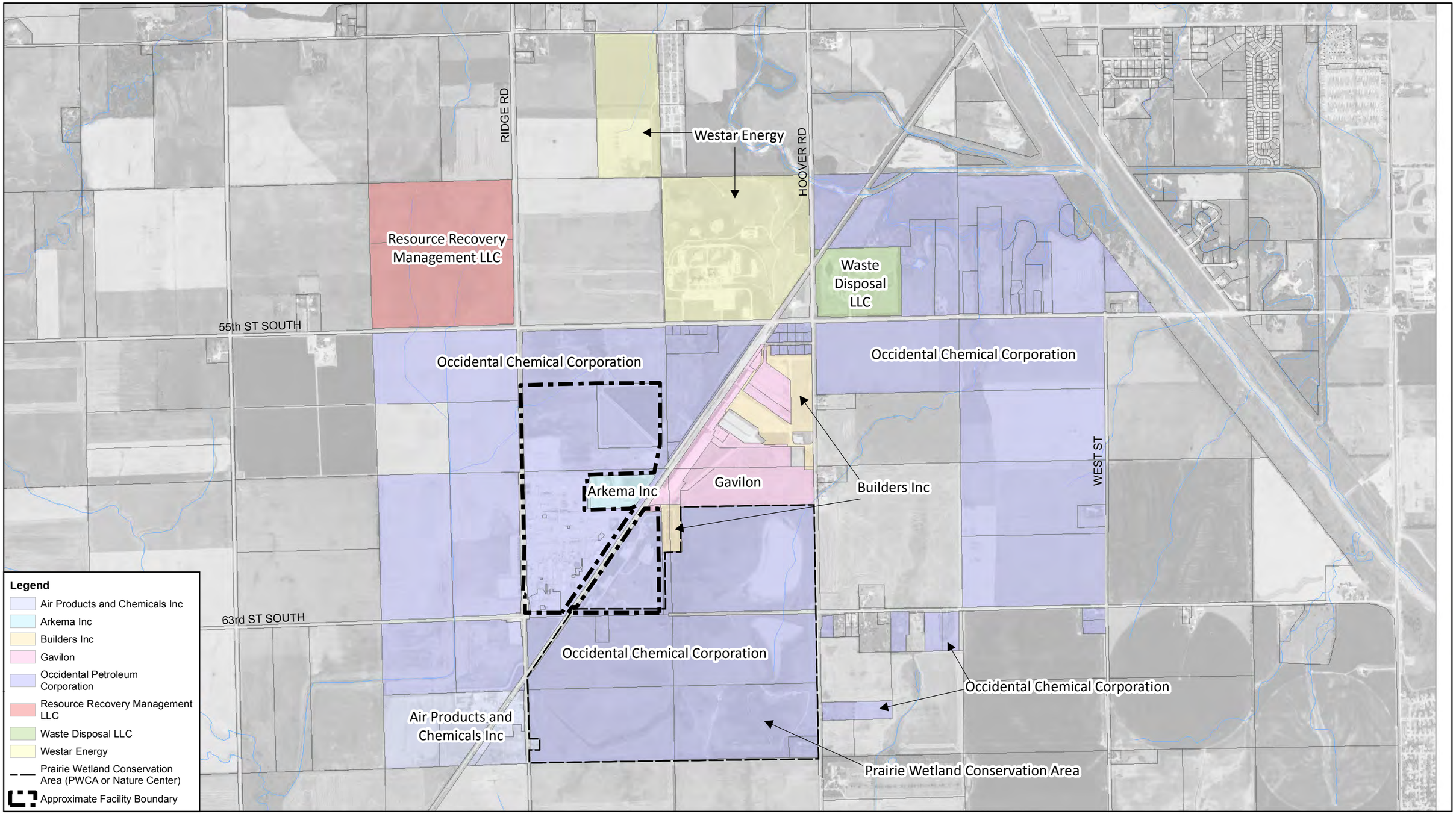
SOIL VAPOR EXTENT NON-PROCESS AREA

figure 16

CAD File: P:\drawings\11137000s\11137148\11137148-REPORT\11137148-D23103(003)\11137148-D23103(003)GN\11137148-D23103(003)GN-WA001.dwg



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

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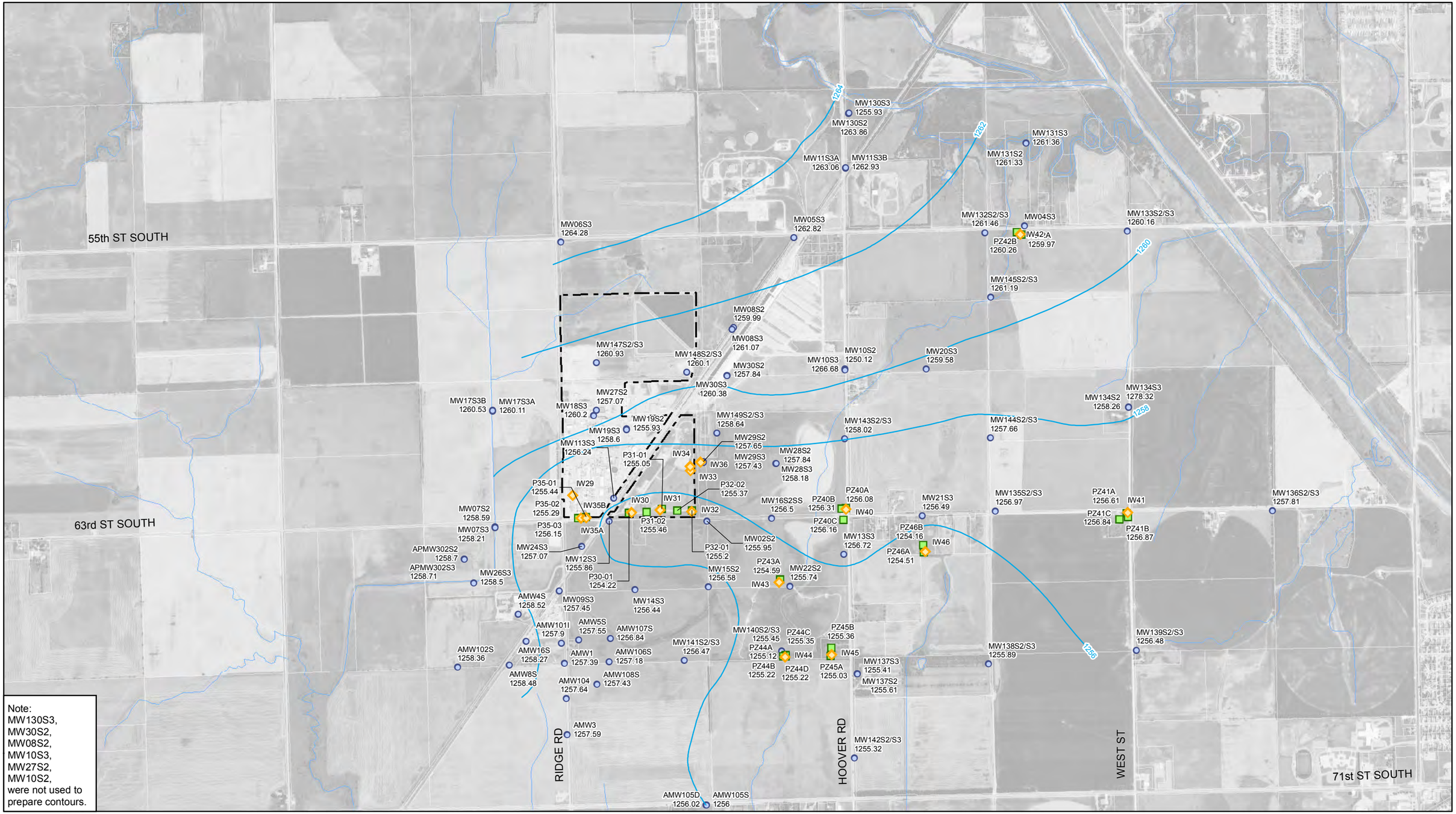
Aug 14, 2017

PROPERTY OWNERSHIP NEAR FACILITY

FIGURE 17

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA015.mxd



Note:
MW130S3,
MW30S2,
MW08S2,
MW10S3,
MW27S2,
MW10S2,
were not used to prepare contours.

Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- S2/S3 Monitoring Well
- S2/S3 Piezometer
- S2/S3 Interceptor Well
- Groundwater Contours - Intermediate (S2/S3) Screened Sand Unit Interval
- Approximate Facility Boundary

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

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GROUNDWATER INTERCEPTOR WELL ICM IN S2/S3
WITH GROUNDWATER POTENTIOMETRIC SURFACE - MAY 2017

FIGURE 18

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA018.mxd

Note:
MW13S1 not used to prepare contours.

Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- S1 Monitoring Well
- S1 Piezometer
- S1 Interceptor Well
- Groundwater Contours - Deep (S1) Screened Sand Unit Interval
- Approximate Facility Boundary

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

GROUNDWATER INTERCEPTOR WELL ICM IN S1
WITH GROUNDWATER POTENTIOMETRIC SURFACE - MAY 2017

FIGURE 19

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA019.mxd

Source: USDA NAIP 2010

0 200 400 600
Feet

Coordinate System:
NAD 1983 StatePlane Kansas
South FIPS 1502 Feet

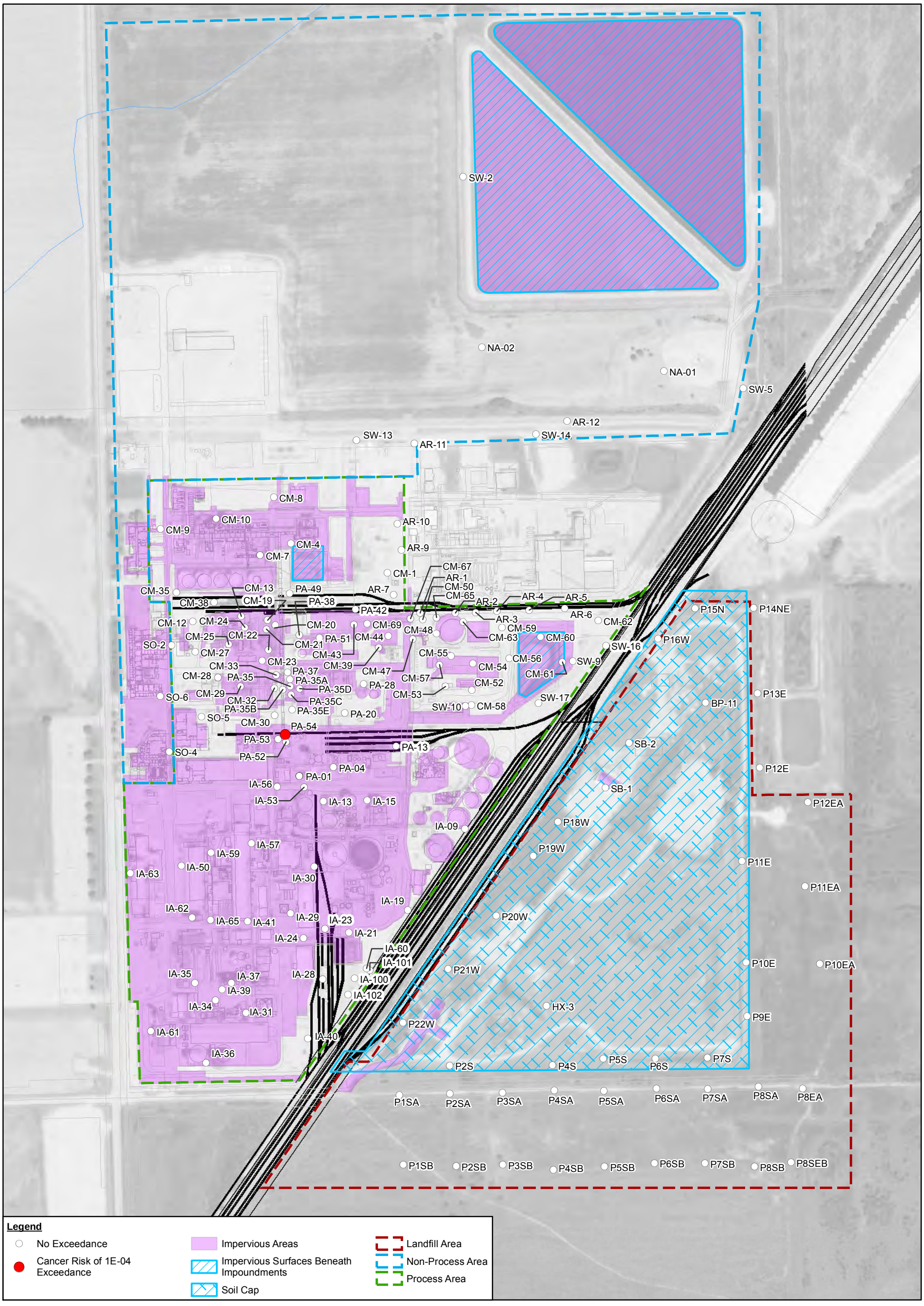
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

SOIL AND VAPOR
ICM LOCATIONS

FIGURE 20

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA020.mxd



Source: USDA NAIP 2010

0 125 250 375
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

N

GHD

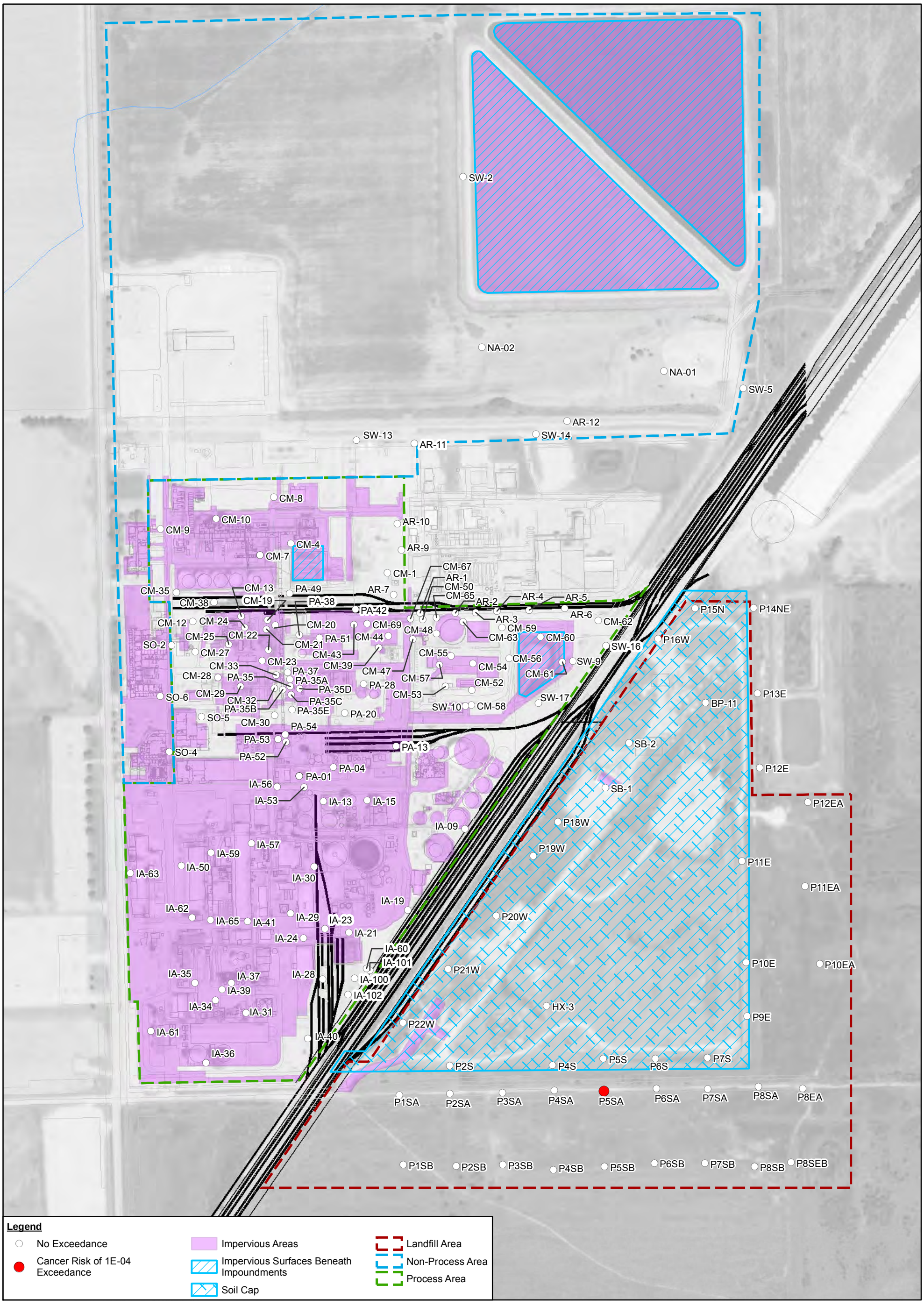
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

PROCESS AREA PENTACHLOROPHENOL EXCEEDANCE LOCATION IN SURFACE SOIL (0 TO 2 FT BGS)

FIGURE 21

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA001.mxd



Source: USDA NAIP 2010

0 125 250 375
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

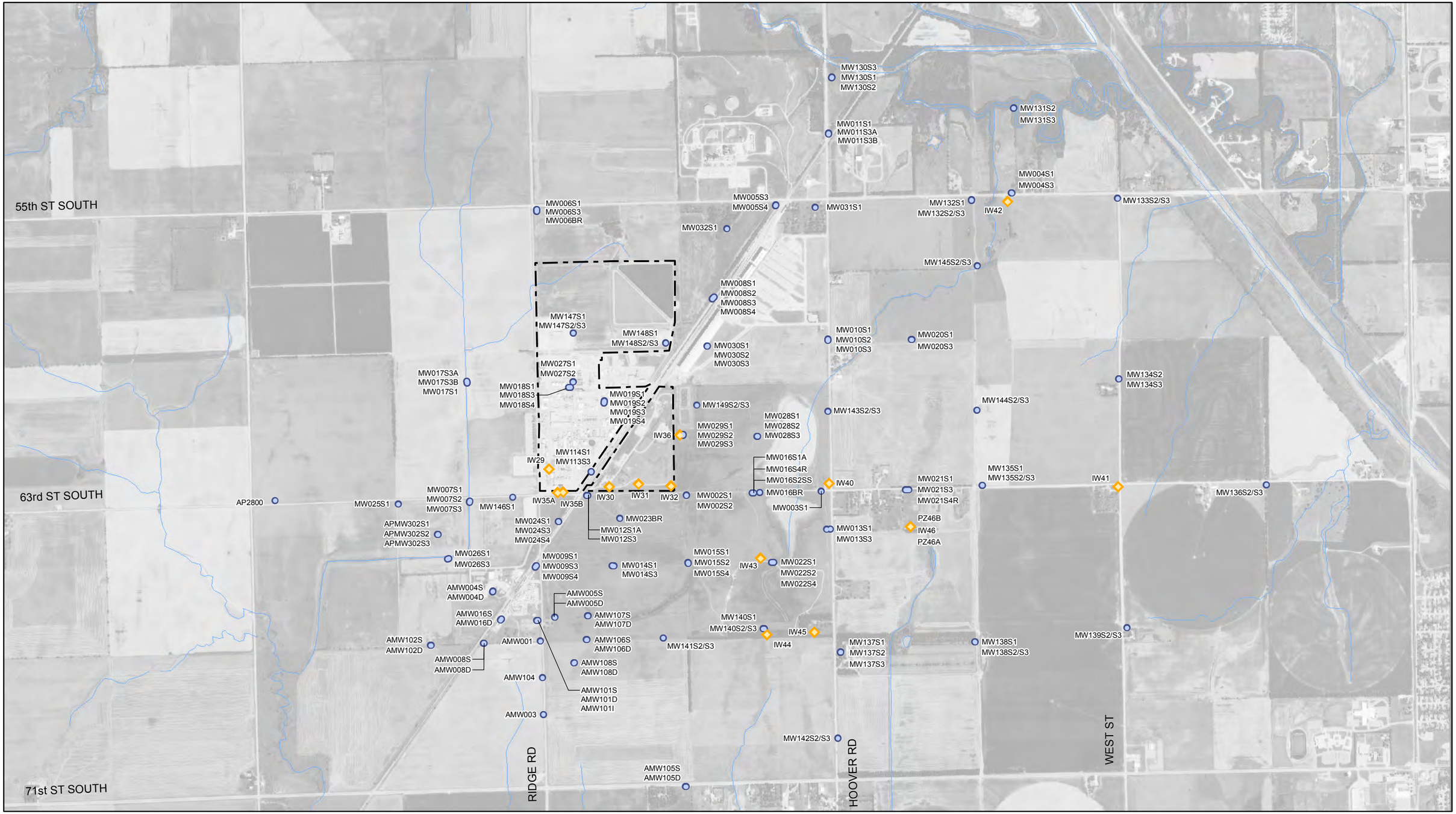
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

LANDFILL AREA ALPHA BHC EXCEEDANCE LOCATION IN SURFACE SOIL (0 TO 2 FT BGS)

11137148-D23103
Aug 14, 2017

FIGURE 22

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA002.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Approximate Facility Boundary

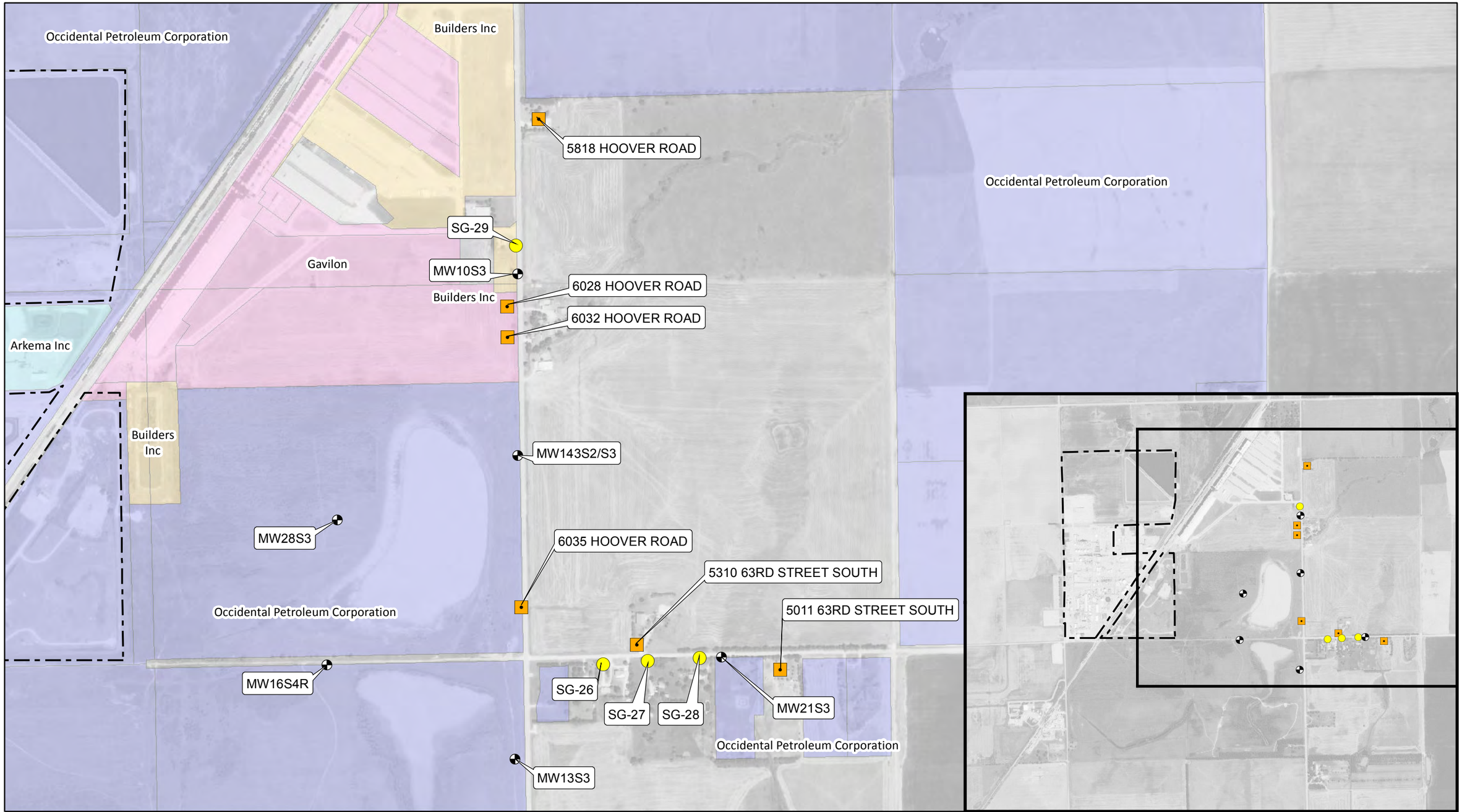
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

GROUNDWATER MONITORING
AND INTERCEPTOR WELL LOCATIONS

11137148-D23103
Aug 14, 2017

FIGURE 23

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA014.mxd



Source: USDA NAIP 2010

0 250 500 750
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

N

Legend

- Monitoring Well
- Recent Soil Gas Sampling Location
- Historical Soil Gas Sampling Location
- Approximate Facility Boundary
- Arkema Inc
- Builders Inc
- Gavilon
- Occidental Petroleum Corporation

GHD

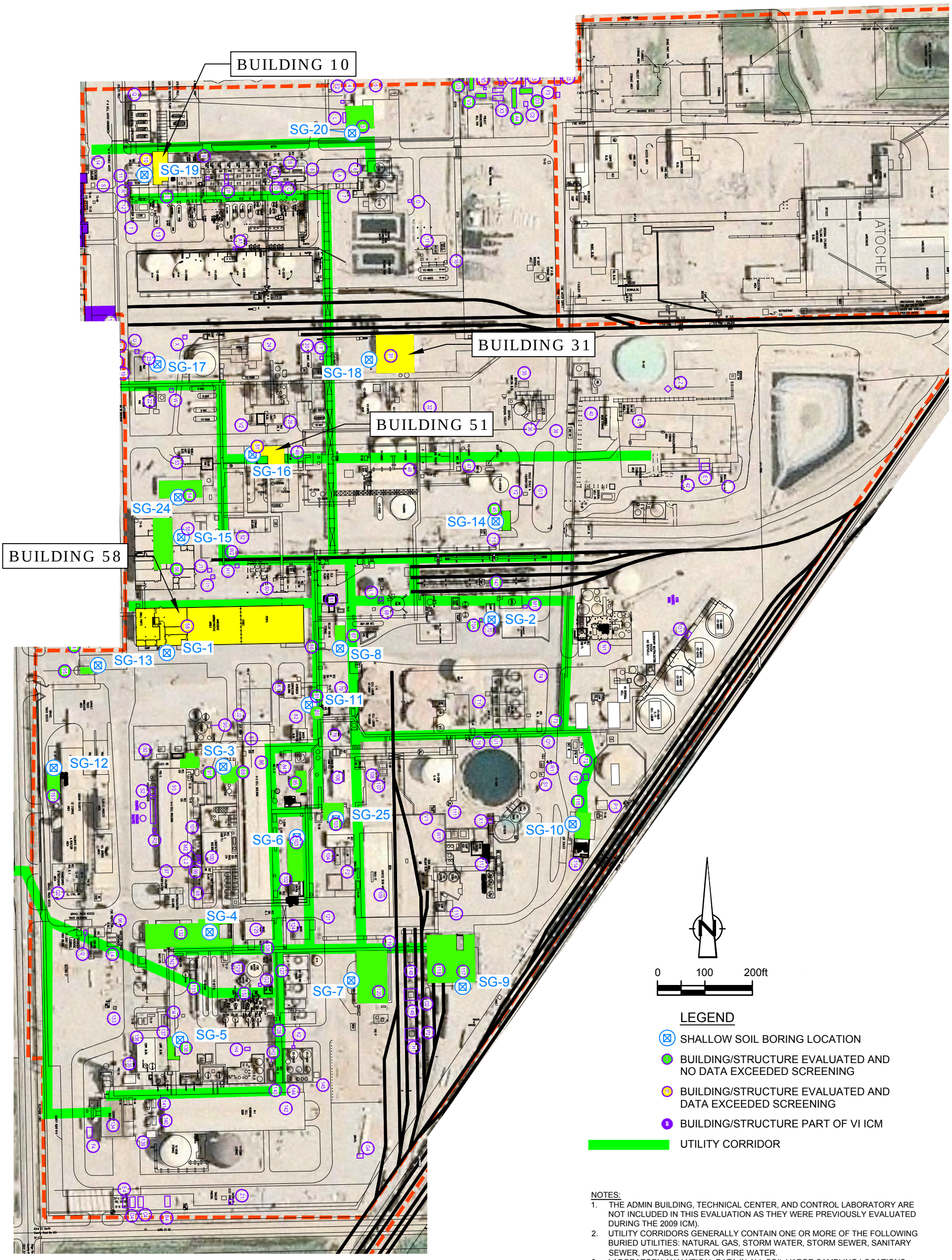
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 14, 2017

OFF-SITE SOIL VAPOR SAMPLE LOCATIONS

FIGURE 24

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA029.mxd



NOTES:
1. THE ADMIN BUILDING, TECHNICAL CENTER, AND CONTROL LABORATORY ARE NOT INCLUDED IN THIS EVALUATION AS THEY WERE PREVIOUSLY EVALUATED DURING THE 2009 ICM).
2. UTILITY CORRIDORS GENERALLY CONTAIN ONE OR MORE OF THE FOLLOWING BURIED UTILITIES: NATURAL GAS, STORM WATER, STORM SEWER, SANITARY SEWER, POTABLE WATER OR FIRE WATER.
3. LABORATORY ANALYTICAL DATA IN ALL SOIL VAPOR SAMPLING LOCATIONS INDICATED VOCs WERE PRESENT IN SOIL GAS.

SOURCE:
- OCC DRAWING NO. 27-1-5-16117_E; PLANT MAP FACILITY SITING ANALYSIS.
- NAIP, 2010.

GHD

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103

Aug 14, 2017

SOIL VAPOR EXTENT PROCESS AREA

figure 25

CAD File: P:\drawings\11137000s\11137148\11137148-REPORT\11137148-D23103(003)\11137148-D23103(003)GN\11137148-D23103(003)GN-WA001.dwg

SOURCE:
- OCC DRAWING NO. 27-1-5-16117_E; PLANT MAP FACILITY SITING ANALYSIS.
- NAIP, 2010.

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

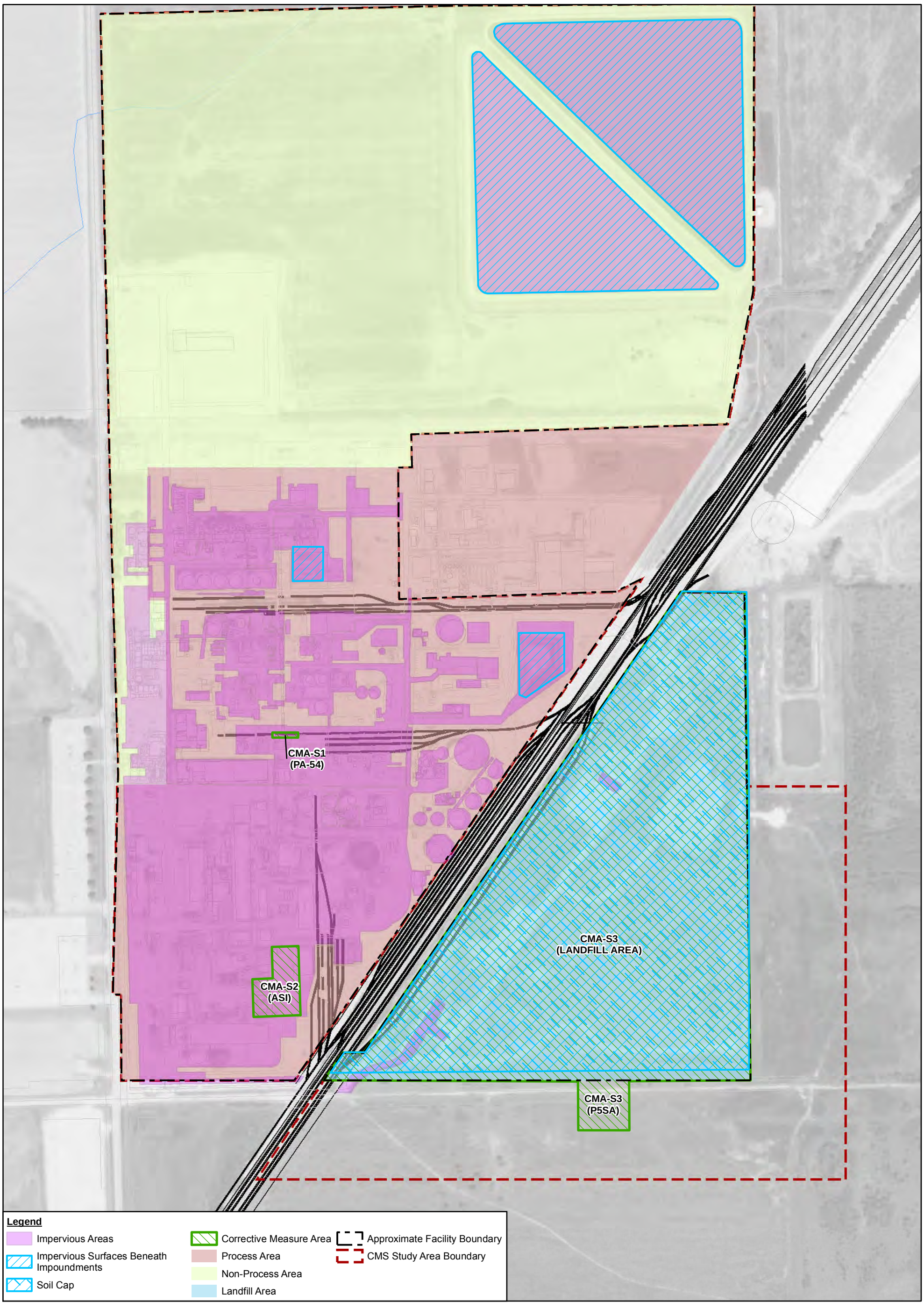
11137148-D23103

Aug 14, 2017

SOIL VAPOR EXTENT LANDFILL AREA

figure 26

CAD File: P:\drawings\11137000s\11137148\11137148-REPORT\11137148-D23103(003)\11137148-D23103(003)GN\11137148-D23103(003)GN-WA001.dwg



Source: USDA NAIP 2010

0 125 250 375
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

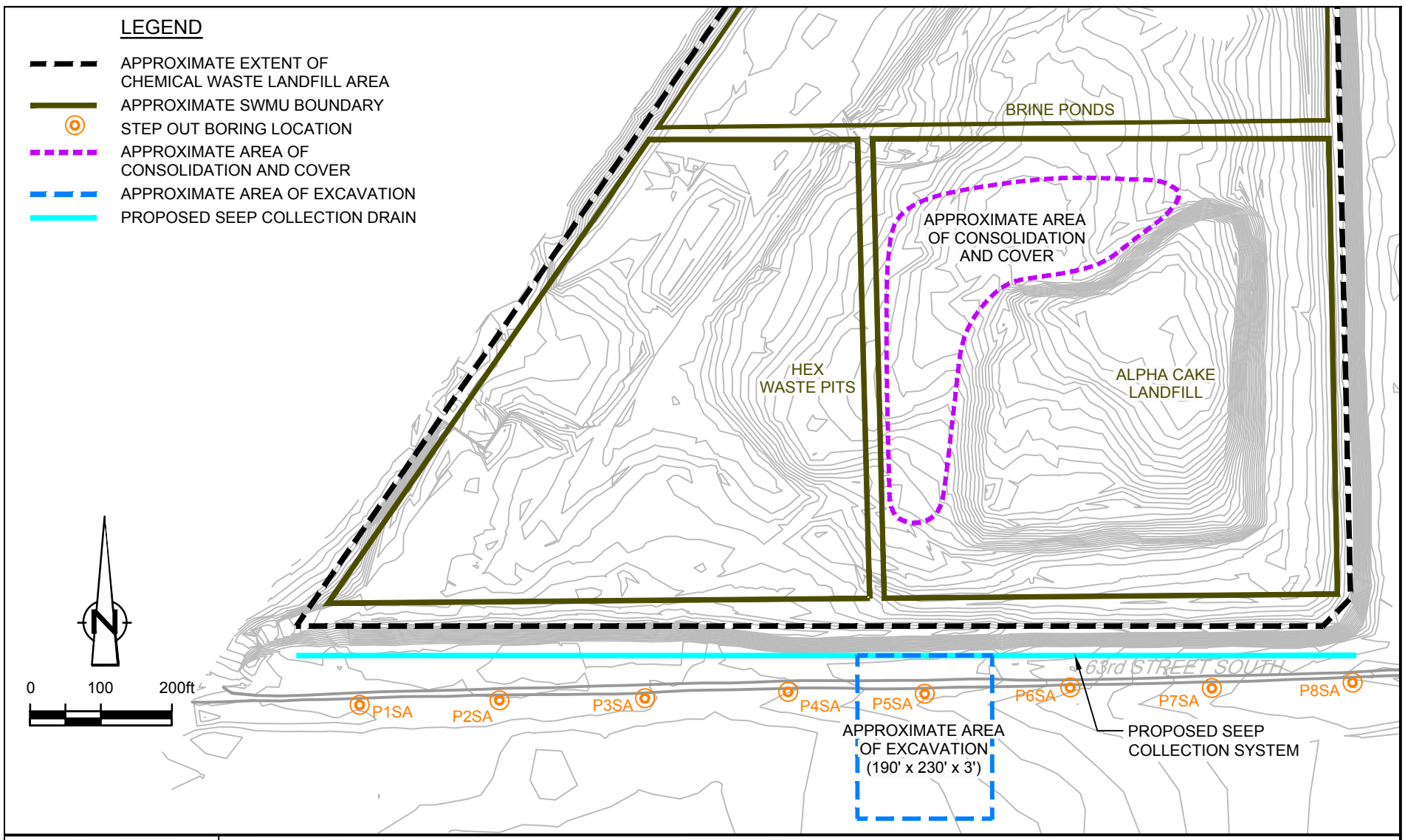
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

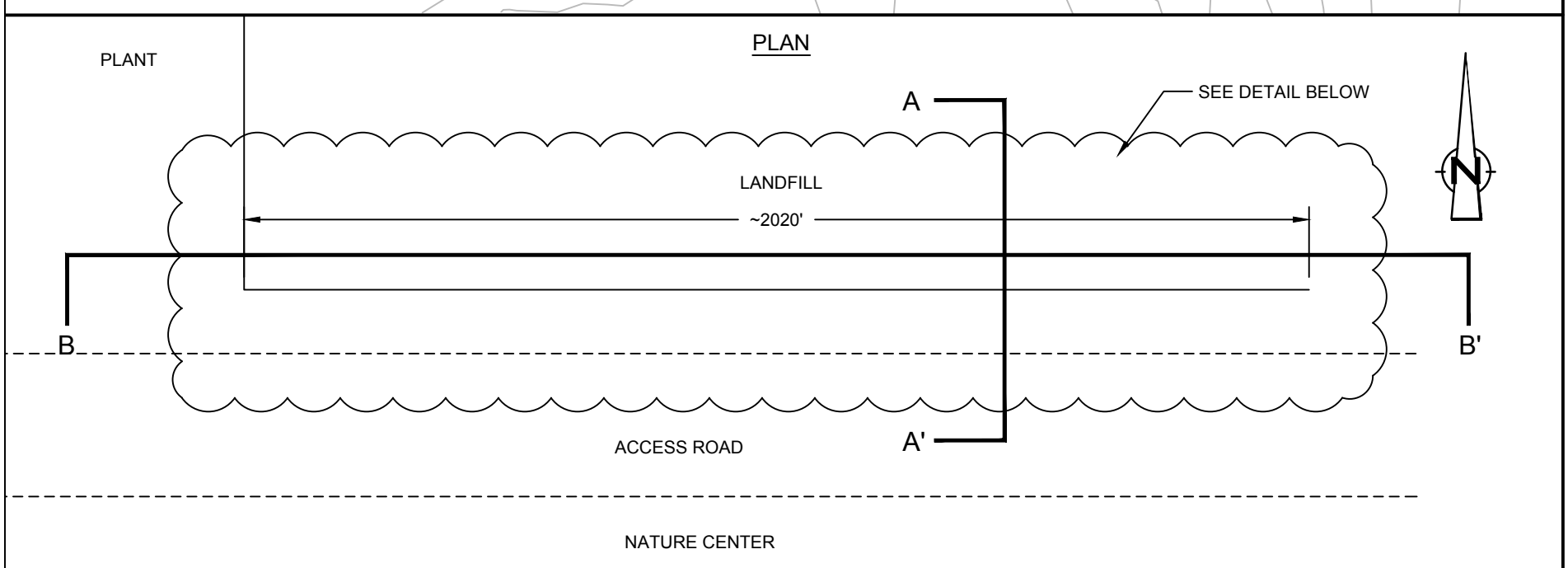
11137148-D23103
Aug 14, 2017

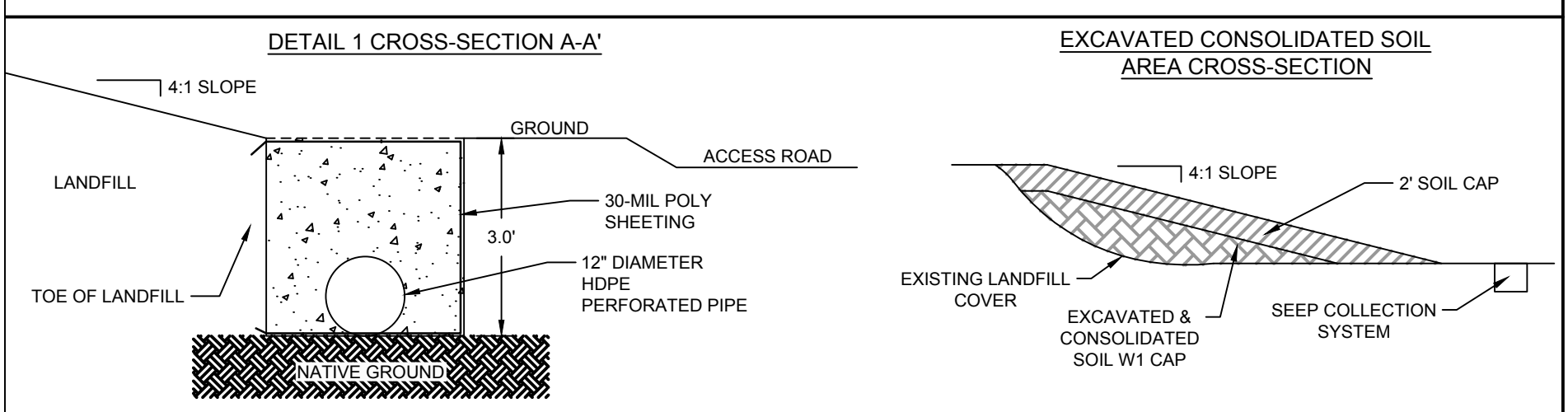
PROPOSED SOIL CORRECTIVE MEASURE LOCATIONS

FIGURE 27

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA031.mxd







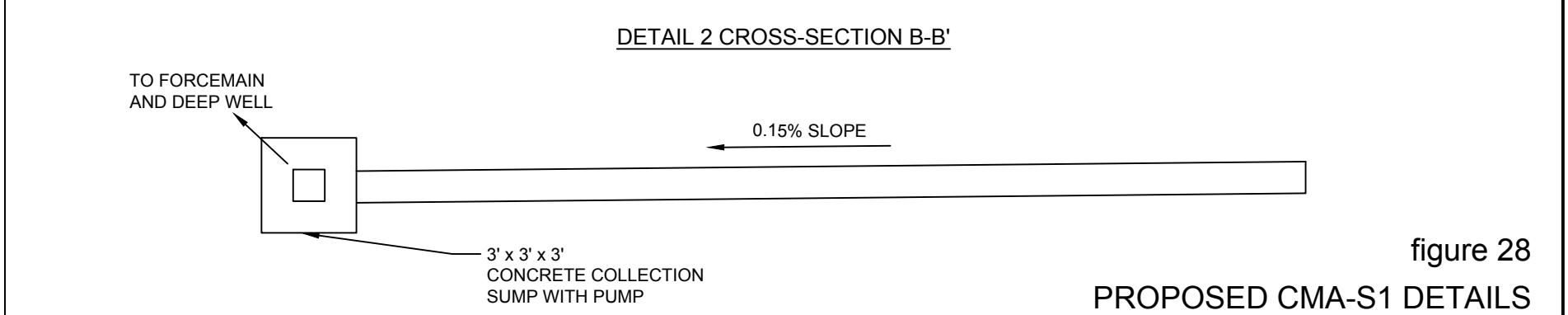
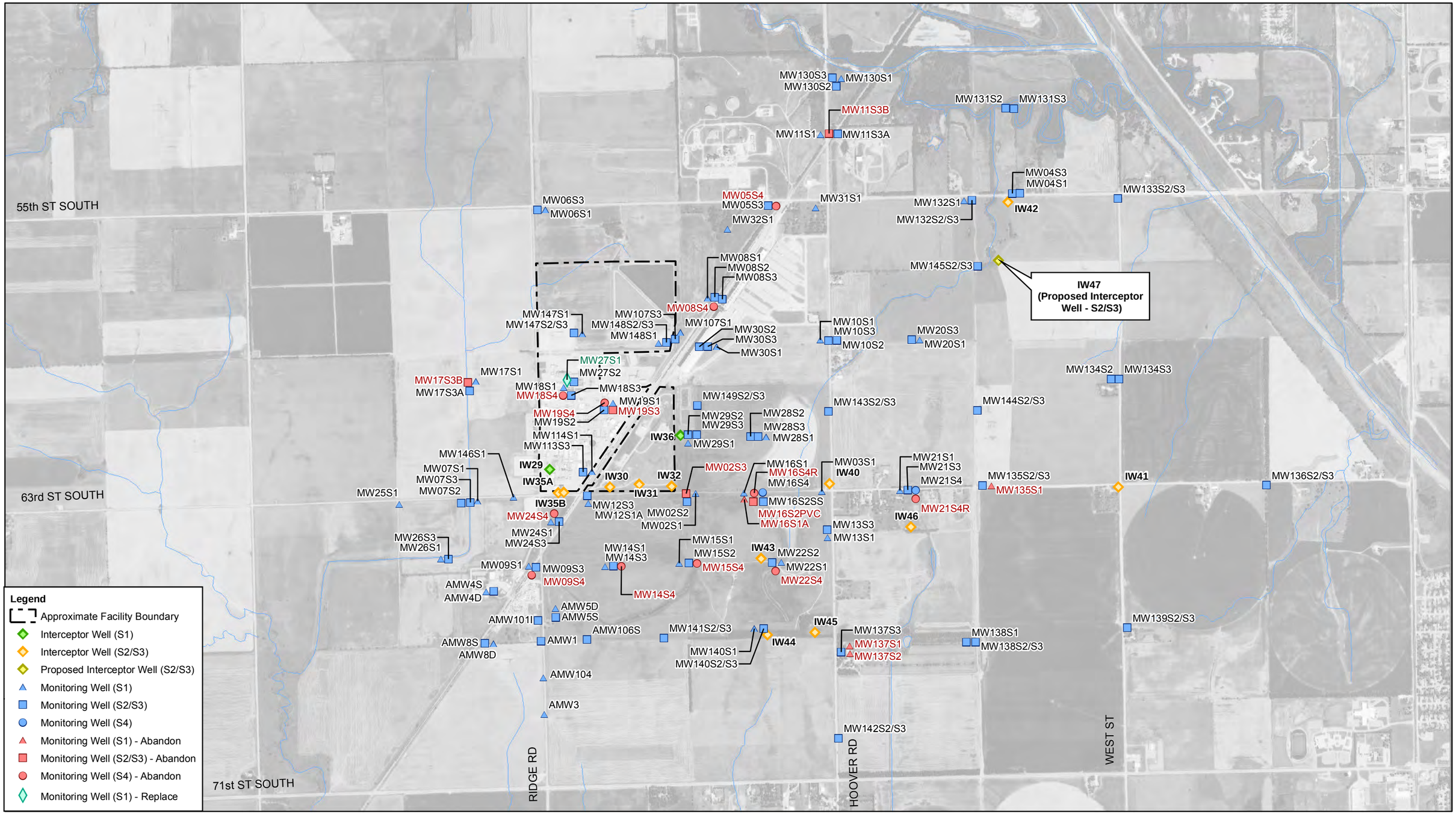


figure 28

PROPOSED CMA-S1 DETAILS
EXCAVATION, CONSOLIDATION, COVER AND SEEP COLLECTION
OCCIDENTAL CHEMICAL CORPORATION
Wichita, Kansas

GHD

11137148-D23103(003)GN-WA007 AUG 15, 2017



Source: USDA NAIP 2010
Note: Well locations have been shifted for display and do not show actual location

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

PROPOSED GROUNDWATER RECOVERY SYSTEM
AND MONITORING WELL NETWORK (CMA - G1)

11137148-D23103
Aug 14, 2017

FIGURE 29

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA032.mxd

Source: USDA NAIP 2010

0 200 400 600
Feet

Coordinate System:
NAD 1983 StatePlane Kansas
South FIPS 1502 Feet

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

PROPOSED SOIL VAPOR CORRECTIVE MEASURE LOCATIONS

11137148-D23103
Aug 14, 2017

FIGURE 30

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA033.mxd

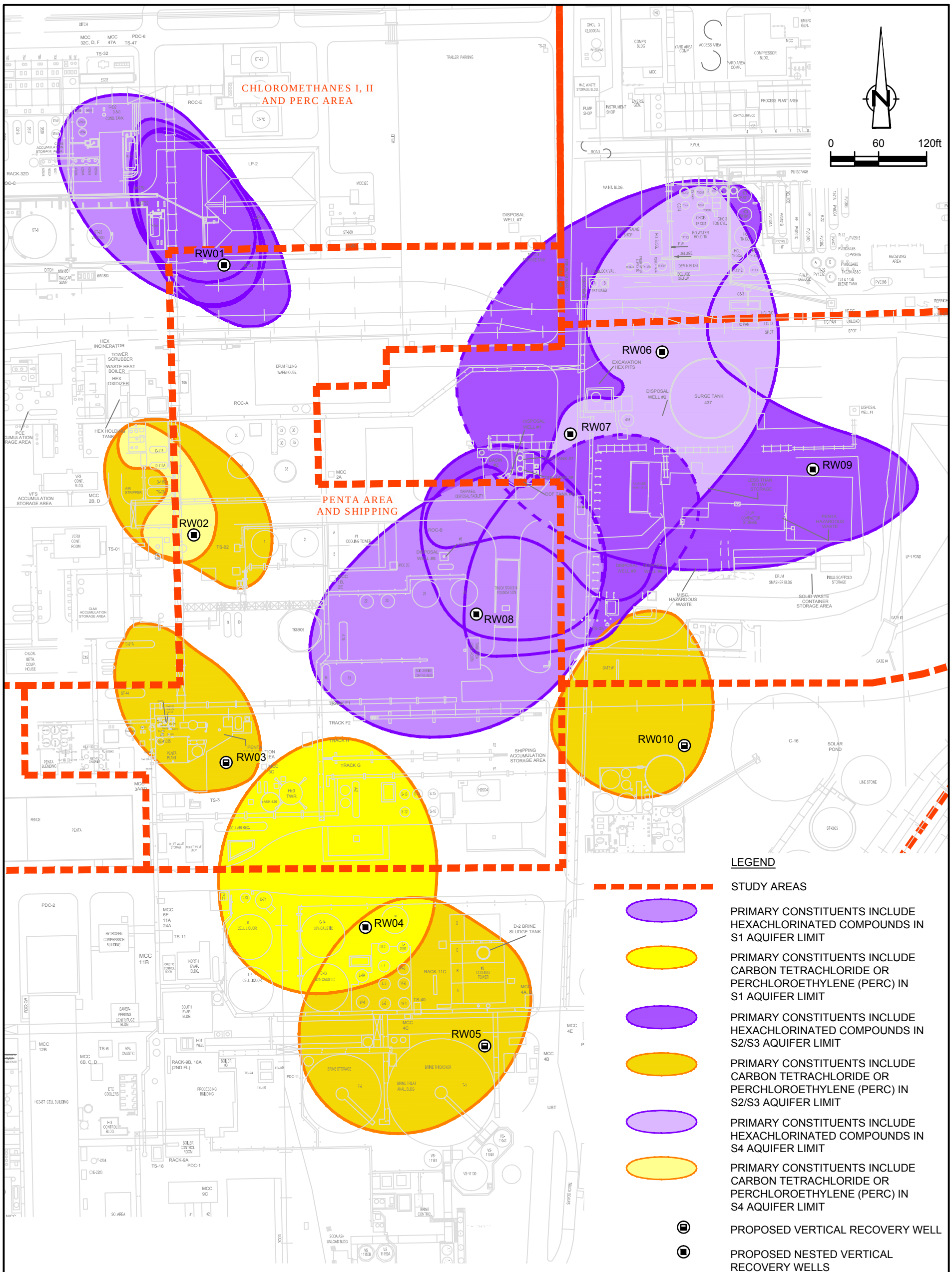


figure 31

PROPOSED DNAPL CORRECTIVE MEASURE LOCATIONS (CMA-D1) VERTICAL RECOVERY WELLS
OCCIDENTAL CHEMICAL CORPORATION
Wichita, Kansas

NOTES:
ACTUAL VERTICAL RECOVERY WELL LOCATIONS WILL BE BASED ON SITE CONDITIONS (E.G. ACCESS, OPERATIONS AREAS, ETC.).
NESTED VERICAL RECOVERY WELLS WILL BE INSTALLED IN AREAS WHERE DNAPL EXISTS IN MULTIPLE WATER-BEARING (S2/S3 AND S1) ZONES.

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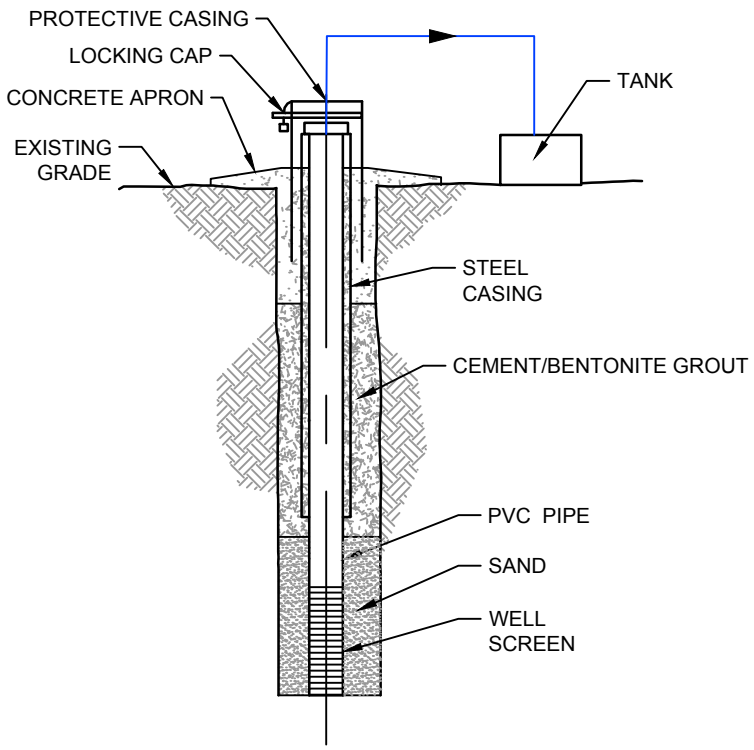
S1 ZONE



S2/S3 ZONE

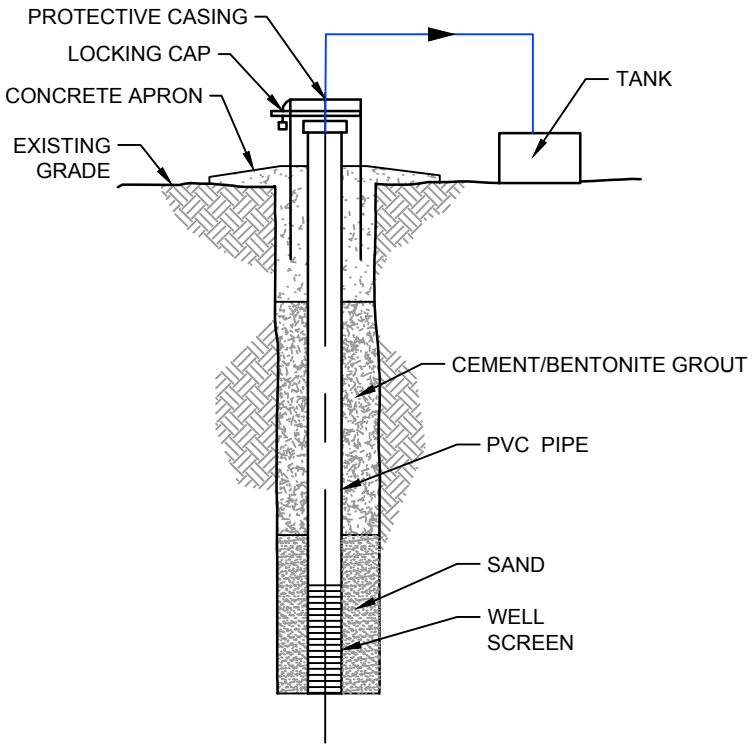
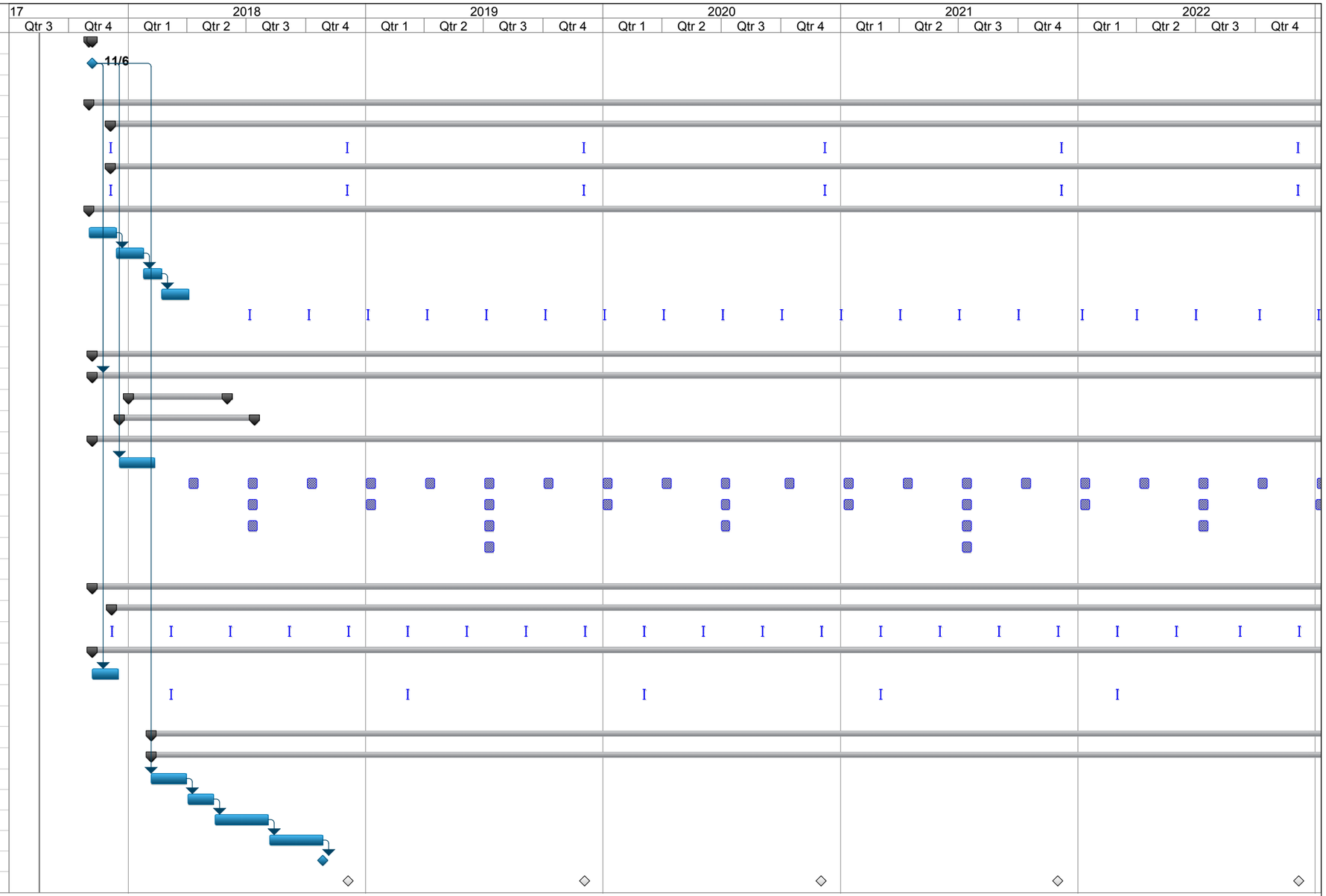


figure 32

TYPICAL VERTICAL RECOVERY WELL CONSTRUCTION
CMA-D1
OCCIDENTAL CHEMICAL CORPORATION
Wichita, Kansas

ID	Task Name	Duration
1	Final Corrective Measures Approval	
2	**Final Corrective Measures Approval**	
3		
4	Soil Corrective Measures	
5	**CMA - S1 (ASI)**	
6	Annual Inspection	
37	**CMA - S1 (Process Area)**	
38	Annual Inspection	
69	**CMA - S1 (Landfill Area)**	
70	Design	30 days
71	Procurement	30 days
72	Excavate & Consolidate	20 days
73	Install Seep Collection Trench	30 days
74	Quarterly Inspection/Maintenance	
189		
190	Groundwater Corrective Measures	
191	**CMA - G1**	
192	Install New S2/S3 IW Well	**110 days**
198	Plug & Abandon MWs	**150 days**
203	System Monitoring Program	
204	Develop Sampling Plan	40 days
205	Potentiometric Surface Gauging	
321	Semi-Annual Sampling & Reporting	
379	Annual Sampling & Reporting	
409	Biennial Sampling	
424		
425	Soil Vapor Corrective Measures	
426	**CMA - V1 - Admin/Tech/Lab**	
427	Quarterly Inspection & Monitoring	
544	**CMA - V1 - Bldg 10/51**	
545	Develop Inspection & Maintenance Plan	30 days
546	Annual Inspection	
576		
577	DNAPL Corrective Measures	
578	**CMA - D1**	
579	Design	40 days
580	Procurement	30 days
581	Install Recovery Wells	60 days
582	Commissioning	60 days
583	System Operation	0 days
584	Annual Reporting	



AUGUST 17, 2017

Task Milestone Summary

GHD

11137148 (3)

FIGURE 33
CMS IMPLEMENTATION SCHEDULE
OCCIDENTAL CHEMICAL CORPORATION, WICHITA, KANSAS

Tables

Table 2.1
Summary of Indoor Air Concentrations
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:								**First Floor**	**First Floor**	**Second Floor**
Sample ID:								**IA-1**	**FD-3**	**IA-2**
Sample Date:								**1/6/2017**	**1/6/2017**	**1/6/2017**
Parameters	**Units**	**Chemical on RTK list**	**Currently or Historically Manufactured**	**Used in Building**	**EPA IA RSLs a**	**EPA IA RSLs b**	**OSHA PELs c**		**(Duplicate)**	
Volatile Organic Compounds		(1)	(2)	(3)						
1,1,1-Trichloroethane	µg/m^3				2200	22000	1900000	1.1 U	1.1 U	1.1 U
1,2-Dichloroethane	µg/m^3				0.47	4.7	80000	0.81 U	0.81 U	0.81 U
1,2-Dichloropropane	µg/m^3		Yes		1.2	12	350000	0.92 U	0.92 U	0.92 U
Benzene	µg/m^3				1.6	13.1	32000	0.45 J	0.45 J	0.45 J
Carbon tetrachloride	µg/m^3	Yes	Yes		2	20	60000	1.7	1.1 J	1.6
Chloroform (Trichloromethane)	µg/m^3	Yes	Yes	d	0.53	5.3	240000	*1.6* [a]	*1.3* [a]	*1.7* [a]
Hexachlorobutadiene	µg/m^3				0.56	5.6	--	2.1 U	2.1 U	2.1 U
Hexachloroethane	µg/m^3				1.1	11	10000	1.9 U	1.9 U	1.9 U
Methylene chloride	µg/m^3	Yes	Yes		260	2600	90000	1.0 J	13 J	1.1
Tetrachloroethene	µg/m^3		Yes		18	180	695000	0.95	0.75	1.0
Trichloroethene	µg/m^3				0.88	8.8	530000	0.21 U	0.21 U	0.21 J
Vinyl chloride	µg/m^3				2.8	28	1200	0.51 U	0.51 U	0.51 U

Notes:

Indoor air concentration that exceeds EPA IA RSL and/or OSHA PEL are identified through formatting changes as noted below.

a EPA Regional Screening Levels (RSLs) Summary Table (TR = 1E-06, HI=0.1) Industrial Air, RSL Calculator access March 30, 2017.
Available at: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search.

b EPA Regional Screening Levels (RSLs) Summary Table (TR = 1E-05, HI=1) Industrial Air, RSL Calculator access March 30, 2017.
Available at: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search.

c US Department of Labor, Occupational Safety and Health Administration (OSHA), Permissible Exposure Limits (PELs) – Annotated Tables,
Available at: https://www.osha.gov/dsg/annotated-pels/index.html (converted to µg/m^3)

d possibly present in indoor air due to use of bleach cleaners

J Estimated concentration.

U Not detected at the associated reporting limit.

(1) The following chemicals are currently on the facility's right to know (RTK) list:

1,1,2,3 Tetrachloropropene
Asbestos
Calcium Carbonate
Carbon Tetrachloride
Chlorine
Chloroform
Cyclohexane
Diesel #1 & #2
Flogard MS6207
Gasoline (Unleaded)
Hydrogen Chloride
Hydrogen Peroxide
Methanol
Methyl Chloride
Methylene Chloride
Nitrogen
Oil (Mobil DTE 25, ISO 46)
Oil (Refrigeration)
Oil (Transformer Non-PCB)
Oil (Used)
Refrigerant R134A
Refrigerant R22
Sodium Carbonate
Sodium Chlorate
Sodium Chlorite
Sodium Hydroxide
Sodium Nitrate
Sodium Sulfate
Sulfur Dioxide
Sulfuric Acid
Zinc Chloride

(2) The following chemicals have been or currently manufactured at the facility:

1,1,2,3 Tetrachloropropene
2,4-Dichlorophenoxyacetic acid
Ammonia
Anhydrous Hydrochloric Acid
Calcium Chloride
Carbon Tetrachloride
Chlorinated Propane Intermediates
Chlorine
Chloroform
Ethylene Dichloride (Technical Center Pilot Plant)
Gamma-BHC (Lindane)
Grain Fumigant
Hydrogen Chloride
Methyl Chloride
Methylene Chloride
Sodium Chlorite
Sodium Hydroxide Beads
Tetrarchloroethylene

(3) Chemicals used in building

Table 2.2
Comparison of Soil Vapor Results to Vapor Intrusion Screening Levels
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:	Chemicals on Facility's Right to Know List	Chemicals manufactured at the Facility	Soil Gas Screening Criteria (1)		Regulatory Limits		Recommended Limits		SG-1	SG-1	SG-2	SG-2	SG-3	SG-3	SG-4	SG-4	SG-5	SG-5
Sample ID:									SG-1	SG-1	SG-2	SG-2	SG-3	SG-3	SG-4	SG-4	SG-5	SG-5
Sample Date:			Cancer risk of 1E-06 and Hazard of 0.1 µg/m^3	Cancer risk of 1E-05 and Hazard of 1 µg/m^3	OSHA PEL (2) (4)		Cal/OSHA PEL: 8-hr. TWA (3) (4)		12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017
Parameters Volatile Organic Compounds					ppm	µg/m3	ppm	µg/m3										
1,1,1-Trichloroethane			73,000	730,000	350	63,658,000	350	63,658,000	3,610	4420 J	130 U	33 U	320 U	44 U	250 U	250 U	33 U	9.3 U
1,2-Dichloroethane			16	160	50	6,746,000	1	135,000	930 U	3700 U	502	25 U	240 U	32 U	180 U	180 U	25 U	6.9 U
1,2-Dichloropropane			41	410	75	11,553,000	75	11,553,000	3,060	2210 J	110 U	28 U	270 U	37 U	210 U	210 U	28 U	7.9 U
Benzene			52	520	10	1,065,000	1	106,000	730 U	2900 U	137	19 U	190 U	112	72.5 J	140 U	11 J	5.4 U
Carbon tetrachloride	x	x	68	680	10	2,097,000	2	419,000	**3,150,000**	**4,560,000**	11,800	594	5,530	981	34,800	47,600	38 U	30
Chloroform (Trichloromethane)	x	x	18	180	50	8,138,000	2	326,000	1,100,000	811,000	11,700	401	36,600	9,280	3,850	2,840	30 U	17
Hexachlorobutadiene			19	190					2500 U	9800 U	250 U	65 U	630 U	85 U	480 U	480 U	65 U	18 U
Hexachloroethane			37	370	1	323,000	1	323,000	2200 U	8800 U	220 U	58 U	560 U	77 U	430 U	430 U	58 U	16 U
Methylene chloride	x	x	8,800	88,000			25	2,895,000	1,260	3200 U	266	26	212	96	1,250	240	27	8
Tetrachloroethene		x	580	5,800	100	22,608,000	25	5,652,000	551,000	568,000	28,400	8	12,400	6,670	7,050	5,610	155	18
Trichloroethene			29	290	100	17,913,000	25	4,478,000	11,900	10,800	19,400	69	1,140	529	1,390	640	63	10
Vinyl chloride			93	930			1	85,000	590 U	2400 U	132	26	1,540	1,430	78.7 J	120 U	470	171

Notes:

(1) Soil Gas Criteria taken from USEPA VISLs https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls (April 2017) based on cancer risk of 1E-06 and Hazard index of 0.1 and cancer risk of 1E-05 and hazard index of 1 and commercial worker.
(2) Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) obtained from https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(3) California Division of Occupational Safety and Health (Cal/OSHA) PELs 8 hour Time Weighted Average (TWA) obtained from https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(4) OSHA PELs and Cal/OSHA PELs in parts per million (ppm) converted to mg/m^3 by dividing parameter's molecular weight and multiplied by unit conversion factor (1000 µg/mg). Then divided by USEPA default attenuation factor of 0.03 to convert the values to soil gas values.
J Estimated concentration.
U Not detected at the associated reporting limit.

Legend

	Exceeds Cancer Risk of 1E-05 and Hazard of 1
3150000	Exceeds Regulatory OSHA PEL
	Exceeds Regulatory Cal/OSHA PEL 8 hr. TWA
	Samples not collected

Table 2.2
Comparison of Soil Vapor Results to Vapor Intrusion Screening Levels
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:	Chemicals on Facility's Right to Know List	Chemicals manufactured at the Facility	Soil Gas Screening Criteria (1)		Regulatory Limits		Recommended Limits		SG-6	SG-6	SG-7	SG-7	SG-8	SG-8	SG-9	SG-9	SG-10	SG-10
Sample ID:									SG-6	SG-6	SG-7	SG-7	SG-8	SG-8	SG-9	SG-9	SG-10	SG-10
Sample Date:			Cancer risk of 1E-06 and Hazard of 0.1 µg/m^3	Cancer risk of 1E-05 and Hazard of 1 µg/m^3	OSHA PEL (2) (4)		Cal/OSHA PEL: 8-hr. TWA (3) (4)		12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017
Parameters Volatile Organic Compounds					ppm	µg/m3	ppm	µg/m3										
1,1,1-Trichloroethane			73,000	730,000	350	63,658,000	350	63,658,000	33 U	33 U	350 U	480 U	550 U	2300 U	55 U	33 U	655	2500 U
1,2-Dichloroethane			16	160	50	6,746,000	1	135,000	25 U	25 U	260 U	360 U	530	1700 U	40 U	25 U	652	1800 U
1,2-Dichloropropane			41	410	75	11,553,000	75	11,553,000	28 U	28 U	300 U	410 U	1,440	1160 J	46 U	28 U	2,850	1540 J
Benzene			52	520	10	1,065,000	1	106,000	31	217	518	204 J	320 U	1400 U	32 U	19 U	1,840	6,360
Carbon tetrachloride	x	x	68	680	10	2,097,000	2	419,000	38 U	21 J	2,890	887	367,000	277,000	41 J	38 U	11,600	1860 J
Chloroform (Trichloromethane)	x	x	18	180	50	8,138,000	2	326,000	30 U	30 U	6,640	3,590	73,700	63,000	1,060	37	82,500	46,300
Hexachlorobutadiene			19	190					65 U	65 U	690 U	940 U	1100 U	4600 U	110 U	65 U	940 U	4800 U
Hexachloroethane			37	370	1	323,000	1	323,000	58 U	58 U	620 U	840 U	628 J	4100 U	96 U	58 U	840 U	4300 U
Methylene chloride	x	x	8,800	88,000			25	2,895,000	24	147	230 U	310 U	792	1500 U	35 U	29	255 J	1600 U
Tetrachloroethene		x	580	5,800	100	22,608,000	25	5,652,000	8	12,000	86,800	136,000	328,000	255,000	22,600	68	902,000	397,000
Trichloroethene			29	290	100	17,913,000	25	4,478,000	6.4 U	5,700	4,780	4,100	27,700	22,200	1,240	13	130,000	137,000
Vinyl chloride			93	930			1	85,000	16 U	10,400	2,840	412	260 U	1100 U	26 U	16 U	220 U	1200 U

Notes:

(1) Soil Gas Criteria taken from USEPA VISLs https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls (April 2017) based on cancer risk of 1E-06 and Hazard index of 0.1 and cancer risk of 1E-05 and hazard index of 1 and commercial worker.
(2) Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) obtained from https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(3) California Division of Occupational Safety and Health (Cal/OSHA) PELs 8 hour Time Weighted Average (TWA) obtained frc https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(4) OSHA PELs and Cal/OSHA PELs in parts per million (ppm) converted to mg/m^3 by dividing parameter's molecular weight an multiplied by unit conversion factor (1000 µg/mg). Then divided by USEPA default attenuation factor of 0.03 to convert the values to soil gas values.
J Estimated concentration.
U Not detected at the associated reporting limit.

Legend

	Exceeds Cancer Risk of 1E-05 and Hazard of 1
3150000	Exceeds Regulatory OSHA PEL
	Exceeds Regulatory Cal/OSHA PEL 8 hr. TWA
	Samples not collected

Table 2.2
Comparison of Soil Vapor Results to Vapor Intrusion Screening Levels
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:	Chemicals on Facility's Right to Know List	Chemicals manufactured at the Facility	Soil Gas Screening Criteria (1)		Regulatory Limits		Recommended Limits		SG-11	SG-11	SG-12	SG-12	SG-13	SG-13	SG-14	SG-14	SG-15	SG-15	SG-16
Sample ID:									SG-11	SG-11	SG-12	SG-12	SG-13	SG-13	SG-14	SG-14	SG-15	SG-15	SG-16
Sample Date:			Cancer risk of 1E-06 and Hazard of 0.1 µg/m^3	Cancer risk of 1E-05 and Hazard of 1 µg/m^3	OSHA PEL (2) (4)		Cal/OSHA PEL: 8-hr. TWA (3) (4)		12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016		12/5/2016		12/2/2016		12/2/2016
Parameters Volatile Organic Compounds					ppm	µg/m3	ppm	µg/m3											
1,1,1-Trichloroethane			73,000	730,000	350	63,658,000	350	63,658,000	22 U	130 U	1.1 U	4.4 U	250 U		5,950		350 J		31000 U
1,2-Dichloroethane			16	160	50	6,746,000	1	135,000	16 U	93 U	0.81 U	2.2 J	190 U		1900 U		370 U		23000 U
1,2-Dichloropropane			41	410	75	11,553,000	75	11,553,000	18 U	110 U	0.92 U	3.7 U	210 U		2100 U		550		26000 U
Benzene			52	520	10	1,065,000	1	106,000	19	43.1 J	1	2.6 U	150 U		1500 U		377		18000 U
Carbon tetrachloride	x	x	68	680	10	2,097,000	2	419,000	56	140 U	62	1,360	13,300		296,000		209,000		**20,400,000**
Chloroform (Trichloromethane)	x	x	18	180	50	8,138,000	2	326,000	124	110 U	94	326	25,100		10,300		86,400		2,000,000
Hexachlorobutadiene			19	190					21 J	250 U	2	8.5 U	490 U		4900 U		980 U		61000 U
Hexachloroethane			37	370	1	323,000	1	323,000	38 U	220 U	1.9 U	7.7 U	440 U		4400 U		880 U		484,000
Methylene chloride	x	x	8,800	88,000			25	2,895,000	14 U	43.1 J	4	4	160 U		1600 U		2,860		25,400
Tetrachloroethene		x	580	5,800	100	22,608,000	25	5,652,000	25,300	53,400	317	497	13,700		309,000		48,300		8,410,000
Trichloroethene			29	290	100	17,913,000	25	4,478,000	1,210	3,380	8	25	460		1,590		1,480		75,200
Vinyl chloride			93	930			1	85,000	22	48.6 J	0.51 U	2.0 U	120 U		1200 U		527		15000 U

Notes:

(1) Soil Gas Criteria taken from USEPA VISLs https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls (April 2017) based on cancer risk of 1E-06 and Hazard index of 0.1 and cancer risk of 1E-05 and hazard index of 1 and commercial worker.
(2) Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) obtained from https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(3) California Division of Occupational Safety and Health (Cal/OSHA) PELs 8 hour Time Weighted Average (TWA) obtained frc https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(4) OSHA PELs and Cal/OSHA PELs in parts per million (ppm) converted to mg/m^3 by dividing parameter's molecular weight an multiplied by unit conversion factor (1000 µg/mg). Then divided by USEPA default attenuation factor of 0.03 to convert the values to soil gas values.
J Estimated concentration.
U Not detected at the associated reporting limit.

Legend

	Exceeds Cancer Risk of 1E-05 and Hazard of 1
3150000	Exceeds Regulatory OSHA PEL
	Exceeds Regulatory Cal/OSHA PEL 8 hr. TWA
	Samples not collected

Table 2.2
Comparison of Soil Vapor Results to Vapor Intrusion Screening Levels
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:	Chemicals on Facility's Right to Know List	Chemicals manufactured at the Facility	Soil Gas Screening Criteria (1)		Regulatory Limits		Recommended Limits		SG-16	SG-18	SG-18	SG-18	SG-19	SG-19	SG-19	SG-20	SG-20	SG-21
Sample ID:									SG-16	SG-18	FD-1	SG-18	SG-19	SG-19	FD-1	SG-20	SG-20	SG-21
Sample Date:			Cancer risk of 1E-06 and Hazard of 0.1 µg/m^3	Cancer risk of 1E-05 and Hazard of 1 µg/m^3	OSHA PEL (2) (4)		Cal/OSHA PEL: 8-hr. TWA (3) (4)		2/10/2017	12/5/2016	12/5/2016		12/5/2016	2/10/2017	2/10/2017	12/5/2016		12/5/2016
											(Duplicate)				(Duplicate)			
Parameters Volatile Organic Compounds					ppm	µg/m3	ppm	µg/m3										
1,1,1-Trichloroethane			73,000	730,000	350	63,658,000	350	63,658,000	33,200	9,000	9,000		2700 U	650 U	500 U	37		22 U
1,2-Dichloroethane			16	160	50	6,746,000	1	135,000	8500 U	23900	33100		2000 U	490 U	370 U	16 U		16 U
1,2-Dichloropropane			41	410	75	11,553,000	75	11,553,000	9700 U	1150 J	1710 J		2300 U	550 U	430 U	18 U		18 U
Benzene			52	520	10	1,065,000	1	106,000	6700 U	783 J	716 J		1600 U	311 J	409	124		13 U
Carbon tetrachloride	x	x	68	680	10	2,097,000	2	419,000	**18,100,000**	296,000	289,000		248,000	152,000	238,000	25 U		11,100
Chloroform (Trichloromethane)	x	x	18	180	50	8,138,000	2	326,000	1,100,000	453,000	453,000		1,010,000	387,000	606,000	269		884
Hexachlorobutadiene			19	190					22000 U	5200 U	5400 U		5300 U	1300 U	980 U	43 U		43 U
Hexachloroethane			37	370	1	323,000	1	323,000	20000 U	4700 U	4900 U		4800 U	1100 U	880 U	38 U		38 U
Methylene chloride	x	x	8,800	88,000			25	2,895,000	9,590	2,990	3,580		2,570	670	816	95		14 U
Tetrachloroethene		x	580	5,800	100	22,608,000	25	5,652,000	1,530,000	433,000	430,000		73,200	30,300	49,700	12,800		1,550
Trichloroethene			29	290	100	17,913,000	25	4,478,000	37,700	37,100	38,200		6,990	3,280	4,780	3,250		12
Vinyl chloride			93	930			1	85,000	5,960	17,300	16,700		1300 U	310 U	129 J	309		10 U

Notes:

(1) Soil Gas Criteria taken from USEPA VISLs https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls (April 2017) based on cancer risk of 1E-06 and Hazard index of 0.1 and cancer risk of 1E-05 and hazard index of 1 and commercial worker.
(2) Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) obtained from https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(3) California Division of Occupational Safety and Health (Cal/OSHA) PELs 8 hour Time Weighted Average (TWA) obtained frc https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(4) OSHA PELs and Cal/OSHA PELs in parts per million (ppm) converted to mg/m^3 by dividing parameter's molecular weight an multiplied by unit conversion factor (1000 µg/mg). Then divided by USEPA default attenuation factor of 0.03 to convert the values to soil gas values.
J Estimated concentration.
U Not detected at the associated reporting limit.

Legend

	Exceeds Cancer Risk of 1E-05 and Hazard of 1
3150000	Exceeds Regulatory OSHA PEL
	Exceeds Regulatory Cal/OSHA PEL 8 hr. TWA
	Samples not collected

Table 2.2
Comparison of Soil Vapor Results to Vapor Intrusion Screening Levels
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:	Chemicals on Facility's Right to Know List	Chemicals manufactured at the Facility	Soil Gas Screening Criteria (1)		Regulatory Limits		Recommended Limits		SG-21	SG-22	SG-22	SG-23	SG-23	SG-25	SG-25	SG-25
Sample ID:									SG-21	SG-22	SG-22	SG-23	SG-23	SG-25	FD-2	SG-25
Sample Date:			Cancer risk of 1E-06 and Hazard of 0.1 µg/m^3	Cancer risk of 1E-05 and Hazard of 1 µg/m^3	OSHA PEL (2) (4)		Cal/OSHA PEL: 8-hr. TWA (3) (4)		2/10/2017	12/5/2016	2/10/2017	12/1/2016	2/10/2017	12/6/2016	12/6/2016	2/9/2017
															(Duplicate)	
Parameters Volatile Organic Compounds					ppm	µg/m3	ppm	µg/m3								
1,1,1-Trichloroethane			73,000	730,000	350	63,658,000	350	63,658,000	8.7 U	22 U	44 U	22 U	44 U	2700 U	5000 U	1.1 U
1,2-Dichloroethane			16	160	50	6,746,000	1	135,000	6.5 U	16 U	32 U	16 U	32 U	2000 U	3700 U	0.81 U
1,2-Dichloropropane			41	410	75	11,553,000	75	11,553,000	7.4 U	18 U	37 U	18 U	37 U	2300 U	4300 U	0.92 U
Benzene			52	520	10	1,065,000	1	106,000	5.1 U	13 U	26 U	4,310	7,250	18,800	17,300	1
Carbon tetrachloride	x	x	68	680	10	2,097,000	2	419,000	1,770	23,000	10,900	25 U	2,090	98,800	103,000	2
Chloroform (Trichloromethane)	x	x	18	180	50	8,138,000	2	326,000	178	1,510	1,150	14 J	674	244,000	240,000	0.73 J
Hexachlorobutadiene			19	190					17 U	43 U	85 U	43 U	85 U	4390 J	6020 J	2.1 U
Hexachloroethane			37	370	1	323,000	1	323,000	12 J	38 U	77 U	38 U	77 U	4700 U	8800 U	1.9 U
Methylene chloride	x	x	8,800	88,000			25	2,895,000	3.8 J	14 U	28 U	8.7 J	28 U	12,400	14,000	2
Tetrachloroethene		x	580	5,800	100	22,608,000	25	5,652,000	1,110	402	267	98	1,230	575,000	635,000	1
Trichloroethene			29	290	100	17,913,000	25	4,478,000	28	10	8.6 U	329	1,640	128,000	134,000	0.20 J
Vinyl chloride			93	930			1	85,000	4.1 U	10 U	20 U	859	2,860	18,400	17,400	0.51 U

Notes:

(1) Soil Gas Criteria taken from USEPA VISLs https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls (April 2017) based on cancer risk of 1E-06 and Hazard index of 0.1 and cancer risk of 1E-05 and hazard index of 1 and commercial worker.
(2) Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) obtained from https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(3) California Division of Occupational Safety and Health (Cal/OSHA) PELs 8 hour Time Weighted Average (TWA) obtained frc https://www.osha.gov/dsg/annotated-pels/index.html (accessed April 10, 2017).
(4) OSHA PELs and Cal/OSHA PELs in parts per million (ppm) converted to mg/m^3 by dividing parameter's molecular weight an multiplied by unit conversion factor (1000 µg/mg). Then divided by USEPA default attenuation factor of 0.03 to convert the values to soil gas values.
J Estimated concentration.
U Not detected at the associated reporting limit.

Legend

	Exceeds Cancer Risk of 1E-05 and Hazard of 1
3150000	Exceeds Regulatory OSHA PEL
	Exceeds Regulatory Cal/OSHA PEL 8 hr. TWA
	Samples not collected

Table 2.4
Summary of Facility Buildings and Determination of Vapor Intrusion Evaluation
Occidental Chemical Corporation
Wichita, Kansas

	Building # and Building Description	Type of Structure	Adjacent Surface Material(s)	Building Utility Locations	Exterior Construction	Building Siting	Building Ventilation	Building Protrusions
10	CLM II Control Room Offices, breakroom, and bathroom West end of Chloromethanes	Building	Concrete	West Side	Cinder Block	Elevated Slab	HVAC on West Side	Sealed Windows
31	Drum Filling Warehouse (offices, portable bathroom) South of RR tracks south of Cooling Tower #7	Building	Concrete	Overhead / East Side	Concrete Panel	Elevated Slab	HVAC on East Side Near Office / Warehouse Open	Garage Doors
51	VCRU Control Room Office and Bathroom On south side of Main E-W Road East of R&D	Building	Concrete	South Side	Concrete Panel	Elevated on South Side, at Grade on North Side	HVAC on Roof, North Side	Sealed Windows
58	Warehouse / PCS Group Offices Offices and Bathroom Annex Conference Room	Building	Concrete	Southwest Side	Concrete Panel	Elevated Slab	HVAC, Garage Doors, Fans	Garage Doors

Table 3.1
Summary of Soil Analytical Results for Landfill Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			P1SA	P1SB	P2SB	P3SA	P4SA	P5SA	P5SB	P7SA
Sample ID:			S-071910-TK-100	S-011212-WP-262	S-011212-WP-261	S-071910-TK-102	S-071910-TK-103	S-071910-TK-104	S-011112-WP-270	S-071910-TK-106
Sample Date:			7/19/2010	1/12/2012	1/12/2012	7/19/2010	7/19/2010	7/19/2010	1/11/2012	7/19/2010
Sample Depth:			(1-2) ft BGS	(0.5-1) ft BGS	(0.5-1) ft BGS	(1-2) ft BGS	(1-2) ft BGS	(1-2) ft BGS	(0.5-1) ft BGS	(1-2) ft BGS
Parameters	**Units**	**Industrial RSLs (1)**								
Volatile Organic Compounds										
1,1,1-Trichloroethane	mg/kg	36000	0.0062 U	0.0049 U	0.0048 U	0.02 U	0.02 U	0.02 U	0.0052 U	0.0059 U
1,2-Dichloroethane	mg/kg	2	0.0062 U	0.0049 U	0.0048 U	0.02 U	0.02 U	0.02 U	0.0052 U	0.0059 U
1,2-Dichloropropane	mg/kg	1.2	0.0062 U	0.0049 U	0.0048 U	0.02 U	0.02 U	0.02 U	0.0052 U	0.0059 U
Benzene	mg/kg	5.1	0.0062 U	0.0049 U	0.0048 U	0.03	0.02 U	0.05	0.0052 U	0.0059 U
Carbon tetrachloride	mg/kg	2.9	0.0062 U	0.0049 U	0.0141	0.02 U	0.02 U	0.02 U	0.0052 U	0.035
Chloroform (Trichloromethane)	mg/kg	1.4	0.0062 U	0.0049 U	0.01	0.076	0.05	0.08 U	0.0052 U	0.172
Chloromethane (Methyl chloride)	mg/kg	460	0.0062 U	0.0049 U	0.0048 U	0.02 U	0.02 U	0.02 U	0.0052 U	0.0059 U
Methylene chloride	mg/kg	1000	0.0062 U	0.0049 U	0.0048 U	0.03	0.02	0.04 U	0.0052 U	0.0059 U
Tetrachloroethene	mg/kg	100	0.0351	0.0049 U	0.41	0.37	0.02 U	0.16	0.0052 U	0.147
Trichloroethene	mg/kg	6	0.0062 U	0.0049 U	0.0048 U	0.02 U	0.02 U	0.02 U	0.0052 U	0.0059 U
Vinyl chloride	mg/kg	1.7	0.0062 U	0.0049 U	0.0048 U	0.02 U	0.02 U	0.02 U	0.0052 U	0.0059 U
Semi-volatile Organic Compounds										
2,3,4,5-Tetrachlorophenol	mg/kg	NV	2.5 U	2.4 U	2.3 U	2.4 U	2.3 U	4.5 U	2.5 U	2.4 U
2,3,4,6-Tetrachlorophenol	mg/kg	25000	2.5 U	2.4 U	2.3 U	2.4 U	2.3 U	4.5 U	2.5 U	2.4 U
2,4,5-Trichlorophenol	mg/kg	82000	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	1 U	0.6 U	0.6 U
2,4,6-Trichlorophenol	mg/kg	210	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	1 U	0.6 U	0.6 U
2,4-Dichlorophenol	mg/kg	2500	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	1 U	0.6 U	0.6 U
2,5-Dichlorophenol	mg/kg	NV	1.2 U	1.2 U	1.2 U	1.2 U	1.1 U	2.3 U	1.2 U	1.2 U
2,6-Dichlorophenol	mg/kg	NV	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	1 U	0.6 U	0.6 U
2-Chlorophenol	mg/kg	5800	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	1 U	0.6 U	0.6 U
3/4-Chlorophenol	mg/kg	NV	2.5 U	2.4 U	2.3 U	2.4 U	2.3 U	4.5 U	2.5 U	2.4 U
alpha-BHC	mg/kg	0.36	0.02 U	0.02 U	0.02 U	6 U	**350**	**990**	0.1	**84**
beta-BHC	mg/kg	1.3	0.49	0.34	0.12	**48**	**50**	**200**	**26**	**120**
delta-BHC	mg/kg	1.3	0.02 U	0.02 U	0.02 U	6 U	20 U	90 U	0.09	10 U
gamma-BHC (lindane)	mg/kg	2.5	0.02 U	0.02 U	0.02 U	6 U	20 U	90 U	0.03	10 U
Hexachlorobenzene	mg/kg	0.96	0.03	0.06	0.02 U	**120**	**60**	**650**	0.48	**110**
Hexachlorobutadiene	mg/kg	5.3	0.02 U	0.02 U	0.02 U	6 U	20 U	90 U	0.02 U	10 U
Hexachloroethane	mg/kg	8	0.02 U	0.02 U	0.02 U	6 U	20 U	90 U	0.02 U	10 U
Herbicides										
2,4-Dichlorophenoxyacetic acid (2,4-D)	mg/kg	9600	0.02 U	0.02 U	0.02 U	0.02 U	0.04	0.09 U	0.02 U	0.02 U
Pentachlorophenol	mg/kg	4	0.02 U	0.02 U	0.02 U	0.21	0.06	0.57 J	0.02 U	0.04
General Chemistry										
Chloride	mg/kg	NV	53	14	12 U	33	93	95	12 U	100
Total solids	%wt	NV	80.9	83.5	86.0	82.4	88.1	88.1	80.1	84.8

Notes:

NV No value.
J Estimated concentration.
U Not detected at the associated reporting limit.
bold Concentration exceeds RSL.
(1) Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1.0), June 2017

Table 3.1
Summary of Soil Analytical Results for Landfill Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			**P7SB**	**P8EA**	**P8EA**	**P8SA**	**P8SB**
Sample ID:			**S-011112-WP-258**	**S-011212-WP-263**	**S-011212-WP-264**	**S-071910-TK-107**	**S-011112-WP-257**
Sample Date:			**1/11/2012**	**1/12/2012**	**1/12/2012**	**7/19/2010**	**1/11/2012**
Sample Depth:			**(0.5-1.5) ft BGS**	**(0.5-1.9) ft BGS**	**(0.5-1.9) ft BGS (Duplicate)**	**(1-2) ft BGS**	**(0.5-1.5) ft BGS**
Parameters	**Units**	**Industrial RSLs (1)**					
Volatile Organic Compounds							
1,1,1-Trichloroethane	mg/kg	36000	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
1,2-Dichloroethane	mg/kg	2	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
1,2-Dichloropropane	mg/kg	1.2	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
Benzene	mg/kg	5.1	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
Carbon tetrachloride	mg/kg	2.9	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
Chloroform (Trichloromethane)	mg/kg	1.4	0.012	0.0046 U	0.005 U	0.0059 U	0.0053 U
Chloromethane (Methyl chloride)	mg/kg	460	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
Methylene chloride	mg/kg	1000	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
Tetrachloroethene	mg/kg	100	0.0134	0.0046 U	0.005 U	0.0153	0.0053 U
Trichloroethene	mg/kg	6	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
Vinyl chloride	mg/kg	1.7	0.0064 U	0.0046 U	0.005 U	0.0059 U	0.0053 U
Semi-volatile Organic Compounds							
2,3,4,5-Tetrachlorophenol	mg/kg	NV	2.6 U	2.3 U	2.3 U	2.4 U	2.5 U
2,3,4,6-Tetrachlorophenol	mg/kg	25000	2.6 U	2.3 U	2.3 U	2.4 U	2.5 U
2,4,5-Trichlorophenol	mg/kg	82000	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
2,4,6-Trichlorophenol	mg/kg	210	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
2,4-Dichlorophenol	mg/kg	2500	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
2,5-Dichlorophenol	mg/kg	NV	1.3 U	1.1 U	1.2 U	1.2 U	1.2 U
2,6-Dichlorophenol	mg/kg	NV	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
2-Chlorophenol	mg/kg	5800	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
3/4-Chlorophenol	mg/kg	NV	2.6 U	2.3 U	2.3 U	2.4 U	2.5 U
alpha-BHC	mg/kg	0.36	0.05	0.02 U	0.02 U	0.15	0.05
beta-BHC	mg/kg	1.3	**6.7**	0.23	0.29	0.17	**3.9**
delta-BHC	mg/kg	1.3	0.03 U	0.02 U	0.02 U	0.02 U	0.02 U
gamma-BHC (lindane)	mg/kg	2.5	0.03 U	0.02 U	0.02 U	0.02 U	0.02 U
Hexachlorobenzene	mg/kg	0.96	0.25	0.057	0.15	0.02 U	0.15
Hexachlorobutadiene	mg/kg	5.3	0.03 U	0.02 U	0.02 U	0.02 U	0.02 U
Hexachloroethane	mg/kg	8	0.03 U	0.02 U	0.02 U	0.02 U	0.02 U
Herbicides							
2,4-Dichlorophenoxyacetic acid (2,4-D)	mg/kg	9600	0.03 U	0.02 U	0.02 U	0.02 U	0.02 U
Pentachlorophenol	mg/kg	4	0.03 U	0.02 U	0.02 U	0.02 U	0.02 U
General Chemistry							
Chloride	mg/kg	NV	13 U	11 U	6.9 U	1230	12 U
Total solids	%wt	NV	77.9	88.4	85.9	84.3	80.7

Notes:

NV No value.
J Estimated concentration.
U Not detected at the associated reporting limit.
bold Concentration exceeds RSL.
(1) Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1.0), June 2017

Table 3.2
Summary of Soil Analytical Results for Non-Process Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			**RA-1**	**RA-2**	**RA-3**	**RA-4**	**RA-5**	**RA-6**	**SW-13**	**SW-14**
Sample ID:			**S-06232015-JR-001**	**S-06232015-JR-004**	**S-06232015-JR-002**	**S-06232015-JR-003**	**S-06232015-JR-005**	**S-06232015-JR-006**	**S-12142012-JR-033**	**S-12142012-JR-032**
Sample Date:			**6/23/2015**	**6/23/2015**	**6/23/2015**	**6/23/2015**	**6/23/2015**	**6/23/2015**	**12/14/2012**	**12/14/2012**
Sample Depth:			**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(0-0.5) ft BGS**	**(0-0.5) ft BGS**
Parameters	**Units**	**Industrial RSLs (1)**								
Volatile Organic Compounds										
1,1,1-Trichloroethane	mg/kg	36000	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
1,2-Dichloroethane	mg/kg	2	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
1,2-Dichloropropane	mg/kg	1.2	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Benzene	mg/kg	5.1	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Carbon tetrachloride	mg/kg	2.9	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Chloroform (Trichloromethane)	mg/kg	1.4	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Chloromethane (Methyl chloride)	mg/kg	460	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Methylene chloride	mg/kg	1000	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Tetrachloroethene	mg/kg	100	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Trichloroethene	mg/kg	6	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Vinyl chloride	mg/kg	1.7	0.0048 U	0.0045 U	0.0048 U	0.0052 U	0.0051 U	0.005 U	0.0062 U	0.0062 U
Semi-volatile Organic Compounds										
2,3,4,5-Tetrachlorophenol	mg/kg	NV	2.5 U	2.5 U	2.5 U	2.7 U	2.5 U	2.6 U	2.8 U	2.8 U
2,3,4,6-Tetrachlorophenol	mg/kg	25000	2.5 U	2.5 U	2.5 U	2.7 U	2.5 U	2.6 U	2.8 U	2.8 U
2,4,5-Trichlorophenol	mg/kg	82000	0.6 U	0.6 U	0.6 U	0.7 U	0.6 U	0.6 U	0.7 U	0.7 U
2,4,6-Trichlorophenol	mg/kg	210	0.6 U	0.6 U	0.6 U	0.7 U	0.6 U	0.6 U	0.7 U	0.7 U
2,4-Dichlorophenol	mg/kg	2500	0.6 U	0.6 U	0.6 U	0.7 U	0.6 U	0.6 U	0.7 U	0.7 U
2,5-Dichlorophenol	mg/kg	NV	1.3 U	1.2 U	1.3 U	1.3 U	1.3 U	1.3 U	1.4 U	1.4 U
2,6-Dichlorophenol	mg/kg	NV	0.6 U	0.6 U	0.6 U	0.7 U	0.6 U	0.6 U	0.7 U	0.7 U
2-Chlorophenol	mg/kg	5800	0.6 U	0.6 U	0.6 U	0.7 U	0.6 U	0.6 U	0.7 U	0.7 U
3/4-Chlorophenol	mg/kg	NV	2.5 U	2.5 U	2.5 U	2.7 U	2.5 U	2.6 U	2.8 U	2.8 U
alpha-BHC	mg/kg	0.36	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U
beta-BHC	mg/kg	1.3	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.16	0.03	0.1
delta-BHC	mg/kg	1.3	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U
gamma-BHC (lindane)	mg/kg	2.5	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U
Hexachlorobenzene	mg/kg	0.96	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.03 U	0.07	0.31
Hexachlorobutadiene	mg/kg	5.3	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U
Hexachloroethane	mg/kg	8	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U
Herbicides										
2,4-Dichlorophenoxyacetic acid (2,4-D)	mg/kg	9600	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.03 U	0.06 U	0.03 U
Pentachlorophenol	mg/kg	4	0.03 U	0.02 U	0.03 U	0.03 U	0.03 U	0.03 U	0.06 U	0.03 U
General Chemistry										
Chloride	mg/kg	NV	13 U	12 U	13 U	14	13 U	13 U	59	90
Total solids	%wt	NV	78.7	81.4	80.0	74.2	78.5	77.3	70.7	72.1

Notes:

NV	No value.
J	Estimated concentration.
U	Not detected at the associated reporting limit.
bold	Concentration exceeds RSL.
(1)	Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1.0), June 2017

Table 3.3
Summary of Soil Analytical Results for Process Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			PA-35C	PA-35C	PA-35C	PA-52	PA-54	RA-7	RA-8	RA-9
Sample ID:			S-011012-WP-248	S-011012-WP-249	S-011012-WP-250	S-030912-AK-018	S-030912-AK-019	S-06252015-JR-009	S-06252015-JR-010	S-06242015-JR-008
Sample Date:			1/10/2012	1/10/2012	1/10/2012	3/9/2012	3/9/2012	6/25/2015	6/25/2015	6/24/2015
Sample Depth:			(0.9-1.4) ft BGS	(8-9) ft BGS	(8-9) ft BGS (Duplicate)	(1-3) ft BGS	(1-3) ft BGS	(1.5-2) ft BGS	(1.5-2) ft BGS	(1.5-2) ft BGS
Parameters	**Units**	**Industrial RSLs (1)**								
Volatile Organic Compounds										
1,1,1-Trichloroethane	mg/kg	36000	10 U	1 U	1 U	0.03 U	0.1 U	0.0046 U	0.08 U	0.004 U
1,2-Dichloroethane	mg/kg	2	10 U	1 U	1 U	0.03 U	0.1 U	0.0046 U	0.08 U	0.0095
1,2-Dichloropropane	mg/kg	1.2	10 U	1 U	1 U	0.03 U	0.1 U	0.0046 U	0.08 U	0.004 U
Benzene	mg/kg	5.1	10 U	1 U	1 U	0.05	0.1 U	0.0046 U	0.08 U	0.004 U
Carbon tetrachloride	mg/kg	2.9	**1080**	**10 J**	**55.7 J**	0.03 U	0.1 U	0.0046 U	0.08 U	0.004 U
Chloroform (Trichloromethane)	mg/kg	1.4	**496 J**	**86.3 J**	**55.4 J**	0.03 U	0.1	0.0046 U	0.08 U	0.0096
Chloromethane (Methyl chloride)	mg/kg	460	10 U	1 U	1 U	0.03 U	0.1 U	0.0046 U	0.08 U	0.004 U
Methylene chloride	mg/kg	1000	20	11 J	3.5 J	0.03 U	0.1 U	0.0046 U	0.08 U	0.004 U
Tetrachloroethene	mg/kg	100	**2310**	4.2 J	**175 J**	0.931	2.4	0.0046 U	3.53	4.28
Trichloroethene	mg/kg	6	10 U	1 U	1 U	0.03 U	0.1 U	0.0046 U	0.08 U	0.011
Vinyl chloride	mg/kg	1.7	10 U	1 U	1 U	0.03 U	0.1 U	0.0046 U	0.08 U	0.004 U
Semi-volatile Organic Compounds										
2,3,4,5-Tetrachlorophenol	mg/kg	NV	2.6 U	2.4 U	2.4 U	2.6 U	2.5 U	2.5 U	2.9 U	2.3 U
2,3,4,6-Tetrachlorophenol	mg/kg	25000	2.6 U	2.4 U	2.4 U	2.6 U	16.8	2.5 U	2.9 U	2.3 U
2,4,5-Trichlorophenol	mg/kg	82000	0.6 U	0.6 U	0.6 U	0.7 U	0.6 U	0.6 U	0.7 U	0.6 U
2,4,6-Trichlorophenol	mg/kg	210	0.6 U	0.6 U	0.6 U	1.6	4.4	0.6 U	0.7 U	0.6 U
2,4-Dichlorophenol	mg/kg	2500	0.6 U	0.6 U	0.6 U	9.1	11	0.6 U	0.7 U	0.6 U
2,5-Dichlorophenol	mg/kg	NV	1.3 U	1.2 U	1.2 U	1.3 U	1.2 U	1.2 U	1.4 U	1.2 U
2,6-Dichlorophenol	mg/kg	NV	0.6 U	0.6 U	0.6 U	0.7 U	0.6 U	0.6 U	0.7 U	0.6 U
2-Chlorophenol	mg/kg	5800	0.6 U	0.6 U	0.6 U	0.7 U	0.6 U	0.6 U	0.7 U	0.6 U
3/4-Chlorophenol	mg/kg	NV	2.6 U	2.4 U	2.4 U	2.6 U	2.5 U	2.5 U	2.9 U	2.3 U
alpha-BHC	mg/kg	0.36	10 U	10 U	100 U	**40**	**3**	0.02 U	0.6 U	0.03
beta-BHC	mg/kg	1.3	10 U	10 U	100 U	**30**	2 U	0.02 U	1	0.9 J
delta-BHC	mg/kg	1.3	10 U	10 U	100 U	10 U	2 U	0.02 U	0.6 U	0.02 U
gamma-BHC (lindane)	mg/kg	2.5	10 U	10 U	100 U	10 U	2 U	0.02 U	0.6 U	0.02 U
Hexachlorobenzene	mg/kg	0.96	10 U	10 U	100 U	10 U	2 U	0.04 J	**4.5**	**12**
Hexachlorobutadiene	mg/kg	5.3	**30**	**20**	100 U	10 U	2 U	0.02 U	0.6 U	1 J
Hexachloroethane	mg/kg	8	**100**	**580 J**	**1700 J**	10 U	2 U	0.02 U	0.6 U	0.02 U
Herbicides										
2,4-Dichlorophenoxyacetic acid (2,4-D)	mg/kg	9600	0.03 U	0.02 U	0.02 U	0.08	0.5 U	0.02 U	0.03 U	0.02 U
Pentachlorophenol	mg/kg	4	0.3	0.05	0.03	**30**	**1000**	0.02 U	0.03 U	0.18
General Chemistry										
Chloride	mg/kg	NV	130	750	650	81	182	39	281	1400
Total solids	%wt	NV	77.4	83.1	82.8	76.8	80.9	80.7	69.1	85.3

Notes:

NV No value.
J Estimated concentration.
U Not detected at the associated reporting limit.
bold Concentration exceeds RSL.
(1) Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1.0), June 2017

Table 3.3
Summary of Soil Analytical Results for Process Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			**RA-10**	**RA-11**	**RA-11**	**RA-12**	**RA-13**	**RA-14**	**RA-15**	**RA-16**
Sample ID:			**S-06232015-JR-007**	**S-06252015-JR-011**	**S-06252015-JR-012**	**S-06252015-JR-013**	**S-06252015-JR-014**	**S-06252015-JR-020**	**S-06252015-JR-016**	**S-06252015-JR-015**
Sample Date:			**6/23/2015**	**6/25/2015**	**6/25/2015**	**6/25/2015**	**6/25/2015**	**6/25/2015**	**6/25/2015**	**6/25/2015**
Sample Depth:			**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS (Duplicate)**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**
Parameters	**Units**	**Industrial RSLs (1)**								
Volatile Organic Compounds										
1,1,1-Trichloroethane	mg/kg	36000	0.0043 U	0.08 U	0.06 U	0.2 U	0.06 U	0.0047 U	0.04 U	0.03 U
1,2-Dichloroethane	mg/kg	2	0.0043 U	0.08 U	0.06 U	0.2 U	0.06 U	0.0047 U	0.04 U	0.03 U
1,2-Dichloropropane	mg/kg	1.2	0.0043 U	0.08 U	0.06 U	0.2 U	0.06 U	0.0047 U	0.04 U	0.03 U
Benzene	mg/kg	5.1	0.0043 U	0.08 U	0.06 U	0.2 U	0.06 U	0.0047 U	0.04 U	0.03 U
Carbon tetrachloride	mg/kg	2.9	0.0043 U	0.36	0.37	0.5	0.06 U	0.0047 U	0.04 U	0.03 U
Chloroform (Trichloromethane)	mg/kg	1.4	0.07	0.1	0.1	0.2 U	0.06 U	0.0047 U	0.08	0.03 U
Chloromethane (Methyl chloride)	mg/kg	460	0.0043 U	0.08 U	0.06 U	0.2 U	0.06 U	0.0047 U	0.04 U	0.03 U
Methylene chloride	mg/kg	1000	0.0043 U	0.08 U	0.06 U	0.2 U	0.06 U	0.0047 U	0.04 U	0.03 U
Tetrachloroethene	mg/kg	100	0.061	4.98	5.98	20.9	0.13	0.011	3.31	1.02
Trichloroethene	mg/kg	6	0.0072	0.08 U	0.06 U	0.2 U	3.39	0.0047 U	0.06	0.21
Vinyl chloride	mg/kg	1.7	0.0043 U	0.08 U	0.06 U	0.2 U	0.06 U	0.0047 U	0.04 U	0.03 U
Semi-volatile Organic Compounds										
2,3,4,5-Tetrachlorophenol	mg/kg	NV	2.4 U	2.9 U	2.5 U	2.2 UJ	2.5 U	2.5 U	R	2.0 U
2,3,4,6-Tetrachlorophenol	mg/kg	25000	2.4 U	2.9 U	2.5 U	2.2 UJ	2.5 U	2.5 U	R	2.0 U
2,4,5-Trichlorophenol	mg/kg	82000	0.6 U	0.7 U	0.6 U	0.5 UJ	0.6 U	0.6 U	R	3 U
2,4,6-Trichlorophenol	mg/kg	210	0.6 U	0.7 U	0.6 U	0.5 UJ	0.6 U	0.6 U	R	3 U
2,4-Dichlorophenol	mg/kg	2500	0.6 U	0.7 U	0.6 U	0.5 UJ	0.6 U	0.6 U	R	3 U
2,5-Dichlorophenol	mg/kg	NV	1.2 U	1.5 U	1.3 U	1.1 UJ	1.3 U	1.2 U	R	6 U
2,6-Dichlorophenol	mg/kg	NV	0.6 U	0.7 U	0.6 U	0.5 UJ	0.6 U	0.6 U	R	3 U
2-Chlorophenol	mg/kg	5800	0.6 U	0.7 U	0.6 U	0.5 UJ	0.6 U	0.6 U	R	3 U
3/4-Chlorophenol	mg/kg	NV	2.4 U	2.9 U	2.5 U	2.2 UJ	2.5 U	2.5 U	R	2.0 U
alpha-BHC	mg/kg	0.36	0.02 U	0.3 J	0.08 J	10 U	0.03 U	1 U	**6**	20 U
beta-BHC	mg/kg	1.3	0.44	1.3	0.66	10 U	0.03 U	**24**	**8**	**50**
delta-BHC	mg/kg	1.3	0.02 U	0.03 U	0.03 U	10 U	0.03 U	1 U	2 U	20 U
gamma-BHC (lindane)	mg/kg	2.5	0.02 U	0.16 J	0.08 J	10 U	0.03 U	1 U	2 U	20 U
Hexachlorobenzene	mg/kg	0.96	0.22	0.03 U	0.04	**50**	0.03 U	**2**	**3**	**170**
Hexachlorobutadiene	mg/kg	5.3	0.08	0.03 U	0.03 U	10 U	0.03 U	1 U	2 U	20 U
Hexachloroethane	mg/kg	8	0.02 U	0.03 U	0.03 U	10 U	0.03 U	1 U	2 U	20 U
Herbicides										
2,4-Dichlorophenoxyacetic acid (2,4-D)	mg/kg	9600	0.02 U	0.03 U	0.03 U	0.02 U	0.03 U	0.02 U	0.02 U	0.02 U
Pentachlorophenol	mg/kg	4	0.02 U	0.03 U	0.03 U	0.14	0.03 U	0.02 U	0.02 U	0.10
General Chemistry										
Chloride	mg/kg	NV	1680	256	275	1000	521	206	1790	125
Total solids	%wt	NV	84.7	68.5	79.6	91.2	79.3	81.6	90.1	83.0

Notes:

NV No value.
J Estimated concentration.
U Not detected at the associated reporting limit.
bold Concentration exceeds RSL.
(1) Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1.0), June 2017

Table 3.3
Summary of Soil Analytical Results for Process Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			**RA-17**	**RA-18**	**RA-19**	**SW-16**	**SW-16**	**SW-17**
Sample ID:			**S-06252015-JR-019**	**S-06252015-JR-017**	**S-06252015-JR-018**	**S-12132012-JR-023**	**S-12132012-JR-024**	**S-12142012-JR-031**
Sample Date:			**6/25/2015**	**6/25/2015**	**6/25/2015**	**12/13/2012**	**12/13/2012**	**12/14/2012**
Sample Depth:			**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(0-0.5) ft BGS**	**(0-0.5) ft BGS (Duplicate)**	**(0-0.5) ft BGS**
Parameters	**Units**	**Industrial RSLs (1)**						
Volatile Organic Compounds								
1,1,1-Trichloroethane	mg/kg	36000	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
1,2-Dichloroethane	mg/kg	2	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
1,2-Dichloropropane	mg/kg	1.2	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Benzene	mg/kg	5.1	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Carbon tetrachloride	mg/kg	2.9	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Chloroform (Trichloromethane)	mg/kg	1.4	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Chloromethane (Methyl chloride)	mg/kg	460	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Methylene chloride	mg/kg	1000	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Tetrachloroethene	mg/kg	100	0.011	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Trichloroethene	mg/kg	6	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Vinyl chloride	mg/kg	1.7	0.0041 U	0.0042 U	0.0047 U	0.0043 U	0.0046 U	0.0044 U
Semi-volatile Organic Compounds								
2,3,4,5-Tetrachlorophenol	mg/kg	NV	2.3 UJ	2.4 U	2.5 U	2.1 U	2.2 U	2.2 U
2,3,4,6-Tetrachlorophenol	mg/kg	25000	2.3 UJ	2.4 U	2.5 U	2.1 U	2.2 U	2.2 U
2,4,5-Trichlorophenol	mg/kg	82000	0.6 UJ	0.6 U	0.6 U	0.5 U	0.5 U	0.5 U
2,4,6-Trichlorophenol	mg/kg	210	0.6 UJ	0.6 U	0.6 U	0.5 U	0.5 U	0.5 U
2,4-Dichlorophenol	mg/kg	2500	0.6 UJ	0.6 U	0.6 U	0.5 U	0.5 U	0.5 U
2,5-Dichlorophenol	mg/kg	NV	1.2 UJ	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U
2,6-Dichlorophenol	mg/kg	NV	0.6 UJ	0.6 U	0.6 U	0.5 U	0.5 U	0.5 U
2-Chlorophenol	mg/kg	5800	0.6 UJ	0.6 U	0.6 U	0.5 U	0.5 U	0.5 U
3/4-Chlorophenol	mg/kg	NV	2.3 UJ	2.4 U	2.5 U	2.1 U	2.2 U	2.2 U
alpha-BHC	mg/kg	0.36	0.02 U	0.02 U	0.02 U	0.09 J	0.02 UJ	0.09 U
beta-BHC	mg/kg	1.3	0.24	0.04	0.1	0.19 J	0.34	0.1
delta-BHC	mg/kg	1.3	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.09 U
gamma-BHC (lindane)	mg/kg	2.5	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.09 U
Hexachlorobenzene	mg/kg	0.96	0.23	0.02 U	0.22	**4.2 J**	**1.4 J**	**1.3**
Hexachlorobutadiene	mg/kg	5.3	0.02 U	0.02 U	0.02 U	0.12 J	0.02 U	0.09 U
Hexachloroethane	mg/kg	8	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.09 U
Herbicides								
2,4-Dichlorophenoxyacetic acid (2,4-D)	mg/kg	9600	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Pentachlorophenol	mg/kg	4	0.02 U	0.02 U	0.02 U	0.09	0.12	0.02 U
General Chemistry								
Chloride	mg/kg	NV	167	137	313	116	324	122 J
Total solids	%wt	NV	85.2	84.8	80.7	93.8	92.0	92.4

Notes:

NV No value.
J Estimated concentration.
U Not detected at the associated reporting limit.
bold Concentration exceeds RSL.
(1) Regional Screening Level (RSL) Summary Table (TR=1E-06, HQ=1.0), June 2017

Table 3.5
Comparison of Soil Analytical Results to Calculated Industrial RBCs for Process Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			PA-35C	PA-35C	PA-35C	PA-52	PA-54	RA-7	RA-13
Sample ID:			S-011012-WP-248	S-011012-WP-249	S-011012-WP-250	S-030912-AK-018	S-030912-AK-019	S-06252015-JR-009	S-06252015-JR-014
Sample Date:			1/10/2012	1/10/2012	1/10/2012	3/9/2012	3/9/2012	6/25/2015	6/25/2015
Sample Depth:			(0.9-1.4) ft BGS	(8-9) ft BGS	(8-9) ft BGS (Duplicate)	(1-3) ft BGS	(1-3) ft BGS	(1.5-2) ft BGS	(1.5-2) ft BGS
		Calculated Industrial RBC (1) TCR = 1E-04							
Parameters	**Units**								
Herbicides									
Pentachlorophenol	mg/kg	441	0.3	0.05	0.03	30	**1000**	0.02 U	0.03 U

Sample Location:			RA-8	RA-9	RA-10	RA-11	RA-11	RA-12	RA-18
Sample ID:			S-06252015-JR-010	S-06242015-JR-008	S-06232015-JR-007	S-06252015-JR-011	S-06252015-JR-012	S-06252015-JR-013	S-06252015-JR-017
Sample Date:			6/25/2015	6/24/2015	6/23/2015	6/25/2015	6/25/2015	6/25/2015	6/25/2015
Sample Depth:			(1.5-2) ft BGS	(1.5-2) ft BGS	(1.5-2) ft BGS	(1.5-2) ft BGS	(1.5-2) ft BGS (Duplicate)	(1.5-2) ft BGS	(1.5-2) ft BGS
		Calculated Industrial RBC (1) TCR = 1E-04							
Parameters	**Units**								
Herbicides									
Pentachlorophenol	mg/kg	441	0.03 U	0.18	0.02 U	0.03 U	0.03 U	0.14	0.02 U

Notes:

TCR	Target Cancer Risk
U	Not detected at the associated reporting limit.
a	Concentration exceeds RBC at TCR of 5E-05.
bold	Concentration exceeds RBC at TCR of 1E-04.
(1)	Industrial Risk-Based Concentration (RBC) calculated using U.S. EPA RSL calculator and the industrial/commercial worker exposure assumptions used in the HHRA.

Table 3.5
Comparison of Soil Analytical Results to Calculated Industrial RBCs for Process Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			**RA-14**	**RA-15**	**RA-16**	**RA-17**
Sample ID:			**S-06252015-JR-020**	**S-06252015-JR-016**	**S-06252015-JR-015**	**S-06252015-JR-019**
Sample Date:			**6/25/2015**	**6/25/2015**	**6/25/2015**	**6/25/2015**
Sample Depth:			**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**	**(1.5-2) ft BGS**
		Calculated Industrial RBC (1)				
		TCR = 1E-04				
Parameters	**Units**					
Herbicides						
Pentachlorophenol	mg/kg	441	0.02 U	0.02 U	0.10	0.02 U

Sample Location:			**RA-19**	**SW-16**	**SW-16**	**SW-17**
Sample ID:			**S-06252015-JR-018**	**S-12132012-JR-023**	**S-12132012-JR-024**	**S-12142012-JR-031**
Sample Date:			**6/25/2015**	**12/13/2012**	**12/13/2012**	**12/14/2012**
Sample Depth:			**(1.5-2) ft BGS**	**(0-0.5) ft BGS**	**(0-0.5) ft BGS (Duplicate)**	**(0-0.5) ft BGS**
		Calculated Industrial RBC (1)				
		TCR = 1E-04				
Parameters	**Units**					
Herbicides						
Pentachlorophenol	mg/kg	441	0.02 U	0.09	0.12	0.02 U

Notes:

TCR	Target Cancer Risk
U	Not detected at the associated reporting limit.
a	Concentration exceeds RBC at TCR of 5E-05.
bold	Concentration exceeds RBC at TCR of 1E-04.
(1)	Industrial Risk-Based Concentration (RBC) calculated using U.S. EPA RSL calculator and the industrial/commercial worker exposure assumptions used in the HHRA.

Table 3.6
Comparison of Soil Analytical Results to Calculated Trespasser RBCs for Landfill Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:			P1SA	P1SB	P2SB	P3SA	P4SA	P5SA	P5SB
Sample ID:			S-071910-TK-100	S-011212-WP-262	S-011212-WP-261	S-071910-TK-102	S-071910-TK-103	S-071910-TK-104	S-011112-WP-270
Sample Date:			7/19/2010	1/12/2012	1/12/2012	7/19/2010	7/19/2010	7/19/2010	1/11/2012
Sample Depth:			(1-2) ft BGS	(0.5-1) ft BGS	(0.5-1) ft BGS	(1-2) ft BGS	(1-2) ft BGS	(1-2) ft BGS	(0.5-1) ft BGS
		Calculated Trespasser RBC (1) TCR = 1E-04							
Parameters	**Units**								
Semi-volatile Organic Compounds									
alpha-BHC	mg/kg	458	0.02 U	0.02 U	0.02 U	6 U	350	**990**	0.1

Sample Location:			P7SA	P7SB	P8EA	P8EA	P8SA	P8SB
Sample ID:			S-071910-TK-106	S-011112-WP-258	S-011212-WP-263	S-011212-WP-264	S-071910-TK-107	S-011112-WP-257
Sample Date:			7/19/2010	1/11/2012	1/12/2012	1/12/2012	7/19/2010	1/11/2012
Sample Depth:			(1-2) ft BGS	(0.5-1.5) ft BGS	(0.5-1.9) ft BGS	(0.5-1.9) ft BGS (Duplicate)	(1-2) ft BGS	(0.5-1.5) ft BGS
		Calculated Trespasser RBC (1) TCR = 1E-04						
Parameters	**Units**							
Semi-volatile Organic Compounds								
alpha-BHC	mg/kg	458	84	0.05	0.02 U	0.02 U	0.15	0.05

Notes:

TCR	Target Cancer Risk
U	Not detected at the associated reporting limit.
a	Concentration exceeds RBC at TCR of 5E-05.
bold	Concentration exceeds RBC at TCR of 1E-04.
(1)	Trespasser Risk-Based Concentration (RBC) calculated using U.S. EPA RSL calculator and the trespasser exposure assumptions used in the HHRA.

Table 3.7
Summary of Soil Vapor Analytical Results for December 2016 and February 2017 Sampling Events
Industrial Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:		Soil Vapor Criteria (1)			SG-1	SG-1	SG-2	SG-2	SG-3	SG-3	SG-4	SG-4	SG-5	SG-5	SG-6	SG-6	SG-7	SG-7
Sample ID:					SG-1	SG-1	SG-2	SG-2	SG-3	SG-3	SG-4	SG-4	SG-5	SG-5	SG-6	SG-6	SG-7	SG-7
Sample Date:		Cancer risk of 1E-06 and Hazard of 0.1 a	Cancer risk of 1E-05 and Hazard of 0.1 b	Cancer risk of 1E-04 and Hazard of 0.1 c	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017
Parameters	**Units**																	
Volatile Organic Compounds																		
1,1,1-Trichloroethane	µg/m^3	73000	73000	73000	3610	4420 J	130 U	33 U	320 U	44 U	250 U	250 U	33 U	9.3 U	33 U	33 U	350 U	480 U
1,2-Dichloroethane	µg/m^3	16	100	100	930 U	3700 U	502^{abc}	25 U	240 U	32 U	180 U	180 U	25 U	6.9 U	25 U	25 U	260 U	360 U
1,2-Dichloropropane	µg/m^3	41	58	58	3060^{abc}	2210 J^{abc}	110 U	28 U	270 U	37 U	210 U	210 U	28 U	7.9 U	28 U	28 U	300 U	410 U
Benzene	µg/m^3	52	440	440	730 U	2900 U	137^{a}	19 U	190 U	112^{a}	72.5 J^{a}	140 U	11 J	5.4 U	31	217^{a}	518^{abc}	204 J^{a}
Carbon tetrachloride	µg/m^3	68	680	1500	3150000^{abc}	4560000^{abc}	11800^{abc}	594^{a}	5530^{abc}	981^{ab}	34800^{abc}	47600^{abc}	38 U	30	38 U	21 J	2890^{abc}	887^{ab}
Chloroform (Trichloromethane)	µg/m^3	18	180	1400	1100000^{abc}	811000^{abc}	11700^{abc}	401^{ab}	36600^{abc}	9280^{abc}	3850^{abc}	2840^{abc}	30 U	17	30 U	30 U	6640^{abc}	3590^{abc}
Hexachlorobutadiene	µg/m^3	19	190	1900	2500 U	9800 U	250 U	65 U	630 U	85 U	480 U	480 U	65 U	18 U	65 U	65 U	690 U	940 U
Hexachloroethane	µg/m^3	37	370	440	2200 U	8800 U	220 U	58 U	560 U	77 U	430 U	430 U	58 U	16 U	58 U	58 U	620 U	840 U
Methylene chloride	µg/m^3	8800	8800	8800	1260	3200 U	266	26	212	95.5	1250	240	27	8.3	24	147	230 U	310 U
Perchloroethylene	µg/m^3	580	580	580	551000^{abc}	568000^{abc}	28400^{abc}	8.1	12400^{abc}	6670^{abc}	7050^{abc}	5610^{abc}	155	18	8.1	12000^{abc}	86800^{abc}	136000^{abc}
Trichloroethene	µg/m^3	29	29	29	11900^{abc}	10800^{abc}	19400^{abc}	68.8^{abc}	1140^{abc}	529^{abc}	1390^{abc}	640^{abc}	62.9^{abc}	10	6.4 U	5700^{abc}	4780^{abc}	4100^{abc}
Vinyl chloride	µg/m^3	93	930	1500	590 U	2400 U	132^{a}	26.3	1540^{abc}	1430^{ab}	78.7 J	120 U	470^{a}	171^{a}	16 U	10400^{abc}	2840^{abc}	412^{a}

Notes:

(1)	Soil Vapor Criteria as presented in Table 8 of the Vapor Intrusion Work Plan
551000^{abc}	Soil vapor concentration exceeds soil vapor criterion
	a - soil vapor criteria based on cancer risk of 1E-06 and Hazard index of 0.1
	b - soil vapor criteria based on cancer risk of 1E-05 and Hazard index of 0.1
	c - soil vapor criteria based on cancer risk of 1E-04 and Hazard index of 0.1
J	Estimated concentration.
U	Not detected at the associated reporting limit.
	Samples not collected

Table 3.7
Summary of Soil Vapor Analytical Results for December 2016 and February 2017 Sampling Events
Industrial Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:		Soil Vapor Criteria (1)			SG-8	SG-8	SG-9	SG-9	SG-10	SG-10	SG-11	SG-11	SG-12	SG-12	SG-13	SG-13	SG-14
Sample ID:					SG-8	SG-8	SG-9	SG-9	SG-10	SG-10	SG-11	SG-11	SG-12	SG-12	SG-13	SG-13	SG-14
Sample Date:		Cancer risk of 1E-06 and Hazard of 0.1 a	Cancer risk of 1E-05 and Hazard of 0.1 b	Cancer risk of 1E-04 and Hazard of 0.1 c	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016	2/9/2017	12/2/2016		12/5/2016
Parameters	**Units**																
Volatile Organic Compounds																	
1,1,1-Trichloroethane	µg/m^3	73000	73000	73000	550 U	2300 U	55 U	33 U	655	2500 U	22 U	130 U	1.1 U	4.4 U	250 U		5950
1,2-Dichloroethane	µg/m^3	16	100	100	530[abc]	1700 U	40 U	25 U	652[abc]	1800 U	16 U	93 U	0.81 U	2.2 J	190 U		1900 U
1,2-Dichloropropane	µg/m^3	41	58	58	1440[abc]	1160 J[abc]	46 U	28 U	2850[abc]	1540 J[abc]	18 U	110 U	0.92 U	3.7 U	210 U		2100 U
Benzene	µg/m^3	52	440	440	320 U	1400 U	32 U	19 U	1840[abc]	6360[abc]	19	43.1 J	0.80	2.6 U	150 U		1500 U
Carbon tetrachloride	µg/m^3	68	680	1500	367000[abc]	277000[abc]	41 J	38 U	11600[abc]	1860 J[abc]	56	140 U	62	1360[ab]	13300[abc]		296000[abc]
Chloroform (Trichloromethane)	µg/m^3	18	180	1400	73700[abc]	63000[abc]	1060[ab]	37[a]	82500[abc]	46300[abc]	124[a]	110 U	94.3[a]	326[ab]	25100[abc]		10300[abc]
Hexachlorobutadiene	µg/m^3	19	190	1900	1100 U	4600 U	110 U	65 U	940 U	4800 U	21 J[a]	250 U	2.2	8.5 U	490 U		4900 U
Hexachloroethane	µg/m^3	37	370	440	628 J[abc]	4100 U	96 U	58 U	840 U	4300 U	38 U	220 U	1.9 U	7.7 U	440 U		4400 U
Methylene chloride	µg/m^3	8800	8800	8800	792	1500 U	35 U	29	255 J	1600 U	14 U	43.1 J	3.8	3.8	160 U		1600 U
Perchloroethylene	µg/m^3	580	580	580	328000[abc]	255000[abc]	22600[abc]	67.8	902000[abc]	397000[abc]	25300[abc]	53400[abc]	317	497	13700[abc]		309000[abc]
Trichloroethene	µg/m^3	29	29	29	27700[abc]	22200[abc]	1240[abc]	13	130000[abc]	137000[abc]	1210[abc]	3380[abc]	8.1	25	460[abc]		1590[abc]
Vinyl chloride	µg/m^3	93	930	1500	260 U	1100 U	26 U	16 U	220 U	1200 U	22	48.6 J	0.51 U	2.0 U	120 U		1200 U

Notes:

(1)	Soil Vapor Criteria as presented in Table 8 of the Vapor Intrusion Work Plan
551000[abc]	Soil vapor concentration exceeds soil vapor criterion
	a - soil vapor criteria based on cancer risk of 1E-06 and Hazard index of 0.1
	b - soil vapor criteria based on cancer risk of 1E-05 and Hazard index of 0.1
	c - soil vapor criteria based on cancer risk of 1E-04 and Hazard index of 0.1
J	Estimated concentration.
U	Not detected at the associated reporting limit.
	Samples not collected

Table 3.7
Summary of Soil Vapor Analytical Results for December 2016 and February 2017 Sampling Events
Industrial Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:		Soil Vapor Criteria [1]			SG-14	SG-15	SG-15	SG-16	SG-16	SG-18	SG-18	SG-18	SG-19	SG-19	SG-19	SG-20
Sample ID:					SG-14	SG-15	SG-15	SG-16	SG-16	SG-18	FD-1	SG-18	SG-19	SG-19	FD-1	SG-20
Sample Date:		Cancer risk of 1E-06 and Hazard of 0.1 a	Cancer risk of 1E-05 and Hazard of 0.1 b	Cancer risk of 1E-04 and Hazard of 0.1 c		12/2/2016		12/2/2016	2/10/2017	12/5/2016	12/5/2016 (Duplicate)		12/5/2016	2/10/2017	2/10/2017 (Duplicate)	12/5/2016
Parameters	**Units**															
Volatile Organic Compounds																
1,1,1-Trichloroethane	µg/m^3	73000	73000	73000		350 J		31000 U	33200	9000	9000		2700 U	650 U	500 U	37
1,2-Dichloroethane	µg/m^3	16	100	100		370 U		23000 U	8500 U	23900[abc]	33100[abc]		2000 U	490 U	370 U	16 U
1,2-Dichloropropane	µg/m^3	41	58	58		550[abc]		26000 U	9700 U	1150 J[abc]	1710 J[abc]		2300 U	550 U	430 U	18 U
Benzene	µg/m^3	52	440	440		377[a]		18000 U	6700 U	783 J[abc]	716 J[abc]		1600 U	311 J[a]	409[a]	124[a]
Carbon tetrachloride	µg/m^3	68	680	1500		209000[abc]		20400000[abc]	18100000[abc]	296000[abc]	289000[abc]		248000[abc]	152000[abc]	238000[abc]	25 U
Chloroform (Trichloromethane)	µg/m^3	18	180	1400		86400[abc]		2000000[abc]	1100000[abc]	453000[abc]	453000[abc]		1010000[abc]	387000[abc]	606000[abc]	269[ab]
Hexachlorobutadiene	µg/m^3	19	190	1900		980 U		61000 U	22000 U	5200 U	5400 U		5300 U	1300 U	980 U	43 U
Hexachloroethane	µg/m^3	37	370	440		880 U		484000[abc]	20000 U	4700 U	4900 U		4800 U	1100 U	880 U	38 U
Methylene chloride	µg/m^3	8800	8800	8800		2860		25400[abc]	9590[abc]	2990	3580		2570	670	816	94.8
Perchloroethylene	µg/m^3	580	580	580		48300[abc]		8410000[abc]	1530000[abc]	433000[abc]	430000[abc]		73200[abc]	30300[abc]	49700[abc]	12800[abc]
Trichloroethene	µg/m^3	29	29	29		1480[abc]		75200[abc]	37700[abc]	37100[abc]	38200[abc]		6990[abc]	3280[abc]	4780[abc]	3250[abc]
Vinyl chloride	µg/m^3	93	930	1500		527[a]		15000 U	5960[abc]	17300[abc]	16700[abc]		1300 U	310 U	129 J[a]	309[a]

Notes:

(1)	Soil Vapor Criteria as presented in Table 8 of the Vapor Intrusion Work Plan
551000[abc]	Soil vapor concentration exceeds soil vapor criterion
	a - soil vapor criteria based on cancer risk of 1E-06 and Hazard index of 0.1
	b - soil vapor criteria based on cancer risk of 1E-05 and Hazard index of 0.1
	c - soil vapor criteria based on cancer risk of 1E-04 and Hazard index of 0.1
J	Estimated concentration.
U	Not detected at the associated reporting limit.
	Samples not collected

Table 3.7
Summary of Soil Vapor Analytical Results for December 2016 and February 2017 Sampling Events
Industrial Area
Occidental Chemical Corporation
Wichita, Kansas

Sample Location:		Soil Vapor Criteria (1)			SG-20	SG-21	SG-21	SG-22	SG-22	SG-23	SG-23	SG-25	SG-25	SG-25
Sample ID:					SG-20	SG-21	SG-21	SG-22	SG-22	SG-23	SG-23	SG-25	FD-2	SG-25
Sample Date:		Cancer risk of 1E-06 and Hazard of 0.1 a	Cancer risk of 1E-05 and Hazard of 0.1 b	Cancer risk of 1E-04 and Hazard of 0.1 c		12/5/2016	2/10/2017	12/5/2016	2/10/2017	12/1/2016	2/10/2017	12/6/2016	12/6/2016 (Duplicate)	2/9/2017
Parameters	**Units**													
Volatile Organic Compounds														
1,1,1-Trichloroethane	µg/m^3	73000	73000	73000		22 U	8.7 U	22 U	44 U	22 U	44 U	2700 U	5000 U	1.1 U
1,2-Dichloroethane	µg/m^3	16	100	100		16 U	6.5 U	16 U	32 U	16 U	32 U	2000 U	3700 U	0.81 U
1,2-Dichloropropane	µg/m^3	41	58	58		18 U	7.4 U	18 U	37 U	18 U	37 U	2300 U	4300 U	0.92 U
Benzene	µg/m^3	52	440	440		13 U	5.1 U	13 U	26 U	**4310^{abc}**	**7250^{abc}**	**18800^{abc}**	**17300^{abc}**	0.77
Carbon tetrachloride	µg/m^3	68	680	1500		**11100^{abc}**	**1770^{abc}**	**23000^{abc}**	**10900^{abc}**	25 U	**2090^{abc}**	**98800^{abc}**	**103000^{abc}**	1.6
Chloroform (Trichloromethane)	µg/m^3	18	180	1400		**884^{ab}**	**178^{a}**	**1510^{abc}**	**1150^{ab}**	14 J	**674^{ab}**	**244000^{abc}**	**240000^{abc}**	0.73 J
Hexachlorobutadiene	µg/m^3	19	190	1900		43 U	17 U	43 U	85 U	43 U	85 U	**4390 J^{abc}**	**6020 J^{abc}**	2.1 U
Hexachloroethane	µg/m^3	37	370	440		38 U	12 J	38 U	77 U	38 U	77 U	4700 U	8800 U	1.9 U
Methylene chloride	µg/m^3	8800	8800	8800		14 U	3.8 J	14 U	28 U	8.7 J	28 U	**12400^{abc}**	**14000^{abc}**	1.5
Perchloroethylene	µg/m^3	580	580	580		**1550^{abc}**	**1110^{abc}**	402	267	98.3	**1230^{abc}**	**575000^{abc}**	**635000^{abc}**	1.2
Trichloroethene	µg/m^3	29	29	29		12	28	10	8.6 U	**329^{abc}**	**1640^{abc}**	**128000^{abc}**	**134000^{abc}**	0.20 J
Vinyl chloride	µg/m^3	93	930	1500		10 U	4.1 U	10 U	20 U	**859^{a}**	**2860^{abc}**	**18400^{abc}**	**17400^{abc}**	0.51 U

Notes:

(1)	Soil Vapor Criteria as presented in Table 8 of the Vapor Intrusion Work Plan
551000^{abc}	Soil vapor concentration exceeds soil vapor criterion
	a - soil vapor criteria based on cancer risk of 1E-06 and Hazard index of 0.1
	b - soil vapor criteria based on cancer risk of 1E-05 and Hazard index of 0.1
	c - soil vapor criteria based on cancer risk of 1E-04 and Hazard index of 0.1
J	Estimated concentration.
U	Not detected at the associated reporting limit.
	Samples not collected

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
Potential Federal ARARs			
ARAR	Archaeological and Historic Preservation Act of 1974 16 U.S.C. § 469 et seq.	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 historical or archaeological materials.
ARAR	Clean Air Act (CAA) 42 U.S.C. § 7401 et seq. as amended in 1977 and 1990	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.
ARAR	CAA - Standards of Performance for New Stationary Sources (40 CFR 60)	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.
ARAR	CAA - National Emission Standards for Hazardous Air Pollutants (40 CFR 61)	Identifies emission standards for specific hazardous air pollutants.	Will be applicable if the identified hazardous air pollutants are emitted from a site.
ARAR	CAA - National Emission Standards for Hazardous Air Pollutants for Source Categories including Site Remediation (40 CFR 63)	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.
ARAR	Clean Water Act (CWA) of 1977 33 U.S.C. § 1251et seq. as amended in 1987	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.
ARAR	CWA - National Pollutant Discharge Elimination System (NPDES) (40 CFR 122)	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.
ARAR	CWA - Storm Water Discharge Requirements NPDES (40 CFR 122.26)	Provide requirements to obtain a permit to discharge to the storm water sewer system under the NPDES program	Will be applicable if the site has storm water that comes in contact with construction or industrial activity or if the selected remedy involves discharge of treated water to surface waters.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
ARAR	CWA - Federal Water Quality Standards (40 CFR 131)	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.
ARAR	CWA - General Pre-treatment Regulations for Existing and New Sources of Pollution for Publicly Owned Treatment Works (40 CFR 403)	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 Publicly Owned Treatment Works (POTW).
ARAR	CWA - Wetlands Protection (40 CFR 22, 40 CFR 230 to 233, and 33 CFR 320 to 330)	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.
ARAR	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	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.
ARAR	CERCLA - National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300)	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.
ARAR	CERCLA - 40 CFR 300.440	Establishes procedures for planning and implementing off-site response actions.	Formally referred to as the "off-site rule" wherein required to determine compliance status of the disposal facility.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
ARAR	Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 42 U.S.C. § 11001 et seq.	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.
ARAR	Endangered Species Act of 1973 7 U.S.C. § 136; 16 U.S.C. § 460 et seq.	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.
ARAR	Explosives 18 U.S.C. § 847	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.
ARAR	Federal Hazardous Materials Transportation Law 49 U.S.C. § 5101 et seq.	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.
ARAR	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1972 7 U.S.C. § 136 et seq.	Provides Federal control of pesticide distribution, sale and use. Allows 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.
ARAR	Fish and Wildlife Conservation Act 16 U.S.C. § 2901 to 2911	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.
ARAR	Fish and Wildlife Coordination Act 16 U.S.C. § 661-667e	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.
ARAR	Flood Control Act of 1944 16 U.S.C. § 460	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.
ARAR	National Historic Preservation Act of 1966 16 U.S.C. § 470 et seq.	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.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
ARAR	Occupational Safety and Health Act (OSHA) of 1970 29 U.S.C. § 651 et seq.	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.
ARAR	Occupational Safety and Health Standards (29 CFR 1910)	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.
ARAR	Safety and Health Regulations for Construction (29 CFR 1926)	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.
ARAR	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.	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 non-hazardous waste. Focuses only on active or future facilities. HSWA requires phasing out land disposal of hazardous waste.	Applies to active hazardous and solid wastes including facilities that treat, store and dispose of these materials as well as generators and transporters of hazardous wastes.
ARAR	RCRA - Solid Waste Disposal Facility Criteria (40 CFR 257 - 258)	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.
ARAR	RCRA - Standards for Identification and Listing of Hazardous Waste (40 CFR 261)	Provides criteria for identification of hazardous and solid wastes.	Will be applicable for identifying hazardous wastes.
ARAR	RCRA - Standards Applicable to Generators of Hazardous Waste (40 CFR 262)	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.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
ARAR	RCRA - Standards Applicable to Transporters of Hazardous Waste (40 CFR 263)	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 off site.
ARAR	RCRA - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264)	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.
ARAR	RCRA - Manifesting, Record Keeping, and Reporting Requirements (40 CFR 264.70 to 264.77)	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.
ARAR	RCRA - Releases from Solid Waste Management Units (40 CFR 264.90 to 264.101)	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.
ARAR	RCRA - Closure and Post Closure Requirements (40 CFR 264.110 to 264.120)	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.
ARAR	RCRA Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (40 CFR 265)	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.
ARAR	RCRA - Land Disposal Restrictions (40 CFR 268)	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.
ARAR	Resource Conservation and Recovery Act (RCRA) of 1976 Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (40 CFR 280)	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.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
ARAR	Safe Drinking Water Act (SDWA) of 1974 42 U.S.C. § 300f et seq. as amended in 1986	Established to protect the quality of drinking water in the Unites States. Focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. The Act authorized 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.
ARAR	SDWA - National Primary Drinking Water Regulations and Implementation (40 CFR 141 and 142)	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.
ARAR	SDWA - National Secondary Drinking Water Standards (40 CFR 143)	Establishes welfare-based secondary standards for public water systems.	Will be applicable at the distribution point (i.e., at the tap).
ARAR	SDWA - Underground Injection Control Program (40 CFR 144 to 148)	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.
ARAR	Toxic Substances Control Act (TSCA) of 1976 15 U.S.C. § 2601 et seq.	Enacted to give EPA the ability to track industrial chemicals currently produced or imported into the United States. EPA screens these chemicals and may require reporting or testing of those that pose an environmental or human-health hazard. 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.
TBC	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, EPA540-G-89-004, October 1988.	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.	

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
TBC	Guidance for Quality Assurance Project Plans, EPA240-R-02- 009, December 2002.	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 useability.	
TBC	Guidance for the Data Quality Objectives Process, EPA600-R- 96-055, August 2000.	Provides a systematic planning process to develop acceptance or performance criteria for collection, evaluation, or use of environmental data.	
TBC	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; Part F EPA540-R-070-002, January 2009.	Provide guidelines for conducting a baseline risk assessment.	
TBC	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.	Identifies Threshold Effect Concentration (TEC) to be used to assess impacts to sediment.	
TBC	Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA542-S-02-001, May 2002.	Identifies methods for sampling groundwater.	
TBC	Remedial Design/Remedial Action Handbook, EPA540-R-95-059, June 1995.	Provides an overview of the remedial design and remedial action processes.	

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
TBC	Management of Remediation Waste under RCRA, EPA530-F- 98-026, October 1998.	Describes management of contaminated environmental media, etc.	
TBC	Best Management Practices (BMPs) for Soils Treatment Technologies, EPA530-R-97-007, May 1997.	Describes various BMPs to be implemented during remedy implementation.	
TBC	Storm Water Management for Construction Activities EPA832-R-92-005, October 1992.	Describes storm water pollution prevention measures.	
TBC	Guide to Discharging CERCLA Aqueous Wastes to Publicly Owned Treatment Works, EPA OSWER Directive 9330.2-13FS, March 1991.	Describes applicability and acceptable means of conveyance to a POTW.	
TBC	Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, EPA OSWER Directive 9200.4-17P, April 21, 1999.	Describes EPA's policy regarding the use of monitored natural attenuation for the remediation of contaminated soil and groundwater at sites administered by EPA's Office of Solid Waste and Emergency Response.	
TBC	Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA OSWER Directive 9355.4-24, December 2002.	Describes EPA's framework for developing risk-based soil screening levels for protection of human health.	
TBC	Regional Screening Levels (RSL), June 2017	Establishes EPA's screening levels for soil, air, and drinking water.	

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
Potential State ARARs			
ARAR	Ambient Air Quality Standards and Air Pollution Control K.A.R. 28-19-1 to 28-19-801	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.
ARAR	Asbestos Control K.A.R. 28-50-1 to 28-50-14	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.
ARAR	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	Requires labeling and registration of agricultural chemicals. Provides regulations for storage and secondary containment, transportation and record keeping 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.
ARAR	Construction, Operation, Monitoring and Abandonment of Salt Solution Mining Wells K.A.R. 28-43-1 to 28-43-11	Regulates the construction, operation, monitoring, testing and abandonment of salt solution mining wells.	Will be applicable if salt solution mining wells are present.
ARAR	Emergency Planning and Right-to- Know K.A.R. 28-65-1 to 28-65-4	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.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
ARAR	Environmental Use Controls K.S.A. 65-1,221 to 65-1,235	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).
ARAR	Explosive Materials K.A.R. 22-4-1 to 22-4-4	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.
ARAR	Hazardous Waste Management Standards and Regulations K.A.R. 28-31-1 to 28-31-16	Identifies the characteristics and listing of hazardous waste. Prohibits underground burial of hazardous waste except as granted by 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 at a site.
ARAR	Hydrocarbon Storage Wells and Well Systems K.A.R. 28-45-1 to 28-45-11	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.
ARAR	Kansas Board of Technical Professions K.A.R. 66-6-1 through 66-14-12	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.
ARAR	Kansas Drycleaner Environmental Response Act K.A.R. 28-68-1 to 28-68-9	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.
ARAR	Kansas Historic Preservation Act K.A.R. 118-3-1 to 118-3-16	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.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
ARAR	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	Establishes the requirements for obtaining, maintaining and transferring water appropriations.	Will be applicable if water appropriations are required for groundwater remediation.
ARAR	Mined Land Reclamation K.A.R. 47-16-1 to 47-16-11	Allows for the reclamation of mined land and associated waters.	Will be applicable if mined land or associated waters are to be reclaimed.
ARAR	Non-Game, Threatened or Endangered Species K.A.R. 115-15-1 to 115-15-4	Identifies Threatened and Endangered Species	Will be applicable if any of the identified species are present at a site.
ARAR	PCB Facility Construction Permit Standards and Regulations K.A.R. 28-55-1 to 28-55-5	Establishes the requirement for permitting of facilities constructed for the treatment, storage or disposal of materials containing polychlorinated biphenyls (PCBs). Establishes standards for PCB facilities.	Will be applicable if treatment, storage or disposal of materials containing PCBs occurs.
ARAR	Pesticides K.A.R. 4-13-1 to 4-13-65	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.
ARAR	Petroleum Products Storage Tanks K.A.R. 28-44-1 to 28-44-29	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.
ARAR	Radiation K.A.R 28-35-1 to 28-35-363	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.
ARAR	Solid Waste Management K.A.R. 28-29-1 to 28-29-121 and K.A.R. 28-29-2101 to 28-29-2113	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.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
ARAR	Spill Reporting K.A.R. 28-48-1 to 28-48-2	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.
ARAR	Underground Injection Control Regulations K.A.R. 28-46-1 to 28-46-44	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.
ARAR	Underground Storage, Disposal Wells and Surface Ponds K.A.R. 28-13-1 to 28-13-9	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.
ARAR	Voluntary Cleanup and Property Redevelopment Program K.A.R. 28-71-1 to 28-71-12	Provides a mechanism for property owners, facility operators, prospective purchasers, and local governments to voluntarily address contaminated properties with technical and regulatory guidance from 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.
ARAR	Water Pollution Control K.A.R. 28-16-1 to 28-16-154	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.
ARAR	Water Well Contractor's License; Water Well Construction and Abandonment K.A.R. 28-30-1 to 28-30-10	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.

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
TBC	Kansas Department of Health and Environment (KDHE), Bureau of Environmental Remediation (BER), Risk Based Standards for Kansas, RSK Manual, March 1, 2003, as amended.	Compiles risk-based cleanup screening goals for contaminants in soil and groundwater	
TBC	Evaluating Future Land Use, KDHE BER Policy #BER-RS- 005.	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.	
TBC	Recommended Remedial Levels for Nitrate in Soil, KDHE BER Policy #BER-RS-012.	Addresses nitrate and ammonia contamination in the soil from point sources of contamination.	
TBC	Investigation and Remediation of Salt (Chloride)-Impacted Soil and Groundwater, KDHE BER Policy #BER-RS-013A	Provides information on methods for investigating, evaluating and remediating soil and ground water contaminated with brine or salt.	
TBC	Consideration for Remedial Standards, KDHE BER Policy #BER-RS-033.	Identifies remedial standards and situations where they should be used.	
TBC	Soil Clean-up Levels for Total Petroleum Hydrocarbons, KDHE BER Policy #BER-RS-041.	Establishes Total Petroleum Hydrocarbon (TPH) human health and environmental risk-based actions levels consistent with the procedures adopted within the Risk-Based Standards for Kansas (RSK) manual.	
TBC	Monitored Natural Attenuation, KDHE BER Policy #BER-RS- 042.	Provides further clarification of additional KDHE-BER requirements to the guidance on monitored natural attenuation provided by EPA Directive 9200.4-17P.	
TBC	Considerations for Groundwater Use and Applying RSK Standards to Contaminated Groundwater KDHE BER Policy #BER-RS-045.	Establishes a mechanism for consistency across BER programs in protecting public health and the environment, in addition to protection of ground water resources of the State.	

Table 4.1
Summary of Potential Applicable or Relevant and Appropriate Requirements
Occidental Chemical Corporation
Wichita, Kansas

ARAR Determination	Regulatory Citation	Description	Comment
TBC	Sediment Policy, KDHE BER Policy #BER-ARS-045	Provides a consistent definition and assessment approach for contaminated sediment sites in Kansas.	
TBC	Consideration for Hydraulic Containment, KDHE BER Policy #BER-RS-028	Presents requirements for hydraulic containment	

Notes:

Not all of the above listed standards or criteria will be applicable or relevant and applicable requirements for the CMS
ARAR Applicable or Relevant and Appropriate Requirements
CFR Code of Federal Regulations
K.A.R. Kansas Administrative Requirements
K.S.A Kansas Statutes Annotated
TBC To Be Considered
U.S.C United States Code

Table 4.2
Technology Evaluation
Occidental Chemical Corporation
Wichita, Kansas

	Category	Technology	Description	Applicable Y/N?	Costs	Notes
I. Soil - Corrective Measure Technologies						
I-A	Remediation	Excavation/ On-Site Consolidation	Impacted material is removed and placed in a centralized, on-Site location commonly with similar materials.	Yes	High	
I-B	Remediation	Excavation/ Off-Site Disposal	Impacted material is removed and transported to a permitted off-site disposal facility.	Yes	Very High	Not carried forward
I-C	Containment	Capping	Surface capping involves covering the contaminated area with an impermeable material. Capping minimizes surface exposure to contaminated materials, minimizes infiltration of surface water, limits gas emissions, and contains materials.	Yes	Medium	
I-C	Capping	Asphalt	Surface capping involves covering the contaminated area with an impermeable material. Capping minimizes surface exposure to contaminated materials, minimizes infiltration of surface water, limits gas emissions, and contains materials.	Yes	Medium	
I-D	Collection	Seep Collection	Drains are subsurface gravity collection systems designed to intercept groundwater and/or surface water. Collected water may be treated.	Yes	Medium	
I-E	Engineering Controls	Access / Security Controls	Access restrictions involve provision of fencing, walls, security, and surveillance; it results in no direct remediation of site contaminants.	Yes	Low	
I-G	Monitoring	Integrity Inspections and Monitoring	Inspection represents periodic physical evaluation of the constructed technology to ensure the technology is effective as originally constructed.	Yes	Medium	
I-F	Institutional Controls	Deed Restrictions	Deed restrictions represent institutional restrictions for managing the excavation and placement of soils at a Site. Soil Management Plans can manage or minimize direct contact with impacted materials. Soil Management Programs result in no direct remediation of site contaminants.	Yes	Low	

Table 4.2
Technology Evaluation
Occidental Chemical Corporation
Wichita, Kansas

	Category	Technology	Description	Applicable Y/N?	Costs	Notes
II. Groundwater - Corrective Measure Technologies						
II-A	Engineering Controls	Access / Security Controls	Access restrictions involve provision of fencing, walls, security, and surveillance; it results in no direct remediation of site contaminants.	Yes	Low	
II-B	Institutional Controls	Deed Restrictions	Deed restrictions represent institutional restrictions for managing the use of groundwater at a Site. Groundwater Monitoring Plans include provisions regarding management or minimizing direct contact with impacted groundwater. Groundwater Monitoring Programs result in no direct remediation of site contaminants.	Yes	Low	
II-C	Collection	Extraction	Interceptor wells are used to contain, divert, remove or manage groundwater. Extracted groundwater may be treated and/or reinjected.	Yes	High	
II-D	Treatment	Air stripping	The air stripping process removes (“strips”) VOCs from water by contacting clean air with impacted water across a high surface area, causing the VOCs to volatilize from the water into the air.	Yes	Medium	
II-E	Treatment	Carbon Adsorption	Groundwater is pumped through one or more vessels containing granular activated carbon (GAC). Dissolved contaminants sorb onto the large internal surface areas of the activated carbon. Periodic replacement or regeneration of saturated carbon is required.	Yes	High	
II-F	Monitoring	Routine Monitoring	Monitoring represents periodic sampling of site media to monitor site contaminants. Monitoring results in no direct remediation of site contaminants.	Yes	Medium	
III. Soil Vapor - Corrective Measure Technologies						
III-A	Institutional Controls	Administrative Controls, Deed Restrictions	Administrative controls represent site controls such as building Standard Operating Procedures (SOPs). Deed restrictions represent legal restrictions for land use or warnings of past site use in the deed for the site. Deed restrictions result in no direct	Yes	Low	
III-B	Monitoring	Routine Monitoring	Monitoring represents periodic sampling of site media to monitor site contaminants. Monitoring results in no direct remediation of site contaminants.	Yes	Medium	
III-C	Monitoring	Inspections	Inspection represents periodic physical evaluation of the constructed technology to ensure the technology is effective as originally constructed.	Yes	Low	
III-D	Treatment	Pressurization	Pressurization is a modification of the HVAC system to building to supply more air than is directly exhausted at the makeup air units.	Yes	Medium	

Table 4.2
Technology Evaluation
Occidental Chemical Corporation
Wichita, Kansas

	Category	Technology	Description	Applicable Y/N?	Costs	Notes
IV. DNAPL - Corrective Measure Technologies						
IV-A	Institutional Controls	Deed Restrictions	Deed restrictions represent legal restrictions for land use or warnings of past site use in the deed for the site. Deed restrictions result in no direct remediation of site contaminants.	Yes	Low	
IV-B	Collection	Extraction	Interceptor wells are used to contain, divert, remove or manage groundwater. Extracted groundwater may be treated and/or reinjected.	Yes	High	
IV-C	Treatment	Vertical Recovery Wells	Vertical Recovery wells are used to contain, divert, remove or manage groundwater. Extracted groundwater may be treated and/or reinjected.	Yes	High	
IV-D	Treatment	Enhanced Vertical Recovery Wells	Increased mobilization of DNAPL at the vertical recovery well recovery point, by upgradient groundwater injection, vertical recovery well extraction, or application of vacuum. Impractical to implement at an active facility, and where separate DNAPL areas exist at various depths and locations.	No	High	Not carried forward
IV-E	Treatment	Co-Solvent Injection and Recovery	Injecting and recovering a co-solvent into nested recovery points within a portion of the DNAPL-impacted area. Co-solvents increase the saturation concentration, therefore more contaminant mass can be recovered per pore volume extracted. Impractical to implement at an active facility, where separate DNAPL areas exist at various depths and locations, and due to the difficulty maintaining hydraulic control of the Site.	No	High	Not carried forward
IV-F	Collection	Horizontal Recovery Wells	Groundwater and DNAPL would be recovered through horizontal wells installed at the base of the conductive zones containing DNAPL in each of the separate DNAPL impacted areas. Potential for well fouling, for not properly intersecting DNAPL due to limitations of an active facility, for the horizontal well to act as a preferential pathway and spread the DNAPL. Small radius of influence therefore multiple horizontal wells required, but this is not feasible at the facility.	No	High	Not carried forward

Table 4.2
Technology Evaluation
Occidental Chemical Corporation
Wichita, Kansas

	Category	Technology	Description	Applicable Y/N?	Costs	Notes
IV. DNAPL - Corrective Measure Technologies (Continued)						
IV-H	Treatment	In Situ Bioremediation	In situ degradation of DNAPL by reductive dehalogenation by natural processes involving microorganisms. Impractical to implement at an active facility, where separate DNAPL areas exist at various depths and locations, and where there is a potential to mobilize DNAPL. The large number of injection points will be disruptive to site activities, and the presence of existing buildings/utilities makes implementation impractical.	No	High	Not carried forward
IV-I	Treatment	Thermal Treatment	The aquifer is heated, followed by vapor extraction. Heating methods may include steam injection, hot water injection, electrical resistive heating, or radio frequency heating. Impractical to implement at an active facility, where separate DNAPL areas exist at various depths and locations, where the presence of existing buildings/utilities makes implementation impractical, due to safety concerns while the facility is active, due to the large electrical power usage, and due to unfavorable geology.	No	High	Not carried forward
IV-J	Treatment	In Situ Chemical Oxidation	Chemical oxidants can be used to destroy DNAPL in situ through direct oxidation. Effectiveness is limited by the rapid degradation of hydrogen peroxide (therefore numerous close injection wells required, but this is not possible due to building locations), and by the violence of the chemical reaction (safety concerns while the facility is active).	No	High	Not carried forward

Table 5.1
Corrective Measure Screening Results
Occidental Chemical Corporation
Wichita, Kansas

			Threshold Criteria				Balancing Criteria								
			a	b	c	d	e	f	g	h	i	j	k		l
	Potential Corrective Measures	Target Media	Protect Human Health and Enviro.	Attain Media Cleanup Object.	Control Source of Release	Comply with Applicable Standards for Waste Mgt	Long-term Reliability and Effect.	Reduction in Toxicity, Mobility or Volume of Wastes	Short-Term Effect. and Short-Term Risks	Implementability	Community Acceptance	Agency Acceptance	Compliance with ARARs		Costs (+50% /- 30%)
I. Soil - Corrective Measure Screening Results															
I-A	CMA S1 - Excavation, Consolidation, Cover, Seep Collection and On-Site Discharge and Inspection	Soil	4	4	4	4	4	2	3	4	4	4	4	3	$1,035,500 [m]
II. Groundwater - Corrective Measure Screening Results															
II-A	CMA G1 - Modification and Continued Operation of Existing Groundwater Interceptor Well System	Groundwater	4	3	4	4	3	3	4	4	4	4	4	2	$18,393,100
III. Soil Vapor - Corrective Measure Screening Results															
III-A	CMA V1 - Existing ICM and Building Inspection	Soil Vapor	4	3	3	5	4	2	4	5	4	4	4	4	$175,400 [n]
IV. DNAPL - Corrective Measure Screening Results															
IV-A	CMA D1 - Groundwater ICM, Administrative Controls, and Vertical Recovery Wells	DNAPL	4	3	4	4	3	3	4	4	4	4	4	2	$3,249,000

Notes:

Comparison Rankings;

1 = Very Unfavorable 2 = Unfavorable 3 = Neutral 4 = Favorable 5 = Very Favorable

Evaluation Criteria

a Corrective Measure Alternatives (CMAs) must be protective of human health and the environment.
b CMAs are required to attain media cleanup standards set by the implementing agency.
c CMAs are required to stop further environmental degradation by controlling or eliminating further releases that may pose a threat to human health and the environment.
d CMAs are required to be in compliance with applicable waste management standards
e Long-term reliability and effectiveness refers to the amount of risk remaining at the Site and the ability of the CMA to maintain reliable protection of human health and the environment over time.
f The CMA must employ technologies that are capable of eliminating or substantially reducing the inherent potential for the wastes to cause future environmental releases or other risks to human health and the environment.
g Short-term effectiveness refers to the speed at which the CMA achieves protection of human health and the environment.
h Implementability is the technical/administrative ease or difficulty in implementing the CMA.
i Community acceptance is the relative level of support of the community for the CMA.
j Agency acceptance is the relative level of support of the State agency for the CMA.
k CMAs should be compliant with ARARs and To Be Considered (TBCs).
l Overall cost to implement and achieve remedial goals. Costs are preliminary estimates. The costs are based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within –30 to +50 percent of the actual project cost.
m Sum of cost for alternatives S1, S2 and S3.
n Sum of cost for alternatives V1 and V2.

Table 5.2
CMA Summary
Occidental Chemical Corporation
Wichita, Kansas

	CMA Designation	Description	Applicable Y/N?	Cost	Notes
I. Soil - Corrective Measure Alternatives					
I-A	CMA S1	Existing Cover and Inspection (ASI)	Yes	$121,500	
I-B	CMA S2	Existing Cover and Inspection (Process Area)	Yes	$29,000	
I-C	CMA S3	Excavation, Consolidation, Cover, Seep Collection and On-Site Discharge and Inspection (Landfill Area)	Yes	$885,000	
II. Groundwater - Corrective Measure Alternatives					
II-A	CMA G1	Modification and Continued Operation of Existing Groundwater Interceptor Well System	Yes	$18,393,100	
III. Soil Vapor - Corrective Measure Alternatives					
III-A	CMA V1	Administration Building, Technical Center and Laboratory Existing ICM	Yes	$151,400	
III-B	CMA V2	Process Area Buildings 10 and 51 Building Inspection	Yes	$24,000	
IV. DNAPL - Corrective Measure Alternatives					
IV-A	CMA D1	Groundwater ICM, Administrative Controls, and Vertical Recovery Wells	Yes	$3,249,000	

Note:

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within –30 to +50 percent of the actual project cost.

Appendices

Appendix A
Interceptor Well Effectiveness Evaluation

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Attachment A1 Groundwater Chemical Trend Evaluation

1. Introduction

This Appendix A of the 2017 Corrective Measures Study (CMS) Report for the Occidental Chemical Corporation (OCC) Facility in Wichita, Kansas (Site) presents a series of focused effectiveness evaluations associated with the Groundwater Interim Corrective Measure (ICM) Interceptor Well System to enhance the containment, capture, and treatment of impacted groundwater at the Site. The Site location is presented on **Figure A.1,** and the CMS Study Area is presented on **Figure A.2**.

These 2017 focused evaluations augment previous effectiveness assessments conducted in 2010 and 2013. The 2017 groundwater effectiveness evaluations focused on the following components:

- The efficacy of the current pump and treat ICM as the final Corrective Measure for groundwater at the Site
- The groundwater chemistry trends and changes since the 2013 Groundwater Interceptor Well Effectiveness Evaluation
- The potential for installing another interceptor well in the vicinity of MW145S2/S3 to facilitate containment and treatment of beta-BHC impacted groundwater
- Streamlining future groundwater chemistry sampling and the hydraulic monitoring regime

The results and conclusions of the effectiveness evaluations were incorporated into the August 2017 CMS Report for the Site.

1.1 Objectives

The objectives of the evaluations were to conduct thorough assessments of the extensive Site investigation data to determine if the current Groundwater Interceptor Well System is effectively containing and capturing impacted groundwater and make recommendations to enhance the capture zones and future monitoring programs. More specifically, these evaluations are intended to:

- Assess groundwater capture of the interceptor well system
- Enhance the interceptor well network and augment its treatment capabilities
- Streamline the groundwater monitoring program
- Reduce the frequency of groundwater samples collected
- Abandon monitoring wells that do not provide beneficial chemical or hydraulic data

1.2 Approach

This document follows an evaluation approach that utilizes, among other things, hydraulic head data, chemical trend data, aquifer hydrogeologic properties and previous effectiveness evaluations to develop lines of evidence to assess the effectiveness of the current groundwater ICM pump and treat system and the associated groundwater monitoring program. The 2017 focused evaluations included the following:

- Groundwater Chemical Trend Evaluation

- Interceptor Well Effectiveness Evaluation
- Groundwater Monitoring Plan Evaluation

1.3 Report Format

This report contains the following sections:

- Section 2 – Background
- Section 3 – Groundwater Chemical Trend Evaluation
- Section 4 – Interceptor Well Effectiveness Evaluation
- Section 5 – Groundwater Monitoring Plan Evaluation
- Section 6 – Recommendations
- Section 7 – References

Attachment A.1 provides the detailed evaluation of groundwater chemistry trends and monitoring plan evaluation.

2. Background

This background section provides a brief review of the Site history, geology and hydrogeology, chemicals of concern, existing interceptor well network, and the results of previous effectiveness evaluations.

2.1 Facility Use and History

The OCC Wichita Facility has been an active chemical plant since 1952 and is located in a rural industrial and agricultural area. OCC acquired the Wichita Facility from Vulcan Chemical in 2005. Details of the investigation, monitoring, and interim remediation activities to date, within the CMS Study Area, are presented in previous reports referenced in the CMS Report.

2.2 Geology and Hydrogeology

The geology at the Site consists of approximately 100 feet of unconsolidated deposits overlying a shale bedrock. The unconsolidated deposits include four generally discrete sand units, S1 through S4 (oldest to youngest), separated by four clay units, C1 through C4 (oldest to youngest). These unconsolidated deposits were created by alternating fluvial (glacial meltwater streams) and lacustrine (lake) environments. The lacustrine depositional environments deposited the fine-grained silt and clay units, and the fluvial depositional environment deposited stratified fine-to-course grained sand or sand and gravel deposits. The sand units within the CMS Study Area appear to slope in a southerly to southeasterly direction. The sand and clay deposits are not laterally continuous, especially in the southern portion of the CMS Study Area. Some locations contain combined sand units (i.e., the S2/S3 zone) where the C2 unit is absent or a combined S1/S2/S3 zone where the C1 and C2 units are absent (**Figure A.3**). At other locations, the S1 unit is not always present above the shale.

The Site hydrogeology includes two general aquifers (the S1 and S2/S3) and S4, a shallow perched zone. The S1 aquifer is the basal aquifer overlying the shale bedrock aquitard. The S1 aquifer is typically encountered approximately 80-100 feet below ground surface (bgs) and is separated from the overlying S2/S3 aquifer by the C1 clay layer. The S1 aquifer is generally encountered under confined conditions when it is present between the basal shale unit and the overlying C1 clay unit. The S1 aquifer tends to be thinner than the S2/S3 aquifer and has a higher silt content in some areas.

The S2/S3 aquifer is regionally extensive and underlies the entire Investigation Area. The aquifer is encountered approximately 40-60 feet bgs. The S2/S3 aquifer is present above the C1 clay layer. The units are separated by a discontinuous C2 clay layer. Potentiometric surface data and response to pumping suggest that the S2 and S3 sands can be interpreted as a single aquifer unit. The S2/S3 aquifer can be up to 60 feet thick and is composed of highly permeable and transmissive sand or sand and gravel deposits.

2.3 Groundwater Contaminants

Chemical contaminants are present in groundwater in concentrations that exceed the Maximum Contaminant Level (MCL) drinking water standards in both the S1 and S2/S3 water bearing units at the Site. Due to the complexity of the Site, five chemicals were selected as indicator parameters that are considered broadly representative of groundwater impacts and migration properties of the chemicals of concern (COCs). The five indicator chemicals include carbon tetrachloride, hexachlorobutadiene, hexachloroethane, perchloroethylene, and beta-BHC. These five chemicals were used in the contaminant concentration trend evaluations. The distribution and concentrations of these five chemicals detected within the S1 and S2/S3 aquifers were also plotted as isoconcentration maps to help assess the efficiency of the groundwater capture system. The isoconcentration maps are presented on **Figures 5 through 14** of the CMS Report.

2.4 Interceptor Well System

OCC installed and continues to operate a Groundwater ICM in the S1 and S2/S3 water-bearing units. The current Groundwater ICM consists of 14 interceptor wells (**Figure A.2**). The Groundwater ICM includes 12 groundwater extraction wells in the S2/S3 zone (i.e., IW30 through IW32, IW35A, IW35B, and IW40 through IW46) and two groundwater extraction wells installed in the S1 zone (i.e., IW29 and IW36). The pumping rates employed at each interceptor well capture the contaminants dissolved in groundwater at concentrations above a cleanup level. The pumped groundwater is treated with activated carbon and then discharged to either an NPDES-permitted outfall, disposed via the Facility's deep well injection, or used as process water at the Facility.

The current recovery system consists of the following:

- The IW Recovery and Treatment Facility on Hoover Road collects and treats impacted groundwater from IW-40, IW-43, IW-44, IW-45, and IW-46
- The recovery systems for IW-41 and IW-42 (east of the Site along 55th Street and 63rd Street, respectively) each operate as an independent carbon treatment system

- The recovery system for IW-29, IW-30, IW-31, IW-32, IW-35A IW-35B, and IW-36 will continue to operate inside the Site and pump groundwater to the Facility's deep well disposal system

The initial groundwater interceptor well IW29 became operational in 1978 and was followed by IW30, IW31 and IW32 in 1979 as part of a groundwater management plan. The Interceptor Well System has been periodically upgraded and augmented. The system upgrades/augmentations include the following:

- 1983 – Interceptor well IW35A was installed
- 1986 through 1996 – Replaced interceptor wells IW29, IW30, IW31, IW32, and IW35A
- 1996 – Interceptor well IW35B was installed
- 2003 – Interceptor Well System augmented with four wells, including IW36 (located on Site) and off-Site interceptor wells IW40, IW41, and IW42
- 2010 – A Groundwater Interceptor Well Effectiveness Evaluation for ten interceptor wells (IW29, IW30, IW31, IW32, IW35A, IW35B, IW36, IW40, IW41, IW42) was completed (CRA, February 2010) and recommended installation of two additional interceptor wells in the S2/S3 to collect and contain groundwater impacted with carbon tetrachloride
- 2011-2012 – Two interceptor wells were installed (IW-43 and IW-44)
- 2011-2012 – Twelve hydraulic monitoring piezometers were installed to help define flow conditions and the hydraulic effects of the pumping operations
- 2013 – A second Groundwater Effectiveness Evaluation was completed and recommended installation of two additional interceptor wells (IW-45 and IW-46) with hydraulic monitoring piezometers at both locations
- 2015 – OCC completed construction of a groundwater treatment system as part of the Groundwater ICM
- 2017 – The groundwater treatment system is being upgraded to include a pre-treating air stripper to minimize activated carbon use in the system
- 2017 – The CMS includes a third Groundwater Interceptor Well ICM Effectiveness Evaluation

2.5 Monitoring Well Network

Currently, groundwater monitoring and reporting is conducted on a semi-annual basis. The current groundwater monitoring well network consists of approximately 170 monitoring wells. The monitoring well locations are shown on **Figure A.2**. The well construction details are presented on **Table A.1**.

In the fall of 2011, the USEPA approved a regular, periodic groundwater monitoring program in which select monitoring wells are sampled on a semi-annual, annual, and biennial basis, based on their location with respect to the groundwater contaminant plumes. Details regarding the approved program are documented in the report entitled *Sampling and Analysis Plan Routine Groundwater Sampling Plan RCRA Corrective Action Program, Revision 2*, dated March 9, 2012 (CRA 2012).

OCC conducts regular monitoring of production wells and water supply wells located on neighboring properties, in addition to the monitoring well sampling program. The program includes sampling at neighboring industrial facilities and nearby residential/agricultural properties. A portion of this monitoring program is required under the Site's current RCRA Permit, and a portion of the sampling program is completed on a voluntary basis.

2.6 Previous ICM Effectiveness Evaluations

The first ICM effectiveness evaluation was conducted in 2010 and followed the United States Environmental Protection Agency's (U.S. EPA's) January 2008 guidance document entitled *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (U.S. EPA, 2008). The six steps suggested by the U.S. EPA document and completed as part of the 2010 effectiveness evaluation included:

- Review site data, site conceptual model, and remedial objectives
- Define site-specific Target Capture Zone(s)
- Interpret water level data including both the horizontal and vertical components
- Perform hydrogeologic calculations
- Evaluate concentration trends
- Re-evaluate actual capture based on steps 1-5, compare to Target Capture Zone(s), and assess uncertainties and data gaps

The estimated groundwater capture zones in the S1 and S2/S3 aquifers were presented in previous CRA reports referenced in the CMS. These estimates were based on estimated hydraulic properties of the aquifers and other Site-specific input parameters (aquifer saturated thickness, hydraulic gradient, hydraulic conductivity, extraction well pumping rate, etc.) to develop a capture zone for each interceptor well or group of interceptor wells.

3. Groundwater Chemical Trend Evaluation

GHD conducted a statistical evaluation to assess concentration trends of five indicator COCs detected in groundwater encountered within the deep aquifer (S1) and shallow aquifer (S2/S3) at the OCC Facility. The methodologies and details of the evaluation are presented in **Attachment A.1** and the results are summarized below.

The statistical trend testing was conducted on concentrations of five different COCs, including:

- Carbon tetrachloride (chlorinated methane compound)
- Perchloroethylene (volatile organic compound)
- Hexachloroethane (semi-volatile organic compound/chlorinated phenol)
- Hexachlorobutadiene (semi-volatile organic compound/chlorinated phenol)
- beta-BHC (pesticide)

The statistical evaluation assessed temporal trends in analytical data from groundwater samples collected between September 2012 and May 2017 (i.e., during the last 10 semi-annual sampling events conducted at the Site). The tests were conducted on a per-well, per-parameter basis, and therefore, included over 715 data sets (i.e., 50 S1 wells and 93 S2/S3 wells tested for five chemicals). The vast majority of data sets in the evaluation consisted of either six observations (annual samples from 2012-2017) or 10 observations (semi-annual samples from Fall 2012 to Spring 2017). Data sets containing three or fewer observations (samples) were not subjected to trend analyses. The trend test findings are considered strongest for data sets with 8 or more observations, and slightly less powerful for data sets with 5-7 observations.

The groundwater concentration trends for each of the five indicator chemicals detected in each monitoring well with an adequate data set were assessed using a Mann-Kendall statistical trend analysis, which is a general trend test procedure for detection of monotonic (single-direction) trends. The Mann-Kendall tests require data sets containing no more than 50 percent non-detect values (i.e., no more than 3 of the 6 samples or 5 of the 10 samples in a single data set being non-detect for the specific chemical and well being evaluated). If a data set contained more than 50 percent non-detects, no temporal trend testing was performed. In the statistical analyses, any field duplicate results were averaged prior to performing trend testing. In cases where the field duplicate results included one detected and one non-detected value, the detected value was retained as a conservative (high) estimate of the chemical concentration present in the groundwater at that time. The trends were interpreted using the 2007 Air Force Center for Environmental Excellence (AFCEE) decision matrix for the classification of Mann-Kendall trend results.

A summary of the trend test results are presented below.

Data Sets	Description
715	Data sets from the S1 zone (250) and S2/S3 zone (465)
510	Data sets eliminated due to insufficient detection frequencies or insufficient number of samples
205	Data sets suitable for trend testing
137	Data sets did not exhibit a statistically significant trend over time
43	Data sets exhibited decreasing trends
25	Data sets exhibited increasing trends

The frequencies of statistically significant chemical concentration trends are summarized below.

Aquifer	Chemical	Increasing	Probably Increasing	Probably Decreasing	Decreasing
S2/S3 (Shallow screened sand aquifer)	Tetrachloroethene	1	2	2	6
	Carbon tetrachloride	6	2	0	15
	Hexachloroethene	0	0	1	3
	Hexachlorobutadiene	0	0	1	0
	beta-BHC	3	2	0	4
S1 (Deep screened sand aquifer)	Tetrachloroethene	1	0	0	2
	Carbon tetrachloride	3	1	2	2
	Hexachloroethene	0	1	0	1
	Hexachlorobutadiene	1	1	0	1
	beta-BHC	1	0	0	3
Total		16	9	6	37
	Total	25		43	

The detailed results of the trend tests are presented in **Attachment A.1**. The 25 data sets at 23 well locations that contained "increasing" trends or "probable increasing" trends are discussed below. Two of the 25 data sets contained increasing concentrations for different chemicals at the same well (carbon tetrachloride and hexachlorobutadiene at MW10S1, and hexachloroethene and hexachlorobutadiene at MW19S1). The location of the 23 wells with increasing concentrations are presented on **Figures 1 and 2** of **Attachment A.1.** Four of the 23 wells showing potential concentration exceedances were interceptor wells (IW31, IW40, IW45, and IW46), suggesting that more contaminant mass is being removed from the OCC plume and the neighboring Gavilon plume. The other 19 wells with potential increasing concentration trends appear to be located near or hydraulically downgradient of a suspected source area. However, all 19 wells are located hydraulic upgradient of an active interceptor well and are within a capture zone of one or more interceptor wells. As indicated in **Attachment A.1**, any well with one of more COCs exhibiting increasing concentration trends over the past five years is proposed to be sampled twice per year (semi-annual monitoring) until the increasing trend stabilizes or decreases.

It is also significant that 43 data sets showed decreasing concentration trends and 510 data sets had insufficient detection frequencies or number of samples to perform a trend evaluation. Both of these findings indicate that the monitoring program should be revised to optimize meaningful data collection for future remedial management.

The wells with increasing concentration trends are summarized below:

Summary of Increasing Concentration Trends in Wells		
Chemical and Aquifer	Increasing (IN) or Probably Increasing (PI)	Well ID
Carbon tetrachloride (12 Wells Total)		
S1	IN	MW002S1, MW010S1, MW030S1
S1	PI	MW015S1
S2/S3	IN	IW40, IW45, IW46, MW010S2, MW021S3, MW148S2/S3, Dieffenbacher
S2/S3	PI	IW31
beta-BHC (6 Wells Total)		
S1	IN	MW032S1
S2/S3	IN	MW030S3, MW131S2, MW145S2/S3
S2/S3	PI	MW005S3, MW008S3
Tetrachloroethene (4 Wells Total)		
S1	IN	MW026S1
S2/S3	IN	MW149S2/S3
S2/S3	PI	AMW4S, APMW302S3
Hexachlorobutadiene (2 Wells Total)		
S1	IN	MW019S1
S1	PI	MW010S1
Hexachloroethene (1 Well Total)		
S1	PI	MW019S1

The chemical concentrations used to determine the trends for the wells identified above are presented in **Tables 1 and 2** of **Attachment A.1**.

4. Interceptor Well Effectiveness Evaluation

The 2017 Interceptor Well Effectiveness program was conducted in phases, including a hydrogeologic data review and estimating capture zones of pumping wells under steady-state conditions using water levels at the pumping wells and in surrounding monitoring wells.

4.1 Hydrogeologic Evaluation

The first phase of the effectiveness evaluation reviewed the hydrogeologic conditions at each S1 or S2/S3 well where the Mann-Kandell trends test results showed increasing chemical concentrations. This evaluation including construction of a generalized geologic cross section to better understand the depth of the impacted intervals and the geologic/hydrogeolgic conditions in relation to the nearest interceptor well. In areas where the interceptor well contained increasing chemical

concentration trends, the cross section was extended from the interceptor well to the chemical source located hydraulically upgradient of the interceptor well to assess capture of the upgradient source. The cross section includes the following data:

- A southerly to southeasterly orientation parallel to the groundwater flow direction and the natural contaminant migration pathways
- The potentiometric surfaces of the S1 and S2/S3 aquifers to assess their hydraulic connection, aquifer conditions (confined versus unconfined) and the geometry of the capture zone surrounding the interceptor wells
- The dewatered portions of the formation (if any) and the drawdown levels at the interceptor well locations
- The saturated thickness of the sand units and the general slope of the underlying and/or overlying clay units
- The chemical constituent concentrations detected at the interceptor well and at locations upgradient and downgradient of the interceptor well to assess mass removal efficiencies and/or chemical concentration decreases

The cross section plotted carbon tetrachloride concentrations for the evaluation as it is the most prevalent chemical constituent detected at the Site.

4.1.1 Cross Section A-A'/Trend Test Increases at MW015S1

The trend test results show increasing carbon tetrachloride concentrations at MW015S1, which is located hydraulically downgradient of three interceptor wells (IW30, IW31 and IW32). Based on the groundwater flow directions, the increasing concentrations detected at MW015S1 may be from the groundwater impacts detected at MW014S3 (located west of MW015S2) and not from leakage through the IW30, IW31, and IW32 extraction system. The A-A' cross section (**Figure A.3**) shows effective mass removal at IW30 and sufficient mass removal at downgradient IW44 (based on the absence of impacts at MW142S2/S3). The equipotential elevations on the cross section show the upper portion of the S2/S3 zone that has been dewatered and the approximate extent of the interceptor well capture zones in both the S1 and S2/S3 zones. This information is consistent with historical evaluations: chemical concentrations in monitoring wells located hydraulically downgradient of IWs indicate an absence of impacts or decreasing concentration trend.

4.2 Interceptor Well Effectiveness Evaluation

The second phase of effectiveness evaluation consists of multiple components, including:

- Conducting an Effectiveness Evaluation for the existing Interceptor Well System
- Assessing the installation of an additional interceptor well near MW145S2/S3 to capture the apparent increasing concentrations of beta-BHC
- Adding an air-stripper pre-treatment component into the IW Treatment Plant

4.2.1 The Groundwater Interceptor Well System currently meets the threshold and balancing criteria for a final groundwater corrective measure. Interceptor Well System Evaluation

Potentiometric contours were generated using a process described in 2002 by Tonkin and Larson, Kriging Water Levels with a Regional-Linear and Point-Logarithmic Drift Groundwater Vol 40. Contouring with kriging requires that the deterministic portion of the data, the drift, be removed from the data before kriging. The mathematics underlying Tonkin and Larson's approach are identical to those underlying the capture formula presented on page 21 of EPA's 2008 guidance A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems.

The contouring was performed using Microsoft Excel to calculate the drift, and Golden Software Surfer for contouring. Capture zones are interpreted using the vector feature in Surfer which determines the groundwater flow direction at every node in a Surfer grid file.

The parameters used to estimate the drawdown around at each interceptor well included pumping rate and transmissivity. The parameters are summarized below.

Interceptor Well	Pumping Rate (gpm)	Transmissivity (T) (ft^2/day)
IW29	97	850
IW30	39	4,200
IW31	29	4,200
IW32	55	5,500
IW35A&B	92	5,500
IW36	48	850
IW40	70	10,600
IW41	52	10,300
IW42	52	12,700
IW43	91	10,600
IW44	40	10,600
IW45	70	10,600
IW46	150	7,000

Figures A.4 and A.5 show the May 2017 groundwater potentiometric surface for the S2/S3 and S1 units, respectively. Colored arrows show groundwater flow paths. Capture zones for individual or a group of interceptor wells are drawn on the potentiometric surface. The two largest capture zones are created by interceptor well groups IW30 / IW31 / IW32 and IW40 / IW46, respectively. These two large capture zones and the IW43 capture zone are containing and capturing the impacts from the OCC Site as well as the groundwater plume of predominantly carbon tetrachloride apparently associated with the Gavilon property. Wells IW44 and IW45 are located to maximize the downgradient capture. These two wells are also capturing groundwater with predominantly carbon tetrachloride apparently associated with the Gavilon property. **Figures A.4 and A.5** include the footprint/outline of all groundwater impacts detected in the S2/S3 and S1 aquifers. The capture zones in both aquifers are adequate to capture the groundwater impacts detected at the Site.

4.2.2 Additional Interceptor Well near MW145S2/S3

Based on the trend test results showing increasing concentrations of beta-BHC at monitoring well MW145S2/S3, the Interceptor Well System will be expanded to include an additional interceptor well (IW47). Although the existing Interceptor Well System is effective in capturing and treating beta-BHC, the new interceptor well IW47 will be located in an area to provide more aggressive capture and treatment of the beta-BHC concentrations. Impacted groundwater captured by the interceptor well will be treated with granular activated carbon and discharged in accordance with the NPDES permit.

4.2.3 Air Stripper Pre-treatment Incorporated into the IW System Groundwater Treatment

An air stripper is being added to the IW Recovery and Treatment facility to reduce the high usage rate of the liquid-phase granular activated carbon (GAC), which is currently the treatment method utilized to remove COCs from the recovered groundwater. The current loading requires carbon replacement of the lead carbon beds approximately every 3 months and carbon replacement of the lag carbon beds approximately every six months. The limiting COC for carbon adsorption is carbon tetrachloride. The air stripper pretreatment of the recovered groundwater is expected to be effective in reducing the carbon tetrachloride concentration prior to carbon treatment, thereby extending the carbon life, reducing overall treatment system downtime, reducing costs, and maintaining the same or improving treatment quality of groundwater discharged in accordance with the NPDES permit. In addition to pre-treatment, a filtration unit will be added between the air stripper and the lead carbon bed.

5. Groundwater Monitoring Plan Evaluation

A Groundwater Monitoring Plan Evaluation based on the groundwater chemistry data and capture zone analysis was completed to optimize future monitoring and management of the Interceptor Well System. The evaluation included assessing the following elements of the current monitoring plan: (i) the frequency of sampling; (ii) sampling locations; (iii) laboratory analytical parameters; and (iv) well abandonments. The methodologies, details and the results of the evaluation are presented in **Attachment A.1**. The evaluation results were used to develop a proposed groundwater monitoring program, which is summarized in **Tables A.2 and A.3**.

Based on the chemical trend tests results, a large portion of the data showed no statistically-significant trends, suggesting chemical concentration in groundwater in the S1 and S2/S3 aquifers are generally stable. However, detectable changes in groundwater quality have occurred over the last 5-year period that show increasing concentrations in a number of monitoring wells and interceptor wells. The capture zone analysis showed the monitoring wells with increasing concentration trends appear to be located hydraulically upgradient of an active interceptor well and are within a capture zone of one or more interceptor wells.

The proposed groundwater monitoring program indicates wells with increasing concentration trends will be sampled on a semi-annual basis to track the trend direction. The proposed groundwater program also classifies wells in accordance with their function and adjusts monitoring frequencies

based on their functional assignment and trend test findings. The following well function assignments and sampling frequencies are part of the proposed groundwater monitoring plan:

Well Function and Sampling Frequency		
Well Trend and/or Function	Definition	Sampling Frequency
Increasing Trends	Data from 2017 Chemical Concentration Trend Tests	Semi-Annual
Plume Source	At or within source zone	Annual
Plume Interior	Between the plume source and plume edge wells	Biennial
Plume Edge	Last locations with COC concentrations above criteria within plume	Annual
Plume Boundary	First locations with COC concentrations below criteria outside plume	Annual
Sentinel Wells	Further from plume, past one or more boundary wells	Biennial
Redundant	No longer regularly needed in well network due to duplication	Not regularly sampled (or Abandon)

Changes to the monitoring well sampling program were developed utilizing the trend tests results for the last 5 years of semi-annual sampling and a calculated MCL or Risk-based Screening Level (RSL) exceedance ratio that accounted for the last 5 year sample history of the well (>1 for MCL or RSL exceedances or <1 for no MCL or RSL exceedances). The evaluation supported the following changes to the groundwater monitoring program.

Groundwater Sample Schedule Changes		
Sample Frequency	2012 (Number of Wells)	2017 (Number of Wells)
Semi-Annual	66	31
Annual	61	65
Biennial	13	24
Not regularly sampled	0	14
OCC Well Abandonment	0	19

The changes to groundwater sample schedule reflect the results of the detailed review of the chemical trends observed at the Site.

No change in the laboratory parameters for the monitoring program is recommended at this time. However, based on the occurrence of COCs above applicable criteria in groundwater at the Site, periodic evaluation of the monitoring plan should be conducted on a regular basis (e.g., updating the monitoring optimization evaluation every 2 to 5 years).

6. Recommendations

GHD completed the 2017 effectiveness evaluations to optimize remedial management and monitoring of the Interceptor Well System at the OOC Wichita facility. The evaluations support the following recommendations:

6.1 Recommendations from the Groundwater Chemical Trend Evaluation

The findings from the Groundwater Chemical Trend Evaluation identified almost twice as many decreasing concentration trends than increasing data trends. The trend tests also identified 510 data sets that had insufficient detection frequencies or an insufficient number of samples to conduct a trend test, indicating a large number of wells are not critical to the current monitoring program. Based on the results of the trend tests, it is recommended that the monitoring program be revised to optimize and streamline future data collection.

6.2 Recommendations from the Interceptor Well Effectiveness Evaluation

The calculations from the Interceptor Well Effectiveness Evaluation show the capture zones in the S1 and S2/S3 aquifers are adequate to contain and capture the groundwater impacts detected at the Site. Therefore, the current Groundwater ICM is effective and should be considered for the final groundwater corrective measure at the Site as it meets all the EPA balancing and threshold criteria. Additionally, the recommended groundwater corrective measure can be augmented by installing a new interceptor well (IW-47) and its associated groundwater treatment system. Proposed IW-47 (installed in the vicinity of MW-145S2/S3) will facilitate containment and treatment of beta-BHC impacted groundwater. A summary of the existing and proposed recovery system and monitoring well network is presented on **Figure A.6**.

6.3 Recommendations from the Groundwater Monitoring Plan Evaluation

Based on the chemical trend tests results, a large portion of the data showed no statistically-significant trends, suggesting chemical concentrations in groundwater in the S1 and S2/S3 aquifers are generally stable. However, 19 well locations did show increasing concentration trends over the last 5-year period. Even though these wells appear to be located hydraulically upgradient of an active interceptor well, it recommended that any well with one of more COCs exhibiting increasing concentration trends be sampled twice per year (semi-annual monitoring) until such a time as the increasing trend stabilizes or decreases. After decades of groundwater sampling and monitoring, the results of the evaluation also support the new proposed groundwater sampling program and monitoring well abandonment program summarized in **Tables A.2 and A.3**.

7. References

Conestoga Rovers & Associates, 2010. Interceptor Well System, Interim Corrective Measure, Effectiveness Evaluation, Glenn Springs Holdings, Inc., Occidental Chemical Corporation Facility, Wichita, Kansas. February.

Conestoga-Rovers & Associates, 2012. Sampling and Analysis Plan Routine Groundwater Sampling Plan RCRA Corrective Action Program, Revision 2. March 9.

Tonkin, M.J. & Larson, S.P., 2002. “Kriging Water Levels with a Regional-Linear and Point-Logarithmic Drift”. Groundwater, 40:2, 185-193. March.

U.S. Environmental Protection Agency, 2008. A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems. EPA/600/R-08/003. January.

Figures

Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas
South FIPS 1502 Feet

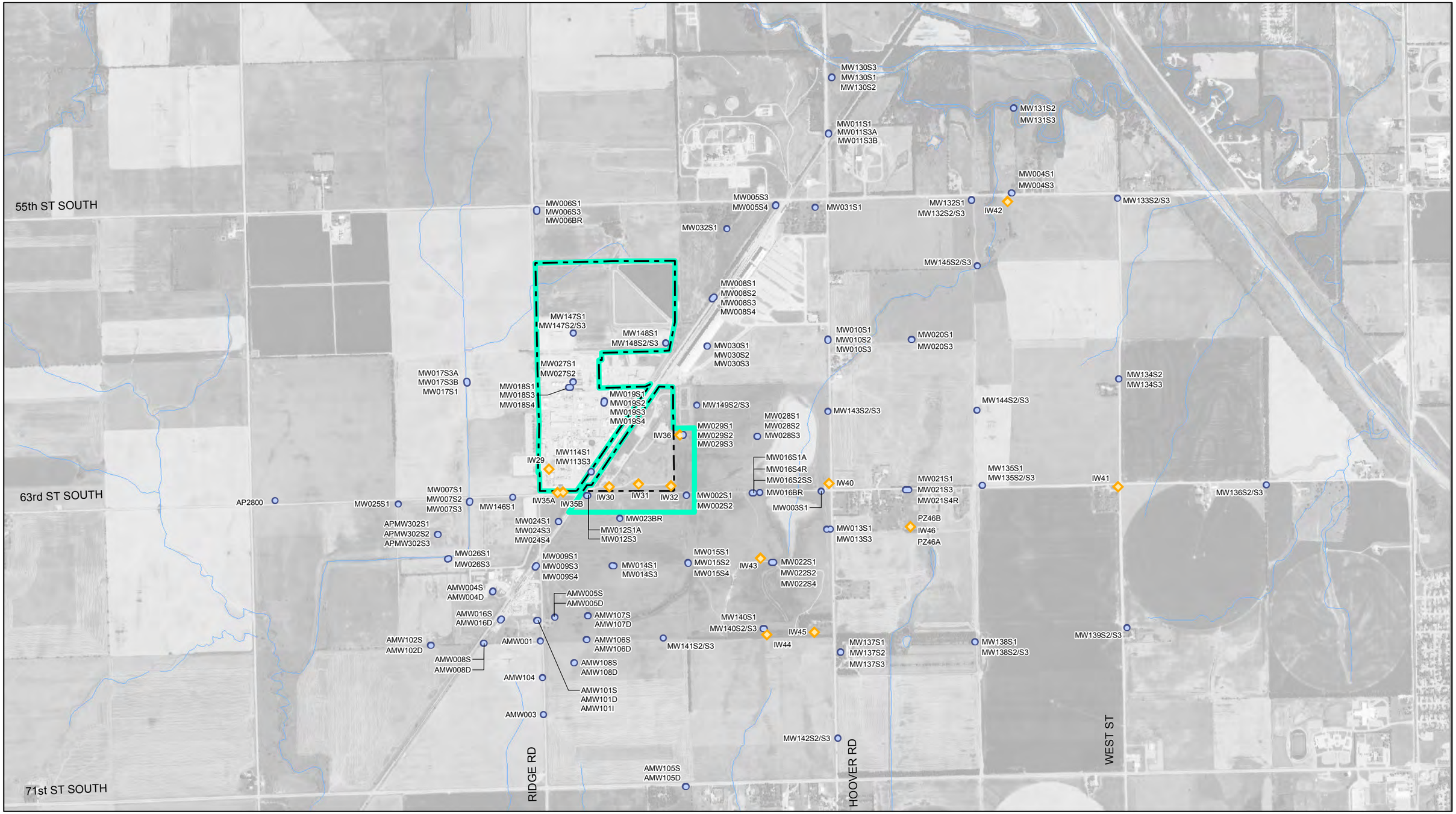
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 9, 2017

FACILITY LOCATION

FIGURE A.1

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA036.mxd



Source: USDA NAIP 2010

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Approximate Facility Boundary
- CMS Study Area

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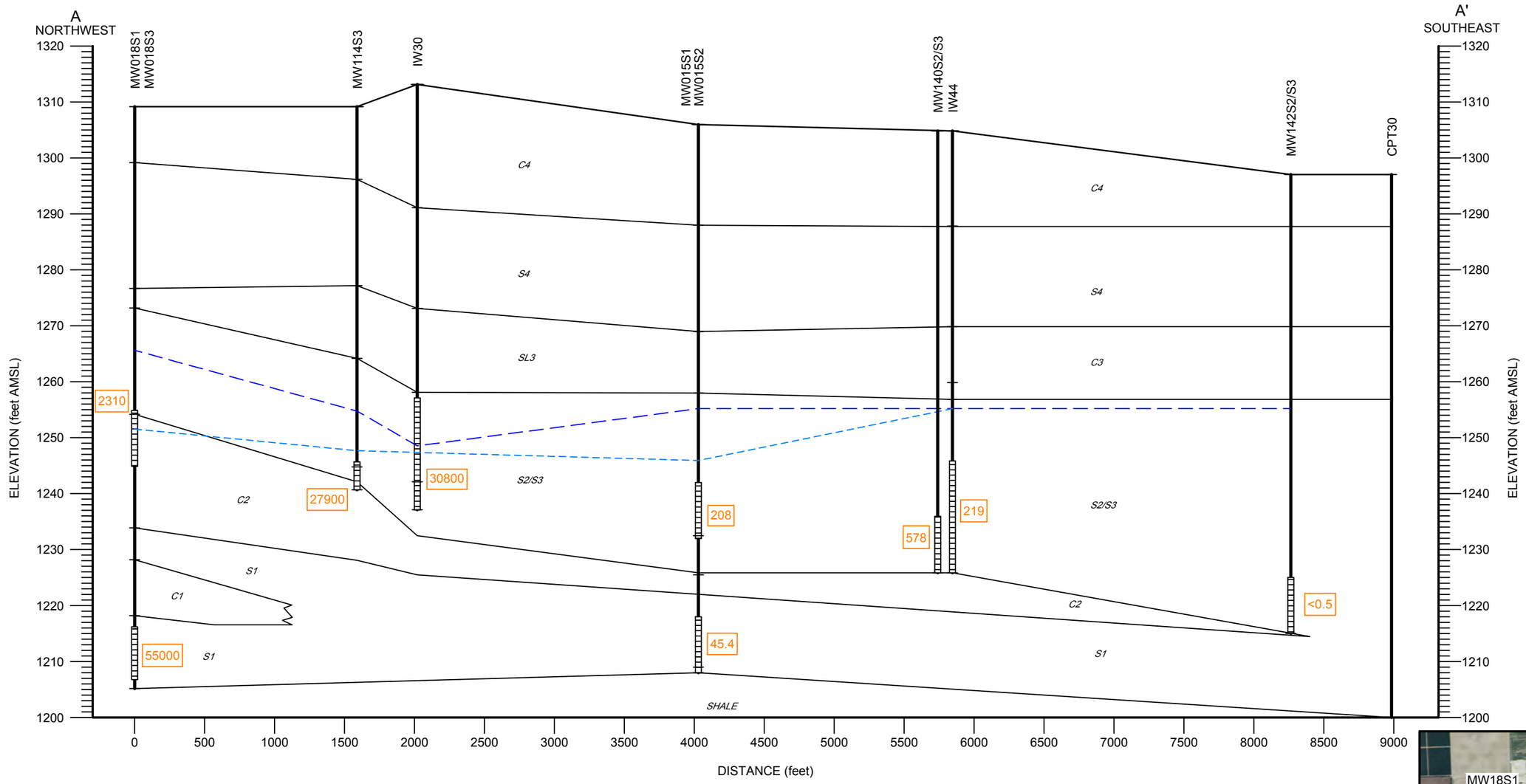
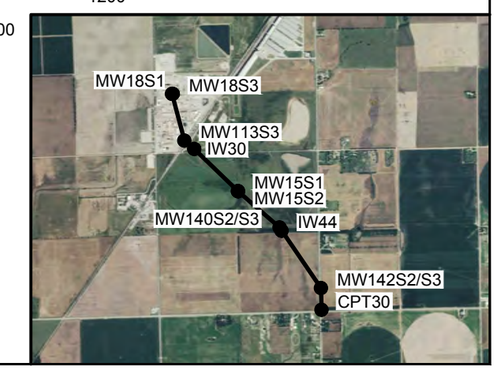
11137148-D23103
Aug 10, 2017

GROUNDWATER MONITORING
AND INTERCEPTOR WELL LOCATIONS

FIGURE A.2

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA037.mxd





SOURCE: NAIP, 2010.

LEGEND

- IW30 — WELL DESIGNATION
- GROUND SURFACE
- OBSERVATION WELL INSTALLATION
- STRATIGRAPHIC CONTACT
- C — TYPICAL SOIL CLASSIFICATION
- SCREENED INTERVAL
- BOTTOM OF BORING

- WATER LEVEL (MAY 2017) LINE FOR S2/S3 UNIT
- WATER LEVEL/EQUIPOTENTIAL SURFACE (MAY 2017) FOR S1 UNIT
- 2310 — CARBON TETRACHLORIDE CONCENTRATION (MAY 2017) IN GROUNDWATER IN MICROGRAMS PER LITER
- S1 — SAND UNIT
- C4 — CLAY UNIT

GHD

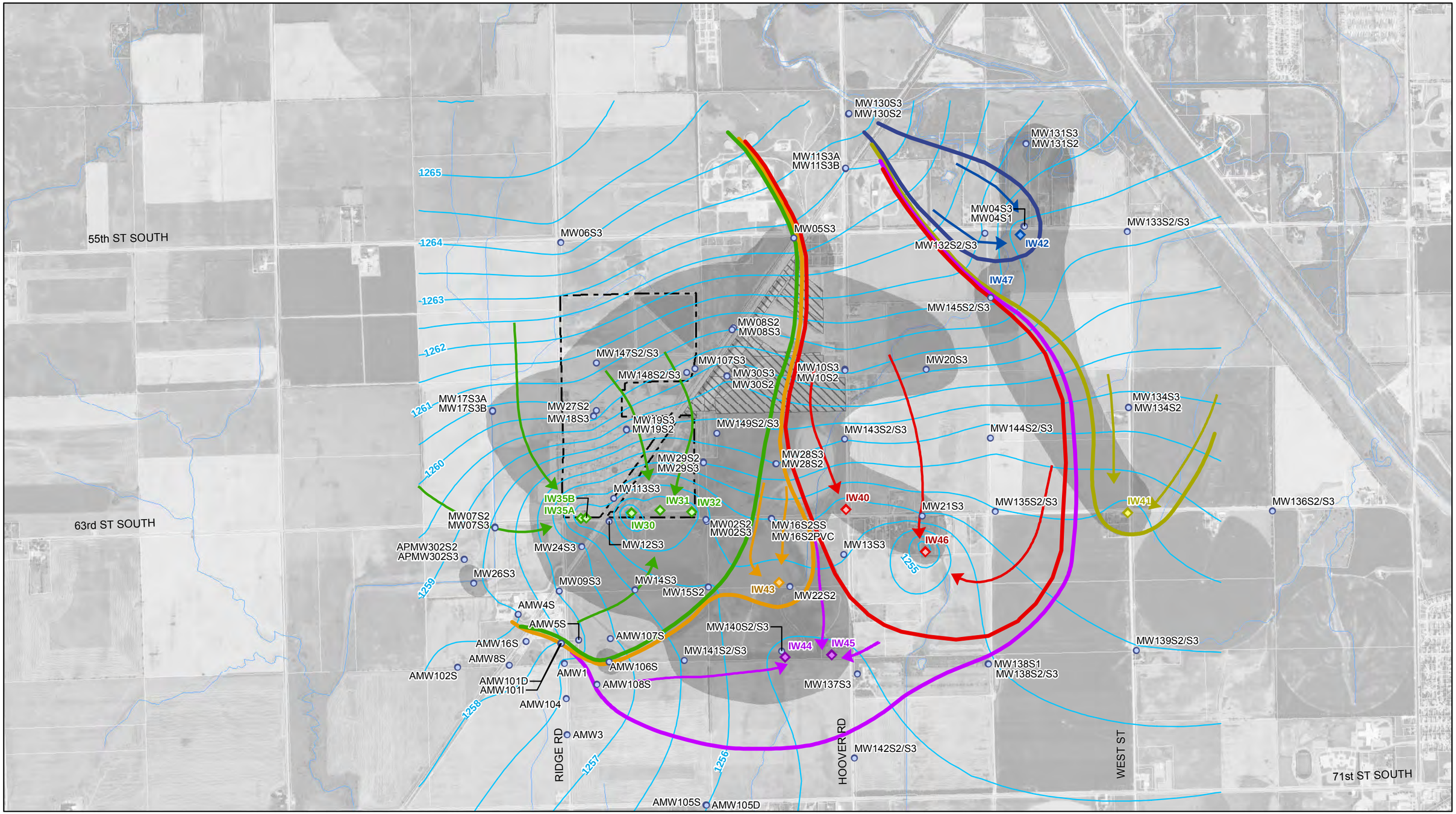
APPENDIX A CORRECTIVE MEASURED STUDY
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 18, 2017

CONCEPTUAL CROSS-SECTION A-A'

figure A.3

CAD File: P:\drawings\11137000s\11137148\11137148-REPORT\11137148-D23103(003)\11137148-D23103(003)GN\11137148-D23103(003)GN-WA008.dwg



Source: USDA NAIP 2010
Note: Cones of Depression, groundwater contours and interceptor well capture zones provided by Services Environmental, Inc. of Phoenixville, PA..

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Contour
- Approximate OCC Facility Boundary
- Approximate Gavilon Facility Boundary
- Groundwater Flow Direction
- Extent of Groundwater Impact

Estimated S2/S3 Interceptor Well System Capture Zones

- IW30, IW31, IW32, IW35A and IW35B
- IW40 and IW46
- IW41
- IW42
- IW43
- IW44 and IW45

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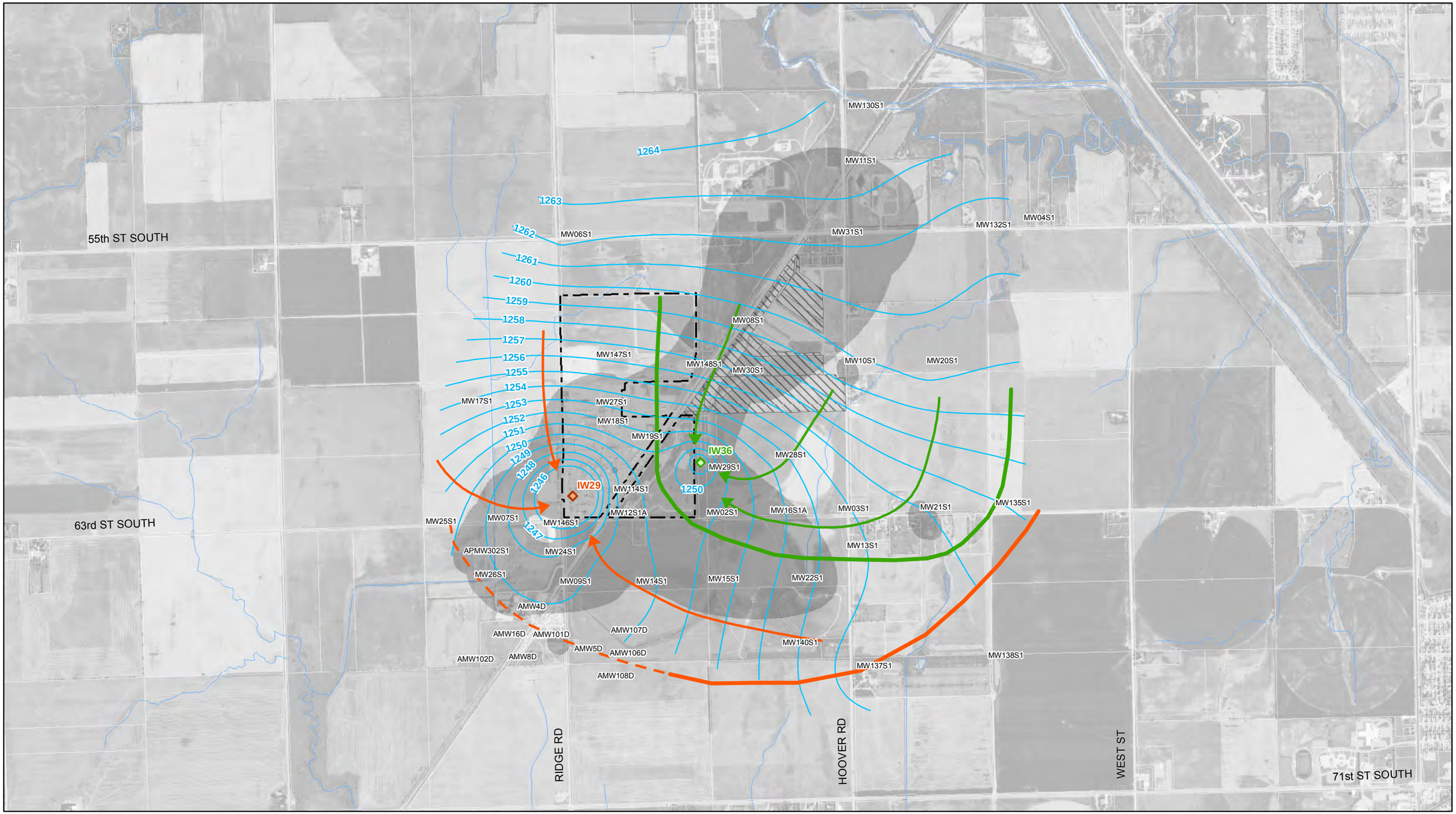
WICHITA, KANSAS

11137148-D23103
Aug 18, 2017

ESTIMATED S2/S3 INTERCEPTOR WELL SYSTEM CAPTURE ZONES

FIGURE A.4

GIS File: C:\Users\rmckenna\Documents\ArcGIS_Tempfiles\Wichita\Working\11137148-D23103(003)GIS-WA040.mxd



Source: USDA NAIP 2010
Note: Cones of Depression, groundwater contours and interceptor well capture zones provided by Services Environmental, Inc. of Phoenixville, PA.

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

Legend

- Monitoring Well
- Interceptor Well
- Groundwater Flow Direction
- Groundwater Contour
- Approximate OCC Facility Boundary
- Approximate Gavilon Facility Boundary
- Extent of Groundwater Impact

Estimated S1 Interceptor Well System Capture Zones

- IW29
- IW29 (Estimated)
- IW36

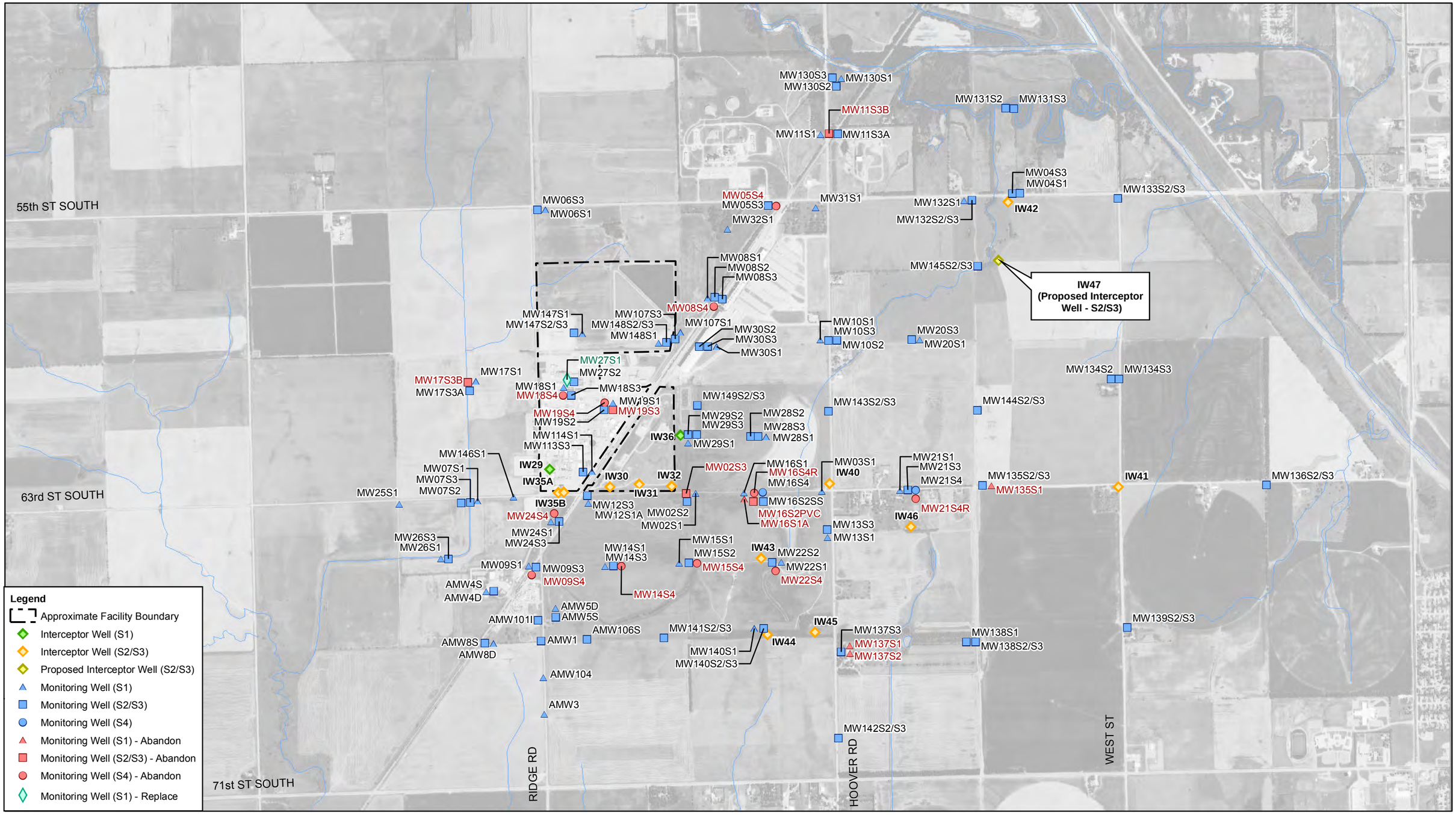
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

11137148-D23103
Aug 18, 2017

ESTIMATED S1 INTERCEPTOR WELL SYSTEM CAPTURE ZONES

FIGURE A.5

GIS File: C:\Users\rmckenna\Documents\ArcGIS_Tempfiles\Wichita\Working\11137148-D23103(003)GIS-WA041.mxd



Source: USDA NAIP 2010
Note: Well locations have been shifted for display and do not show actual location

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS

PROPOSED GROUNDWATER RECOVERY SYSTEM
AND MONITORING WELL NETWORK (CMA - G1)

11137148-D23103
Aug 18, 2017

FIGURE A.6

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA038.mxd

Tables

Table A.1
Well Construction Details
Occidental Chemical Corporation
Wichita, Kansas

Well Identifier	Installation Date	Sand Unit	Northing	Easting	Top of Casing Elevation (ft AMSL)[1]	Total Depth (ft BGS)[2]	Diameter (inches)	Top of Screen (ft BGS)	Base of Screen (ft BGS)
IW29[3]	12/23/1991	S1	1646614.5773	1623873.5307	1309.48	111.00	16.00	95.0	105.0
IW30	11/2/2011	S2/S3	1646288.5656	1624972.7905	1315.25	74.00	16.00	61.0	71.0
IW31	10/11/1977	S2/S3	1646341.5296	1625508.7554	1315.47	77.00	16.00	58.0	74.0
IW32	1/6/2011	S2/S3	1646307.7216	1626100.5395	1313.78	77.00	16.00	61.0	76.0
IW35A	6/28/1983	S2/S3	1646187.1026	1624027.9391	1309.06	74.00	16.00	52.5	72.5
IW35B	12/3/1996	S2/S3	1646190.9950	1624126.9233	1309.08	70.00	16.00	46.0	66.0
IW36	6/23/2003	S1	1647232.5176	1626263.8998	1309.15	101.00	12.00	91.0	101.0
IW40	3/4/2003	S2/S3	1646522.7287	1629150.9634	1306.77	83.00	12.00	73.0	83.0
IW41	2/18/2003	S2/S3	1646289.0136	1634262.7012	1303.07	58.00	12.00	48.0	58.0
IW42	2/20/2003	S2/S3	1651492.9999	1632247.8862	1295.27	54.00	12.00	39.0	54.0
IW43	3/23/2011	S2/S3	1644982.4160	1627737.0289	1305.93	82.50	16.00	62.0	82.0
IW44	3/30/2011	S2/S3	1643587.8118	1627849.1557	1304.84	80.00	16.00	59.0	79.0
IW45	7/23/2013	S2/S3	1643632.5476	1628718.2241	1306.22	76.00	16.00	56.0	71.0
IW46	7/23/2013	S2/S3	1645561.5328	1630475.1832	1300.26	71.00	16.00	53.5	66.0
MW02S1	10/5/1983	S1	1646139.1092	1626385.8231	1306.54	101.20	2.00	85.0	95.0
MW02S2	10/5/1983	S2/S3	1646131.7673	1626385.0749	1306.93	65.00	2.00	45.0	65.0
MW03S1	3/3/1977	S1	1646209.7470	1628847.2777	1306.87	105.33	6.00	89.7	99.7
MW04S1	2/21/1991	S2/S3	1651654.5063	1632319.5291	1290.96	65.80	2.00	51.5	61.5
MW04S3	3/3/1977	S2/S3	1651653.8914	1632330.3734	1291.17	35.00	2.00	25.0	35.0
MW05S3	3/3/1977	S2/S3	1651434.4841	1628016.5404	1302.42	47.60	6.00	37.5	47.5
MW05S4	2/15/1991	S4	1651423.9004	1628011.8282	1301.37	24.00	2.00	17.0	24.0
MW06BR	NA[4]	BR	1651319.0266	1623652.8980	1310.34	NA	6.00	NA	NA
MW06S1	3/3/1977	S1	1651343.5609	1623650.5457	1310.88	100.00	6.00	76.0	86.0
MW06S3	3/3/1977	S2/S3	1651353.9237	1623649.2436	1310.77	60.00	6.00	50.0	60.0
MW07S1	2/15/1991	S1	1646029.1244	1622430.9461	1307.52	114.00	2.00	106.0	111.0
MW07S2	3/3/1977	S2/S3	1646020.2484	1622422.0335	1306.33	86.50	6.00	76.5	86.5
MW07S3	3/3/1977	S2/S3	1646008.4935	1622423.1202	1306.39	61.00	6.00	51.0	61.0
MW08S1	9/28/1983	S1	1649732.9124	1626869.4397	1307.43	106.00	2.00	97.0	102.0
MW08S2	2/14/1991	S2/S3	1649758.7278	1626888.7447	1307.71	84.00	2.00	72.0	82.0
MW08S3	3/3/1977	S2/S3	1649715.5916	1626857.1997	1308.44	58.40	6.00	48.3	58.3
MW08S4	1/8/1990	S4	1649744.7673	1626877.2577	1307.50	35.00	2.00	24.7	34.7
MW09S1	9/29/1983	S1	1644843.9759	1623638.6623	1307.15	115.00	2.00	100.0	110.0
MW09S3	3/3/1977	S2/S3	1644826.3195	1623625.6479	1307.04	82.60	6.00	72.5	82.5
MW09S4	4/28/1988	S4	1644854.2437	1623645.9475	1308.57	41.50	2.00	36.5	41.5
MW10S1	2/9/1991	S1	1648975.7830	1628969.7898	1299.25	107.00	2.00	93.0	107.0
MW10S2	3/3/1977	S2/S3	1648985.4337	1628970.4195	1298.59	68.00	2.00	58.0	68.0
MW10S3	3/3/1977	S2/S3	1648962.4567	1628968.2457	1298.84	45.70	2.00	35.7	45.7
MW11S1	2/6/1991	S1	1652728.0849	1628981.0026	1290.94	84.80	2.00	70.5	80.5
MW11S3A	3/3/1977	S2/S3	1652735.6273	1628980.5640	1291.35	55.00	6.00	45.0	55.0
MW11S3B	3/3/1977	S4	1652746.6358	1628981.1088	1290.82	35.00	6.00	25.0	35.0
MW12S1A	3/3/1977	S1	1646131.0019	1624584.3919	1310.00	100.00	2.00	81.9	91.9
MW12S3	10/4/1983	S2/S3	1646130.5595	1624560.0619	1308.26	70.00	6.00	46.0	66.0
MW13S1	1/9/1990	S1	1645518.7911	162010.0824	1304.34	111.50	2.00	99.0	109.0
MW13S3	3/3/1977	S2/S3	1645509.9341	1628974.9501	1308.01	68.73	6.00	54.1	64.1
MW14S1	10/28/1987	S1	1644848.7658	1625061.3014	1310.46	102.00	2.00	92.0	102.0
MW14S3	10/28/1987	S2/S3	1644847.9489	1625040.7124	1308.54	72.00	2.00	62.0	72.0
MW15S1	10/28/1987	S1	1644891.0400	1626416.3200	1306.48	100.00	2.00	88.0	98.0
MW15S2	10/28/1987	S2/S3	1644899.7421	1626415.4886	1305.98	74.00	2.00	64.0	74.0
MW15S4	4/28/1988	S4	1644909.7566	1626415.2803	1307.97	40.00	2.00	33.0	38.0
MW16BR	2/9/1990	BR	1646182.1112	1627725.6715	1305.07	148.00	2.00	123.0	138.0
MW16S1A	1/11/2002	S1	1646177.5404	1627582.1846	1306.67	100.00	2.00	92.0	97.0

Table A.1
Well Construction Details
Occidental Chemical Corporation
Wichita, Kansas

Well Identifier	Installation Date	Sand Unit	Northing	Easting	Top of Casing Elevation (ft AMSL)[1]	Total Depth (ft BGS)[2]	Diameter (inches)	Top of Screen (ft BGS)	Base of Screen (ft BGS)
MW16S2SS	10/28/1987	S2/S3	1646179.5445	1627598.1963	1305.95	80.00	2.00	70.0	80.0
MW16S4R	3/19/2013	S4	1646180.2694	1627611.4298	1306.89	40.00	2.00	35.0	40.0
MW17S1	12/19/1989	S1	1648220.7403	1622376.1826	1307.16	119.00	2.00	101.0	118.0
MW17S3A	12/20/1989	S2/S3	1648184.2818	1622376.6061	1307.31	83.00	2.00	67.5	80.0
MW17S3B	12/19/1989	S2/S3	1648202.9058	1622377.2311	1307.08	58.00	2.00	38.0	55.0
MW18S1	1/23/1990	S1	1648105.7148	1624237.4907	1308.25	103.00	2.00	93.0	103.0
MW18S3	1/26/1990	S2/S3	1648105.1881	1624265.6371	1309.17	66.00	2.00	54.3	64.3
MW18S4	1/24/1990	S4	1648105.7518	1624252.0773	1309.20	34.30	2.00	29.3	34.3
MW19S1	1/13/1990	S1	1647815.7833	1624880.7948	1310.34	104.00	2.00	89.0	104.0
MW19S2	1/15/1990	S2/S3	1647859.3862	1624883.6544	1310.26	83.00	2.00	73.0	83.0
MW19S3	1/16/1990	S2/S3	1647843.7556	1624882.2868	1310.54	55.00	2.00	45.0	55.0
MW19S4	1/14/1990	S4	1647828.7725	1624881.2817	1310.01	35.74	2.00	30.7	35.7
MW20S1	1/28/1990	S1	1648978.2720	1630500.9935	1305.81	101.00	2.00	84.5	99.5
MW20S3	1/28/1990	S2/S3	1648977.7447	1630490.8299	1305.45	67.00	2.00	57.0	67.0
MW21S1	1/14/1990	S1	1646234.9591	1630382.1006	1299.58	108.00	2.00	98.2	108.2
MW21S3	1/15/1990	S2/S3	1646234.5347	1630417.1166	1299.26	58.25	2.00	48.3	58.3
MW21S4R	3/20/2013	S4	1646236.1340	1630443.1464	1299.99	37.50	2.00	27.5	37.5
MW22S1	1/5/1990	S1	1644911.0683	1627980.2105	1304.12	111.00	2.00	96.0	111.0
MW22S2	1/6/1990	S2/S3	1644912.2625	1627942.2812	1304.55	85.00	2.00	70.0	85.0
MW22S4	1/5/1990	S4	1644911.9911	1627960.3841	1304.16	36.00	2.00	26.0	36.0
MW23BR	NA	BR	1645711.4736	1625167.8070	1309.67	NA	2.00	NA	NA
MW24S1	6/3/1990	S1	1645650.6212	1624052.7606	1309.32	100.00	2.00	87.3	97.3
MW24S3	6/4/1990	S2/S3	1645659.2857	1624044.5251	1308.22	67.50	2.00	56.0	66.0
MW24S4	6/5/1990	S4	1645658.9513	1624056.3458	1308.73	40.40	2.00	31.5	36.5
MW25S1	4/13/1993	S1	1645974.6016	1621124.8449	1311.63	120.00	2.00	107.0	117.0
MW26S1	4/16/1993	S1	1644978.9381	1622044.1862	1308.74	116.00	2.00	101.0	111.0
MW26S3	5/27/1993	S2/S3	1644976.3579	1622025.5931	1308.93	60.00	2.00	49.0	59.0
MW27S1	8/16/1977	S1	1648205.2650	1624309.9120	1309.23	109.00	6.00	97.0	107.0
MW27S2	10/6/1977	S2/S3	1648206.8451	1624317.3679	1309.49	87.00	6.00	77.0	83.0
MW28S1	11/20/1996	S1	1647212.2402	1627674.8180	1309.34	108.50	2.00	93.0	108.0
MW28S2	11/20/1996	S2/S3	1647211.9419	1627679.5075	1309.44	84.00	2.00	74.0	84.0
MW28S3	11/20/1996	S2/S3	1647211.6087	1627684.4502	1309.51	63.00	2.00	53.0	63.0
MW29S1	11/20/1996	S1	1647239.8234	1626323.4393	1305.39	99.00	2.00	88.0	98.0
MW29S2	11/20/1996	S2/S3	1647244.7544	1626322.7595	1305.46	72.00	2.00	57.0	72.0
MW29S3	11/20/1996	S2/S3	164227.0676	1626325.1920	1306.58	55.50	2.00	44.0	54.0
MW30S1	11/20/1996	S1	1648862.2343	1626767.2155	1310.00	108.00	2.00	98.0	108.0
MW30S2	1/9/1997	S2/S3	1648858.1780	1626764.4302	1309.95	80.00	2.00	70.0	80.0
MW30S3	1/9/1997	S2/S3	1648854.3753	1626761.5076	1310.05	54.00	2.00	44.0	54.0
MW31S1	11/20/1996	S1	1651390.6746	1628731.9635	1298.06	92.00	2.00	77.0	92.0
MW32S1	11/20/1996	S1	1651001.7550	1627126.1190	1307.08	95.00	2.00	85.0	95.0
MW113S3	7/15/1971	S2/S3	1646564.4390	1624643.2299	1309.26	68.50	5.00	63.5	68.5
MW114S1	NA	S1	1646569.6097	1624646.5667	1308.98	NA	5.00	NA	NA
MW130S1	1/10/2002	S1	1653757.5609	1629036.0906	1284.92	73.00	2.00	55.0	70.0
MW130S2	1/10/2002	S2/S3	1653762.6188	1629039.5427	1284.95	44.00	2.00	38.0	43.0
MW130S3	1/10/2002	S2/S3	1653767.6449	1629042.4803	1284.89	35.00	2.00	25.0	35.0
MW131S2	12/12/2001	S2/S3	1653205.5649	1632360.1384	1281.73	55.00	2.00	47.5	51.5
MW131S3	12/13/2001	S2/S3	1653203.6153	1632357.5178	1281.49	45.00	2.00	40.0	45.0
MW132S1	12/10/2001	S1	1651520.6921	1631591.2567	1295.75	84.00	2.00	66.0	76.0
MW132S2/S3	12/12/2001	S2/S3	1651526.7527	1631591.8445	1295.87	50.50	2.00	35.0	50.0
MW133S2/S3	1/7/2002	S2/S3	1651557.5176	1634254.9850	1284.05	42.00	2.00	26.0	36.0
MW134S2	12/19/2001	S2/S3	1648258.3774	1634277.3954	1302.31	59.00	2.00	47.0	50.0

Table A.1
Well Construction Details
Occidental Chemical Corporation
Wichita, Kansas

Well Identifier	Installation Date	Sand Unit	Northing	Easting	Top of Casing Elevation (ft AMSL)[1]	Total Depth (ft BGS)[2]	Diameter (inches)	Top of Screen (ft BGS)	Base of Screen (ft BGS)
MW134S3	12/19/2001	S2/S3	1648264.6729	1634277.0804	1302.29	45.00	2.00	35.0	45.0
MW135S1	12/17/2001	S1	1646318.2233	1631790.5887	1302.60	104.00	2.00	95.0	100.0
MW135S2/S3	12/17/2001	S2/S3	1646317.6866	1631782.2204	1302.62	58.00	2.00	41.5	56.5
MW136S2/S3	1/8/2002	S2/S3	1646322.9370	1636971.8586	1287.43	51.00	2.00	30.0	45.0
MW137S1	12/31/2001	S1	1643270.2892	1629194.7957	1304.99	117.50	2.00	109.0	112.0
MW137S2	12/14/2001	S1	1643270.6855	1629198.5363	1304.92	103.00	2.00	95.0	102.0
MW137S3	12/14/2001	S2/S3	1643271.5196	1629202.8418	1304.88	81.00	2.00	60.0	80.0
MW138S1	12/16/2001	S2/S3	1643464.7015	1631653.7121	1298.82	89.00	2.00	74.5	84.5
MW138S2/S3	12/16/2001	S2/S3	1643458.2501	1631655.6947	1298.83	61.00	2.00	50.0	60.0
MW139S2/S3	1/9/2002	S2/S3	1643717.4133	1634428.0369	1299.13	63.00	2.00	38.5	53.5
MW140S1	4/13/2010	S2/S3	1643699.7696	1627805.3267	1304.95	98.50	2.00	87.5	93.5
MW140S2/S3	4/15/2010	S2/S3	1643699.4730	1627787.0997	1304.76	79.00	2.00	69.0	79.0
MW141S2/S3	3/18/2011	S2/S3	1643528.2929	1625965.0799	1307.86	90.00	2.00	79.0	89.0
MW142S2/S3	3/20/2011	S2/S3	1641701.6139	1629148.8546	1297.03	90.00	2.00	72.0	82.0
MW143S2/S3	3/20/2011	S2/S3	1647670.1598	1628967.4074	1300.32	75.00	2.00	63.0	68.0
MW144S2/S3	3/22/2011	S2/S3	1647692.5703	1631690.1246	1303.64	65.00	2.00	47.0	57.0
MW145S2/S3	3/21/2011	S2/S3	1650322.9712	1631696.7776	1291.12	60.00	2.00	48.0	53.0
MW146S1	9/25/2014	S1	1646099.1200	1623215.3800	1306.30	108.00	2.00	91.0	101.0
MW147S1	9/22/2014	S1	1649092.3000	1624318.6700	1309.96	105.00	2.00	96.0	101.0
MW147S2/S3	9/22/2014	S2/S3	1649098.6900	1624318.7600	1310.11	55.00	2.00	42.0	52.0
MW148S1	9/23/2014	S1	1648914.9300	1626008.2400	1309.94	105.00	2.00	91.0	101.0
MW148S2/S3	9/23/2014	S2/S3	1648920.7600	1626007.2800	1309.96	60.00	2.00	50.0	60.0
MW149S2/S3	9/22/2014	S2/S3	1647781.6100	1626575.8800	1305.53	55.00	2.00	41.0	51.0
Abbott Monitoring Wells									
AMW1	9/26/1979	S2/S3	1643473.2174	1623720.6995	1307.77	82.00	5.26	63.0	78.0
AMW3	9/27/1979	S1/S2	1642132.4650	1623772.8753	1308.25	128.00	5.00	64.0	124.0
AMW4D	9/27/1979	S1	1644375.0091	1622848.6438	1309.27	107.00	5.26	83.0	103.0
AMW4S	9/27/1979	S2/S3	1644385.0229	1622852.0093	1309.17	75.92	5.26	52.0	72.0
AMW5D	9/28/1979	S1	1643908.4946	1623976.6203	1307.57	97.50	5.26	84.0	97.0
AMW5S	9/28/1979	S2/S3	1643908.6536	1623986.4754	1307.50	79.80	5.26	NA	NA
AMW8D	9/26/1979	S1	1643433.8532	1622679.7084	1307.74	123.00	5.26	99.0	119.0
AMW8S	9/26/1979	S2/S3	1643434.9098	1622690.2400	1307.70	83.00	5.26	58.0	78.0
AMW16D	9/25/1979	S1	1643859.7111	1622989.4302	1308.97	109.49	6.00	NA	NA
AMW16S	9/25/1979	S2/S3	1643878.9725	1623005.1842	1309.02	76.20	6.00	NA	NA
AMW101D	10/25/1983	S2/S3	1643848.2130	1623649.3170	1306.17	108.00	4.25	71.0	92.0
AMW101I	10/25/1983	S2/S3	1643849.1330	1623662.1740	1306.26	60.18	4.25	NA	NA
AMW101S	10/25/1983	S4	1643849.7540	1623675.5450	1306.31	46.20	4.25	NA	NA
AMW102D	10/28/1983	S1	1643395.1918	1621714.7922	1310.40	147.00	4.25	96.0	110.0
AMW102S	10/28/1983	S2/S3	1643395.5966	1621722.1890	1310.31	NA	4.25	44.0	58.0
AMW104	11/20/1983	S1/S2/S3	1642807.4030	1623754.9999	1306.09	114.50	4.25	49.0	106.0
AMW105D	12/5/1983	S1/S2	1640818.1214	1626369.6145	1300.31	113.00	5.26	80.0	111.0
AMW105S	12/5/1983	S2/S3	1640818.1818	1626379.9679	1300.10	55.00	5.26	NA	NA
AMW106D	5/6/1991	S1	1643499.5249	1624567.5992	1307.16	100.00	2.00	83.3	98.3
AMW106S	5/7/1991	S2/S3	1643499.8552	1624556.6769	1306.93	75.00	2.00	47.9	72.9
AMW107D	5/11/1991	S1	1643936.3312	1624590.2942	1305.66	103.00	2.00	91.9	101.9
AMW107S	5/14/1991	S2/S3	1643936.3870	1624579.4246	1305.64	72.00	2.00	46.3	71.3
AMW108D	9/26/1991	S1	1643076.9529	1624341.3298	1307.13	106.00	2.00	84.0	104.0
AMW108S	9/27/1991	S2/S3	1643076.0621	1624330.3861	1307.34	70.00	2.00	47.0	67.0
APMW302S1	9/12/1997	S1	1645416.7424	1621838.5251	1307.93	124.00	6.00	114.0	124.0
APMW302S2	9/12/1997	S2/S3	1645423.9800	1621844.7084	1307.98	105.50	6.00	95.5	105.5

Table A.1
Well Construction Details
Occidental Chemical Corporation
Wichita, Kansas

Well Identifier	Installation Date	Sand Unit	Northing	Easting	Top of Casing Elevation (ft AMSL)[1]	Total Depth (ft BGS)[2]	Diameter (inches)	Top of Screen (ft BGS)	Base of Screen (ft BGS)
APMW302S3	9/12/1997	S2/S3	1645415.8025	1621849.2904	1307.74	85.00	6.00	75.0	85.0
Piezometers									
PZ40A	4/12/2010	S2/S3	1646372.2820	1628985.5631	1305.68	78.00	1.00	73.0	78.0
PZ40B	4/13/2010	S2/S3	1646363.6676	1628905.8973	1305.36	78.00	1.00	73.0	78.0
PZ40C	4/13/2010	S2/S3	1646152.4257	1628942.4778	1305.81	74.00	1.00	69.0	74.0
PZ41A	4/14/2010	S2/S3	1646273.1772	1634243.9014	1301.91	56.00	1.00	51.0	56.0
PZ41B	4/14/2010	S2/S3	1646211.2672	1634263.4534	1301.74	56.00	1.00	51.0	56.0
PZ41C	4/14/2010	S2/S3	1646164.9105	1634106.9346	1303.67	55.00	1.00	50.0	55.0
PZ42A	4/15/2010	S2/S3	1651492.6366	1632272.3917	1294.95	48.00	1.00	43.0	48.0
PZ42B	4/15/2010	S2/S3	1651537.6451	1632188.7724	1292.29	50.00	1.00	45.0	50.0
PZ43A	3/15/2011	S2/S3	1645037.3334	1627757.1290	1306.00	85.00	2.00	69.0	79.0
PZ44A	3/15/2011	S2/S3	1643595.3890	1627857.2728	1303.57	75.00	2.00	63.0	73.0
PZ44B	3/18/2011	S2/S3	1643607.8916	1627850.5864	1303.93	75.00	2.00	63.0	73.0
PZ44C	3/17/2011	S2/S3	1643623.2075	1627860.9680	1303.75	75.00	2.00	63.0	73.0
PZ44D	3/17/2011	S2/S3	1643603.7984	1627817.1685	1303.38	75.00	2.00	63.0	73.0
PZ45A	7/25/2013	S2/S3	1643605.6002	1628703.7746	1306.68	76.00	1.00	65.0	70.0
PZ45B	7/25/2013	S2/S3	1643759.1020	1628716.0399	1306.81	76.00	1.00	65.0	70.0
PZ46A	7/25/2013	S2/S3	1645547.3525	1630447.8928	1300.75	71.00	1.00	60.0	65.0
PZ46B	7/25/2013	S2/S3	1645682.3903	1630432.8191	1300.26	71.00	1.00	56.0	61.0

Notes:

Top of casing elevations resurveyed in 2010.

The following wells were surveyed and/or resurveyed in October 2013: AMW101D, AMW101I, AMW101S, MW16S4R, MW21S4R, PZ45A, PZ45B, PZ46A, PZ46B, IW45, and IW46.

The following wells were surveyed and/or resurveyed in November 2014: MW146S1, MW147S1, MW147S2/S3, MW148S1, MW148S2/S3, MW149S2/S3, and MW15S1.

[1] ft AMSL - feet above mean sea level
[2] ft BGS - feet below ground surface
[3] IW - interceptor well
[4] NA - not available

Table A.2
2017 Proposed Groundwater Monitoring Program
Occidental Chemical Corporation
Wichita, Kansas

Well Identifier	Sand Unit	# of Wells	MCL[1] Exceedance Ratio	Current Monitoring Frequency						Proposed Monitoring Frequency						Watch List			Abandon		
				6 m	1 yr	2 yr	NRM[2]	NS[3]	HM[4]	6 m	1 yr	2 yr	NRM[2]	NS[3]	HM[4]	A	B	C	X	Y	Z
IW29[5]	S1	1	NA		1						1				1						
IW30	S2/S3	1	NA		1						1				1						
IW31	S2/S3	1	NA		1					1					1						
IW32	S2/S3	1	NA		1						1				1						
IW35A	S2/S3	1	NA		1						1				1						
IW35B	S2/S3	1	NA		1						1				1						
IW36	S1	1	NA		1						1				1						
IW40	S2/S3	1	NA	1						1					1						
IW41	S2/S3	1	NA	1							1				1						
IW42	S2/S3	1	NA	1							1				1						
IW43	S2/S3	1	NA	1							1				1						
IW44	S2/S3	1	NA	1							1				1						
IW45	S2/S3	1	NA							1					1						
IW46	S2/S3	1	NA							1					1						
MW02S1	S1	1	9.0		1					1					1						
MW02S2	S2/S3	1	99.1		1						1				1						
MW02S3	S2/S3	1	NA					1						1						1	
MW03S1	S1	1	395.2	1							1				1						
MW04S1	S2/S3	1	0.3			1							1		1						
MW04S3	S2/S3	1	10.3			1							1		1						
MW05S3	S2/S3	1	6.8		1					1					1						
MW05S4	S4	1	7.1		1									1					1		
MW06BR	BR	1	2.1			1							1		1						
MW06S1	S1	1	0		1								1		1						
MW06S3	S2/S3	1	0		1						1				1						
MW07S1	S1	1	852	1								1			1						
MW07S2	S2/S3	1	0.1	1							1				1						
MW07S3	S2/S3	1	0.1	1							1				1						
MW08S1	S1	1	43.8	1								1			1	1					
MW08S2	S2/S3	1	30.7	1						1					1						
MW08S3	S2/S3	1	64.1	1								1			1						
MW08S4	S4	1	6	1										1					1		
MW09S1	S1	1	75.3	1								1			1						
MW09S3	S2/S3	1	4.6	1							1				1						
MW09S4	S4	1	NA	1										1					1		
MW10S1	S1	1	1.8	1						1					1						
MW10S2	S2/S3	1	7.9	1						1					1						
MW10S3	S2/S3	1	3.7	1							1				1	1					
MW11S1	S1	1	23.5	1								1			1						
MW11S3A	S2/S3	1	1.1	1							1				1						
MW11S3B	S2/S3	1	0.1					1						1							1
MW12S1A	S1	1	2,000	1								1			1						
MW12S3	S2/S3	1	2,218.2	1								1			1						
MW13S1	S1	1	0.2	1							1				1						
MW13S3	S2/S3	1	1.2	1							1				1						
MW14S1	S1	1	0.5	1								1			1						
MW14S3	S2/S3	1	1,002	1							1				1						
MW14S4	S4	1	NA					1						1					1		
MW15S1	S1	1	9.1		1					1					1						
MW15S2	S2/S3	1	230	1							1				1						
MW15S4	S4	1	1.9		1									1					1		
MW16BR	BR	1	1.3			1						1			1						
MW16S1 [6]	S1	1	NA							1[5]					1						
MW16S1A	SI	1	NA								1				1						
MW016S2PVC	S2/S3	1	NA					1						1						1	
MW16S2SS	S2/S3	1	372	1							1				1						
MW16S4R	S4	1	NA		1									1					1		
MW17S1	S1	1	0.2		1						1				1						
MW17S3A	S2/S3	1	6.6		1						1				1						
MW17S3B	S2/S3	1	1.9		1									1						1	
MW18S1	S1	1	32,000		1							1			1						
MW18S3	S2/S3	1	23,200		1								1		1						
MW18S4	S4	1	NA		1									1					1		
MW19S1	S1	1	1,622.7		1					1					1						
MW19S2	S2/S3	1	4,692.3		1						1				1						
MW19S3	S2/S3	1	NA		1									1						1	
MW19S4	S4	1	50,000		1									1					1		
MW20S1	S1	1	0.1	1									1		1						
MW20S3	S2/S3	1	18.2	1							1				1						
MW21S1	S1	1	42.7	1						1					1						
MW21S3	S2/S3	1	2.9	1						1					1						
MW21S4R	S4	1	NA	1										1					1		
MW22S1	S1	1	18.3	1								1			1						
MW22S2	S2/S3	1	1,296	1									1		1						
MW22S4	S4	1	0	1										1					1		
MW23BR	BR	1	0			1						1			1						
MW24S1	S1	1	18.2		1							1			1						
MW24S3	S2/S3	1	3.2		1						1				1						
MW24S4	S4	1	0.3		1									1					1		

Notes:

[1] Maximum Contaminant Level Exceedance Ratio - 5 year analytical data screen of max chemical concentration detected divided by its respective cleanup criteria (value >1 = MCL exceedance)

[2] NRM - Not Regularly Monitored

[3] NS - Not Sampled

[4] HM - Hydraulic Monitoring

[5] IW - Interceptor Well

[6] Semi-annual sampling is proposed on an interim basis until 5 data points are obtained

NA - Not Available

A	OCC Well to keep based on 5 yr MCL Exceedance Ratio, however potentially abandon in near future
B	AMW Wells to keep based on 5 yr MCL Exceedance Ratio, however potentially abandon in near future
C	AMW Wells to potentially abandon as they are no longer needed for chemical or hydraulic monitoring
X	OCC Wells to abandon - all S4 Wells
Y	OCC Wells to abandon - no longer needed for chemical or hydraulic monitoring
Z	OCC Wells to abandon based on insignificant impacts or no detections
MW19S1	OCC Well with increasing concentration trend

Table A.2
2017 Proposed Groundwater Monitoring Program
Occidental Chemical Corporation
Wichita, Kansas

Well Identifier	Sand Unit	# of Wells	MCL[1] Exceedance Ratio	Current Monitoring Frequency						Proposed Monitoring Frequency						Watch List			Abandon		
				6 m	1 yr	2 yr	NRM[2]	NS[3]	HM[4]	6 m	1 yr	2 yr	NRM[2]	NS[3]	HM[4]	A	B	C	X	Y	Z
MW25S1	S1	1	0.5	1							1				1						
MW26S1	S1	1	1.7	1						1					1						
MW26S3	S2/S3	1	11.4	1								1			1						
MW27S1	S1	1	21,230.8		1						1				1						
MW27S2	S2/S3	1	68,461.5		1							1			1						
MW28S1	S1	1	3.2		1						1				1						
MW28S2	S2/S3	1	13.2		1						1				1						
MW28S3	S2/S3	1	54.2		1						1				1						
MW29S1	S1	1	17.8		1							1			1						
MW29S2	S2/S3	1	116.8		1						1				1						
MW29S3	S2/S3	1	110.5		1						1				1						
MW30S1	S1	1	8.9	1						1					1						
MW30S2	S2/S3	1	2,260			1						1			1						
MW30S3	S2/S3	1	4,300	1						1					1						
MW31S1	S1	1	35	1								1			1						
MW32S1	S1	1	48.2		1					1					1						
MW113S3	S2/S3	1	12,940		1						1				1						
MW114S1	S1	1	22.5		1							1			1						
MW130S1	S1	1	0			1							1		1						
MW130S2	S2/S3	1	0.4			1					1				1						
MW130S3	S2/S3	1	0.7			1					1				1						
MW131S2	S2/S3	1	17.4		1					1					1						
MW131S3	S2/S3	1	40.9		1						1				1						
MW132S1	S1	1	0	1									1		1						
MW132S2/S3	S2/S3	1	0.3	1							1				1						
MW133S2/S3	S2/S3	1	0.2	1							1				1						
MW134S2	S2/S3	1	0			1					1				1						
MW134S3	S2/S3	1	0.3			1					1				1						
MW135S1	S1	1	0.1			1						1									1
MW135S2/S3	S2/S3	1	0			1					1				1						
MW136S2/S3	S2/S3	1	0.3		1						1				1						
MW137S1	S1	1	0		1							1									1
MW137S2	S1	1	0.2	1										1							1
MW137S3	S2/S3	1	0.2	1							1				1						
MW138S1	S2/S3	1	0		1						1				1						
MW138S2/S3	S2/S3	1	0.7		1						1				1						
MW139S2/S3	S2/S3	1	0		1						1				1						
MW140S1	S1	1	0	1							1				1						
MW140S2/S3	S2/S3	1	378.0	1							1				1						
MW141S2/S3	S2/S3	1	7.6	1							1				1						
MW142S2/S3	S2/S3	1	0.2	1							1				1						
MW143S2/S3	S2/S3	1	6.4	1							1				1						
MW144S2/S3	S2/S3	1	0	1							1				1						
MW145S2/S3	S2/S3	1	46.8	1						1					1						
MW146S1	S1	1	0										1		1						
MW147S1	S1	1	0.2										1		1						
MW147S2/S3	S2/S3	1	8.7								1				1						
MW148S1	S1	1	9.9									1			1						
MW148S2/S3	S2/S3	1	187.7							1					1						
MW149S2/S3	S2/S3	1	30.4							1					1						
Builders	S2/S3	1	NA								1				1						
Dieffenbacher	S2/S3	1	NA							1					1						
Brogden	--	1	--							1					1						
Forster	--	1	--							1					1						
Smarsh	--	1	--							1					1						
Sponsel 1	--	1	--							1					1						
Sponsel 2	--	1	--							1					1						
Piezometers																					
PZ40A	S2/S3	1	NA						1						1						
PZ40B	S2/S3	1	NA						1						1						
PZ40C	S2/S3	1	NA						1						1						
PZ41A	S2/S3	1	NA						1						1						
PZ41B	S2/S3	1	NA						1						1						
PZ41C	S2/S3	1	NA						1						1						
PZ42A	S2/S3	1	NA						1						1						
PZ42B	S2/S3	1	NA						1						1						
PZ43A	S2/S3	1	NA						1						1						
PZ44A	S2/S3	1	NA						1						1						
PZ44B	S2/S3	1	NA						1						1						
PZ44C	S2/S3	1	NA						1						1						
PZ44D	S2/S3	1	NA						1						1						
PZ45A	S2/S3	1	NA						1						1						
PZ45B	S2/S3	1	NA						1						1						
PZ46A	S2/S3	1	NA						1						1						
PZ46B	S2/S3	1	NA						1						1						

Notes:
[1] Maximum Contaminant Level Exceedance Ratio - 5 year analytical data screen of max chemical concentration detected divided by its respective cleanup criteria (value >1 = MCL exceedance)
[2] NRM - Not Regularly Monitored
[3] NS - Not Sampled
[4] HM - Hydraulic Monitoring
[5] IW - Interceptor Well
[6] Semi-annual sampling is proposed on an interim basis until 5 data points are obtained
NA - Not Available

A	OCC Well to keep based on 5 yr MCL Exceedance Ratio, however potentially abandon in near future
B	AMW Wells to keep based on 5 yr MCL Exceedance Ratio, however potentially abandon in near future
C	AMW Wells to potentially abandon as they are no longer needed for chemical or hydraulic monitoring
X	OCC Wells to abandon - all S4 Wells
Y	OCC Wells to abandon - no longer needed for chemical or hydraulic monitoring
Z	OCC Wells to abandon based on insignificant impacts or no detections
MW19S1	OCC Well with increasing concentration trend

Table A.2
2017 Proposed Groundwater Monitoring Program
Occidental Chemical Corporation
Wichita, Kansas

Well Identifier	Sand Unit	# of Wells	MCL[1] Exceedance Ratio	Current Monitoring Frequency						Proposed Monitoring Frequency						Watch List			Abandon		
				6 m	1 yr	2 yr	NRM[2]	NS[3]	HM[4]	6 m	1 yr	2 yr	NRM[2]	NS[3]	HM[4]	A	B	C	X	Y	Z
Abbott Monitoring Wells																					
AMW1	S2/S3	1	0.1		1							1			1			1			
AMW3	S1/S2	1	0.7		1									1	1			1			
AMW4D	S1	1	1.8	1							1				1		1				
AMW4S	S2/S3	1	0.3	1						1					1						
AMW5D	S1	1	15.1	1							1				1		1				
AMW5S	S2/S3	1	0	1							1				1			1			
AMW8D	S1	1	0.2		1									1	1			1			
AMW8S	S2/S3	1	1.3		1								1		1		1				
AMW16D	S1	1	0		1						1				1			1			
AMW16S	S2/S3	1	0.3		1									1	1			1			
AMW101D	S2/S3	1	1.3		1									1	1			1			
AMW101I	S2/S3	1	2.6		1								1		1		1				
AMW101S	S4	1	2.6		1									1	1			1			
AMW102D	S1	1	0.3		1									1	1			1			
AMW102S	S2/S3	1	0		1									1	1			1			
AMW104	S1/S2/S3	1	1.1		1								1		1		1				
AMW105D	S1/S2	1	0	1										1	1			1			
AMW105S	S2/S3	1	0.1	1							1				1			1			
AMW106D	S1	1	0.3					1						1	1			1			
AMW106S[6]	S2/S3	1	2.2					1		1[5]					1			1			
AMW107D	S1	1	0.6	1								1			1			1			
AMW107S	S2/S3	1	0.3	1							1				1			1			
AMW108D	S1	1	0.3		1									1	1			1			
AMW108S	S2/S3	1	0.4		1									1	1			1			
APMW302S1	S1	1	6.5	1							1				1		1	1			
APMW302S2	S2/S3	1	0.4	1										1	1			1			
APMW302S3	S2/S3	1	0.7	1						1					1						
Total		**180**		66	61	13	0	6	17	31	65	24	14	29	161	2	6	20	11	4	4
Sampling Events over 5 Yrs				10	5	2.5				10	5	2.5	1			28			19		
Est. Samples over 5 Yrs				660	305	33				310	325	60	14								
Total Samples over 5 Yrs				998						709											

S1 wells to potetnially abandon in future:	1
S2/S3 wells to potetnailly abandon in future:	1
Abbott wells to potentially abandon in future	26
Total:	28

S1 wells to abandon:	4
S2/S3 wells to abandon:	4
S4 wells to abandon:	11
Total	19

Notes:

[1] Maximum Contaminant Level Exceedance Ratio - 5 year analytical data screen of max chemical concentration detected divided by its respective cleanup criteria (value >1 = MCL exceedance)

[2] NRM - Not Regularly Monitored

[3] NS - Not Sampled

[4] HM - Hydraulic Monitoring

[5] IW - Interceptor Well

[6] Semi-annual sampling is proposed on an interim basis until 5 data points are obtained

NA - Not Available

A	OCC Well to keep based on 5 yr MCL Exceedance Ratio, however potentially abandon in near future
B	AMW Wells to keep based on 5 yr MCL Exceedance Ratio, however potentially abandon in near future
C	AMW Wells to potentially abandon as they are no longer needed for chemical or hydraulic monitoring
X	OCC Wells to abandon - all S4 Wells
Y	OCC Wells to abandon - no longer needed for chemical or hydraulic monitoring
Z	OCC Wells to abandon based on insignificant impacts or no detections
MW19S1	OCC Well with increasing concentration trend

Table A.3
2017 Well Functions and Proposed Sample Frequency
Occidental Chemical Corporation
Wichita, Kansas

	Proposed Monitoring Frequency			
	6 m	1 yr	2 yr	NRM
Wells with Increasing COC Trends				
APMW302S3	1			
AMW4S	1			
Dieffenbacher	1			
IW31	1			
IW40	1			
IW45	1			
IW46	1			
MW02S1	1			
MW05S3	1			
MW08S2	1			
MW10S1	1			
MW10S2	1			
MW15S1	1			
MW19S1	1			
MW21S1	1			
MW21S3	1			
MW26S1	1			
MW30S1	1			
MW30S3	1			
MW32S1	1			
MW131S2	1			
MW145S2/S3	1			
MW148S2/S3	1			
MW149S2/S3	1			
Plume Source				
MW19S2		1		
MW27S1		1		
MW27S2			1	
MW113S3		1		
Plume Interior				
IW29		1 ‡		
IW36		1 ‡		
MW07S1			1	
MW08S1			1	
MW08S3			1	
MW09S1			1	
MW11S1			1	
MW12S1A			1	
MW12S3			1	
MW14S1			1	
MW16BR			1	
MW16S1 (1)	1			
MW16S1A		1		
MW18S1			1	
MW22S1			1	
MW23BR			1	
MW24S1			1	
MW29S1			1	
MW30S2			1	
MW31S1			1	
MW114S1			1	
MW146S1				1
MW148S1			1	
Sentinel				
AMW1			1	
AMW107D			1	
MW26S3			1	
MW135S1			1	
MW137S1			1	
Redundant				
AMW8S				1
AMW101I				1
AMW106S (1)	1			
IW30		1 ‡		
IW35A		1 ‡		
IW44		1 ‡		
MW04S1				1
MW04S3				1
MW18S3				1
MW22S2				1

	Proposed Monitoring Frequency			
	6 m	1 yr	2 yr	NRM
Boundary				
AMW5D		1		
AMW5S		1		
AMW16D		1		
AMW104				1
AMW105S		1		
AMW107S		1		
MW02S2		1		
MW06BR				1
MW06S1				1
MW06S3		1		
MW07S2		1		
MW07S3		1		
MW10S3		1		
MW11S3A		1		
MW13S3		1		
MW17S1		1		
MW17S3A		1		
MW20S1				1
MW20S3		1		
MW24S3		1		
MW28S1		1		
MW28S2		1		
MW28S3		1		
MW29S2		1		
MW29S3		1		
MW130S1				1
MW130S2		1		
MW130S3		1		
MW132S1				1
MW132S2/S3		1		
MW133S2/S3		1		
MW134S2		1		
MW134S3		1		
MW135S2/S3		1		
MW136S2/S3		1		
MW137S3		1		
MW138S1		1		
MW138S2/S3		1		
MW139S2/S3		1		
MW140S1		1		
MW140S2/S3		1		
MW141S2/S3		1		
MW142S2/S3		1		
MW144S2/S3		1		
MW147S1				1
MW147S2/S3		1		
Plume Edge				
APMW302S1		1		
AMW4D		1		
Builders		1		
IW32		1		
IW35B		1		
IW41		1		
IW42		1		
IW43		1		
MW03S1		1		
MW09S3		1		
MW13S1		1		
MW14S3		1		
MW15S2		1		
MW16S2SS		1		
MW25S1		1		
MW131S3		1		
MW143S2/S3		1		
Residential Wells (without increasing trends)				
Brogden	1			
Forster	1			
Smarsh	1			
Sponsel 1	1			
Sponsel 2	1			
Total	31	65	24	14

Notes:

(1) Semi-annual sampling is proposed on an interim basis until 5 groundwater sample analytical results are obtained and a concentration trend test can be conducted to determine well function and future sampling frequency.

‡ Interceptor wells to be sampled at a miniumum annually

NRM Not Regularly Monitored

Attachments

Attachment A1
Groundwater Chemical Trend Evaluation

Technical Memorandum

August 18, 2017

To:	Charles Janson	Ref. No.:	11137148
From:	Wesley Dyck/Daniela Araujo/kf/1		
CC:	Gordon Hotchkiss		
Subject:	**Groundwater Monitoring Data Evaluation Occidental Chemical Corporation Wichita, Kansas**		

1. Introduction

Groundwater monitoring, including sampling and chemical analysis, has been conducted at the Occidental Chemical Corporation, Wichita, Kansas, site (Site). Monitoring wells are screened in different aquifers at the Site, and it is of interest to look for an evidence of trends over time in concentrations of monitored parameters in groundwater.

The present evaluation consists of statistical trend testing considering concentrations of five contaminants of concern (COCs) in two aquifer zones at the Site. These tests are conducted on a per-well, per-parameter basis for the following groups:

Aquifer Groups	COCs
• Intermediate screened sand unit (S2/S3)	• Beta BHC
• Deep screened sand unit (S1)	• Carbon Tetrachloride
	• Hexachlorobutadiene
	• Hexachloroethane
	• Tetrachloroethane

Further details of the evaluation are presented below.

2. Statistical Methods for Temporal Trend Testing

Statistical procedures for evaluating trends are discussed in United States Environmental Protection Agency (USEPA) and United States Geological Survey (USGS) guidance documents and other environmental statistics texts (e.g., USEPA, 2009; 2004; 2006; USGS, 2002). Different trend test procedures are available for a variety of purposes and data set characteristics. The selection of an appropriate test to

conduct depends on satisfying any underlying assumptions of the statistical method, as well as the type of hypothesized trend investigated (e.g., trend over time or space, trend over time *and* space, trend overlaid with seasonal patterns or external influences such as rainfall patterns) and desired application of the test results (e.g., will a rate/slope estimate be required, or just the presence or absence of a trend?).

Some of the key characteristics of environmental data sets and monitoring objectives that are influential in trend test method selection include the following:

- The presence of censored (non-detect) data. Such data do not have a unique numeric value, but rather represent a range of possible values between zero and the reported detection limit. Where higher proportions of censored data are present, particularly when more than one-half of the values in a data set are non-detects, methods based on coded data (e.g., detect=1, non-detect=0) are required.
- The presence of underlying seasonal patterns in a data set (for monitoring occurring more frequently than on an annual basis). Concentrations of certain analytes may vary significantly throughout the year, which can obscure the detection of longer-term trends unless properly taken into account.
- Changes in conditions due to anthropogenic activities, for example through site cleanup and contaminant mitigation efforts. When such activities occur, monitoring results before and after often belong to different statistical populations, and trend testing must take this into account (e.g., by performing before and after comparisons, or by restricting the scope of data considered by the trend analysis to one population).

A detailed discussion of potentially applicable trend testing procedures under different scenarios is not provided herein, but may be found in related guidance (e.g., USEPA, 2006, 2009; USGS, 2002) and environmental statistics texts (e.g., Gilbert, 1987; Gibbons and Coleman, 2001).

The Mann-Kendall trend test is a general trend test procedure for detection of *monotonic* (single-direction) trends, does not make any distributional assumptions (e.g., does not require data to be normally or lognormally distributed) or assumptions of trend shape (e.g., does not require a linear or exponential trend), and is well suited for evaluating environmental data. This is a non-parametric (rank-based) test, which is relatively unaffected by individual outlying observations. The use of the Mann-Kendall test is therefore appropriate for evaluating overall temporal trends in contaminant concentrations in groundwater at the Site.

The presence of censored concentration data (i.e., non-detects) impacts the applicability of the trend testing procedures employed. The Mann-Kendall procedure does not require assignment of a numeric value for non-detects, since it is based on ranking data points relative to each other, and non-detects may therefore be ranked as lower than detected values and tied with other non-detects. However, the Mann-Kendall test does lose sensitivity at higher levels of censored data (e.g., above 50 percent non-detects in a given data set), and is not recommended for such data (e.g., see Table 13.3 of USGS, 2002). Due to these considerations, the following approach was utilized for data sets containing censored data (non-detects):

- If a data set contained no more than 50 percent non-detects, then it was subjected to trend evaluation by the Mann-Kendall test, treating all non-detects as tied and of lower rank than detected values.[1]

[1] For computational convenience, a value of zero was used for non-detects, although any value at or below the highest detection limit and lowest detected value could be used, yielding an identical test result.

- If a data set contained more than 50 percent non-detects, no temporal trend testing was performed.

In the statistical analyses, any field duplicate results were averaged prior to carrying out trend testing. In cases where the field duplicate results included one detected and one non-detected value, the detected value was retained as a conservative (high) estimate of the chemical concentration present in the groundwater at that time.

The Air Force Center for Environmental Excellence (AFCEE) (2007) provides a decision matrix for the classification of Mann-Kendall trend results. This general approach was followed in interpreting the trend test results, as summarized in the following table.

Probability of Significance	M-K Statistic (S)	Classification of Concentration Trend
<0.05	Positive	Increasing
	Negative	Decreasing
0.05-0.10	Positive	Probably Increasing
	Negative	Probably Decreasing
>0.10	< any>	No Trend

3. Scope of Data

For the temporal trend tests, groundwater monitoring data were evaluated on a per-parameter, per-well basis. To focus on what is currently happening in groundwater underlying the Site, the trend tests considered the last five years of groundwater monitoring, covering the period between September 2012 and May 2017. The data used in the trend tests are listed in Table 1 (S2/S3) and Table 2 (S1). This scope of data provided a target sample size of 10, since the majority of wells are sampled twice per year. The number of samples varied somewhat by well and analyte, with some wells being sampled only once per year, and a few wells having extra samples collected (1 to 7 extra samples) during the 2012-2017 period. The vast majority of data sets (well x analyte) considered consisted of either 6 observations (annual samples from 2012-2017) or 10 observations (semi-annual samples from Fall 2012 to Spring 2017). Very small data sets, containing 3 or fewer observations, were not subjected to trend analyses.

For the most part, the available data were suitable for the statistical trend tests performed. It is recommended in USEPA guidance (2009, 2015) that trend tests be performed for data sets having 8 or more observations. The requirement was met at many of the monitoring wells, with slightly reduced numbers (5-6 samples) at those wells sampled on an annual basis. The trend test findings are considered strongest for data sets with 8 or more observations, and slightly less powerful for data sets with 5-7 observations.

4. Temporal Trend Test Results

Mann-Kendall trend tests were conducted considering the entire September 2012 through May 2017 period for all data sets with sufficient detection frequencies (i.e., 50 percent detects or better). The data and test

statistics are shown in Table 1 (S2/S3) and Table 2 (S1), and a summary of the trend test results is provided in Table 3.

Of the potential 715 data sets considered (50 S1 wells and 93 S2/S3 wells by 5 COCs), 510 had insufficient detection frequencies or number of samples for trend evaluation, and the remaining 205 data sets were suitable for trend testing. There were 137 tested data sets that did not exhibit a statistically significant trend over time. Decreasing trends were noted for 43 data sets, and increasing trends were found for 25 data sets. The frequencies of statistically significant trends identified by COC are summarized below.

Aquifer	COC	Increasing	Probably Increasing	Probably Decreasing	Decreasing
S2/S3 (Intermediate screened sand aquifer)	Tetrachloroethene	1	2	2	6
	Carbon tetrachloride	6	2	0	15
	Hexachloroethene	0	0	1	3
	Hexachlorobutadiene	0	0	1	0
	beta-BHC	3	2	0	4
S1 (Deep screened sand aquifer)	Tetrachloroethene	1	0	0	2
	Carbon tetrachloride	3	1	2	2
	Hexachloroethene	0	1	0	1
	Hexachlorobutadiene	1	1	0	1
	beta-BHC	1	0	0	3

Counts are the number of wells with COC data sets having the stated trend test result. The spatial distribution of trend test results are presented on Figure 1 (S2/S3) and Figure 2 (S1).

5. Monitoring Program Optimization

As a secondary focus of the present evaluation, opportunities to optimize the groundwater monitoring program were considered. Following initial identification of, and response to, groundwater contamination, conditions in subsurface aquifers tend to change slowly over time. Therefore, long-term monitoring needs to be initiated in such a manner that the nature of contamination presence may be initially characterized with confidence, to then determine and demonstrate effectiveness of an appropriate management strategy, and thereafter be optimized to ensure that identified patterns and conditions are maintained and/or reduced over time.

The monitoring elements evaluated for optimization included: (i) the frequency of sampling; (ii) sampling locations; and (iii) lab analytical parameters. Evaluation approaches for each of these program elements are presented below.

5.1 Sampling frequency

Recommendations for sampling frequency are typically based on the stability of the groundwater contaminant plume in conjunction with consideration of any known ongoing releases. The key assessment element used to consider plume stability is trend analysis (USEPA, 2004), which has been introduced above.

Ongoing release of new contaminant mass is not expected at the Site, and it is therefore appropriate to consider concentration trends in determining whether or not conditions are progressing towards remedial objectives. If so, the frequency of groundwater sampling should be selected to confirm this progression over the expected timeframe for achieving objectives.

5.2 Sampling locations

In optimizing a groundwater monitoring program, it is desirable to identify redundant wells if possible and remove these from the program. In this case, redundant wells are those that are spatially proximate, monitor similar groundwater (i.e., same aquifer, etc.), and exhibit similar patterns in groundwater quality.

Section 2.5.1 of USEPA (2004) introduces monitoring well network design and provides an example of potential placement of wells to monitor contaminant conditions within an aquifer in the area of a release. The example layout includes the following well placements.

a) An upgradient well, measuring conditions entering the plume.

b) A source zone well (in the area of highest contaminant concentrations), measuring contaminant loading into the plume.

c) Plume boundary wells at the leading and/or sidegradient edges of the plume (i.e., having groundwater with contaminant concentrations above applicable criteria).

d) A downgradient well (past the leading edge of the plume), to monitor for possible plume expansion.

e) If required, wells along the plume to measure contaminant transformation and attenuation within the plume.

In cases where multiple source areas, plumes, and/or contaminated aquifers are present at a site, the minimum number of wells sampled should be increased accordingly to accommodate each distinct impacted area.

For the purposes of the current optimization effort, multiple wells that fall into one of the five spatial categories above (a-e) and do not exhibit strongly divergent patterns in concentrations of monitored parameters are considered to be redundant, and would be candidates for removal from the monitoring program.

5.3 Lab analytical parameters

Optimization of the lab analytical parameters to include in a groundwater monitoring program is based on the nature of contamination present, the detectability of each parameter, and the comparison of concentrations against applicable groundwater quality criteria and/or background conditions (for naturally occurring inorganics).

For the purposes of the present assessment, any lab analytical parameter that has not been detected in groundwater samples collected from any wells at a concentration within an order of magnitude of an applicable regulatory or clean-up criterion was considered for removal from the monitoring program.

5.4 Optimization recommendations

The elements listed above (sampling frequency, locations, and analytical parameters) were considered in evaluating the existing groundwater monitoring data from the Site. The current monitoring program is spatially expansive (over 100 wells), with sampling occurring up to twice per year, and includes laboratory analysis of Site-related COCs. Based on the assessment of groundwater data over the past five years, opportunities for groundwater monitoring optimization have been identified applying the following logic framework.

i) Analytical parameters:

No change in the five primary COCs considered is recommended. Each of these COCs has multiple wells with concentrations exceeding the applicable quality criteria (MCL or RSL), indicative of a plume in specific areas of the S1 and S2/S3 aquifers. Until such a time that concentrations of one or more of the five COCs are consistently below criteria, these analytical parameters should be retained in the monitoring program.

ii) Monitoring locations and frequencies:

Opportunities for optimization of monitoring locations and frequencies are apparent from the program review. The current monitoring program (2012[2]) specifies different monitoring frequencies by well, ranging from semi-annual (twice per year), to annual (once per year) and biennial (once every two years). The sampling frequency differs well to well, depending on the function of the sampling location (e.g., is it a location within the identified plume, or a sentinel location outside of any previously-identified contamination?). The monitoring well networks for both the intermediate (S2/S3) and deep (S1) screened sand units (see Figures 1 and 2) surround the Site and extend over 10000 feet from the property boundary, providing delineation of groundwater plumes containing concentrations above criteria for the five primary COCs considered.

In consideration of the desired well placement roles found in USEPA (2004) introduced above in Section 5.2, each of the Site's monitoring wells could be classified into one of the following groups:

- Upgradient Wells
- Source Zone Wells
- Plume Boundary Wells
- Downgradient Wells
- Within-Plume Wells

Since a groundwater capture system is in operation for the Site, classifying a well as being upgradient, downgradient or sidegradient of the Site is not necessarily the most representative description. For this reason, the following well function assignments have been made:

- Plume source wells

[2] "Sampling and Analysis Plan Routine Groundwater Sampling Plan RCRA Corrective Action Program", March 9, 2012"

- Plume interior wells (between the source and edge wells)
- Plume edge wells (last locations with COC concentrations above criteria)
- Boundary wells (first locations with COC concentrations below criteria)
- Sentinel wells (further from plume, past one or more boundary wells)

Due to the lengthy historic monitoring record and general stability of COC concentrations, as demonstrated by the trend analysis results, it would be appropriate to adjust monitoring frequencies at wells based on their current functional assignment and trend test findings. The following strategy is proposed:

a) Any well with one of more COCs exhibiting *increasing* concentration trends over the past 5 years should be sampled twice per year (semi-annual monitoring) until such a time as the increasing trend stabilizes or decreases.

b) Wells that define and delineate the overall groundwater plume (i.e., having one or more of the five primary COCs above MCLs) should be sampled once a year (annual monitoring) to demonstrate stable conditions overall. These include:

   i. Plume source wells

   ii. Plume edge wells

   iii. Boundary wells

   If conditions in any of these wells remain stable over a suitable review period (e.g., 5 years), a reduction in sampling to a once every two years (biennial monitoring) could be considered.

   Boundary wells that have not had a COC above its MCL over the past 5 years could be removed from the regular monitoring list but retained in usable order for potential future sampling should plume conditions change (e.g., increasing trends in adjacent plume edge wells).

c) Plume interior wells (between plume source and plume edge wells) should be sampled less frequently (e.g., every two years = biennial monitoring) to verify plume status until such a time as the plume boundaries retreat and these become plume edge wells.

d) Sentinel wells, located further from the plume than the boundary wells, should also be sampled less frequently to periodically demonstrate a lack of plume expansion. This could start out at a once every two years (biennial monitoring) frequency, potentially being reduced to once every 3-5 years if no changes are noted over a suitable review period (e.g., 5 years)

e) Redundant wells – a number of monitoring locations have been identified as potentially redundant in the monitoring program. These are primarily sentinel wells located distant from existing plume boundaries for which additional sentinel wells lie closer to the plume. However, redundant wells also exist within plume boundaries. Regular monitoring at these wells represents wasted effort, as the information obtained overlaps with that from other wells. Consequently, redundant wells should not be sampled regularly until a change in conditions occurs (e.g., a potential change in plume boundaries such that the wells are no longer redundant).

In the case of interceptor wells (IW), there is utility in sampling groundwater at these locations on a minimum annual basis (even if the recommended sampling frequency from the list above would propose less frequent sampling).

Applying the logic presented above to the existing monitoring program yields the following recommendations:

Intermediate (S2/S3) Wells

Group/Function	Monitoring Frequency	Monitoring Wells			
Wells with increasing COC trends or insufficient data	2x/year (semi-annual)	AMW4S	IW40	MW08S2	MW131S2
		AMW106S *	IW45	MW10S2	MW145S2/S3
		APMW302S3	IW46	MW21S3	MW148S2/S3
		Dieffenbacher	MW05S3	MW30S3	MW149S2/S3
		IW31	* new (2017) plume edge well – sample semi-annually until a minimum of 5 observations, then re-evaluate		
Plume Source	1x/year (annual)	MW19S2	MW113S3		
		(MW18S3 and MW27S2 are also source wells, but listed under redundant below)			
Plume Interior	1x/2 years (biennial)	MW08S3	MW12S3	MW30S2	
		(IW31, MW30S3, MW148S2/S3 and MW149S2/S3 are also plume interior wells, but have increasing trends – see above)			
		(IW30 is also a plume interior well, but is listed under redundant below)			
Plume Edge	1x/year (annual)	Builders	IW41	MW09S3	MW16S2SS
		IW32	IW42	MW14S3	MW131S3
		IW35B	IW43	MW15S2	MW143S2/S3
		(Dieffenbacher, IW40, IW45, IW46, MW05S3, MW08S2, MW10S2, MW21S3, MW131S2 and MW145S2/S3 are also plume edge wells, but have increasing trends – see above)			
		(IW35A, IW44, MW04S1, MW04S3 and MW22S2 are also plume edge wells, but are listed under redundant below.)			
		(MW17S3B is also a plume edge well, but is no longer needed for chemical or hydraulic monitoring – no sampling proposed)			
Boundary	1x/year (annual)	AMW5S	MW13S3	MW130S3	MW138S1
		AMW105S	MW17S3A	MW132S2/S3	MW138S2/S3
		AMW107S	MW20S3	MW133S2/S3	MW139S2/S3
		MW02S2	MW24S3	MW134S2	MW140S2/S3
		MW06S3	MW28S2	MW134S3	MW141S2/S3
		MW07S2	MW28S3	MW135S2/S3	MW142S2/S3
		MW07S3	MW29S2	MW136S2/S3	MW144S2/S3
		MW10S3	MW29S3	MW137S3	MW147S2/S3
		MW11S3A	MW130S2		
		(MW11S3B is also a plume edge well, but is no longer needed for chemical or hydraulic monitoring – no sampling proposed)			

Group/Function	Monitoring Frequency	Monitoring Wells			
Sentinel	1x/2 years (biennial)	AMW1	MW26S3		
		(AMW4S and APMW302S3 are also sentinel wells, but have increasing trends – see above). AMW0106S (new sentinel well) is also listed with increasing trends above.			
		(AMW8S, AMW16S, AMW101D, AMW101I, AMW102S, AMW108S and APMW302S2 are also sentinel wells, but are listed under redundant below)			
Redundant	1x/year (annual) – interceptor wells	IW30 (Plume interior well, redundant with IW32 and IW35B))			
		IW35A (Plume edge well, redundant with IW35B)			
		IW44 (Boundary well, redundant with MW140S2/S3)			
	1x/2 years (biennial)	MW18S3 (Source well, redundant with MW19S2)			
		MW27S2 (Source well, redundant with MW18S3 and MW19S2)			
	Not regularly sampled	AMW8S (Sentinel well, redundant with MW09S3)			
		AMW16S (Sentinel well, redundant with MW09S3)			
		AMW101D (Sentinel well, redundant with AMW5S)			
		AMW101I (Sentinel well, redundant with AMW5S)			
		AMW102S (Sentinel well, redundant with MW09S3)			
		AMW106S (New sentinel well, redundant with AMW107S)			
		AMW108S (Sentinel well, redundant with AMW107S)			
		APMW302S2 (Sentinel, redundant with MW07S2, MW07S3 & MW26S3)			
		MW04S1 (Plume edge well, redundant with MW04S3 and IW42)			
		MW04S3 (Plume edge well, redundant with IW42)			
		MW22S2 (Plume edge well, redundant with IW3)			
		(APMW302S3 and IW31 are also redundant wells, but have increasing trends – see above)			

Deep (S1) Wells

Group/Function	Monitoring Frequency	Monitoring Wells			
Wells with increasing COC trends or insufficient data	2x/year (semi-annual)	MW02S1	MW16S1*	MW21S1**	MW30S1
		MW10S1	MW19S1	MW26S1	MW32S1
		MW15S1			
		* new (2017) plume edge well – sample semi-annually until a minimum of 5 observations, then re-evaluate			
		** possible recent increase in COC concentrations – four of five COCs were detected for the first time in 2017			
Plume Source	1x/year (annual)	MW27S1			
		(MW19S1 is also a plume source well, but is included with increasing trends above)			

Group/Function	Monitoring Frequency	Monitoring Wells			
Plume Interior	1x/year (annual)	IW29 ‡	IW36 ‡	‡ Interceptor wells	
	1x/2 years (biennial)	MW07S1	MW12S1A	MW22S1	MW31S1
		MW08S1	MW14S1	MW24S1	MW114S1
		MW09S1	MW18S1	MW29S1	MW148S1
		MW11S1			
	Not regularly sampled	MW146S1 – Groundwater at this well does not have COCs above MCLs, but is surrounded by the plume. Regular monitoring is therefore not useful.			
		(MW02S1, MW30S1, IW31, MW30S3, MW148S2/S3 and MW149S2/S3 are also plume interior wells, but have increasing trends – see above). (MW16S1 (new interior well) also listed with increasing trends above)			
		(IW30 is also plume interior, but is listed under redundant below)			
Plume Edge	1x/year (annual)	AMW4D	MW03S1	MW16S1A	MW25S1
		APMW302S1	MW13S1		
		(Wells MW10S1, MW15S1, MW26S1, and MW32S1 are also plume edge, but have increasing trends)			
		(MW21S1 is a plume edge well with a potential increase – see explanation with increasing trends list above)			
Boundary	1x/year (annual)	AMW5D	MW17S1	MW28S1	MW140S1
		AMW16D			
	Not regularly monitored (below MCLs)	MW06S1	MW130S1	MW132S1	MW147S1
		MW20S1			
Sentinel	1x/2 years (biennial)	AMW107D	MW135S1	MW137S1	
		(AMW8D, AMW102D, AMW106D, AMW108D and MW137S2 are also sentinel wells, but listed under redundant below)			
Redundant	Not regularly monitored	AMW8D (Sentinel well, redundant with AMS16D)			
		AMW102D (Sentinel well, redundant with AMS16D)			
		AMW106D (Sentinel well, redundant with AMW107D)			
		AMW108D (Sentinel well, redundant with AMW107D)			
		MW137S2 (Sentinel, redundant with MW140S1, MW22S1 & MW13S1)			

One final consideration could be made of co-located well nests at different depths included in the same unit (e.g., MW130S2 & MW130S3; MW28S2 & MW28S3, etc.). Where these occur it may be appropriate to pick one (e.g., containing the higher COC concentrations or closer to the nearest zone of contaminated groundwater) to retain and consider the other as redundant for the purposes of monitoring at the Site.

As noted in the summary table above, conditions at well MW146S1 are unusual, in that no COCs are present above MCLs (i.e., it is a “clean” well), but it is surrounded on all sides by impacted groundwater. Given that this is a plume interior well without contamination, further sampling at this well would have limited utility, and is not proposed at present.

Five additional residential wells have been identified for sampling for which trend tests have not been performed. These wells are proposed to be sampled on a conservative semi-annual basis. These five additional wells are:

Group/Function	Monitoring Frequency	Monitoring Wells			
Residential wells	2x/year (semi-annual)	Brogden	Smarsh	Sponsel 1	Sponsel 2
		Forster			

6. Conclusions

In consideration of the results of the data evaluation presented above, the following conclusions may be drawn:

i) The large majority of data sets in by aquifer units considered (S2/S3 and S1) either exhibited no statistically-significant trends (at 95 or 90 percent confidence) over the past 5 years of monitoring for the five primary COCs, or were mainly comprised of non-detect results and therefore did not require trend evaluation.

ii) Considering data sets where statistically significant trends were identified:

   a. In the intermediate screened sand (S2/S3) aquifer unit, there were twice as many data sets with significant decreasing (95 percent confidence) or probably decreasing (90 percent confidence) trends over time in the past 5 years (32 data sets) than with increasing or probably increasing trends (16 data sets). As seen in Figure 1, decreasing trends are distributed in wells closer to the facility boundary, with the increasing trends typically occurring further away from the boundary (e.g., to the east and northeast).

   b. In the deep screened sand (S1) aquifer unit, the frequency of occurrence for increasing or probably increasing trends (9 data sets) was approximately equal to the occurrence of decreasing or probably decreasing trends (11 data sets). This could suggest that overall contaminant mass in this groundwater zone is fairly stable but varying between well locations. As seen in Figure 2, the wells with decreasing trends are primarily along the plume centerline, whereas wells with increasing trends occur further from the plume's center.

iii) Given the overall stability of COC concentrations at the vast majority of monitoring wells in the network, it is appropriate to consider optimizing monitoring efforts. As presented in Section 5.4 above, the key optimization elements include:

   a. Monitoring frequency – sampling most frequently (twice per year) at wells where observable COC concentration increases have occurred over the past 5 years; less frequently but still annually at wells in source areas and at plume edges (just inside or outside of the plume); and least frequently (once every two years = biennially) at other wells (those in the interior of the plume away from the edges, or sentinel wells far distant from current plume edges).

   b. Monitoring locations – a number of monitoring wells are redundant (duplicating monitoring effort with other wells located in similar spatial locations and monitoring roles), as indicated in

Section 5.4. Regular monitoring of these wells is not required, and only infrequent sampling (e.g., every 5 years) could be conducted unless a change in plume extents and nature is observed in future monitoring.

c. Monitoring parameters – no change in the five primary COCs monitored is recommended.

iv) Given the continued occurrence of COC concentrations above applicable criteria in groundwater surrounding the Site, ongoing groundwater monitoring is appropriate. In addition to regular reporting of monitoring results (e.g., annual reports), the performance of the monitoring system as a whole should be periodically reviewed (e.g., updating the monitoring optimization evaluation every 2-5 years) until remedial objectives are attained.

Overall, the results of the current evaluation indicate that COC concentrations in groundwater underlying the Site are generally stable in the intermediate (S2/S3) and deep (S1) screened sand aquifer units, but detectable changes have occurred over the last 5-year period. It is therefore appropriate to continue contaminant management efforts and monitoring groundwater quality (i.e., COC concentrations) to track progress towards remedial goals.

7. References

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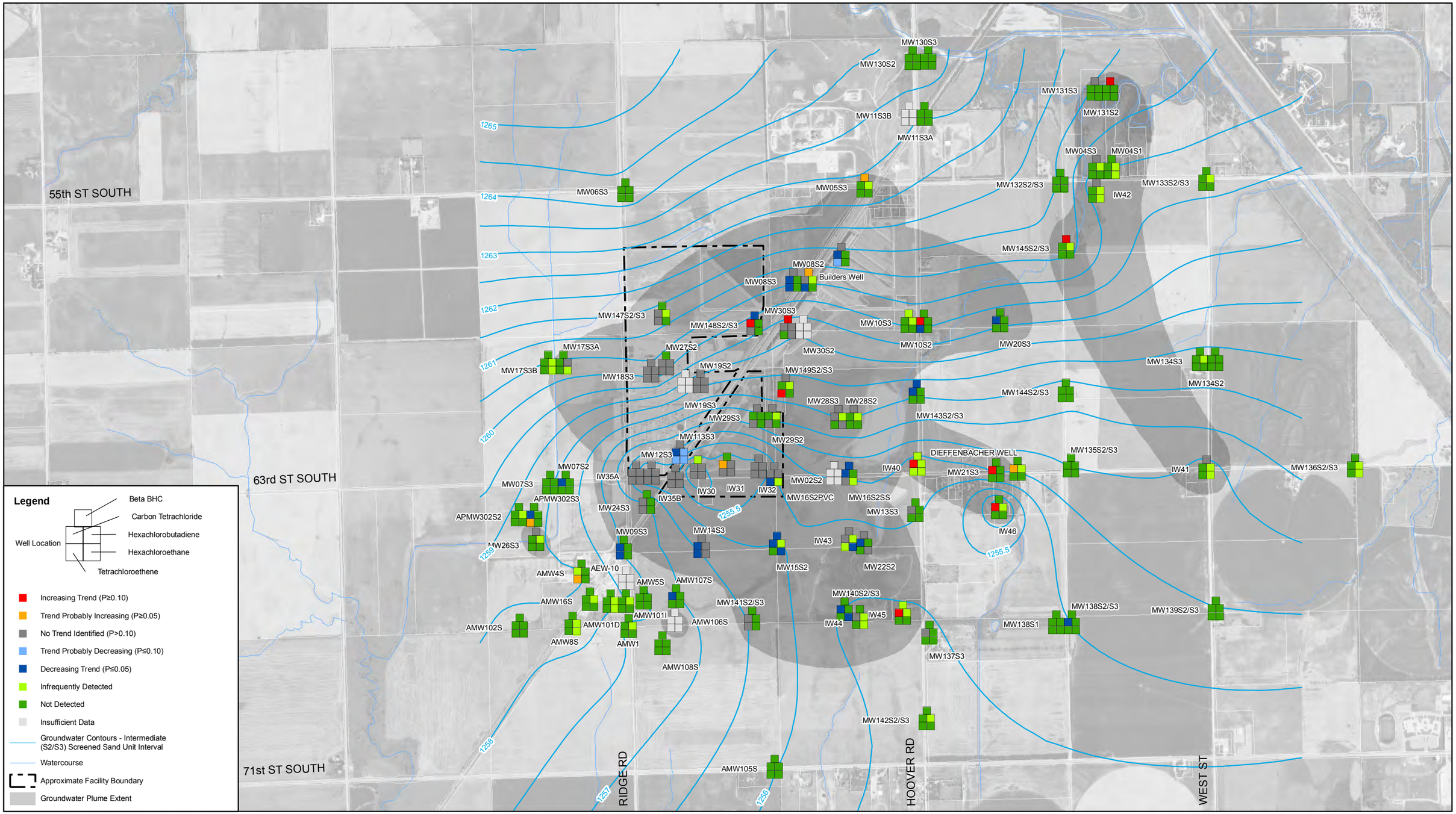


Source: USDA NAIP 2010
Note: Well locations for display purposes, not geographically accurate. Cone of depression groundwater contours and interceptor wells provided by Services Environmental, Inc. of Phoenixville PA.

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

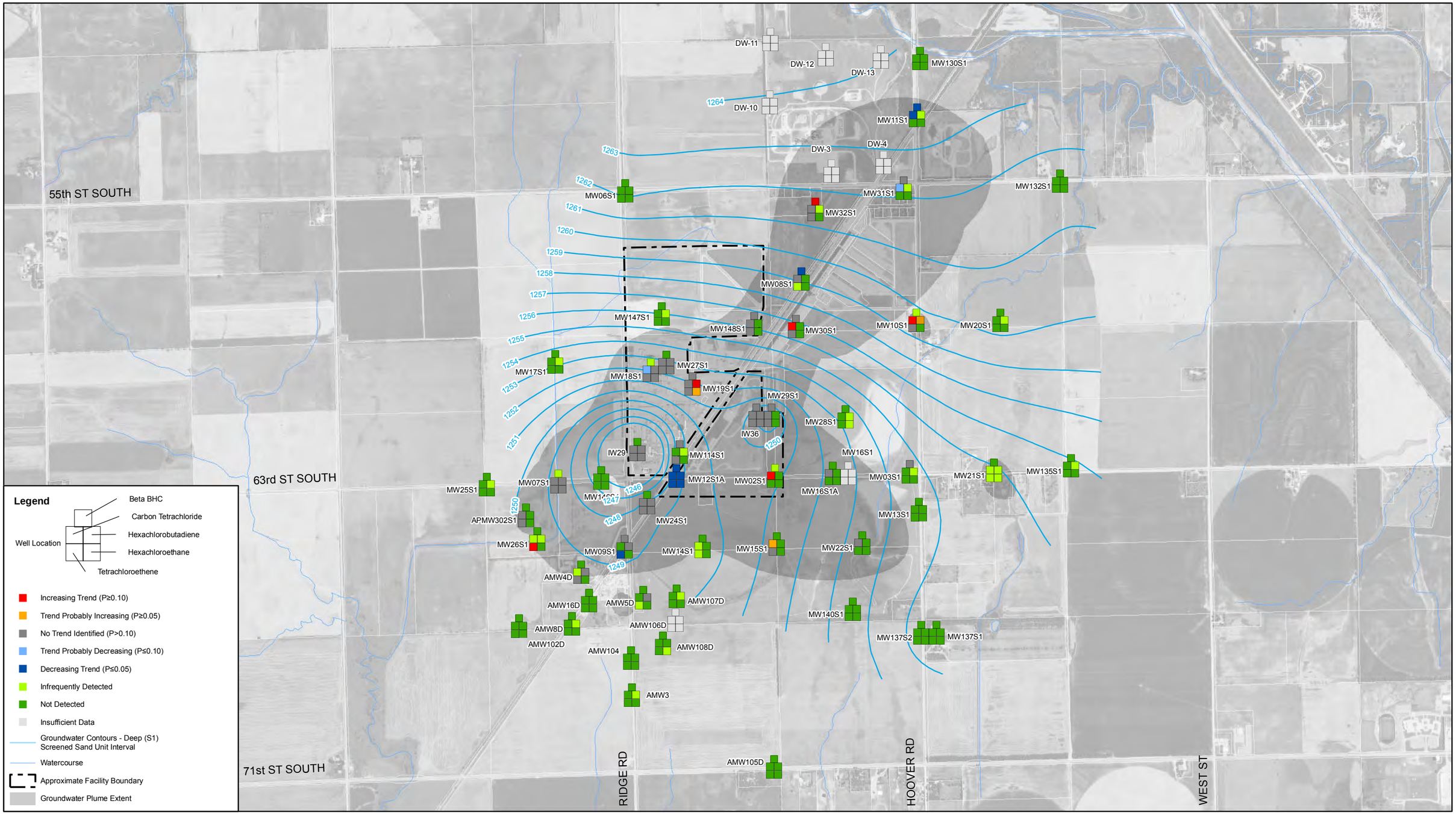
OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS
TREND ANALYSIS SUMMARY

INTERMEDIATE (S2/S3) SCREENED SAND UNIT INTERVAL MANN-KENDALL TREND TEST RESULTS 2012-2017

11137148-D23103
Aug 18, 2017

FIGURE 1

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA042.mxd



Source: USDA NAIP 2010
Note: Well locations for display purposes, not geographically accurate. Cone of depression groundwater contours and interceptor wells provided by Services Environmental, Inc. of Phoenixville PA.

0 500 1,000 1,500
Feet

Coordinate System:
NAD 1983 StatePlane Kansas South
FIPS 1502 Feet

N

GHD

OCCIDENTAL CHEMICAL CORPORATION
WICHITA, KANSAS
TREND ANALYSIS SUMMARY

DEEP (S1) SCREENED SAND UNIT INTERVAL MANN-KENDALL TREND TEST RESULTS 2012-2017

11137148-D23103
Aug 18, 2017

FIGURE 2

GIS File: Q:\GIS\PROJECTS\11137000s\11137148\Layouts\003\11137148-D23103(003)GIS-WA043.mxd

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
AEW-10						
	Samples:	0	0	0	0	0
	% Non-detects:	--	--	--	--	--
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
AMW1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	83%	100%
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
AMW4S						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.8	0.6	0.02 U	0.02 U	0.037 U
	6/2015	1.4	0.6	0.02 U	0.02 U	0.037 U
	11/2015	1.7	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	1.3	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	1.1/1.1	0.5 U/0.5 U	0.02 U/0.02 U	0.02 U/0.02 U	0.037 U/0.037 U
	5/2017	0.7	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	40%	80%	100%	100%	100%
	Statistic:	19	--	--	--	--
	Probability:	0.095	--	--	--	--
	Conclusion:	**Probably Increasing**	>50% ND	100% ND	100% ND	100% ND
AMW5S						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
AMW8S						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.07	0.13	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	83%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	>50% ND	>50% ND	100% ND
AMW16S						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
AMW101D						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.04	0.34	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	83%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	>50% ND	>50% ND	100% ND
AMW101I						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
AMW102S						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
AMW105S						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
AMW106S						
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.048
	Samples:	3	3	3	3	3
	% Non-detects:	100%	100%	100%	100%	67%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
AMW107S						
	11/2012	0.5 U	1.7	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	1.4	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	1.4	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U / 0.5 U	0.7 / 0.8	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2014	0.5 U	0.9	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	1.1	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	1.1	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.7	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	10%	100%	100%	100%
	Statistic:	--	-33	--	--	--
	Probability:	--	0.004	--	--	--
	Conclusion:	100% ND	**Decreasing Trend**	100% ND	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
AMW108S						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
APMW302S2						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	7/2013	0.5 U	0.5 U	0.02 U	0.10	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	90%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
APMW302S3						
	10/2012	0.8	0.9	0.02 U	0.02 U	0.037 U
	7/2013	1.6	0.6	0.02 U	0.02 U	0.037 U
	11/2013	1.2	0.6	0.02 U	0.02 U	0.037 U
	5/2014	1.6	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	1.4	1.5	0.02 U	0.02 U	0.037 U
	6/2015	1.5	0.6	0.02 U	0.02 U	0.037 U
	11/2015	1.7	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	2.9	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	1.4	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	2.1	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	0%	50%	100%	100%	100%
	Statistic:	21	-22	--	--	--
	Probability:	0.071	0.040	--	--	--
	Conclusion:	**Probably Increasing**	**Decreasing Trend**	100% ND	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
Builders Well						
	10/2012	1.4	136	0.02 U	0.02 U	0.272
	5/2013	1.8	131	0.02 U	0.02 U	0.306
	10/2013		153	0.02 U	0.02 U	0.250
	5/2014		130.	0.02 U	0.02 U	0.322
	11/2014		62.3	0.02 U	0.02 U	0.208
	5/2015	1.1	105	0.02 UJ	0.02 UJ	0.290 J
	10/2015		48.8	0.02 U	0.02 U	0.186
	5/2016	0.7 J	25.8	0.02 U	0.02 U	0.208
	11/2016	0.6	13.6	0.02 U	0.02 U	0.153
	5/2017	0.7	15.1	0.02 U	0.02 U	0.30
	Samples:	6	10	10	10	10
	% Non-detects:	0%	0%	100%	100%	0%
	Statistic:	-10	-37	--	--	-14
	Probability:	0.085	0.001	--	--	0.243
	Conclusion:	**Probably Decreasing**	**Decreasing Trend**	100% ND	100% ND	**No trend identified**
Dieffenbacher Well						
	10/2012	0.5 U	9.9	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	11.2	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	16.0	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	15.3	0.02 UJ	0.02 UJ	0.037 UJ
	10/2014	0.5 U	18.2	0.02 U	0.02 U	0.037 U
	5/2015	0.5 U	20.8	0.02 UJ	0.02 UJ	0.037 UJ
	10/2015	0.5 U	18.3	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	19.2	0.02 U	0.02	0.037 U
	11/2016	0.5 U	11.2	0.02 U	0.02 U	0.037 U
	Samples:	9	9	9	9	9
	% Non-detects:	100%	0%	100%	89%	100%
	Statistic:	--	17	--	--	--
	Probability:	--	0.093	--	--	--
	Conclusion:	100% ND	**Probably Increasing**	100% ND	>50% ND	100% ND
IW30						
	5/2013	9900	22000			9.3 U
	5/2014	9900 / 9300	20000 / 20300	975 / 1030	823 / 875	15 U / 15 U
	6/2015	6070 / 7100	15200 / 12300	664 / 636	667 / 637	15 U / 5.46 J
	5/2016	6740	14700	729	613	9.3 U
	11/2016	9480	18800	1160	1060	9.3 U
	5/2017	11200	30800	1180	1060	4.3
	Samples:	6	6	5	5	6
	% Non-detects:	0%	0%	0%	0%	67%
	Statistic:	1	1	6	3	--
	Probability:	1.000	1.000	0.221	0.624	--
	Conclusion:	No trend identified	No trend identified	No trend identified	No trend identified	>50% ND
IW31						
	5/2013	8800	2270			15 U
	5/2014	7300	1800	767	698	15 U
	6/2015	8250	3400 J	765	604	15 U
	5/2016	6220	7050	449	315	9.3 U
	11/2016	10700	13100	850.	609	9.3 U
	5/2017	8990	9980	1050	822	7.4 U
	Samples:	6	6	5	5	6
	% Non-detects:	0%	0%	0%	0%	100%
	Statistic:	3	11	4	2	--
	Probability:	0.707	0.060	0.462	0.806	--
	Conclusion:	No trend identified	**Probably Increasing**	No trend identified	No trend identified	**100% ND**

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
IW32						
	5/2013	157	234			1.49 J
	5/2014	169	291	8.36	1.5	2.19
	6/2015	140.	205	10.9	2.29 J	1.48 J
	5/2016	313	395	12.0	6.14	1.32 J
	11/2016	92	124	4.94 J	2.1 J	1.42 J
	5/2017	158	180.	17	11	2.0 J
	Samples:	6	6	5	5	6
	% Non-detects:	0%	0%	0%	0%	0%
	Statistic:	-1	-5	4	6	-3
	Probability:	1.000	0.452	0.462	0.221	0.707
IW35A						
	5/2013	29	119	0.17	0.29	0.861
	5/2014	13.5	54.9	0.13		1.18
	6/2015	37.9	107	0.26	0.46	0.910
	5/2016	14.6	62.3	0.08	0.15	0.771
	11/2016	34.7	111	0.22	0.33	1.06
	5/2017	21 / 0.5 U	78.0 / 90.8	0.23 / 0.02 U	0.37 / 0.02 U	1.12 J / 0.037 U
	Samples:	6	6	6	5	6
	% Non-detects:	0%	0%	0%	0%	0%
	Statistic:	1	-1	3	2	3
	Probability:	1.000	1.000	0.707	0.806	0.707
IW35B						
	5/2013	640	1960	5.61	1.4	1.68
	5/2014	270	770	4.70	1.3	1.53
	6/2015	365	629	2.34	2.60	1.45
	5/2016	310.	515	1.33	0.48	1.34
	11/2016	376	483	1.99	0.62	1.49
	5/2017	500	870	2.16	0.75	1.60
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	0%	0%	0%
	Statistic:	3	-7	-9	-5	-3
	Probability:	0.707	0.260	0.133	0.452	0.707
IW40						
	11/2012	0.5 U	10.4	0.02 U	0.02 U	0.038
	5/2013	0.5 U	14.4	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	12.2	0.02 U	0.02 U	0.045
	5/2014	0.5 U	8.2	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	17.4	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	26.8	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	26.7	0.02 U	0.02 U	0.037 U
	1/2016	-	32.3	-	-	-
	2/2016	-	35.2 / 35.9 / 36.8 / 39.1	-	-	-
	3/2016	-	34.7 / 32.0 / 38.8	-	-	-
	4/2016	-	33.2	-	-	-
	5/2016	0.5 U	35.2 / 21.3	0.02 U	0.02 U	0.037 U
	11/2016	0.7/0.7	95.7/95.9	0.02 U/0.04	0.02 UJ/0.06 J	0.037 U/0.037 U
	5/2017	0.5 U	92.5	0.02 U	0.02 U	0.037 U
	Samples:	10	14	10	10	10
	% Non-detects:	90%	0%	90%	90%	80%
	Statistic:	--	65	--	--	--
	Probability:	--	4.6E-04	--	--	--
	Conclusion:	>50% ND	**Increasing Trend**	>50% ND	>50% ND	>50% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
IW41	**9/2012**	-	-	-	-	0.037 U
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U / 0.450
	2/2013	-	-	-	-	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U / 0.462
	8/2013	-	-	-	-	0.037 U
	9/2013	-	-	-	-	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.574 / 0.037 U
	2/2014	-	-	-	-	0.037 U
	5/2014	-	-	-	-	0.037 U
	6/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.407
	8/2014	-	-	-	-	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.479
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.418
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.388
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.265
	11/2016	0.5 U	0.5 U	0.15	0.48	0.244
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.314
	Samples:	10	10	10	10	17
	% Non-detects:	100%	100%	90%	90%	41%
	Statistic:	--	--	--	--	13
	Probability:	--	--	--	--	0.607
	Conclusion:	100% ND	100% ND	>50% ND	>50% ND	No trend identified
IW42	**9/2012**	-	-	-	-	0.037 U
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U / 0.173
	2/2013	-	-	-	-	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U / 0.148
	8/2013	-	-	-	-	0.037 U
	9/2013	-	-	-	-	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.204 / 0.037 U
	2/2014	-	-	-	-	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U / 0.148
	8/2014	-	-	-	-	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.126
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.127
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.092
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.089
	11/2016	0.5 U	0.5 U	0.09	0.35	0.061
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.111
	Samples:	10	10	10	10	16
	% Non-detects:	100%	100%	90%	90%	38%
	Statistic:	--	--	--	--	4
	Probability:	--	--	--	--	0.889
	Conclusion:	100% ND	100% ND	>50% ND	>50% ND	No trend identified
IW43						
	11/2012	1.0 U	1650	0.35	0.02 U	0.151
	5/2013	1.0	1800	0.59	0.02 U	0.230
	10/2013	50 U	960	0.35	0.02 U	0.284
	5/2014	50 U	690	0.33	0.02 U	0.295
	11/2014	20 U	1380	0.44	0.02 U	0.291
	6/2015	0.9	982	0.31	0.16	0.260
	11/2015	20 U / 20 U	1520 / 1490	0.35 / 0.35	0.02 U / 0.02 U	0.242 / 0.257
	5/2016	20 U	913	0.32	0.02 U	0.236
	11/2016	20 U	919	0.29	0.03	0.131
	5/2017	20 U	974	0.29	0.02 U	0.204
	Samples:	10	10	10	10	10
	% Non-detects:	80%	0%	0%	80%	0%
	Statistic:	--	-13	-27	--	-11
	Probability:	--	0.283	0.018	--	0.371
	Conclusion:	>50% ND	No trend identified	**Decreasing Trend**	>50% ND	No trend identified

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
IW44						
	11/2012	5 U	344	0.02	0.02 U	0.037 U
	5/2013	5 U	386		0.02 U	0.037 U
	10/2013	5 U	133	0.02 U	0.02 U	0.037 U
	5/2014	3 U	106	0.02 U	0.02 U	0.037 U
	11/2014	2 U	217	0.03 J	0.02 U	0.037 U
	6/2015	2 U	252	0.03	0.03	0.037 U
	11/2015	2 U	264	0.02 U	0.02 U	0.037 U
	1/2016	-	242	-	-	-
	2/2016	-	220. / 211 / 232 / 222	-	-	-
	3/2016	-	215 / 182 / 204	-	-	-
	4/2016	-	179	-	-	-
	5/2016	2 U	172 / 198	0.02 U	0.02 U	0.037 U
	11/2016	5 U	282	0.04	0.02 U	0.037 U
	5/2017	5 U	219	0.02 U	0.02 U	0.037 U
	Samples:	10	14	9	10	10
	% Non-detects:	100%	0%	56%	90%	100%
	Statistic:	--	-13	--	--	--
	Probability:	--	0.511	--	--	--
	Conclusion:	100% ND	No trend identified	>50% ND	>50% ND	100% ND
IW45						
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.072
	6/2015	0.5 U	2.2	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	5.1	0.02 U	0.02 U	0.037 U
	1/2016	-	7.6	-	-	-
	2/2016	-	9.9 / 9.3 / 9.5 / 9.6	-	-	-
	3/2016	-	13.8 / 10.7 / 11.8	-	-	-
	4/2016	-	19.8	-	-	-
	5/2016	0.5 U	22.8 / 31.1	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	32.1	0.02 U	0.04	0.037 U
	5/2017	0.5 U	61.1	0.02 U	0.02 U	0.037 U
	Samples:	7	11	7	7	7
	% Non-detects:	100%	18%	100%	86%	86%
	Statistic:	--	54	--	--	--
	Probability:	--	3.5E-05	--	--	--
	Conclusion:	100% ND	**Increasing Trend**	100% ND	>50% ND	>50% ND
IW46						
	5/2014	0.5 U	1.5	0.02 U	0.02	0.037 U
	11/2014	0.5 U	2.3	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	3.2	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	4.2	0.02 U	0.02 U	0.037 U
	1/2016	-	4.3	-	-	-
	2/2016	-	6.5 / 6.4 / 8.3 / 5.1	-	-	-
	3/2016	-	6.1 / 5.7 / 6.5	-	-	-
	4/2016	-	5.4	-	-	-
	5/2016	0.5 U	3.9 / 4.2	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	6.2	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	6.5	0.02 U	0.02 U	0.037 U
	Samples:	7	11	7	7	7
	% Non-detects:	100%	0%	100%	86%	100%
	Statistic:	--	35	--	--	--
	Probability:	--	0.008	--	--	--
	Conclusion:	100% ND	**Increasing Trend**	100% ND	>50% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW01S2/S3						
	Samples:	0	0	0	0	0
	% Non-detects:	--	--	--	--	--
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
MW02S2						
	5/2013	7.0	118	0.29	2.85	1.48
	5/2014	6.5	106	0.02 U	0.02 U	1.26
	6/2015	6.2 / 6.1	99.2 / 106	0.02 U / 0.02 U	0.02 U / 0.02 U	1.61 / 1.59
	5/2016	5.6	78.9	0.02 U	0.02	2.18
	11/2016	4.8	95.6	0.02 U	0.02 U	2.05
	5/2017	3.5	124	0.02 U	0.03	2.09
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	83%	50%	0%
	Statistic:	-15	-3	--	0	9
	Probability:	0.009	0.707	--	1.000	0.133
	Conclusion:	**Decreasing Trend**	No trend identified	>50% ND	No trend identified	No trend identified
MW02S3						
	Samples:	0	0	0	0	0
	% Non-detects:	--	--	--	--	--
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
MW04S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.04	0.07	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	80%	80%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	>50% ND	>50% ND	100% ND
MW04S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.226
	6/2015	0.5 UJ	0.5 UJ	0.02 U	0.02 U	0.130
	5/2016	0.5 U	0.5 U	0.02 U	0.07	0.078
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.055
	5/2017	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.111 / 0.108
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	100%	80%	0%
	Statistic:	--	--	--	--	-6
	Probability:	--	--	--	--	0.221
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	No trend identified

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW05S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.03	0.072
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.066
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.081
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.150
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.145
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	83%	17%
	Statistic:	--	--	--	--	11
	Probability:	--	--	--	--	0.060
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	**Probably Increasing**
MW06S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW07S2						
	10/2012	0.5 U	0.6	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.6	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.7	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U / 0.5 U	0.6 / 0.5	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	50%	100%	100%	100%
	Statistic:	--	-26	--	--	--
	Probability:	--	0.016	--	--	--
	Conclusion:	100% ND	**Decreasing Trend**	100% ND	100% ND	100% ND
MW07S3						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW08S2						
	11/2012		24	0.02 U	0.02 U	0.447
	5/2013	4.1	13.9	0.02 U	0.02 U	0.469
	11/2013	4.0	14.7	0.02 U	0.02 U	0.555
	5/2014	4.0	15.2	0.02 U	0.02 U	0.536
	11/2014	3.6	9.8	0.02 U	0.02 U	0.472
	6/2015	3.4	9.8	0.02 U	0.02 U	0.446
	11/2015	3.1	14.3	0.02 U	0.02 U	0.547
	5/2016	3.4	15.3	0.02 U	0.04	0.651
	6/2016	2.7 / 2.5	18.2 / 17.7	0.02 U / 0.02 U	0.02 U / 0.02 U	0.589 / 0.601
	11/2016	3.5	29.4	0.02 U	0.02 U	0.484
	5/2017	3.0	107	0.02 U	0.02	0.675
	Samples:	10	11	11	11	11
	% Non-detects:	0%	0%	100%	82%	0%
	Statistic:	-31	22	--	--	25
	Probability:	0.007	0.101	--	--	0.062
	Conclusion:	**Decreasing Trend**	No trend identified	100% ND	>50% ND	**Probably Increasing**
MW08S3						
	11/2012		217	0.02 U	0.02 U	0.486
	5/2013	7.3	192	0.02 U	0.02 U	0.615
	11/2013	7	99	0.02 U	0.02 U	1.14
	5/2014	4	28	0.02 U	0.02 U	1.00
	11/2014	6.8	59.1	0.02 U	0.02 U	1.13
	6/2015	6.9	57.7	0.02 U	0.02 U	1.17
	11/2015	6.1	63.2	0.02 U	0.02 U	1.41
	5/2016	3.7	19.8	0.02 U	0.02 U	1.30
	11/2016	2.6	5.1	0.02 U	0.02 U	1.08
	5/2017	1.9	6.9	0.02 U	0.02 U	1.05
	Samples:	9	10	10	10	10
	% Non-detects:	0%	0%	100%	100%	0%
	Statistic:	-28	-33	--	--	17
	Probability:	0.005	0.004	--	--	0.152
	Conclusion:	**Decreasing Trend**	**Decreasing Trend**	100% ND	100% ND	**No trend identified**
MW09S3						
	10/2012		15.7	0.02 U	0.02 U	0.037 U
	5/2013	4.9	22.2	0.02 U	0.02 U	0.037 U
	11/2013	4.7	23.1	0.02 U	0.02 U	0.037 U
	5/2014	3.0	12.2	0.02 U	0.02 U	0.037 U
	11/2014	2.7	11.4	0.02 U	0.02 U	0.037 U
	6/2015	1.6	6.8	0.02 U	0.02 U	0.037 U
	11/2015	1.9	7.1	0.02 U	0.02 U	0.037 U
	5/2016	1.8	4.9	0.02 U	0.02 U	0.037 U
	11/2016	2.1	7.4	0.02 U	0.02 U	0.037 U
	5/2017	1.4	4.9	0.02 U	0.02 U	0.037 U
	Samples:	9	10	10	10	10
	% Non-detects:	0%	0%	100%	100%	100%
	Statistic:	-26	-30	--	--	--
	Probability:	0.009	0.009	--	--	--
	Conclusion:	**Decreasing Trend**	**Decreasing Trend**	100% ND	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW10S2						
	11/2012	2.3	26.7	0.02 U	0.02 U	0.037 U
	5/2013	1.7	26.7	0.02 U	0.02 U	0.037 U
	11/2013	1.9 / 1.8	26.2 / 30.5	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	5/2014	2.0	32.5	0.02 U	0.02 U	0.037 U
	11/2014	1.5	28.4	0.02 U	0.02 U	0.037 U
	6/2015	1.5	33.4	0.02 U	0.02 U	0.037 U
	11/2015	1.3	38.5	0.02 U	0.02 U	0.037 U
	5/2016	0.9 J	36.9	0.02 U	0.02 U	0.037 U
	11/2016	1.0	39.5	0.02 U	0.02 U	0.037 U
	5/2017	0.9	36.8	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	0%	0%	100%	100%	100%
	Statistic:	-35	34	--	--	--
	Probability:	0.002	0.003	--	--	--
	Conclusion:	**Decreasing Trend**	**Increasing Trend**	100% ND	100% ND	100% ND
MW10S3						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02	0.081 J
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.17	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	80%	90%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	>50% ND
MW11S3A						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW11S3B						
	5/2016	0.5 U / 0.5 U	0.6 / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	3	3	3	3	3
	% Non-detects:	100%	67%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW12S3						
	11/2012	41	86	0.50	1.72	25.7
	5/2013	43.9	104	0.61	1.22	9.07
	11/2013	9.3	8.6		0.9	37.5
	5/2014	49	109	0.76	1.02	4.28
	11/2014	30.	65.6	0.3 J	0.72 J	12.5 J
	6/2015	33.3	93.8	0.43	0.52	5.87
	11/2015	24.7 / 28.8	66.4 / 82.9	0.2 / 0.2	0.48 / 0.41	15.7 / 14.0
	5/2016	32.0	49.2		0.6	16.0
	11/2016	52.7	37.3	1.2	1.4	14.8
	5/2017	50.8	54.0	0.60	1.56	11.3
	Samples:	10	10	8	10	10
	% Non-detects:	0%	0%	0%	0%	0%
	Statistic:	9	-15	0	-9	-3
	Probability:	0.474	0.210	1.000	0.474	0.858
MW13S3						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.6	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	1.2	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	2.0	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	2.3	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	6.1	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	2.1	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	30%	100%	100%	100%
	Statistic:	--	8	--	--	--
	Probability:	--	0.525	--	--	--
	Conclusion:	100% ND	No trend identified	100% ND	100% ND	100% ND
MW14S3						
	11/2012	500	3070	5.22	1.1	0.584
	5/2013	640	3980	7.25	1.5	0.475 J
	10/2013	720	4320	7.38	1.4	0.508 J
	5/2014	720	4160	7.46 J	1.6 J	0.646 J
	11/2014	610 / 640	3390 / 3260	7.17 / 7.87	1.2 / 1.4	0.548 / 0.571
	6/2015	420	2800	4.17	0.87	0.417 J
	11/2015	480	2960	3.90	0.84	0.363 J
	5/2016	490 / 460	2950 / 2790	5.07 / 4.87	1.11 / 1.08	0.468 / 0.463
	11/2016	480/460.	2740/1980	6.35/4.72	1.5/1.1	0.36/0.370
	5/2017	440	2620	5.41	1.26	0.473
	Samples:	10	10	10	10	10
	% Non-detects:	0%	0%	0%	0%	0%
	Statistic:	-24	-27	-5	-12	-19
	Probability:	0.040	0.020	0.721	0.323	0.107

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW15S2						
	11/2012	20 U	1000	0.06	0.02 U	0.270
	5/2013	30 U	935	0.04	0.02 U	0.221
	11/2013	20 U	877	0.03	0.02 U	0.253
	5/2014	10 U	749	0.04	0.02 U	0.218
	11/2014	10 U / 30 U	683 / 570.	0.03 / 0.02	0.02 U / 0.02 U	0.140 / 0.108
	6/2015	5 U / 5 U	561 / 596	0.03 J / 0.02 U	0.02 U / 0.28 J	0.060 / 0.057
	11/2015	10 U	514	0.02 U	0.02 U	0.047
	5/2016	5 U	210.	0.02 U	0.02 U	0.069
	11/2016	5 U	157	0.02 U	0.02 U	0.194
	5/2017	2 U	208	0.02 U	0.02 U	0.108
	Samples:	10	10	10	10	10
	% Non-detects:	100%	0%	40%	90%	0%
	Statistic:	--	-43	-33	--	-25
	Probability:	--	1.7E-04	0.003	--	0.032
	Conclusion:	100% ND	**Decreasing Trend**	**Decreasing Trend**	>50% ND	**Decreasing Trend**
MW16S2PVC						
	Samples:	0	0	0	0	0
	% Non-detects:	--	--	--	--	--
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
MW16S2SS						
	11/2012	20 U	1310	0.41	0.02 U	1.17
	5/2013	50 U	680		0.02 U	1.14
	11/2013	2.9	79.2	0.02 U	0.02 U	1.74
	5/2014	20 U	250	0.06	0.04 U	1.47
	11/2014	5 U	115	0.03	0.02 U	1.15
	6/2015	2.0	82.2	0.02 U	0.02 U	0.867
	11/2015	1 U	26.7	0.02 U	0.02 U	0.946
	5/2016	1.2	21.0	0.02 U	0.02 U	0.685
	11/2016	0.9	64.6	0.02 U	0.02 U	0.599
	5/2017	0.5 J	29.0	0.02 U	0.02 U	0.273
	Samples:	10	10	9	10	10
	% Non-detects:	50%	0%	67%	100%	0%
	Statistic:	7	-31	--	--	-33
	Probability:	0.564	0.007	--	--	0.004
	Conclusion:	No trend identified	**Decreasing Trend**	>50% ND	100% ND	**Decreasing Trend**
MW16S3						
	Samples:	0	0	0	0	0
	% Non-detects:	--	--	--	--	--
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
MW17S3A						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.28	1.72	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.48	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.84	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	83%	50%	100%
	Statistic:	--	--	--	8	--
	Probability:	--	--	--	0.159	--
	Conclusion:	100% ND	100% ND	>50% ND	No trend identified	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW17S3B						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02	0.13	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	83%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	>50% ND	>50% ND	100% ND
MW18S3						
	5/2013	35000	96700	1410	210	
	5/2014	16000	74300	349	97	7.4 U
	6/2015	6100	28500	123	8.9	13.7
	5/2016	2390	10100	61.6	9.1	8.93
	11/2016	21100	116000	530.	17 J	11.3 J
	5/2017	1020	2310	25.3	7.2	12.0
	Samples:	6	6	6	6	5
	% Non-detects:	0%	0%	0%	0%	20%
	Statistic:	-9	-7	-9	-9	4
	Probability:	0.133	0.260	0.133	0.133	0.462432717
MW19S2						
	5/2013	4500	2500	328	479	20
	5/2014	5430	2490	265	308	22.8
	6/2015	3170	5510	219	58	37.5
	5/2016	6590	4320	424	502	7.4 U
	11/2016	3180	5280	720.	707	12
	5/2017	3850	4710	666	1220	40.0
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	0%	0%	17%
	Statistic:	-1	5	7	9	3
	Probability:	1.000	0.452	0.260	0.133	0.707
MW19S3						
	Samples:	0	0	0	0	0
	% Non-detects:	--	--	--	--	--
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
MW20S3						
	10/2012	0.5 U	91.2	0.02 U	0.02 U	0.037 U
	5/2013	1 U	60.2	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	64.3	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	60.6	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	48.7	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	52.5	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	61.1	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	52.3	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	49.4	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	45.3	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	0%	100%	100%	100%
	Statistic:	--	-27	--	--	--
	Probability:	--	0.020	--	--	--
	Conclusion:	100% ND	**Decreasing Trend**	100% ND	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW21S3						
	11/2012	0.5 U	7.2	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	7.8	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	9.5	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	8.8	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	7.2	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	10.4	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U / 0.5 U	8.8 / 9.2	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	5/2016	0.5 U	14.3	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	13.8	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	11.4	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	0%	100%	100%	100%
	Statistic:	--	26	--	--	--
	Probability:	--	0.025	--	--	--
	Conclusion:	100% ND	**Increasing Trend**	100% ND	100% ND	100% ND
MW22S2						
	11/2012	50 U	5380	0.02 UJ	0.02 UJ	0.037 UJ
	5/2013	50 U	4750	1.14	0.02 U	0.145
	11/2013	50 U	4380	1.08	0.02 U	0.136
	5/2014	50 U / 50 U	3730 / 4220	1.05 / 0.98	0.02 U / 0.02 U	0.107 / 0.113
	11/2014	50 U	3830	1.12	0.02 U	0.072
	6/2015	50 U / 50 U	3850 / 3590	0.86 / 0.85	0.02 U / 0.02 U	0.079 / 0.080
	11/2015	50 U	4400	0.97	0.02 U	0.098
	11/2016	50 U	1430	0.26	0.02 U	0.037 U
	5/2017	20 U	522	0.14	0.02 U	0.037 U
	Samples:	9	9	9	9	9
	% Non-detects:	100%	0%	11%	100%	33%
	Statistic:	--	-28	-14	--	-15
	Probability:	--	0.005	0.175	--	0.136
	Conclusion:	100% ND	**Decreasing Trend**	No trend identified	100% ND	No trend identified
MW24S3						
	5/2013	2.5	10.3	0.02 U	0.02 U	0.037 U
	5/2014	4.3	15.9	0.02 U	0.02 U	0.037 U
	6/2015	3.6	13.3	0.02 U	0.02 U	0.037 U
	5/2016	3.0	9.9	0.02 U	0.02 U	0.037 U
	11/2016	4.6	12.8	0.02 U	0.02 U	0.037 U
	5/2017	4.0	14.7	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	100%	100%	100%
	Statistic:	5	1	--	--	--
	Probability:	0.452	1.000	--	--	--
	Conclusion:	No trend identified	No trend identified	100% ND	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW26S3						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.251
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.071
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.164
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U/0.5 U/0.5 U	0.5 U/0.5 U/0.5 U	0.02 U/0.02 U/0.02 U	0.04/0.04/0.02	0.088/0.086/0.077
	6/2016	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.077
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.075
	Samples:	11	11	11	11	11
	% Non-detects:	100%	100%	100%	82%	45%
	Statistic:	--	--	--	--	3
	Probability:	--	--	--	--	0.870
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	No trend identified
MW27S2						
	5/2013	407	60	2200	17800	190 U
	6/2014	546	165	1030	2510	15 U
	6/2015	661	130	990	1900	37 U
	5/2016	4050	1810	2130	3590	19 U
	11/2016	3230	750	1700	1580	19 U
	5/2017	2000	270	1590	3150	15 U
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	0%	0%	100%
	Statistic:	9	7	-3	-5	--
	Probability:	0.133	0.260	0.707	0.452	--
	Conclusion:	No trend identified	No trend identified	No trend identified	No trend identified	100% ND
MW28S2						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.107
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.069
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.131
	5/2016	0.5 U	0.5 U	0.02 U	0.03	0.138
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.088
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.189
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	83%	0%
	Statistic:	--	--	--	--	7
	Probability:	--	--	--	--	0.260
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	No trend identified
MW28S3						
	5/2013	0.5 U / 0.5 U	89.3 / 83.6	0.02 U / 0.02 U	0.02 U / 0.02 U	0.072 / 0.070
	5/2014	0.5 U / 0.5 U	37.2 / 47.4	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	6/2015	5 U	242	0.14	0.02 U	0.044
	5/2016	3 U	271	0.25	0.02	0.081
	11/2016	0.5 U	3.3	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.9	0.19	0.14	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	0%	50%	67%	50%
	Statistic:	--	-5	6	--	-4
	Probability:	--	0.452	0.314	--	0.546
	Conclusion:	100% ND	No trend identified	No trend identified	>50% ND	No trend identified

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW29S2						
	5/2013	5.8	3 U	0.04 U	0.08 U	2.17
	5/2014	11	2 U	0.02 U	0.02 U	1.91
	6/2015	5.8	2 U	0.02 U	0.02 U	1.44
	5/2017	3	3 U	0.02 U	0.06	1.68 J
	Samples:	4	4	4	4	4
	% Non-detects:	0%	100%	100%	75%	0%
	Statistic:	-3	--	--	--	-4
	Probability:	0.542	--	--	--	0.334
	Conclusion:	No trend identified	100% ND	100% ND	>50% ND	No trend identified
MW29S3						
	5/2013	73.8	3 U	0.02 U	0.02 U	1.42 J
	5/2014	63	5 U	0.02 U	0.02 U	1.28 J
	6/2015	35	3 U	0.02 U	0.02 U	1.35 J
	5/2016	47.8	2 U	0.02 U	0.02 U	1.44
	11/2016	52.6	2 U	0.02 U	0.02 U	1.08
	5/2017	55.9	0.5 U	0.02 U	0.02 U	1.32 J
	Samples:	6	6	6	6	6
	% Non-detects:	0%	100%	100%	100%	0%
	Statistic:	-3	--	--	--	-3
	Probability:	0.707	--	--	--	0.707
	Conclusion:	No trend identified	100% ND	100% ND	100% ND	No trend identified
MW30S2						
	5/2016	0.5 U	42.1	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	58.0	0.04	0.02 U	0.037 U
	5/2017	0.5 U	47.6	0.02 U	0.02 U	0.037 U
	Samples:	3	3	3	3	3
	% Non-detects:	100%	0%	67%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
MW30S3						
	11/2012	200 U	15200	3.62	0.03	0.301
	5/2013	200 U	13300	3.82	0.03	0.329
	11/2013	200 U	15400	4.45	0.02	0.405
	5/2014	200 U	12700	4.20	0.03	0.325
	11/2014	200 U	12400	5.47	0.05	0.328
	6/2015	200 U	17900	5.19	0.04	0.403
	11/2015	200 U	17200	5.21		0.343
	5/2016	200 U	12300	5.05	0.12	0.462
	11/2016	200 U	14400	4.56	0.03	0.356
	5/2017	100 U	11700	3.78	0.06	0.439
	Samples:	10	10	10	9	10
	% Non-detects:	100%	0%	0%	0%	0%
	Statistic:	--	-13	9	16	23
	Probability:	--	0.283	0.474	0.100	0.049
	Conclusion:	100% ND	No trend identified	No trend identified	No trend identified	**Increasing Trend**
MW113S3						
	5/2013	10600	64700	230	98	4.4
	5/2014	11000	52400	203	95.8	5.64 J
	6/2015	6600	32900	136	82.7	5.24
	5/2016	6400	32600	104	55.5	3.5
	11/2016	4200	24400	95.7	42.5	2.8
	5/2017	5700	27900	114	59.0	4.24
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	0%	0%	0%
	Statistic:	-11	-13	-11	-11	-7

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
	Probability:	0.060	0.024	0.060	0.060	0.260

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW130S2						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW130S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW131S2						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 UJ	0.5 UJ	0.02 U	0.02 U	0.037
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.113
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.164
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.383
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	33%
	Statistic:	--	--	--	--	14
	Probability:	--	--	--	--	0.013
	Conclusion:	100% ND	100% ND	100% ND	100% ND	**Increasing Trend**
MW131S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.038
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.176
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.508
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.519
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.899
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.188
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	0%
	Statistic:	--	--	--	--	9
	Probability:	--	--	--	--	0.133
	Conclusion:	100% ND	100% ND	100% ND	100% ND	No trend identified

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW132S2/S3						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW133S2/S3						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.06 / 0.02	0.037 U / 0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.04	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	80%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
MW134S2						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW134S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	100%	80%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW135S2/S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U/0.5 U	0.5 U/0.5 U	0.02 U/0.02 U	0.02 U/0.02 U	0.037 U/0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW136S2/S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.03	0.07	0.037 U
	11/2016	0.5 U/0.5 U	0.5 U/0.5 U	0.02 U/0.02 U	0.02 U/0.02 U	0.037 U/0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	83%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	>50% ND	>50% ND	100% ND
MW137S3						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.6	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.7	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.7	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.9	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.6	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	30%	100%	100%	100%
	Statistic:	--	11	--	--	--
	Probability:	--	0.358	--	--	--
	Conclusion:	100% ND	No trend identified	100% ND	100% ND	100% ND
MW138S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	9	9	9	9	9
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW138S2/S3						
	10/2012	0.5 U / 0.5 U	3.5 / 2.5	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	5/2013	0.5 U / 0.5 U	2.5 / 2.7	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	10/2013	0.5 U	2.9	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	2.0	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	1.2	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.7	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	30%	100%	100%	100%
	Statistic:	--	-40	--	--	--
	Probability:	--	4.0E-04	--	--	--
	Conclusion:	100% ND	**Decreasing Trend**	100% ND	100% ND	100% ND
MW139S2/S3						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW140S2/S3						
	11/2012	20 U / 20 U	1480 / 1380	0.12 / 0.12	0.02 U / 0.02 U	0.037 U / 0.037 U
	5/2013	5 U	1890	0.18	0.02 U	0.037 U
	11/2013	50 U	1750	0.13	0.02 U	0.037 U
	5/2014	20 U	1660	0.15	0.02 U	0.037 U
	11/2014	50 U	1310	0.09	0.02 U	0.037 U
	6/2015	20 U	1000	0.06	0.02 U	0.037 U
	11/2015	20 U	820.	0.04	0.02 U	0.037 U
	5/2016	10 U	557	0.04	0.02 U	0.037 U
	11/2016	10 U	1000	0.07	0.02 U	0.037 U
	5/2017	10 U	578	0.04	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	0%	0%	100%	100%
	Statistic:	--	-32	-28	--	--
	Probability:	--	0.005	0.014	--	--
	Conclusion:	100% ND	**Decreasing Trend**	**Decreasing Trend**	100% ND	100% ND

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW141S2/S3						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	2.2	0.02 U	0.02 U	0.037 U
	11/2013	1.0	7.9	0.02 U	0.02 U	0.037 U
	5/2014	3.2	24.0	0.02 U	0.02 U	0.037 U
	11/2014	4.1	29.6	0.02 U	0.02 U	0.037 U
	6/2015	4.5	37.8	0.02 U	0.02 U	0.037 U
	11/2015	3.8	34.9	0.02 U	0.02 U	0.037 U
	5/2016	3.1	24.9	0.02 U	0.02 U	0.037 U
	11/2016	2.4	17.8	0.02 U	0.02 U	0.037 U
	5/2017	2.5	22.1	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	20%	10%	100%	100%	100%
	Statistic:	12	17	--	--	--
	Probability:	0.323	0.152	--	--	--
	Conclusion:	No trend identified	No trend identified	100% ND	100% ND	100% ND
MW142S2/S3						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 UJ	0.5 UJ	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.06	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.03	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	70%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
MW143S2/S3						
	11/2012	0.5 U	12.0	0.02 U	0.02 U	0.140
	5/2013	0.5 U / 0.5 U	12.7 / 12.6	0.02 U / 0.02 U	0.02 U / 0.02 U	0.114 / 0.109
	10/2013	0.5 U	17.3	0.02 U	0.02 U	0.140
	5/2014	0.5 U	17.2	0.02 U	0.02 U	0.115
	11/2014	0.5 U	15.2	0.02 U	0.02 U	0.098
	6/2015	0.5 U	13.5	0.02 U	0.02 U	0.106
	11/2015	0.5 U	9.8	0.02 U	0.02 U	0.082
	5/2016	0.5 U	6.2	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U/0.5 U	4.7/5.0	0.02 U/0.02 U	0.02 U/0.02 U	0.038/0.037 U
	5/2017	0.5 U	4.2	0.02 U	0.02 U	0.038
	Samples:	10	10	10	10	10
	% Non-detects:	100%	0%	100%	100%	10%
	Statistic:	--	-27	--	--	-33
	Probability:	--	0.020	--	--	0.004
	Conclusion:	100% ND	**Decreasing Trend**	100% ND	100% ND	**Decreasing Trend**

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW144S2/S3						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW145S2/S3						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.335
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.381
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.686
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.669
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.781
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.784
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.687
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.847
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.798
	5/2017	0.5 U	0.5 U	0.02 U	0.04	1.03
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	90%	0%
	Statistic:	--	--	--	--	37
	Probability:	--	--	--	--	0.001
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	**Increasing Trend**
MW147S2/S3						
	11/2014	2.0	41.5	0.02 U	0.02 U	0.037 U
	6/2015	1.8	33.4	0.02 U	0.02 U	0.037 U
	11/2015	2.0	43.6	0.02 U	0.02 U	0.037 U
	5/2016	2.0	34.0	0.02 U	0.09	0.037 U
	11/2016	1.2	21.0	0.02 U	0.02 U	0.037 U
	5/2017	1.8	34.5	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	100%	83%	100%
	Statistic:	-5	-3	--	--	--
	Probability:	0.444	0.707	--	--	--
	Conclusion:	No trend identified	No trend identified	100% ND	>50% ND	100% ND
MW148S2/S3						
	11/2014	4.0	1.2	0.02 U	0.02 U	4.13
	6/2015	3.4	9.8	0.02 U	0.02 U	3.25
	11/2015	4.1	30.2	0.02 U	0.02 U	2.45
	5/2016	3.9	88.3	0.02 U	0.02 U	2.20
	11/2016	3.5	173	0.02 U	0.02 U	1.78
	5/2017	4.4	261	0.02 U	0.02 U	1.23
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	100%	100%	0%
	Statistic:	3	15	--	--	-15
	Probability:	0.707	0.009	--	--	0.009
	Conclusion:	No trend identified	**Increasing Trend**	100% ND	100% ND	**Decreasing Trend**

Table 1

Monitoring Data and Trend Test Results - Intermediate (S2/S3) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW149S2/S3						
	11/2014	15.5	0.5 U	0.02 U	0.02 U	0.621
	6/2015	16.4	0.5 U	0.02 U	0.02 U	0.538
	11/2015	23.5	0.5 U	0.02 U	0.02 U	0.506
	5/2016	22.3	0.5 U	0.02 U	0.03	0.486
	11/2016	28.8	0.5 U	0.02 U	0.02 U	0.669
	5/2017	29.4	0.5 U	0.02 U	0.02 U	0.594
	Samples:	6	6	6	6	6
	% Non-detects:	0%	100%	100%	83%	0%
	Statistic:	13	--	--	--	-1
	Probability:	0.024	--	--	--	1.000
	Conclusion:	**Increasing Trend**	100% ND	100% ND	>50% ND	No trend identified

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
AMW4D						
	11/2012	4.2	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	7.4	0.8	0.02 U	0.02	0.037 U
	11/2013	7.4	0.5 U	0.02 U	0.03	0.037 U
	5/2014	7.2 / 6.7	1.0 / 0.8	0.02 U / 0.02 U	0.03 / 0.03	0.037 U / 0.037 U
	11/2014	8.2	0.5 U	0.02 U	0.03	0.037 U
	6/2015	7.5	0.5 U	0.02 U	0.03	0.037 U
	11/2015	8.8	0.6	0.02 U	0.02	0.037 U
	5/2016	5.2	1.6	0.02 U	0.02 U	0.037 U
	11/2016	6.6	0.5 U	0.02 U	0.03	0.037 U
	5/2017	5.1	0.5 U	0.02 U	0.02	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	0%	60%	100%	20%	100%
	Statistic:	-2	--	--	1	--
	Probability:	0.928	--	--	1	--
	Conclusion:	No trend identified	>50% ND	100% ND	No trend identified	100% ND
AMW5D						
	11/2012	1.0	0.5 U	0.02 U	0.05	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.04	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	90%	100%	100%	50%	100%
	Statistic:	--	--	--	-16	--
	Probability:	--	--	--	0.143	--
	Conclusion:	>50% ND	100% ND	100% ND	No trend identified	100% ND
AMW8D						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.05	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
AMW16D						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
AMW102D						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
AMW106D						
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	3	3	3	3	3
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
AMW107D						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.16	0.037 U
	6/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	11	11	11	11	11
	% Non-detects:	100%	100%	100%	91%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
AMW108D						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	80%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	>50% ND	100% ND	100% ND

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
APMW302S1						
	10/2012	3.0	5.3	0.02 U	0.02 U	0.037 U
	7/2013	5.6	12.1	0.02 U	0.02 U	0.037 U
	11/2013	6.3	11.6	0.02 U	0.02 U	0.037 U
	5/2014	8.1	25.5	0.02 U	0.02 U	0.037 U
	11/2014	7.1	16.3	0.02 U	0.02 U	0.037 U
	6/2015	9.7	23.7	0.02 U	0.02 U	0.037 U
	11/2015	10.3	32.3	0.02 U	0.02 U	0.037 U
	5/2016	9.9 / 9.8	24.0 / 24.0	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2016	6.2	12.7	0.02 U	0.02 U	0.037 U
	5/2017	4.8	9.9	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	0%	0%	100%	100%	100%
	Statistic:	13	9	--	--	--
	Probability:	0.283	0.474	--	--	--
	Conclusion:	No trend identified	No trend identified	100% ND	100% ND	100% ND
IW29						
	5/2013	1200	610	7.3	52.9	0.74 U
	5/2014	760	390	6.6	40.1	1.1 U
	6/2015	1130	530	5.9	44.2	0.93 U
	5/2016	1500	693	5.3	51.6	0.74 U
	11/2016	1150	450	5.6	45.3	0.74 U
	5/2017	420	210	7.1	64.6	0.74 U
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	0%	0%	100%
	Statistic:	-3	-5	-5	5	--
	Probability:	0.707	0.452	0.452	0.452	--
	Conclusion:	No trend identified	No trend identified	No trend identified	No trend identified	100% ND
IW36						
	5/2013	0.8	19.5	0.02 U	0.02 U	0.298
	6/2014	0.7	20.1	0.02 U	0.02 U	0.281
	6/2015	0.6	14.4	0.31	1.88	0.303
	5/2016	1.1	29.6	0.02 U	0.02 U	0.236
	11/2016	0.9	15.5	0.03	0.05	0.272
	5/2017	0.9	25.5	0.02	0.04	0.344
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	50%	50%	0%
	Statistic:	4	3	4	4	1
	Probability:	0.566	0.707	0.546	0.546	1
MW02S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	2.2	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	10.6	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	18.9	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	12.6	0.02 U	0.02 U	0.199
	Samples:	6	6	6	6	6
	% Non-detects:	100%	33%	100%	100%	83%
	Statistic:	--	12	--	--	--
	Probability:	--	0.035	--	--	--
	Conclusion:	100% ND	**Increasing Trend**	100% ND	100% ND	>50% ND

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW03S1						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.162
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.40
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.267
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.421
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.206
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.215
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.380
	5/2016	0.5 U	0.5 U	0.02 U	0.03	0.055
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.407
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	90%	10%
	Statistic:	--	--	--	--	-7
	Probability:	--	--	--	--	0.592
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	No trend identified
MW06S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U/0.5 U	0.5 U/0.5 U	0.02 U/0.02 U	0.02 U/0.02 U	0.037 U/0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW07S1						
	10/2012	146	4	0.07	0.05	0.051
	5/2013	290	1340	6.34	1.2	0.099
	11/2013	680	3210	17	2.1	0.19
	5/2014	880	4140	19.0	2.58	0.195
	11/2014	670	2590	17.5	2.8	0.19 U
	6/2015	620	3100	15.0	2.3	0.37 U
	11/2015	740	3080	19.4 J	3.2 J	0.37 U
	5/2016	360	1250	9.64	1.8	0.19 U
	11/2016	280	850	4.86	0.84	0.074 U
	5/2017	350	1460	8.79	1.9	0.19 U
	Samples:	10	10	10	10	10
	% Non-detects:	0%	0%	0%	0%	60%
	Statistic:	-3	-5	1	7	--
	Probability:	0.858	0.721	1.000	0.592	--
	Conclusion:	No trend identified	No trend identified	No trend identified	No trend identified	>50% ND
MW08S1						
	11/2012	0.5 U	2.2	0.02 U	0.02 U	0.778
	5/2013	0.5 U	3.2	0.02 U	0.02 U	0.739
	11/2013	0.5 U	4.5	0.02 U	0.02 U	0.964
	5/2014	0.5 U	5.1	0.02 U	0.02 U	0.717
	11/2014	0.5 U	3.0	0.02 U	0.02 U	0.688
	6/2015	0.5	4.2	0.02 U	0.02 U	0.619
	11/2015	0.5 U	4.4	0.02 U	0.02 U	0.616
	5/2016	0.5 U	4.3	0.02 U	0.02 U	0.822
	11/2016	0.7	4.0	0.02 U	0.02 U	0.601
	5/2017	0.6	3.8	0.02 U	0.02 U	0.687
	Samples:	10	10	10	10	10
	% Non-detects:	70%	0%	100%	100%	0%
	Statistic:	--	3	--	--	-23
	Probability:	--	0.858	--	--	0.049
	Conclusion:	>50% ND	No trend identified	100% ND	100% ND	**Decreasing Trend**

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW09S1						
	10/2012	108	2 U	0.02 U	0.74	0.055
	5/2013	101	2 U	0.02 U	0.80	0.040
	11/2013	139	2 U	0.02 U	0.95	0.088 J
	5/2014	139	2 U	0.02 U	0.95	0.060
	11/2014	120. / 120.	2 U / 2 U	0.02 U / 0.02 U	0.86 / 0.84	0.061 / 0.055
	6/2015	91.0	2 U	0.02 U	0.84	0.056
	11/2015	93.5	2 U	0.02 U	0.91	0.063
	5/2016	90.5	3 U	0.02 U	0.91	0.065
	11/2016	45.0	2 U	0.02 U	0.94	0.090
	5/2017	49.3	0.5 U	0.02 U	0.70	0.060
	Samples:	10	10	10	10	10
	% Non-detects:	0%	100%	100%	0%	0%
	Statistic:	-28	--	--	3	18
	Probability:	0.016	--	--	0.857	0.127
	Conclusion:	**Decreasing Trend**	100% ND	100% ND	No trend identified	No trend identified
MW10S1						
	11/2012	0.6	1.6	0.02 U	0.02 U	0.037 U
	5/2013	0.8	1.8	0.02 U	0.02 U	0.037 U
	11/2013	0.8	1.8	0.02 U	0.08	0.037 U
	5/2014	1.0	2.4	0.02 U	0.02 U	0.037 U
	11/2014	0.9	2.1	0.02 U	0.02 U	0.037 U
	6/2015	1.1	2.7	0.02 U	0.03	0.037 U
	11/2015	0.9	2.5	0.02 U	0.02	0.038
	5/2016	1.1	2.7	0.02 U	0.02	0.040
	11/2016	1.0	3.1	0.02 U	0.05	0.037 U
	5/2017	0.7	2.2	0.02 U	0.32	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	0%	0%	100%	40%	80%
	Statistic:	15	29	--	22	--
	Probability:	0.205	0.012	--	0.051	--
	Conclusion:	No trend identified	**Increasing Trend**	100% ND	**Probably Increasing**	>50% ND
MW11S1						
	11/2012	0.5 U	22.2	0.02 U	0.02 U	0.224
	5/2013	0.5 U	31.5	0.02 U	0.02 U	0.266
	10/2013	0.5 U	42.1	0.02 U	0.02 U	0.287
	5/2014	0.5 U	28.0	0.02 U	0.02 U	0.271
	11/2014	0.5 U	19.8	0.02 U	0.02 U	0.273
	6/2015	0.5 U	12.8	0.02 U	0.02 U	0.194
	11/2015	0.5 U	11.0	0.02 U	0.02 U	0.164
	5/2016	0.5 U	7.0	0.02 U	0.03	0.207
	11/2016	0.5 U	6.2	0.02 U	0.02 U	0.155
	5/2017	0.5 U	2.3	0.02 U	0.02 U	0.152
	Samples:	10	10	10	10	10
	% Non-detects:	100%	0%	100%	90%	0%
	Statistic:	--	-37	--	--	-25
	Probability:	--	0.001	--	--	0.032
	Conclusion:	100% ND	**Decreasing Trend**	100% ND	>50% ND	**Decreasing Trend**

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW12S1A						
	11/2012	3000	10000	29.2	10.0 J	1.40 J
	5/2013	2200	8460			1.25 J
	11/2013	2000	7300	25.0 J	9.08 J	1.38 J
	5/2014	1400	4300	17.2 J	7.9 J	1.03 J
	11/2014	800 / 800	2100 / 2100	9.55 J / 8.43 J	5.69 J / 5.27 J	0.592 J / 0.601 J
	6/2015	500	1900	6.71 J	3.66 J	0.573 J
	11/2015	540	1600	5.48	3.15	0.354
	5/2016	740	1690	8.13	4.01	0.535
	11/2016	750	1750	9.55	4.89	0.491
	5/2017	560	1390	7.61	4.29	0.525 J
	Samples:	10	10	9	9	10
	% Non-detects:	0%	0%	0%	0%	0%
	Statistic:	-29	-39	-20	-20	-35
	Probability:	0.012	0.001	0.048	0.048	0.002
MW13S1						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW14S1						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.6	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.9	0.02 U	0.02 U	0.037 U
	5/2017	0.7	0.6	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	90%	70%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	>50% ND	>50% ND	100% ND	100% ND	100% ND
MW15S1						
	5/2013	0.5	18.3	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	24.2	0.02 U	0.02 U	0.042 U
	5/2016	0.6	36.4	0.02 U	0.02 U	0.037 U
	11/2016	0.5	34.4	0.02 U	0.02 U	0.037 U
	5/2017	0.7	45.4	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	20%	0%	100%	100%	100%
	Statistic:	5	8	--	--	--
	Probability:	0.312	0.086	--	--	--
	Conclusion:	No trend identified	**Probably Increasing**	100% ND	100% ND	100% ND

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW16S1						
	5/2017	0.5 U	10.6	0.02 U	0.02 U	0.037 U
	Samples:	1	1	1	1	1
	% Non-detects:	100%	0%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
MW16S1A						
	5/2013	0.5 U	12.0	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	20.3	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	23.7	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	18.6	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	15.3	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	0%	100%	100%	100%
	Statistic:	--	0	--	--	--
	Probability:	--	1.000	--	--	--
	Conclusion:	100% ND	No trend identified	100% ND	100% ND	100% ND
MW17S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.06	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
MW18S1						
	5/2013	38400	152000	1270	230	19 U
	5/2014	42900	160000	855	150	4.52
	6/2015	45000	152000	1120	160	15 U
	5/2016	28500	69300	866	233	7.4 U
	11/2016	42200	103000	1610	180	15 U
	5/2017	23300	55000	1120	290	4.21 J
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	0%	0%	67%
	Statistic:	-5	-10	2	7	--
	Probability:	0.452	0.085	0.848	0.260	--
	Conclusion:	No trend identified	**Probably Decreasing**	No trend identified	No trend identified	>50% ND
MW19S1						
	5/2013	434	176	45.5	39.6	0.37 U
	5/2014	287	62.6	36.5	48.4	0.74 U
	6/2015	1290 J	830.	117	77.0	23.4
	5/2016	2060 / 1950	1610 / 1630	181 / 195	92.4 / 101	35.7 / 29.3
	11/2016	1380	724	120.	88.2	8.29
	5/2017	1430	750.	209	145	16.4
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	0%	0%	33%
	Statistic:	9	5	11	13	6
	Probability:	0.133	0.452	0.060	0.024	0.339

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW20S1						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.03	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	90%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
MW21S1						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2016	0.5 U/0.5 U	0.5 U/0.5 U	0.02 U/0.02 U	0.02 U/0.02 U	0.037 U/0.037 U
	5/2017	3.0	1.6	1.01	11.1	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	90%	90%	90%	90%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	>50% ND	>50% ND	>50% ND	>50% ND	100% ND
MW22S1						
	11/2012	0.5 U	39.0	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	33.6	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	11.0	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	17.4	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	2.6	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	1.5	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	3.2	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	4.8	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	7.8	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U / 0.5 U	21.3 / 14.1	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	0%	100%	100%	100%
	Statistic:	--	-11	--	--	--
	Probability:	--	0.371	--	--	--
	Conclusion:	100% ND	No trend identified	100% ND	100% ND	100% ND
MW24S1						
	5/2013	33.3	91	0.41		0.037 U
	5/2014	21	54	0.22	0.10	0.037 U
	6/2015	13	42.0	0.16	0.07	0.043 U
	5/2016	23.0	48.5	0.15	0.12	0.037 U
	11/2016	18	47.6	0.17	0.11	0.037 U
	5/2017	26.7	82.6	0.31	0.22	0.037 U
	Samples:	6	6	6	5	6
	% Non-detects:	0%	0%	0%	0%	100%
	Statistic:	-1	-3	-3	6	--
	Probability:	1.000	0.707	0.707	0.221	--
	Conclusion:	No trend identified	No trend identified	No trend identified	No trend identified	100% ND

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW25S1						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.06	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.05	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	80%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
MW26S1						
	11/2012	2.5	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	3.9	0.5 U	0.02 U	0.02 U	0.037 U
	11/2013	4.5	0.5	0.02 U	0.02 U	0.037 U
	5/2014	4.4	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	2.6	1.0	0.02 U	0.02 U	0.037 U
	6/2015	3.3	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	4.7	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	8.1	0.5 U	0.02 U	0.02 U	0.037 U
	6/2016	6.7	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	8.3	1.0	0.02 U	0.02 U	0.037 U
	5/2017	7.5	0.5 U	0.02 U	0.02	0.037 U
	Samples:	11	11	11	11	11
	% Non-detects:	0%	73%	100%	91%	100%
	Statistic:	35	--	--	--	--
	Probability:	0.008	--	--	--	--
	Conclusion:	**Increasing Trend**	>50% ND	100% ND	>50% ND	100% ND
MW27S1						
	5/2013	279	14	310	1800	19 U
	6/2014	173	2 U	170	599	7.4 U
	6/2015	158	5 U	130	397	7.4 U
	5/2016	5190	1600	2020	5520	7.4 U
	11/2016	4350	1310	2040	3590	37 U
	5/2017	2660	830	1730	2310	37 U
	Samples:	6	6	6	6	6
	% Non-detects:	0%	33%	0%	0%	100%
	Statistic:	3	4	5	3	--
	Probability:	0.707	0.566	0.452	0.707	--
	Conclusion:	No trend identified	No trend identified	No trend identified	No trend identified	100% ND
MW28S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.35	0.037 U
	6/2016	0.5 U	0.5 U	0.02 U	0.10	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.08	0.12	0.037 U
	Samples:	7	7	7	7	7
	% Non-detects:	100%	100%	86%	57%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	>50% ND	>50% ND	100% ND

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW29S1						
	5/2013	0.5 U	88.8	0.02 U	0.10 U	0.191
	5/2014	0.8	18.9	0.02 U	0.02 U	0.243
	6/2015	0.9	17.2	0.02 U	0.02 U	0.232
	5/2016	0.7	15.9	0.02 U	0.02 U	0.199
	11/2016	0.9	12.8	0.02 U	0.02 U	0.211
	5/2017	0.9	34.1	0.02 U	0.02 U	0.232
	Samples:	6	6	6	6	6
	% Non-detects:	17%	0%	100%	100%	0%
	Statistic:	8	-7	--	--	2
	Probability:	0.188	0.260	--	--	0.848
	Conclusion:	No trend identified	No trend identified	100% ND	100% ND	No trend identified
MW30S1						
	11/2012	0.5 U	1.8	0.02 U	0.02 U	0.154
	5/2013	0.5 U	2.3	0.02 U	0.02 U	0.145
	11/2013	0.6	3.3	0.02 U	0.02 U	0.195
	5/2014	0.7	3.4	0.02 U	0.02 U	0.128
	11/2014	0.5 U	2.6	0.02 U	0.02 U	0.128
	6/2015	0.6	3.6	0.02 U	0.02 U	0.146
	11/2015	0.5 J	4.3	0.02 U	0.02 U	0.103
	5/2016	0.7	5.3	0.02 U	0.02 U	0.164
	11/2016	0.5 U	4.1	0.02 U	0.02 U	0.165
	5/2017	0.7 J	6.3	0.02 U	0.02 U	0.184
	Samples:	10	10	10	10	10
	% Non-detects:	40%	0%	100%	100%	0%
	Statistic:	13	37	--	--	8
	Probability:	0.264	0.001	--	--	0.530
	Conclusion:	No trend identified	**Increasing Trend**	100% ND	100% ND	No trend identified
MW31S1						
	11/2012	2 U	114	0.02 U	0.02 U	0.302
	5/2013	2 U	141	0.02 U	0.02 U	0.292
	10/2013	2 U	154	0.02 U	0.02 U	0.370
	5/2014	2 U	175	0.02 U	0.02 U	0.260
	11/2014	5 U	140.	0.02 U	0.02 U	0.271
	6/2015	2 U	158	0.02 U	0.02 U	0.268
	11/2015	2 U	121	0.02 U	0.02 U	0.263
	5/2016	2 U	110.	0.02 U	0.02 U	0.342
	11/2016	2 U	84.6	0.02 U	0.02	0.363
	5/2017	2 U	68.0	0.02 U	0.04	0.336
	Samples:	10	10	10	10	10
	% Non-detects:	100%	0%	100%	80%	0%
	Statistic:	--	-21	--	--	3
	Probability:	--	0.074	--	--	0.858
	Conclusion:	100% ND	**Probably Decreasing**	100% ND	>50% ND	No trend identified
MW32S1						
	5/2013	4.5	3.4	0.02 U	0.02 U	0.597
	5/2014	5.7	4.1	0.02 U	0.02 U	0.632
	6/2015	4.8	11.0	0.02 U	0.02 U	0.682
	5/2016	5.1	42.6	0.02 U	0.03	1.04
	11/2016	4.8	40.3	0.02 U	0.02 U	0.825
	5/2017	4.4	34.5	0.02 U	0.02 U	1.06
	Samples:	6	6	6	6	6
	% Non-detects:	0%	0%	100%	83%	0%
	Statistic:	-4	9	--	--	13
	Probability:	0.566	0.133	--	--	0.024
	Conclusion:	No trend identified	No trend identified	100% ND	>50% ND	**Increasing Trend**

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW114S1						
	5/2013	2.6	0.5 U	0.02 U	0.02 U	0.335
	5/2014	3.8	0.5 U	0.02 U	0.02 U	0.449
	6/2015	3.2	0.5 U	0.02 U	0.02 U	0.424
	5/2016	3.7	0.5 U	0.02 U	0.02	0.391
	11/2016	2.3	0.5 U	0.02 U	0.02 U	0.345
	5/2017	2.8	0.5 U	0.02 U	0.02 U	0.494
	Samples:	6	6	6	6	6
	% Non-detects:	0%	100%	100%	83%	0%
	Statistic:	-3	--	--	--	3
	Probability:	0.707	--	--	--	0.707
	Conclusion:	No trend identified	100% ND	100% ND	>50% ND	No trend identified
MW130S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW132S1						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U / 0.5 U	0.5 U / 0.5 U	0.02 U / 0.02 U	0.02 U / 0.02 U	0.037 U / 0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW135S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.03	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	5	5	5	5	5
	% Non-detects:	100%	100%	100%	80%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW137S1						
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW137S2						
	10/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW140S1						
	11/2012	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	10/2013	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	10	10	10	10	10
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND
MW146S1						
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	100%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	100% ND	100% ND

Table 2

Monitoring Data and Trend Test Results - Deep (S1) Screened Sand Unit
Occidental Chemical Corporation
Wichita, Kansas

Sample Location	Sample Date	Tetrachloroethene (µg/L)	Carbon tetrachloride (µg/L)	Hexachloroethane (µg/L)	Hexachlorobutadiene (µg/L)	beta-BHC (µg/L)
MW147S1						
	11/2014	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	6/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	11/2015	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2016	0.5 U	0.5 U	0.02 U	0.05	0.037 U
	11/2016	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	5/2017	0.5 U	0.5 U	0.02 U	0.02 U	0.037 U
	Samples:	6	6	6	6	6
	% Non-detects:	100%	100%	100%	83%	100%
	Statistic:	--	--	--	--	--
	Probability:	--	--	--	--	--
	Conclusion:	100% ND	100% ND	100% ND	>50% ND	100% ND
MW148S1						
	11/2014	0.9	0.6	0.02 U	0.02 U	0.173
	6/2015	0.6	0.7	0.02 U	0.02 U	0.170
	11/2015	0.7	0.8	0.02 U	0.02 U	0.132
	5/2016	0.5 U	0.7	0.02 U	0.02 U	0.139
	11/2016	0.6	0.7 J	0.02 U	0.02 U	0.142
	5/2017	0.6 / 0.7	0.7 / 0.9	0.02 U / 0.02 U	0.02 U / 0.02 U	0.186 / 0.218
	Samples:	6	6	6	6	6
	% Non-detects:	17%	0%	100%	100%	0%
	Statistic:	-4	7	--	--	1
	Probability:	0.566	0.227	--	--	1.000
	Conclusion:	No trend identified	No trend identified	100% ND	100% ND	No trend identified

Table 3

Summary of Trend Test Results and Monitoring Optimization Recommendations
Occidental Chemical Corporation
Wichita, Kansas

		Trend Test Results Considering Last 5 years (Fall 2012-Spring 2017)					Monitoring Optimization Recommendation		
Aquifer	**Well Name**	**Tetrachloroethene**	**Carbon tetrachloride**	**Hexachloroethane**	**Hexachlorobutadiene**	**beta-BHC**	**Monitoring Well Role**	**Current Frequency**	**Proposed Frequency**
S1	AMW4D	No trend identified	>50% ND	100% ND	No trend identified	100% ND	Edge of plume	Semi-annual	Annual
	AMW5D	>50% ND	100% ND	100% ND	No trend identified	100% ND	Boundary	Semi-annual	Annual
	AMW8D	100% ND	100% ND	100% ND	>50% ND	100% ND	Sentinel	Annual	Not regularly monitored
	AMW16D	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	AMW102D	100% ND	100% ND	100% ND	100% ND	100% ND	Sentinel	Annual	Not regularly monitored
	AMW106D	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Sentinel	Semi-annual	Not regularly monitored
	AMW107D	100% ND	100% ND	100% ND	>50% ND	100% ND	Sentinel	Semi-annual	Biennial
	AMW108D	100% ND	100% ND	>50% ND	100% ND	100% ND	Sentinel	Annual	Not regularly monitored
	APMW302S1	No trend identified	No trend identified	100% ND	100% ND	100% ND	Edge of plume	Semi-annual	Annual
	IW29	No trend identified	No trend identified	No trend identified	No trend identified	100% ND	Interior of plume	Annual	Annual
	IW36	No trend identified	No trend identified	No trend identified	No trend identified	No trend identified	Interior of plume	Annual	Annual
	MW02S1	100% ND	**Increasing Trend**	100% ND	100% ND	>50% ND	Interior of plume	Annual	Semi-annual
	MW03S1	100% ND	100% ND	100% ND	>50% ND	No trend identified	Edge of plume	Semi-annual	Annual
	MW06S1	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Not regularly monitored
	MW07S1	No trend identified	No trend identified	No trend identified	No trend identified	>50% ND	Interior of plume	Semi-annual	Biennial
	MW08S1	>50% ND	No trend identified	100% ND	100% ND	**Decreasing Trend**	Interior of plume	Semi-annual	Biennial
	MW09S1	**Decreasing Trend**	100% ND	100% ND	No trend identified	No trend identified	Interior of plume	Semi-annual	Biennial
	MW10S1	No trend identified	**Increasing Trend**	100% ND	Probably Increasing	>50% ND	Edge of plume	Semi-annual	Semi-annual
	MW11S1	100% ND	**Decreasing Trend**	100% ND	>50% ND	**Decreasing Trend**	Interior of plume	Semi-annual	Biennial
	MW12S1A	**Decreasing Trend**	**Decreasing Trend**	**Decreasing Trend**	**Decreasing Trend**	**Decreasing Trend**	Interior of plume	Semi-annual	Biennial
	MW13S1	100% ND	100% ND	100% ND	100% ND	100% ND	Edge of plume	Semi-annual	Annual
	MW14S1	>50% ND	>50% ND	100% ND	100% ND	100% ND	Interior of plume	Semi-annual	Biennial
	MW15S1	No trend identified	Probably Increasing	100% ND	100% ND	100% ND	Edge of plume	Annual	Semi-annual
	MW16S1	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Interior of plume	New 2017	Semi-annual (interim*)
	MW16S1A	100% ND	No trend identified	100% ND	100% ND	100% ND	Edge of plume	Annual	Annual
	MW17S1	100% ND	100% ND	100% ND	>50% ND	100% ND	Boundary	Annual	Annual
	MW18S1	No trend identified	Probably Decreasing	No trend identified	No trend identified	>50% ND	Interior of plume	Annual	Biennial
	MW19S1	No trend identified	No trend identified	Probably Increasing	**Increasing Trend**	No trend identified	Plume source	Annual	Semi-annual
	MW20S1	100% ND	100% ND	100% ND	>50% ND	100% ND	Boundary	Semi-annual	Not regularly monitored
	MW21S1	>50% ND	>50% ND	>50% ND	>50% ND	100% ND	Edge of plume	Semi-annual	Semi-annual
	MW22S1	100% ND	No trend identified	100% ND	100% ND	100% ND	Interior of plume	Semi-annual	Biennial
	MW24S1	No trend identified	No trend identified	No trend identified	No trend identified	100% ND	Interior of plume	Annual	Biennial
	MW25S1	100% ND	100% ND	100% ND	>50% ND	100% ND	Edge of plume	Semi-annual	Annual
	MW26S1	**Increasing Trend**	>50% ND	100% ND	>50% ND	100% ND	Edge of plume	Semi-annual	Semi-annual
	MW27S1	No trend identified	No trend identified	No trend identified	No trend identified	100% ND	Plume source	Annual	Annual
	MW28S1	100% ND	100% ND	>50% ND	>50% ND	100% ND	Boundary	Annual	Annual
	MW29S1	No trend identified	No trend identified	100% ND	100% ND	No trend identified	Interior of plume	Annual	Biennial
	MW30S1	No trend identified	**Increasing Trend**	100% ND	100% ND	No trend identified	Interior of plume	Semi-annual	Semi-annual
	MW31S1	100% ND	Probably Decreasing	100% ND	>50% ND	No trend identified	Interior of plume	Semi-annual	Biennial
	MW32S1	No trend identified	No trend identified	100% ND	>50% ND	**Increasing Trend**	Edge of plume	Annual	Semi-annual
	MW114S1	No trend identified	100% ND	100% ND	>50% ND	No trend identified	Interior of plume	Annual	Biennial
	MW130S1	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Not regularly monitored
	MW132S1	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Semi-annual	Not regularly monitored
	MW135S1	100% ND	100% ND	100% ND	>50% ND	100% ND	Sentinel	Annual	Biennial
	MW137S1	100% ND	100% ND	100% ND	100% ND	100% ND	Sentinel	Annual	Biennial
	MW137S2	100% ND	100% ND	100% ND	100% ND	100% ND	Sentinel	Semi-annual	Not regularly monitored
	MW140S1	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Semi-annual	Annual
	MW146S1	100% ND	100% ND	100% ND	100% ND	100% ND	Interior of plume	Annual	Not regularly monitored
	MW147S1	100% ND	100% ND	100% ND	>50% ND	100% ND	Boundary	Annual	Not regularly monitored
	MW148S1	No trend identified	No trend identified	100% ND	100% ND	No trend identified	Interior of plume	Annual	Biennial

Table 3

Summary of Trend Test Results and Monitoring Optimization Recommendations
Occidental Chemical Corporation
Wichita, Kansas

		Trend Test Results Considering Last 5 years (Fall 2012-Spring 2017)					Monitoring Optimization Recommendation		
Aquifer	**Well Name**	**Tetrachloroethene**	**Carbon tetrachloride**	**Hexachloroethane**	**Hexachlorobutadiene**	**beta-BHC**	**Monitoring Well Role**	**Current Frequency**	**Proposed Frequency**
S2/S3	AEW-10	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	< n/a >	< None >	< None >
	AMW1	100% ND	100% ND	100% ND	>50% ND	100% ND	Sentinel	Biennial	Biennial
	AMW4S	Probably Increasing	>50% ND	100% ND	100% ND	100% ND	Sentinel	Semi-annual	Semi-annual
	AMW5S	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	AMW8S	100% ND	100% ND	>50% ND	>50% ND	100% ND	Sentinel	5-years	Not regularly sampled
	AMW16S	100% ND	100% ND	100% ND	>50% ND	100% ND	Sentinel	5-years	Not regularly sampled
	AMW101D	100% ND	100% ND	>50% ND	>50% ND	100% ND	Sentinel	5-years	Not regularly sampled
	AMW101I	100% ND	100% ND	100% ND	>50% ND	100% ND	Sentinel	5-years	Not regularly sampled
	AMW102S	100% ND	100% ND	100% ND	100% ND	100% ND	Sentinel	5-years	Not regularly sampled
	AMW105S	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	AMW106S	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Sentinel	Semi-Annual	Semi-annual (interim*)
	AMW107S	100% ND	**Decreasing Trend**	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	AMW108S	100% ND	100% ND	100% ND	100% ND	100% ND	Sentinel	5-years	Not regularly sampled
	APMW302S2	100% ND	100% ND	100% ND	>50% ND	100% ND	Sentinel	5-years	Not regularly sampled
	APMW302S3	Probably Increasing	**Decreasing Trend**	100% ND	100% ND	100% ND	Sentinel	Semi-annual	Semi-annual
	Builders Well	Probably Decreasing	**Decreasing Trend**	100% ND	100% ND	No trend identified	Edge of plume	Annual	Annual
	Dieffenbacher	100% ND	Probably Increasing	100% ND	>50% ND	100% ND	Edge of plume	Semi-annual	Semi-annual
	IW30	No trend identified	No trend identified	No trend identified	No trend identified	>50% ND	Interior of plume	5-years	Not regularly sampled
	IW31	No trend identified	Probably Increasing	No trend identified	No trend identified	100% ND	Interior of plume	Semi-annual	Semi-annual
	IW32	No trend identified	No trend identified	No trend identified	No trend identified	No trend identified	Edge of plume	Annual	Annual
	IW35A	No trend identified	No trend identified	No trend identified	No trend identified	No trend identified	Edge of plume	5-years	Not regularly monitored
	IW35B	No trend identified	No trend identified	No trend identified	No trend identified	No trend identified	Edge of plume	Annual	Annual
	IW40	>50% ND	**Increasing Trend**	>50% ND	>50% ND	>50% ND	Edge of plume	Semi-annual	Semi-annual
	IW41	100% ND	100% ND	>50% ND	>50% ND	No trend identified	Edge of plume	Annual	Annual
	IW42	100% ND	100% ND	>50% ND	>50% ND	No trend identified	Edge of plume	Annual	Annual
	IW43	>50% ND	No trend identified	**Decreasing Trend**	>50% ND	No trend identified	Edge of plume	Annual	Annual
	IW44	100% ND	No trend identified	>50% ND	>50% ND	100% ND	Edge of plume	5-years	Not regularly monitored
	IW45	100% ND	**Increasing Trend**	100% ND	>50% ND	>50% ND	Edge of plume	Semi-annual	Semi-annual
	IW46	100% ND	**Increasing Trend**	100% ND	>50% ND	100% ND	Edge of plume	Semi-annual	Semi-annual
	MW01S2/S3	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	n/a	< None >	< None >
	MW02S2	**Decreasing Trend**	No trend identified	>50% ND	No trend identified	No trend identified	Boundary	Annual	Annual
	MW02S3	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	n/a	< None >	< None >
	MW04S1	100% ND	100% ND	>50% ND	>50% ND	100% ND	Edge of plume	5-years	Not regularly monitored
	MW04S3	100% ND	100% ND	100% ND	>50% ND	No trend identified	Edge of plume	5-years	Not regularly monitored
	MW05S3	100% ND	100% ND	100% ND	>50% ND	Probably Increasing	Edge of plume	Semi-annual	Semi-annual
	MW06S3	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW07S2	100% ND	**Decreasing Trend**	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW07S3	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW08S2	**Decreasing Trend**	No trend identified	100% ND	>50% ND	Probably Increasing	Edge of plume	Semi-annual	Semi-annual
	MW08S3	**Decreasing Trend**	**Decreasing Trend**	100% ND	100% ND	No trend identified	Interior of plume	Annual	Biennial
	MW09S3	**Decreasing Trend**	**Decreasing Trend**	100% ND	100% ND	100% ND	Edge of plume	Annual	Annual
	MW10S2	**Decreasing Trend**	**Increasing Trend**	100% ND	100% ND	100% ND	Edge of plume	Semi-annual	Semi-annual
	MW10S3	100% ND	100% ND	100% ND	>50% ND	>50% ND	Boundary	Annual	Annual
	MW11S3A	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW11S3B	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Boundary	Semi-Annual	< None > †
	MW12S3	No trend identified	No trend identified	No trend identified	No trend identified	No trend identified	Interior of plume	Biennial	Biennial
	MW13S3	100% ND	No trend identified	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW14S3	**Decreasing Trend**	**Decreasing Trend**	No trend identified	No trend identified	No trend identified	Edge of plume	Annual	Annual
	MW15S2	100% ND	**Decreasing Trend**	**Decreasing Trend**	>50% ND	**Decreasing Trend**	Edge of plume	Annual	Annual
	MW16S2PVC	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	n/a	< None >	< None >
	MW16S2SS	No trend identified	**Decreasing Trend**	>50% ND	100% ND	**Decreasing Trend**	Edge of plume	Annual	Annual
	MW16S3	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	n/a	< None >	< None >

Table 3

Summary of Trend Test Results and Monitoring Optimization Recommendations
Occidental Chemical Corporation
Wichita, Kansas

		Trend Test Results Considering Last 5 years (Fall 2012-Spring 2017)					Monitoring Optimization Recommendation		
Aquifer	**Well Name**	**Tetrachloroethene**	**Carbon tetrachloride**	**Hexachloroethane**	**Hexachlorobutadiene**	**beta-BHC**	**Monitoring Well Role**	**Current Frequency**	**Proposed Frequency**
S2/S3	MW17S3A	100% ND	100% ND	>50% ND	No trend identified	100% ND	Boundary	Annual	Annual
	MW17S3B	100% ND	100% ND	>50% ND	>50% ND	100% ND	Edge of plume	Annual	None †
	MW18S3	No trend identified	No trend identified	No trend identified	No trend identified	No trend identified	Plume source	3-years	Biennial
	MW19S2	No trend identified	No trend identified	No trend identified	No trend identified	No trend identified	Plume source	Annual	Annual
	MW19S3	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	n/a	< None >	< None >
	MW20S3	100% ND	**Decreasing Trend**	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW21S3	100% ND	**Increasing Trend**	100% ND	100% ND	100% ND	Edge of plume	Semi-annual	Semi-annual
	MW22S2	100% ND	**Decreasing Trend**	No trend identified	100% ND	No trend identified	Edge of plume	5-years	Not regularly monitored
	MW24S3	No trend identified	No trend identified	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW26S3	100% ND	100% ND	100% ND	>50% ND	No trend identified	Sentinel	Biennial	Biennial
	MW27S2	No trend identified	No trend identified	No trend identified	No trend identified	100% ND	Plume source	3-years	Biennial
	MW28S2	100% ND	100% ND	100% ND	>50% ND	No trend identified	Boundary	Annual	Annual
	MW28S3	100% ND	No trend identified	No trend identified	>50% ND	No trend identified	Boundary	Annual	Annual
	MW29S2	No trend identified	100% ND	100% ND	>50% ND	No trend identified	Boundary	Annual	Annual
	MW29S3	No trend identified	100% ND	100% ND	100% ND	No trend identified	Boundary	Annual	Annual
	MW30S2	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Interior of plume	< None >	Biennial
	MW30S3	100% ND	No trend identified	No trend identified	No trend identified	**Increasing Trend**	Interior of plume	Semi-annual	Semi-annual
	MW113S3	Probably Decreasing	**Decreasing Trend**	Probably Decreasing	Probably Decreasing	No trend identified	Plume source	Annual	Annual
	MW130S2	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW130S3	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW131S2	100% ND	100% ND	100% ND	100% ND	**Increasing Trend**	Edge of plume	Semi-annual	Semi-annual
	MW131S3	100% ND	100% ND	100% ND	100% ND	No trend identified	Edge of plume	Annual	Annual
	MW132S2/S3	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW133S2/S3	100% ND	100% ND	100% ND	>50% ND	100% ND	Boundary	Annual	Annual
	MW134S2	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW134S3	100% ND	100% ND	100% ND	>50% ND	100% ND	Boundary	Annual	Annual
	MW135S2/S3	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW136S2/S3	100% ND	100% ND	>50% ND	>50% ND	100% ND	Boundary	Annual	Annual
	MW137S3	100% ND	No trend identified	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW138S1	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW138S2/S3	100% ND	**Decreasing Trend**	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW139S2/S3	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW140S2/S3	100% ND	**Decreasing Trend**	**Decreasing Trend**	100% ND	100% ND	Boundary	Annual	Annual
	MW141S2/S3	No trend identified	No trend identified	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW142S2/S3	100% ND	100% ND	100% ND	>50% ND	100% ND	Boundary	Annual	Annual
	MW143S2/S3	100% ND	**Decreasing Trend**	100% ND	100% ND	**Decreasing Trend**	Edge of plume	Annual	Annual
	MW144S2/S3	100% ND	100% ND	100% ND	100% ND	100% ND	Boundary	Annual	Annual
	MW145S2/S3	100% ND	100% ND	100% ND	>50% ND	**Increasing Trend**	Edge of plume	Semi-annual	Semi-annual
	MW147S2/S3	No trend identified	No trend identified	100% ND	>50% ND	100% ND	Boundary	Annual	Annual
	MW148S2/S3	No trend identified	**Increasing Trend**	100% ND	100% ND	**Decreasing Trend**	Interior of plume	Semi-annual	Semi-annual
	MW149S2/S3	**Increasing Trend**	100% ND	100% ND	>50% ND	No trend identified	Interior of plume	Semi-annual	Semi-annual

Notes

* New wells with too few observations to evaluate should be sampled on a semi-annual basis until 5 data points are available, then their monitoring requirements re-evaluated.

† No longer needed for chemical or hydraulic monitoring

Appendix B
DNAPL Mobility and Recoverability Pilot Study

Appendix B DNAPL Mobility and Recoverability Pilot Study

1. Purpose

The DNAPL Mobility and Recoverability Pilot Study evaluated the mobility and potential recoverability of dense non-aqueous phase liquids (DNAPLs) at the Site. Two wells exist on Site that are known to contain DNAPL (MW27S1 and MW27S2) (**Figure 5**), and which are centrally located and representative of two of the most impacted zones at the Facility. Therefore, these wells were selected as the locations of the Pilot Study. Well construction details are provided in **Table B.1**.

Table B.1 Well Construction Details – Pilot Study Wells

Well Identifier	Installation Date	Sand Unit	Northing NAD83 State Plane (KS South) ft.	Easting NAD83 State Plane (KS South) ft	Top of Casing Elev. ft. AMSL	Total Depth ft. bgs	Dia. in.	Top of Screen ft. bgs	Base of Screen ft. bgs
MW27S1	8/16/1977	S1	1648205.2650	1624309.9120	1309.23	109	6	97	107
MW27S2	10/6/1977	S2/S3	1648206.8451	1624317.3679	1309.49	87	6	77	83

In order for DNAPL recovery to be feasible, two conditions must be met. First, DNAPL must be able to be recovered from wells at a reasonable rate. Second, the rate must be maintained over a period long enough to recover a significant portion of the DNAPL present. This Pilot Study set out to determine the DNAPL recovery rates that could be achieved at the site and then determine the significance of these DNAPL recovery rates with regard to the volume and location of the DNAPL present at the site.

In order to gather baseline data, the Pilot Study was conducted in two phases:

- Phase 1 – Initial recovery rates of DNAPL were gauged during a preliminary phase that was conducted over 4 days. Phase 1 fieldwork was conducted to gauge the order of magnitude of the DNAPL recovery rate, given that no DNAPL recovery rate data were previously available and this value is difficult to estimate theoretically. Phase 1 also allowed the collection of data on the initial maximum DNAPL recovery rate at the two wells MW27S1 and MW27S2.
- Phase 2 – Field activities were conducted to gather data to provide insight into the attenuation rate of this initial maximum DNAPL recovery rate. That is, as more DNAPL is removed, it is expected that the rate of recovery will decline with time, and it is this attenuation that the Phase 2 work attempted to estimate.

2. Pilot Test Location, Geology, and Background

A comprehensive discussion of Site geology and hydrogeology is provided in the report entitled Phase 2 Groundwater Report and are not replicated here. The S2/S3 aquifer is the principal aquifer system at the Site and generally overlies the C1 clay layer. The S2/S3 aquifer is regionally extensive. The S2 and S3

aquifer units are in hydraulic connection. The S1 aquifer appears to be a confined aquifer which overlies the shale bedrock aquitard. The S1 aquifer is separated from the overlying S2/S3 aquifer by the C1 clay layer. The Groundwater Interim Corrective Measure (ICM) consists of 14 interceptor wells screened in the two aquifer zones to maintain cones of depression within the aquifers to prevent the migration of contaminants. The ongoing effectiveness of the Groundwater ICM has been confirmed through the semi-annual groundwater gauging and sampling events.

The DNAPL source areas at the site are associated with historical waste disposal practices. The chemical makeup and areal extent of DNAPL within the Site have been determined (**Figure 28**). DNAPL was observed extending through the saturated zone in four areas at the site: Eastern Hex Area, Northwestern Hex Area, Landfill Hex Area, and CT and Perc Area. The primary compounds that occur with DNAPL at the Site are carbon tetrachloride, chloroform, perchloroethylene, pentachlorophenol, hexachlorobenzene, hexachlorobutadiene, hexachloroethane, and benzene hexachloride. The dissolved-phase concentrations originating from the identified DNAPL sources are addressed on an ongoing basis by the Groundwater ICM, discussed above.

DNAPL mass and volume are difficult to estimate, and it is unlikely that more than an order of-magnitude estimate will ever be possible. OCC has performed a calculation that provides a rough order of magnitude estimate of the volume of DNAPL at the site. For this calculation, the depths of DNAPL in monitoring wells in which DNAPL has been historically observed in the S1, S2, and S3 units.[1] were assumed to represent the depth of DNAPL within that unit. The order-of-magnitude estimate was performed by combining these data with estimates of the DNAPL-impacted areas from the CMS Report (Figure 15) and general assumptions as to the porosity of the unit and the percentage of the pore space occupied by DNAPL. The table below presents the estimated volume of the potential DNAPL at the site.

Table B.2 Estimated Volume of Potential DNAPL On-Site

Order of Magnitude Estimate of DNAPL Volume at the Site							
Aquifer	Surface Area (ft^2)		MW Containing DNAPL	DNAPL Observed[1] (ft)	Assumed Porosity (-)	Assumed % of DNAPL in pore space	Volume (ft^3)
	Hex	PCE					
S4	107,000	12,000	None	0	0.35	-	-
S2	345,000	156,000	MW-19S3	0.33	0.35	50	29,000
S3	345,000	156,000	MW-27S2	4.57	0.35	50	400,000
S1	135,000	69,000	MW-27S1	2.27	0.35	50	81,000
							500,000

Based on the calculations above, OCC has estimated that an order-of-magnitude volume of DNAPL present in the subsurface to be approximately 4 million gallons. Of this volume, it is expected that approximately less than 1% to 5% of the 4 million gallons of DNAPL may be mobile, but the data needed to refine this estimate won't be available until DNAPL recovery operations begin.

The Pilot Study field activities were conducted on wells MW27S1and MW27S2 (**Figure 5**), where DNAPL had been observed in semi-annual groundwater monitoring events. DNAPL thicknesses in each well have ranged from several inches to several feet in multiple semi-annual gauging events. Monitoring well

[1] Data obtained from the Spring 2016 Semi-Annual Groundwater Sampling Event.

construction details for each well are provided in **Table B.1**. During the Pilot Study, the geology in the vicinity of these two monitoring wells was found to be sufficiently representative of Site conditions, and the location and nature of the DNAPL encountered was deemed representative of the broader DNAPL-impacted area at the Site.

3. Pilot Study Methodology

The field activities for both wells were accomplished in two phases: Phase 1 included a relatively short time period (approximately 4 days) of field data collection. As discussed above, Phase 1 data was collected to determine the order of magnitude of the DNAPL recovery rates and to provide an initial estimate of the maximum initial DNAPL recovery rate. Phase 2 included field data collection over a longer time period, and this data was collected to estimate the attenuation of the DNAPL recovery rate. The procedures for Phase 1 and Phase 2 field data collection for each well are outlined below. The additional information on the methodology are presented in **Appendix A** of the CMS Work Plan.

4. Phase 1 Methodology and Results

The following protocol was used to collect Phase 1 data:

1. Site and contractor-specific health and safety requirements for the work were followed.
2. The well cap was removed to allow the pressure to stabilize for approximately half an hour. The water level was measured frequently with a battery-operated water level indicator to ensure that stabilization of the water level had occurred. Once the water level had stabilized (i.e., was static), the static water level was documented in the field logbook.
3. A weighted cord or tape coated with indicator paste was used to measure the total depth of the well and the DNAPL thickness. The total well depth and DNAPL thickness were recorded in the field logbook. The tape was then decontaminated.
4. A low-flow DNAPL-rated submersible pump (Xitech 2-inch piston pump or QED Eliminator bladder pump) was installed into the well, and the pump inlet was placed approximately 0.3 feet above the bottom of the well sump.
5. The water level was verified to have equilibrated utilizing the procedure in Step 2, and was documented in the field logbook.
6. The DNAPL thickness was verified and recorded utilizing the procedure in Step 3.
7. The inside diameter of the well casing was measured to calculate the volume of DNAPL in the well.
8. The pumping rate was set to a flow rate between 0.5 and 1.0 liter per minute, and the static water level and DNAPL thickness was immediately recorded utilizing the procedures in Steps 2 and 3.
9. The DNAPL was pumped until approximately 90% of the volume of DNAPL had been removed; the static water level and DNAPL thickness were verified utilizing the procedure in Steps 2, 3, and 7.
10. Once 90% of the DNAPL volume had been removed, the static water level and DNAPL thickness were measured as outlined in Steps 2 and 3 at the following intervals:

a. Once every 15 minutes for the first hour
The Project Manager was contacted immediately after the data from the first hour of the test was collected to confirm the discharge rates, DNAPL thicknesses, and water level elevations. Based upon the initial data, the following gauging schedule was adjusted. (Note: the first event was at the time that the 90 percent volume reduction was confirmed.)

b. Once every 1 hour for the next 4 hours.

c. Once every 4 hours for the next 16 hours.

d. Once every 16 hours for the next 64 hours.

11. All equipment was removed and decontaminated. The well cap was replaced.

12. All liquid investigation--derived waste was containerized as it was produced and disposed on Site via deep well disposal.

13. The flow rates for each of the interceptor wells during the testing period were obtained and documented.

To obtain initial data on potential DNAPL recovery rates, DNAPL was removed from each of the two recovery wells on four occasions using four recovery periods between tests, following the methodology discussed above. Specifically, during the first test sequence, approximately one well volume of DNAPL was removed every 15 minutes for 1 hour, giving 15 minutes for DNAPL to move back into the well prior to the next DNAPL removal. During the second test sequence, approximately one well volume of DNAPL was recovered every hour for 4 hours, giving 1 hour for DNAPL to move back into the well prior to the next DNAPL removal. During the third test sequence, approximately one well volume of DNAPL was recovered every 4 hours for 16 hours. Finally, approximately one well volume of DNAPL was recovered every 16 hours for 64 hours. Basically, most all the DNAPL in a well was recovered, and the well was allowed to recover for 15 minutes, 1 hour, 4 hours, or 16 hours, prior to removing all the DNAPL from the well again, and so on, until the DNAPL had been removed and allowed to recover four times.

For the longer recovery periods (4 and 16 hours), DNAPL was observed to return to (at least) the initial height after about 120 minutes. Given that the height of the DNAPL in the well was measured over time as the DNAPL returned to the well, the DNAPL recovery rate could be measured. The highest recovery rates, which occurred in the 15-minute test sequence, are the "initial maximum recovery rates," which are not attenuated. The average of the four 15-minute recovery rates for each well were 0.12 gallons per minute (gpm) for MW27S1 and 0.20 gpm for MW27S2 (**Table B.2**). These values represent an estimate of the initial maximum recovery rates that could be expected at the beginning of a DNAPL recovery effort, and they provide baseline data for the second phase of the Pilot Study which was performed to understand potential attenuation with continued recovery.

Table B.3 Average Recovery Rates in MW27S1 and MW27S2

			MW27S1		MW27S2	
Test Sequence	Elapsed Time min	Delta Time min	Product Volume gal	Flow Rate gpm	Product Volume gal	Flow Rate gpm
1	15	15	1.40	0.093	2.61	0.174
1	30	15	1.67	0.112	2.83	0.189
1	45	15	1.89	0.126	3.14	0.210
1	60	15	2.13	0.142	3.45	0.230
		Test Sequence Average		0.12		0.20

5. Phase 2 Methodology and Results

The following protocol was used to collect Phase 2 data:

1. The wells were monitored every other week for 12 weeks when the following activities were performed:
   a. Static water level and DNAPL thickness were measured as outlined in Phase 1 Steps 1, 2, and 3.
   b. Phase 1 Steps 4 through 8 above were performed.
   c. Phase 1 Steps 10, 11, and 12 above were performed.
2. 2. The Project Manager was contacted immediately after the data was collected to confirm the discharge rates, DNAPL thicknesses, and water level elevations.

Conceptually, as DNAPL is removed from the subsurface, the rate at which future recovery occurs should decline (attenuate). DNAPL was continuously removed from each recovery well, and the rate at which recovery occurred was measured over time to estimate an attenuation trend. Three outcomes were anticipated: (i) no change in recovery rate over the timeframe of testing, (ii) no recovery after initial recovery, or (iii) a reduction in recovery rate with time. Thus, in order to estimate the attenuation rate of the "initial maximum recovery rate" measured in Phase 1 of the Pilot Study, longer term DNAPL recovery tests were performed using the same wells as in Phase 1.

DNAPL was removed from the recovery well continuously, and the recovered volume was measured every 15 minutes. Recovery wells were allowed to recover overnight after each day's recovery test, prior to starting a new recovery test the next day. Several constraints were encountered during field testing: (i) lightning interrupted Phase 2 testing on two occasions, (ii) after the first day of Phase 2 testing, a graduated measuring device was used to obtain a measurement to ±5 milliliters (mL) (on the first day, measurements were ±25 mL), and (iii) periodically, especially at the beginning of testing, water entered the pumping tubing instead of DNAPL and a disruption occurred until DNAPL recovery could be reestablished. Because DNAPL flow into the recovery wells was not always uniform during the first part of each day's recovery due to water incursion into the recovery line, the 15-minute increments of data were combined into 1-hour groupings for analysis to smooth the recovery curves and reduce noise in the results.

Results of the Phase 2 testing are provided in **Table B.3**. Because the testing procedure was the same, the first test sequence in the Phase 1 tests provided the initial maximum recovery rate, and that first test sequence is labeled Trial 1 for purposes of comparison to Phase 2 results. The remaining trials are from four sequential days of Phase 2 testing, and these trials were labeled Trials 2 through 5. DNAPL was recovered from each well continuously and measured every 15 minutes over the course of a day (generally 4 to 10 hours, depending on the weather conditions as discussed above). The following day after one night's recovery period, recovery testing was reinitiated. To estimate the attenuation rate, GHD performed several calculations to interpret the results:

- Comparison of the recovery rates at the beginning of each day's trial after overnight re-equilibration (daily "initial recovery rate")
- Calculation of the recovery rate at the end of each day's trial (daily "ending recovery rate")
- Calculation of the attenuation rate considering recovery rates over the course of multiple hours of DNAPL recovery during the same test period ("intra-day rate")

6. Initial Recovery Rate Analysis

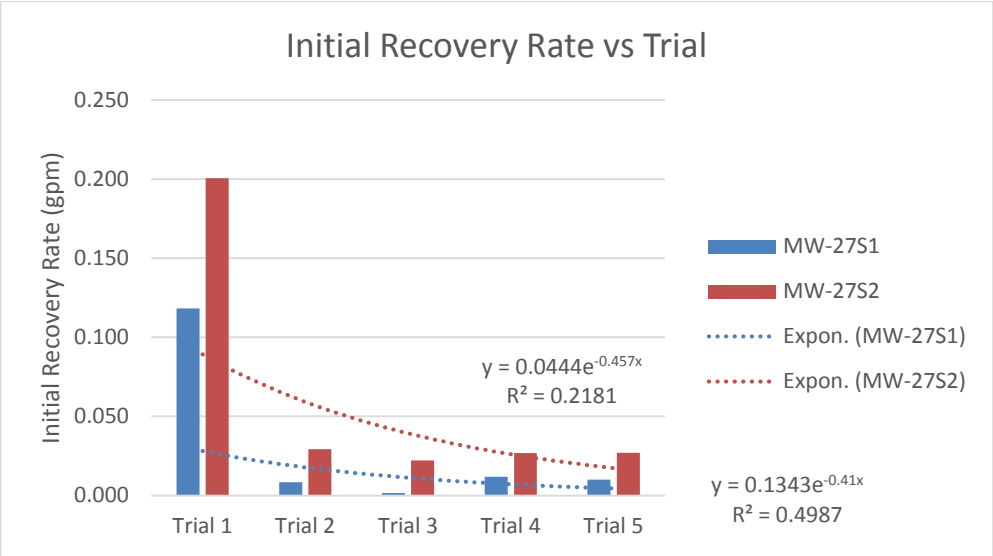
As discussed above, the "initial recovery rates" were not steady, indicating that an initial period of disequilibrium occurred prior to the time when DNAPL flow into the recovery well became more steady, requiring data to be combined into 1-hour increments. Nevertheless, a dramatic decline in recovery rates was observed between Phase 1 and Phase 2 testing, as can be observed by comparing Phase 1 Trial 1 and the remaining Phase 2 Trials 2 to 5. During the Phase 2 Trials, the daily "initial recovery rates" were observed to be relatively constant (i.e., no trend was observed) (**Table B.3 and Figure B.1**). Specifically, the Phase 2 Trial 5 daily "initial recovery rate" is the recovery rate obtained during the first 1-hour measurement during Trial 5. The Phase 2 Trial 5 daily "initial recovery rates" were 0.010 gpm for MW27S1 and 0.027 gpm for MW27S2, approximately an order of magnitude less than the Trial 1 daily "initial recovery rates" of 0.118 gpm for MW27S1 and 0.201 gpm for MW27S2, meaning that recovery of DNAPL in Phase 1 affected the amount of DNAPL available for transport in Phase 2 such that the recovery rates declined by an order of magnitude, but continued DNAPL recovery did not result in much additional attenuation (i.e., Trials 2 to 5 results were similar). These data suggest that the Phase 1 testing, after Trial 1, resulted in the attenuation of the DNAPL recovery rate between Phase 1 and Phase 2, but the Phase 2 testing did not result in a significant decrease in attenuation in the ensuing 4 days of testing. Hence, no quantitative estimate for the rate of attenuation rate for the DNAPL recovery rate with time can be calculated using all of the daily "initial recovery rates" data. Nevertheless, daily "initial recovery rates" associated with Trial 5 can be used as new upper-bounds for the maximum recovery rate for each recovery well, thereby replacing the Phase 1 values. These new "attenuated maximum recovery rates" are 15 gallons per day (gpd) (0.010 gpm) for MW27S1 and 39 gpd (0.027 gpm) for MW27S2. Comparing these values to the original Phase 1 data, the "unattenuated" maximum recovery rates were much higher at 170 gpd and 289 gpd, respectfully.

Table B.4 Phase 2 Data Analysis: Comparison of Initial Recovery Rates

	MW27S1					MW27S2				
	Trial 1* gpm	Trial 2 gpm	Trial 3 gpm	Trial 4 gpm	Trial 5 gpm	Trial 1 gpm	Trial 2 gpm	Trial 3 gpm	Trial 4 gpm	Trial 5 gpm
Recovery Rate Hour 1 "Initial"	0.118	0.008	0.002	0.012	0.010	0.201	0.029	0.022	0.027	0.027

Note:
Trial 1 consists of Phase 1 data, which are directly comparable to Phase 2 data, and these data constitute the "maximum recovery rate".

Figure B.1



7. Ending Recovery Rate Analysis

Next, an attempt was made to compare the Trial 1 to 5 recovery rates at the end of the day. Even with the use of 1-hour recovery rates, no clear pattern was observed in the data from Trials 1 to 5 when the whole dataset was considered, due to initial disequilibrium in DNAPL flow (**Figure B.2**). When testing occurred over periods of less than 5 hours, the "ending recovery rate" was sometimes higher than the initial recovery rate. This was not the case when testing lasted longer than 5 hours. In those cases, the ending recovery rate was less than or the same as the initial recovery rate. Nevertheless, the values at initial recovery rates and ending recovery rates were similar. Recovery rates associated with the final hours of the long-term Trials (>5 hours) were: 0.015 gpm in MW27S1 for Trial 4 and 0.012 gpm and 0.025 gpm for MW27S2 for Trials 3 and 4, respectfully (**Table B.4** and **Figure B.3**). When considering the trend as a whole, these data suggest that there is an initial period of intermittent movement of DNAPL after which DNAPL movement to the well is more steady, but at a declining rate. This trend is discussed in the following section.

Table B.5 Recovery Rates Versus Time

Description	MW27S1					MW27S2				
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Recovery Rate Hour 1 "Initial"	0.118	0.008	0.002	0.012	0.010	0.201	0.029	0.022	0.027	0.027
Recovery Rate Hour 2	0.051	0.008	0.010	0.018	0.031	0.079		0.043	0.038	0.022
Recovery Rate Hour 3	0.035	0.019	0.025	0.012	0.015	0.095		0.015	0.029	0.034
Recovery Rate Hour 4	0.063	0.015	0.019	0.018		0.108		0.033	0.010	0.045
Recovery Rate Hour 5	0.064	0.017		0.010		0.112		0.035	0.020	
Recovery Rate Hour 6				0.024				0.031	0.044	
Recovery Rate Hour 7				0.013				0.023	0.039	
Recovery Rate Hour 8				0.025				0.013	0.027	
Recovery Rate Hour 9				0.007				0.012	0.025	
Recovery Rate Hour 10				0.015						
Average Daily Recovery Rate	--	0.013	0.011	0.016	0.015	0.150	0.029	0.025	0.029	0.030
Recovery Final Hour	--	0.017	0.019	**0.015**	0.015	0.201	0.029	**0.012**	**0.025**	0.045

Figure B.2

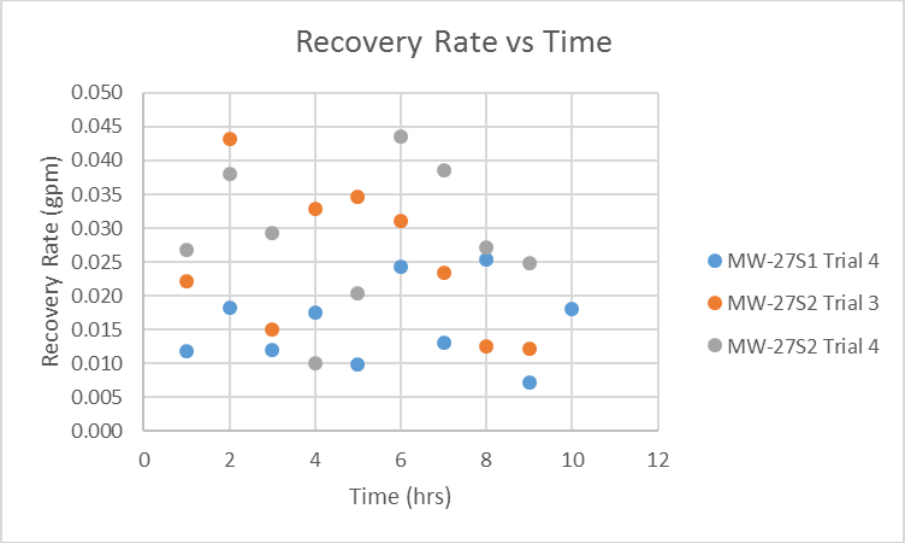
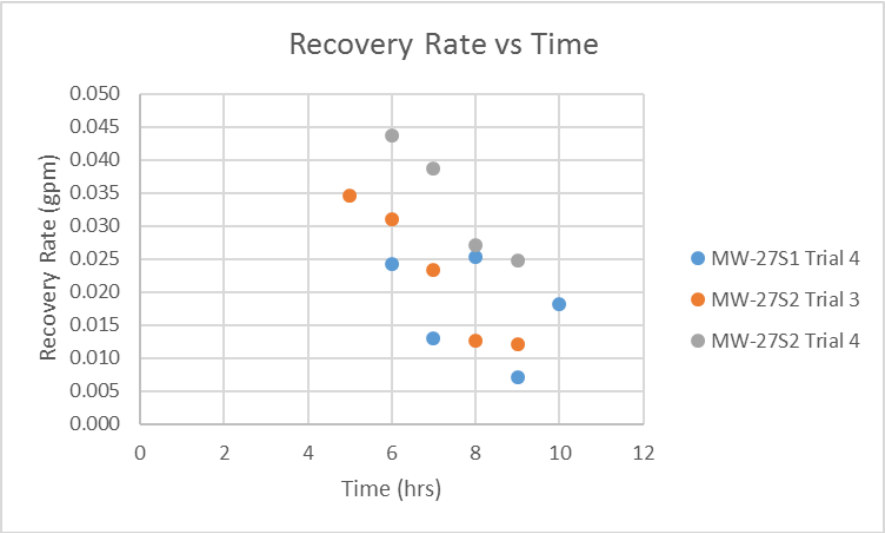


Figure B.3



8. Intra-Day Trend Analysis

Finally, an attempt was made to compare the Trial 1 to 5 recovery rates over the course of the day that they were collected (i.e., intra-day rates). When data were collected for more than 5 hours, a potential trend emerged (**Figures B.4 and B.5**) – in fact the curves produced can be modeled as a first-order decay. The areas under these curves (volume recovered) were calculated for the integrals of fitted exponential lines for each of the long-term curves. The first-order attenuation rates for the recovery rates are 0.119 per hour for Trial 4 at MW27S1, 0.300 per hour for Trial 3 at MW27S2, and 0.204 per hour for Trial 4 at MW27S2. The total volumes that can be recovered based on this calculation are on the order of 20 to 50 gallons. These calculated volumes are low, indicating that the trends calculated are not likely representative over longer periods of time, but would be useful in determining volumes recovered over shorter pumping periods without sufficient recovery time. That is, it appears that the recovery rates attenuate relatively quickly after 5 hours of DNAPL recovery, but, if pumping is pulsed through cycles of pumping and not pumping, the level of DNAPL can recover in the well (meaning the recovery rates measured in this Pilot Study are not sustainable over more than about half a day). Assuming that the DNAPL recovery attenuates over the course of 12 hours of pumping followed by 12 hours without pumping (as described by these curves), pulsed pumping could yield a maximum "half--day" recovery of 17 and 37 gpd (0.011 and 0.025 gpm, respectively, similar to the values calculated by the other methods) – at least until the DNAPL near the well is exhausted. Hence, only half these rates, or 0.005 gpm (9 gpd) and 0.012 gpm (18 gpd), respectively, could actually be achieved due to the need for pulsed pumping. Again, these values provide an estimate of the near-term pumping rates that are achievable, but they do not allow insight into further attenuation in pumping rates as the DNAPL near the well is exhausted (i.e., after pumping for a month or more).

Figure B.4

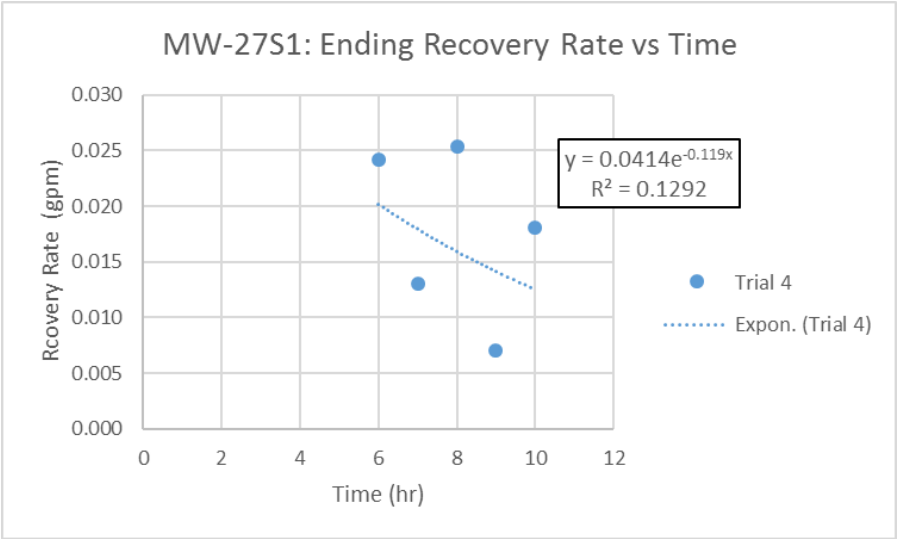
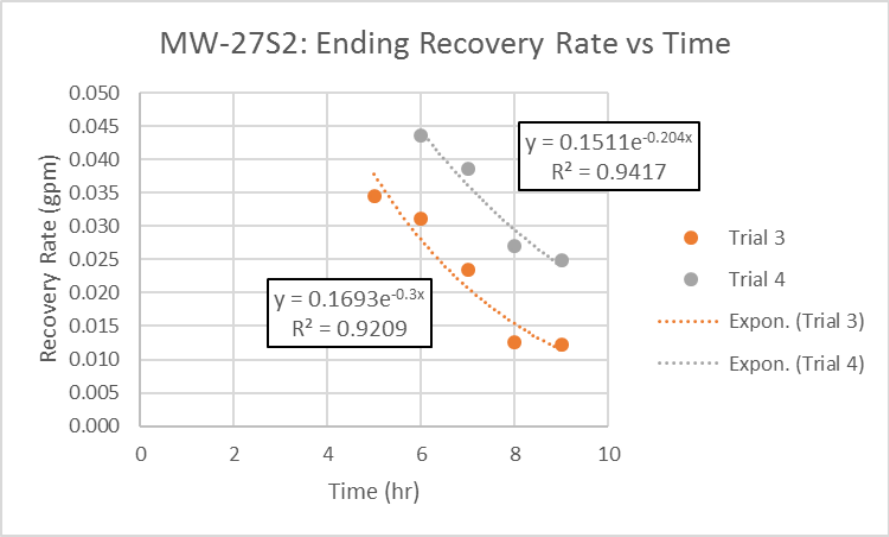


Figure B.5



9. Conclusions

For DNAPL to be mobile, it must be present in the subsurface above the residual saturation point for the porous media. DNAPL present at the residual saturation point in the pore space occurs as a discontinuous phase, where it is trapped by capillary forces and cannot migrate under normal subsurface conditions. Research has shown that, even above the residual saturation level, high density and low viscosity DNAPLs (such as the chlorinated compounds found at this Site) cease migrating in relatively permeable media as soon as a few months to a few years following the time of release, suggesting that only a limited amount of "mobile" DNAPL is present at the Site. This Pilot Study was conducted to assess the presence

and significance of DNAPL present at the Site through the measurement of DNAPL recovery rates, as well as the attenuation of these rates over time.

The "attenuated maximum recovery rates" measured in Phase 2 of the Pilot Study were about an order of magnitude less than the "initial recovery rates" determined in Phase 1, indicating a reduction in DNAPL recovery rates due to attenuation with time (i.e., the DNAPL very near the well is recovered, and the DNAPL remaining in the vicinity of the well is less available). These rates are summarized in **Table B.3.** Additionally, first order attenuation rates were estimated based on available data for these recovery rates using the later results from long-term Trials, namely 0.119 per hour for Trial 4 at MW27S1, 0.300 per hour for Trial 3 at MW27S2, and 0.204 per hour for Trial 4 at MW27S2. These rates appear to be representative of attenuation associated with longer-term, continuous DNAPL removal. These attenuation rates indicate that recovery at the rates provided in **Table B.4** are not sustainable even over a 24-hour period. Finally, even these rates, if implemented in a pulsed fashion, are likely to decrease dramatically once DNAPL located near the recovery well is exhausted. Hence, continuous recovery is not possible at these recovery rates and, at best, a pulse recovery system may be feasible, as will be discussed below.

10. Discussion and Conclusions

Several calculations were performed in order to understand the relevance of the field--measured recovery rates. First, a calculation of the time to recovery of all of the DNAPL mass at the attenuated recovery rates was performed. Assuming approximately 4 million gallons of DNAPL has been released and a recoverable fraction of 1 to 5%, the total recoverable volume would range from about 40,000 to 200,000 gallons. Based on an overall average recovery rate of 0.020 gpm per recovery well (divided by two to account for pulsing the system), DNAPL recovery would take from about 1 to 4 years based on a total number of ten recovery wells. This calculation assumes that the pulsed recovery rate does not attenuate further with time, which is anticipated (see below). A further assumption in this calculation is that recovery wells could be installed throughout the area impacted by DNAPL, which is not the case at this active facility. If the recovery rate attenuates exponentially with time, this time estimate increases exponentially.

An additional calculation was performed to understand what would be required to recover 10,000 gallons of DNAPL (approximately 0.05 percent of the total amount present). The current overall average recovery rate of 27 gpd per well is assumed to for at least 1 year without significant attenuation for this theoretical calculation. Likely, the timeframe would be 2 years, given the need for pulsed pumping. For this volume to be recovered, the radius of influence of each recovery well must be more than 20 feet, assuming an effective porosity of 0.1 and an average depth of 2 feet of DNAPL. Given the limitation on the installation of numerous recovery wells at this active facility, the time to recover any appreciable portion of the DNAPL by direct pumping is on the order of millennia (if it is even possible for the DNAPL to move 20 feet to the recovery well). Furthermore, once the recoverable fraction of the DNAPL is recovered, significant residual DNAPL will remain in place. This indistinguishably smaller volume of DNAPL will provide an on-going source that is little different in terms of either the risk to human health and the environment or the remedial effort needed to contain flux, as compared to the original volume of DNAPL present. Moreover, the current groundwater remediation system will be little effected in terms of concentrations treated and the time to groundwater recovery cessation with or without DNAPL recovery. In summary, if setting recovery wells on 20--foot centers were possible, the time to recovery would be large and the fraction recovered as compared to the total volume present would be small.

A final semi-quantitative comparison was made between the anticipated DNAPL recovery rate of 0.020 gpm (divided by two in these calculations to account for pulsing) to (i) the dissolution rate of the DNAPL into Site groundwater, (ii) the attenuation rate of dissolved constituents prior to capture by the pumping system, and (iii) the recovery rate from the pumping system. The results of the calculations suggest that the amount of DNAPL recovered *in the first year* at each well could be on the order of 6,000 gallons which is greater than the approximately 1,000 gallons (50% +/-) collected by the groundwater interceptor well system.

Two case studies (Michalski et al., 1995; Sale & Applegate, 1997) were reviewed where multi-year DNAPL recovery implementation indicated that DNAPL recovery became asymptotic after about 100 to 200 days with the attenuated recovery rate at the end of the recovery period that was a fraction of the initial rate. In one study, other recovery methodologies were employed to recover DNAPL after an initial phase of direct recovery (i.e., dewatering, hot water injection, TVE dewatering, and TVE regeneration). These additional means of recovery allowed the additional recovery of only a small percentage of total DNAPL present. In general, DNAPL recovery in the papers reviewed indicated the potential to recover DNAPL attenuated to very low levels within the first 100 days. While enhanced recovery has removed additional DNAPL, the volumes have been small as compared to the total, and there is a requirement to maintain strict hydraulic control of the DNAPL-impacted area, which would be difficult at an active facility. Numerous other more recent pilot studies and research efforts have revealed similar results for mechanical recovery of DNAPL.

The Interstate Technology and Regulatory Council (ITRC) published Technical and Regulatory Guidance on Integrated DNAPL Site Strategy (ITRC, 2011). In that document, source treatment is discussed in terms of meeting a set of absolute and functional objectives. The absolute objectives are protection of human health and the environment, conservation of natural resources, addressing adverse community impacts, and minimizing past practices on future generations. The functional objectives involve consideration of the following: risks, extent, longevity, community, land use, economic, sustainability, and resource conservation.

In terms of absolute objectives, there are no current risks to human health and the environment. While the groundwater resource is lost, no technology allows for significantly accelerating the clean-up process that would restore the groundwater resource while the active facility is present. Currently, there are no impacts to the community, and the current remedial strategy of pumping groundwater is indistinguishable from supplementary DNAPL recovery in addition to groundwater pumping in terms of timeframe to closure, risk to the public, and recovery of the natural resource. In terms of functional objectives, there are no current risks (once on-Site- vapor intrusion is addressed), and supplementary DNAPL recovery will not decrease the risk to current or future receptors over the current groundwater pumping alone. In fact, there would be a slight increase in human health risk due to worker exposure during the DNAPL recovery process, which would not exist otherwise. The extent of the plume will not change for the foreseeable future with or without supplementary DNAPL recovery. The groundwater capture system contains the extent of the plume, and will into the foreseeable future. Likewise, the time to closure will not be significantly affected by supplementary DNAPL recovery, given the volume and inaccessibility of the DNAPL due to the presence of the active facility. The water supply is not within the impacted area; hence, the community is not affected. The land use is conducive to the current remedial strategy. The final three functional objectives are adversely affected by supplementary DNAPL recovery. The cost of the recovery (to obtain even an insignificant portion of the DNAPL) will be high, and supplementary DNAPL recovery (depending on the

size of the effort) can use large amounts of resources, such as electricity, and produce large amounts of greenhouse gases, while providing no real risk reduction to human health and the environment. Hence, the ITRC guidance provides a rationale for a limited or stepwise path forward with regard to supplementary DNAPL recovery to ensure that sufficient DNAPL could actually be recovered to justify the increased costs and potential for remedial worker exposure.

Based on the data provided above, supplementary DNAPL recovery is not likely to reduce significantly the mass flux from the source area. In addition, there are no completed exposure pathways associated with the DNAPL. In fact, risks and extent of the impacted area will be controlled by a combination of the vapor control system and current groundwater capture system. A qualitative comparison of risk and extent of the plume with and without DNAPL recovery yields the simple conclusion that:

- Relative risk reduction: Current or future receptors on Site or off Site are equally protected by the current ICMs; that is, there is no difference in risk with or without DNAPL recovery, as long as the groundwater remediation system is operational. DNAPL recovery does not decrease the risk of exposure at the Site because there is no current or future exposure pathway to groundwater that is not eliminated by the operation of the currently operating pump-and-treat system. In fact, actual risks increase both in terms of exposure to recovered DNAPL and exposure to workplace hazards during remedial system construction.
- DNAPL mass recovery: Because mass reduction by DNAPL recovery will result in the recovery of only a tiny fraction of the total mass, significant mass flux reduction is not expected. Hence, the groundwater ICM will have to operate over approximately the same period with or without source treatment.

11. Recommendation

It is recommended that long-term DNAPL recovery from available locations within the active facility be performed in order to better characterize long-term attenuation of the recovery rate with time.

12. References

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

Michalski, A. et al., 1995. A Field Study of Enhanced Recovery of DNAPL Pooled Below the Water Table. *Groundwater Monitoring and Remediation*. National Ground Water Association. Winter. 90--100.

Sale, T. and D. Applegate, 1997. Mobile NAPL Recovery: Conceptual, Field, and Mathematical Considerations. *Ground Water*. 35--3. May--June.

Appendix C
Cost Estimates

Soil Alternative: CMA S1
EXISTING COVER, INSPECTION, AND MAINTENANCE
(Asbestos Surface Impoundment)

COST ESTIMATE SUMMARY S1

Site: OCC Wichita Kansas
Location: Wichita, Kansas
Phase: CMS (-30% to +50%)
Base Year: 2017
Date: August 16, 2017

Description: Soil Alternative CMA S1 was designed to eliminate direct contact exposure to surface soil potentially containing asbestos containing materials that could potentially come into direct contact with potential site-specific receptors. The CMA S1 alternative includes the following elements: Administrative controls; Inspection; Maintenance of existing cover; Soil Handling/Management procedures. Capital costs occur in Year 0. Annual O&M costs (inspection and documentation). Periodic costs (maintenance) in Years 5, 10, 15, 20, 25, 30.

Discount=7.4%

CAPITAL COSTS

No capital costs - already in place

TOTAL CAPITAL COSTS $0

ANNUAL O&M COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Operation, Maintenance, Monitoring					
Inspect and document cover conditions	4	hour	$ 150	$ 600	Plant personnel complete
SUBTOTAL				$ 600	
SUBTOTAL				$ 600	
Contingency		25%		$200	
TOTAL O&M COSTS				$800	

PERIODIC COSTS:

Five Year					
Concrete Removal	1,000	SF	$ 37	$ 37,000	Source: RS Means, section 02 41 19.16
- assume 10% of surface area (surface area is 10,000 sf)					
Concrete Repair	1000	SF	$ 15	$ 15,000	Source: RS Means, section 02 41 19.16; Site experience.
- assume 10% of surface area (surface area is 10,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (1,000 ft^2 x 0.3 ft. 0.08 ton/ft^3)	24	ton	$ 50	$ 1,200	Assume $40-$50/ton (landfill experience)
Documentation and Reporting	8	hour	$ 150	$ 1,200	Plant personnel complete
				$ 54,400	
Ten Year					
Concrete Removal	1,000	SF	$ 37	$ 37,000	(as above)
- assume 10% of surface area (surface area is 10,000 sf)					
Concrete Repair	1000	SF	$ 15	$ 15,000	
- assume 10% of surface area (surface area is 10,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (1,000 ft^2 x 0.3 ft. 0.08 ton/ft^3)	24	ton	$ 50	$ 1,200	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 54,400	
Fifteen Year					
Concrete Removal	1,000	SF	$ 37	$ 37,000	
- assume 10% of surface area (surface area is 10,000 sf)					
Concrete Repair	1000	SF	$ 15	$ 15,000	
- assume 10% of surface area (surface area is 10,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (1,000 ft^2 x 0.3 ft. 0.08 ton/ft^3)	24	ton	$ 50	$ 1,200	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 54,400	
Twenty Year					
Concrete Removal	1,000	SF	$ 37	$ 37,000	
- assume 10% of surface area (surface area is 10,000 sf)					
Concrete Repair	1000	SF	$ 15	$ 15,000	
- assume 10% of surface area (surface area is 10,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (1,000 ft^2 x 0.3 ft. 0.08 ton/ft^3)	24	ton	$ 50	$ 1,200	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 54,400	
Twenty-five Year					
Concrete Removal	1,000	SF	$ 37	$ 37,000	
- assume 10% of surface area (surface area is 10,000 sf)					
Concrete Repair	1000	SF	$ 15	$ 15,000	
- assume 10% of surface area (surface area is 10,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (1,000 ft^2 x 0.3 ft. 0.08 ton/ft^3)	24	ton	$ 50	$ 1,200	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 54,400	
Thirty Year					
Concrete Removal	1,000	SF	$ 37	$ 37,000	
- assume 10% of surface area (surface area is 10,000 sf)					
Concrete Repair	1000	SF	$ 15	$ 15,000	
- assume 10% of surface area (surface area is 10,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (1,000 ft^2 x 0.3 ft. 0.08 ton/ft^3)	24	ton	$ 50	$ 1,200	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 54,400	

Soil Alternative: CMA S1
EXISTING COVER, INSPECTION, AND MAINTENANCE
(Asbestos Surface Impoundment)

COST ESTIMATE SUMMARY S1

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$0	$0	1.000	$0	
Annual O&M Cost	1-30	$24,000	$800	11.926	$9,541	
Periodic Cost	5	$54,400	$54,400	0.700	$38,070	
Periodic Cost	10	$54,400	$54,400	0.490	$26,641	
Periodic Cost	15	$54,400	$54,400	0.343	$18,644	
Periodic Cost	20	$54,400	$54,400	0.240	$13,047	
Periodic Cost	25	$54,400	$54,400	0.168	$9,130	
Periodic Cost	30	$54,400	$54,400	0.117	$6,390	
		$350,400			$121,463	

TOTAL PRESENT VALUE OF ALTERNATIVE $121,500

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within –30 to +50 percent of the actual project cost.

Soil Alternative: CMA S2
EXISTING COVER, INSPECTION, AND MAINTENANCE
(Process Area)

COST ESTIMATE SUMMARY S2

Site: OCC Wichita Kansas
Location: Wichita, Kansas
Phase: CMS (-30% to +50%)
Base Year: 2017
Date: August 16, 2017

Description: Soil Alternative CMA S2 was designed to eliminate direct contact exposure to surface soil potentially containing pentachlorophenol (PA-54) above site-specific risk levels that could potentially come into direct contact with potential site-specific receptors. The CMA S2 alternative includes the following elements: Administrative controls; Inspection; Maintenance of existing cover; Soil Handling/Management procedures. No capital costs occur in Year 0. Annual O&M costs (inspection and documentation). Periodic costs (maintenance) in Years 5, 10, 15, 20, 25, 30.

Discount=7.4%

CAPITAL COSTS

No capital costs - already in place

TOTAL CAPITAL COSTS $0

ANNUAL O&M COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Operation, Maintenance, Monitoring					
Inspect and document cover conditions	2	hour	$ 150	$ 300	Plant personnel complete
SUBTOTAL				$ 300	
SUBTOTAL				$ 300	
Contingency		25%		$100	
TOTAL O&M COSTS				$400	

PERIODIC COSTS:

Five Year					
Concrete Removal	200	SF	$ 37	$ 7,400	Source: RS Means, section 02 41 19.16
- assume 10% of surface area (surface area is 2,000 sf)					
Concrete Repair	200	SF	$ 15	$ 3,000	Source: RS Means, section 02 41 19.16; Site experience.
- assume 10% of surface area (surface area is 2,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (200 ft^2 x 0.3 ft. 0.08 ton/ft^3)	4.8	ton	$ 50	$ 240	Assume $40-$50/ton (landfill experience)
Documentation and Reporting	8	hour	$ 150	$ 1,200	Plant personnel complete
				$ 11,800	
Ten Year					
Concrete Removal	200	SF	$ 37	$ 7,400	(as above)
- assume 10% of surface area (surface area is 2,000 sf)					
Concrete Repair	200	SF	$ 15	$ 3,000	
- assume 10% of surface area (surface area is 2,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (200 ft^2 x 0.3 ft. 0.08 ton/ft^3)	4.8	ton	$ 50	$ 240	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 11,800	
Fifteen Year					
Concrete Removal	200	SF	$ 37	$ 7,400	
- assume 10% of surface area (surface area is 2,000 sf)					
Concrete Repair	200	SF	$ 15	$ 3,000	
- assume 10% of surface area (surface area is 2,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (200 ft^2 x 0.3 ft. 0.08 ton/ft^3)	4.8	ton	$ 50	$ 240	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 11,800	
Twenty Year					
Concrete Removal	200	SF	$ 37	$ 7,400	
- assume 10% of surface area (surface area is 2,000 sf)					
Concrete Repair	200	SF	$ 15	$ 3,000	
- assume 10% of surface area (surface area is 2,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (200 ft^2 x 0.3 ft. 0.08 ton/ft^3)	4.8	ton	$ 50	$ 240	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 11,800	
Twenty-five Year					
Concrete Removal	200	SF	$ 37	$ 7,400	
- assume 10% of surface area (surface area is 2,000 sf)					
Concrete Repair	200	SF	$ 15	$ 3,000	
- assume 10% of surface area (surface area is 2,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (200 ft^2 x 0.3 ft. 0.08 ton/ft^3)	4.8	ton	$ 50	$ 240	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 11,800	
Thirty Year					
Concrete Removal	200	SF	$ 37	$ 7,400	
- assume 10% of surface area (surface area is 2,000 sf)					
Concrete Repair	200	SF	$ 15	$ 3,000	
- assume 10% of surface area (surface area is 2,000 sf). Assume 4-inch slab.					
- assume performed by contractor					
- assume oversight by plant					
Concrete Disposal (200 ft^2 x 0.3 ft. 0.08 ton/ft^3)	4.8	ton	$ 50	$ 240	
Documentation and Reporting	8	hour	$ 150	$ 1,200	
				$ 11,800	

Soil Alternative: CMA S2
EXISTING COVER, INSPECTION, AND MAINTENANCE
(Process Area)

COST ESTIMATE SUMMARY S2

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$0	$0	1.000	$0	
Annual O&M Cost	1-30	$12,000	$400	11.926	$4,771	
Periodic Cost	5	$11,800	$11,800	0.700	$8,258	
Periodic Cost	10	$11,800	$11,800	0.490	$5,779	
Periodic Cost	15	$11,800	$11,800	0.343	$4,044	
Periodic Cost	20	$11,800	$11,800	0.240	$2,830	
Periodic Cost	25	$11,800	$11,800	0.168	$1,981	
Periodic Cost	30	$11,800	$11,800	0.117	$1,386	
		$82,800			$29,048	

TOTAL PRESENT VALUE OF ALTERNATIVE $29,000

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within –30 to +50 percent of the actual project cost.

Soil Alternative: CMA S3
EXCAVATION, CONSOLIDATION, COVER, SEEP COLLECTION AND ON-SITE DISCHARGE, INSPECTION AND MAINTENANCE (Landfill Area)

COST ESTIMATE SUMMARY S3

Site: OCC Wichita Kansas
Location: Wichita, Kansas
Phase: CMS (-30% to +50%)
Base Year: 2017
Date: August 16, 2017

Description: Soil Alternative CMA S3 was designed to eliminate direct contact exposure to surface soil potentially containing alpha BHC (P5SA) above site-specific risk levels that could potentially come into direct contact with potential site-specific receptors. The CMA S3 alternative includes the following elements: Excavation, Backfilling, Covering, Inspection, Maintenance, Administrative controls; Inspection. Capital costs occur in Year 0. Annual O&M costs (inspection and documentation). Periodic costs (maintenance) in Years 5, 10, 15, 20, 25, 30.

Discount=7.4%

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization/Demobilization					
Mobilization	1	LS	$ 15,000	$ 15,000	Site experience
Temporary Facilities and Utilities	1	LS	$ 15,000	$ 15,000	Fence, roads, signs, trailers, etc.
H&S Plans and submittals	1	LS	$ 10,000	$ 10,000	HASP, quality control, etc.
Demobilization	1	LS	$ 10,000	$ 10,000	Site experience
SUBTOTAL				$ 50,000	
Excavate Soil at P5SA					
Develop Design Work Plan	1	LS	$ 10,000	$ 10,000	Site experience
Excavate impacted soil from vicinity of P5SA	3,000	CY	$ 10	$ 30,000	Quotes ($8, $9, $12) on similar project
Place (consolidate) impacted soil onto adjacent landfill	3,000	CY	$ 10	$ 30,000	(similar rate as Excavate)
Backfill excavation with clean fill	3,000	CY	$ 15	$ 45,000	Quotes ($13, $15, $18) on similar project
Native seed	8,100	SF	$ 0.1	$ 810	Assume 10ft depth, therefore 8,100sf footprint. Rates ($1000, $1700, $5000/acre)
SUBTOTAL				$ 115,800	
Install seep collection system					
Excavate Trench along toe of landfill	700	CY	$ 10	$ 7,000	3' x 3' x 2020'
- assume 2,200ft x 3.2ft x 3ft					
- assume slope excavation: 0.15%					
- trench keyed into interface between topsoil and clay cap					
Install 30-mil poly liner	24,240	SF	$ 0.8	$ 19,392	Estimate from Titan: $0.8/sf. Supplied + installed
- install continuous along bottom, side and top of trench					
- area: (3' + 3' + 3' + 3') x 2020'					
Place 12" HDPE perforated pipe	2,020	FT	$ 35	$ 70,700	Quotes ($27, $55) on similar projects. Supplied and installed
Place gravel	600	CY	$ 30	$ 18,000	Quotes ($13, $30, $51) on similar projects
- place 1/2-inch clean washed gravel around perforated pipe					
- Volume: (3' x 3' x 2020') - (volume of pipe and top gravel)					
Install collection sump (3' x 3' x 3')	1	LS	$ 4,500	$ 4,500	Six quotes (ranging $3000-$6000) on similar jobs
Install and purchase pump	1	LS	$ 2,000	$ 2,000	10 to 30 gpd. AMT/Gorman 12-V
Connect sump pump to existing force main	200	LF	$ 30	$ 6,000	Quotes ($30, $47, $57) on similar projects
Sump: mechanical connections, electrical	1	LF	$ 6,000	$ 6,000	Similar projects: $1,000 piping installed $5,000 wiring to sump, connection within sump
Place gravel (3-inch layer)	60	CY	$ 30	$ 1,800	0.25' x 3' x 2020'
- gravel atop the 30-mil liner topping the trench					
System startup, commissioning (assume 5 days)					
- technician	50	hour	$ 100	$ 5,000	Site experience
- senior advisor	50	hour	$ 150	$ 7,500	Site experience
Project management	(assume 10% of construction cost)			$ 14,789	Site experience
Documentation and reporting	1	LS	$ 10,000	$ 10,000	Site experience
SUBTOTAL				$ 172,700	
Install cap/cover					
Place clay cover soil	3,300	CY	$ 18	$ 59,400	Quotes ($10, $13, $20) on similar project, assume on-Site source clay
- Volume: 2' x 190' x 230'					
Place clean fill cover	1,700	CY	$ 15	$ 25,500	Quotes ($13, $15, $18) on similar project
- Volume: 1' x 190' x 230'					
Place topsoil cover	1,700	CY	$ 15	$ 25,500	Quotes ($12, $13), increase to match rate for placing clean fill
- Volume: 1' x 190' x 230'					
Hydro seed	9,800	SY	$ 0.1	$ 980	(similar as Native Seed, above)
- Area: 2 x (190' x 230')					
SUBTOTAL				$ 111,400	
SUBTOTAL				$ 449,900	
Contingency		25%		$112,500	10% scope + 15% bid
SUBTOTAL				$562,400	
Project Management		8%		$45,000	
Remedial Design		15%		$84,400	
Construction Management		10%		$56,300	
TOTAL CAPITAL COSTS				$748,100	

Soil Alternative: CMA S3
EXCAVATION, CONSOLIDATION, COVER, SEEP COLLECTION
AND ON-SITE DISCHARGE, INSPECTION AND MAINTENANCE (Landfill Area)

COST ESTIMATE SUMMARY S3

ANNUAL O&M COSTS:

Operation, Monitor, Maintenance							
Quarterly Inspections and Documentation							
- Cap Integrity (by Plant personnel)	16	hour	$	150	$	2,400	4hr/event
- Seep Collection (by Plant personnel)	8	hour	$	150	$	1,200	2hr/event
Annual electrical							
- sump pump for seep collection	1	LS	$	1,000	$	1,000	Site experience
Annual pump maintenance	1	LS	$	500	$	500	Mechanical (valves, piping)
Semi-annual mowing	16	hour	$	50	$	800	8hr/event
SUBTOTAL					$	5,900	
SUBTOTAL					$	5,900	
Contingency		25%				$1,500	10% scope + 15% bid
TOTAL O&M COSTS						$7,400	

PERIODIC COSTS:

Five Year							
Cap Maintenance	1	LS	$	10,000	$	10,000	Site experience
- assume 5% of surface area (surface area is 40 acres)							
- assume performed by contractor							
- assume oversight by plant							
- Documentation and Reporting	8	hour	$	150	$	1,200	8hr/event
Seep Collection Trench Repair/Maintenance							
- clean out sump and drain	1	LS	$	5,000	$	5,000	Site experience
- regrade trench surface gravel cover	6,060	SF	$	1	$	6,060	3' x 2020'. Site experience
- add gravel to 10% of surface area	18	CY	$	30	$	540	0.08' x 3' x 2020' (assume 1-inch replace)
					$	22,800	
Ten Year							
Cap Maintenance	1	LS	$	10,000	$	10,000	(as above unless noted otherwise)
- assume 5% of surface area (surface area is 40 acres)							
- assume performed by contractor							
- assume oversight by plant							
- Documentation and Reporting	8	hour	$	150	$	1,200	
Seep Collection Trench Repair/Maintenance							
- clean out sump and drain	1	LS	$	5,000	$	5,000	
- replace and install sump pump	1	LS	$	2,000	$	2,000	10 to 30 gpd. AMT/Gorman 12-V
- regrade trench surface gravel cover	6,060	SF	$	1	$	6,060	
- add gravel to 10% of surface area	18	CY	$	30	$	540	
					$	24,800	
Fifteen Year							
Cap Maintenance	1	LS	$	10,000	$	10,000	
- assume 5% of surface area (surface area is 40 acres)							
- assume performed by contractor							
- assume oversight by plant							
- Documentation and Reporting	8	hour	$	150	$	1,200	
Seep Collection Trench Repair/Maintenance							
- clean out sump and drain	1	LS	$	5,000	$	5,000	
- regrade trench surface gravel cover	6,060	SF	$	1	$	6,060	
- add gravel to 10% of surface area	18	CY	$	30	$	540	
					$	22,800	
Twenty Year							
Cap Maintenance	1	LS	$	10,000	$	10,000	
- assume 5% of surface area (surface area is 40 acres)							
- assume performed by contractor							
- assume oversight by plant							
- Documentation and Reporting	8	hour	$	150	$	1,200	
Seep Collection Trench Repair/Maintenance							
- clean out sump and drain	1	LS	$	5,000	$	5,000	
- replace and install sump pump	1	LS	$	2,000	$	2,000	10 to 30 gpd. AMT/Gorman 12-V
- regrade trench surface gravel cover	6,060	SF	$	1	$	6,060	
- add gravel to 10% of surface area	18	CY	$	30	$	540	
					$	24,800	
Twenty-five Year							
Cap Maintenance	1	LS	$	10,000	$	10,000	
- assume 5% of surface area (surface area is 40 acres)							
- assume performed by contractor							
- assume oversight by plant							
- Documentation and Reporting	8	hour	$	150	$	1,200	
Seep Collection Trench Repair/Maintenance							
- clean out sump and drain	1	LS	$	5,000	$	5,000	
- regrade trench surface gravel cover	6,060	SF	$	1	$	6,060	
- add gravel to 10% of surface area	18	CY	$	30	$	540	
					$	22,800	

Soil Alternative: CMA S3
EXCAVATION, CONSOLIDATION, COVER, SEEP COLLECTION AND ON-SITE DISCHARGE, INSPECTION AND MAINTENANCE (Landfill Area)

COST ESTIMATE SUMMARY S3

Thirty Year						
Cap Maintenance	1	LS	$	10,000	$	10,000
- assume 5% of surface area (surface area is 40 acres)						
- assume performed by contractor						
- assume oversight by plant						
- Documentation and Reporting	8	hour	$	150	$	1,200
Seep Collection Trench Repair/Maintenance						
- clean out sump and drain	1	LS	$	5,000	$	5,000
- replace and install sump pump	1	LS	$	2,000	$	2,000
- regrade trench surface gravel cover	6,060	SF	$	1	$	6,060
- add gravel to 10% of surface area	18	CY	$	30	$	540
					$	24,800

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$748,100	$748,100	1.000	$748,100	
Annual O&M Cost	1-30	$222,000	$7,400	11.926	$88,254	
Periodic Cost	5	$22,800	$22,800	0.700	$15,956	
Periodic Cost	10	$24,800	$24,800	0.490	$12,145	
Periodic Cost	15	$22,800	$22,800	0.343	$7,814	
Periodic Cost	20	$24,800	$24,800	0.240	$5,948	
Periodic Cost	25	$22,800	$22,800	0.168	$3,827	
Periodic Cost	30	$24,800	$24,800	0.117	$2,913	
		$1,112,900			$884,957	

TOTAL PRESENT VALUE OF ALTERNATIVE $885,000

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within –30 to +50 percent of the actual project cost.

Groundwater Alternative: CMA G1
GROUNDWATER INTERCEPTOR SYSTEM

COST ESTIMATE SUMMARY G1

Site: OCC Wichita Kansas
Location: Wichita, Kansas
Phase: CMS (-30% to +50%)
Base Year: 2017
Date: August 16, 2017

Description: Groundwater Alternative CMA G1 was designed to intercept groundwater to prevent contact with site-specific receptors. The CMA G1 alternative includes the following elements: Well installation, Well abandonment, Operation, Maintenance, Inspection. Capital costs occur in Year 0. Annual O&M costs (inspection and documentation). Periodic costs (maintenance) in Years 5, 10, 15, 20, 25, 30.

Discount=7.4%

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mobilization/Demobilization					
Mobilization for well installation	1	LS	$ 7,500	$ 7,500	Driller quote: Cascade Drilling
Mobilization for well abandon	1	LS	$ 7,500	$ 7,500	Driller quote: Cascade Drilling
Temporary Facilities and Utilities	1	LS	$ 5,000	$ 5,000	Fence, roads, signs, trailers, etc.
H&S Plans and submittals	1	LS	$ 5,000	$ 5,000	HASP, quality control, etc.
Demobilization for well installation	1	LS	$ -	$ -	Included in mobilization rate
Demobilization for well abandon	1	LS	$ -	$ -	Included in mobilization rate
SUBTOTAL				$ 25,000	
Install new IW-47 Recovery Well					
Develop Design Work Plan	1	LS	$ 5,000	$ 5,000	Site experience
Modify NPDES Permit	1	LS	$ 5,000	$ 5,000	Site experience
Install PVC Recovery Well (50ft)	1	LS	$ 13,000	$ 13,000	double-cased well, assume 8 inch
Well development	1	LS	$ 5,000	$ 5,000	Site experience
Install 400gpm submersible pump	1	LS	$ 5,000	$ 5,000	Lower head losses with 8 inch diameter
Pump controllers, mechanical hookup	1	LS	$ 6,000	$ 6,000	Similar projects: $1,000 piping installed $5,000 wiring to sump, connection within sump
Install dual-canister carbon treatment system	1	LS	$ 20,000	$ 20,000	Estimated 6,000-lb vessel required. Vendor quote: two 3,000-lb ($14k), manifold ($1k), carbon ($5k).
Install 30x30 steel shed (well house)	1	LS	$ 30,000	$ 30,000	GenSteel.com(installed). Assume no hurricane-specific req.
Discharge piping to NPDES outfall	500	LF	$ 30	$ 15,000	Similar to IW-41 and IW-42
System startup, commissioning (assume 2 days)					Quotes ($30, $47, $57) on similar projects
- technician	20	Hour	$ 80	$ 1,600	Site experience
- senior advisor	20	Hour	$ 150	$ 3,000	Site experience
Cuttings Disposal	20	Drum	$ 450	$ 9,000	Site experience
Transportation for waste disposal	2	One-way	$ 500	$ 1,000	One-way: $20/hr drive for 1 day
Dispose Development Water		(dispose in Facility)		$ -	Deep well injection
SUBTOTAL				$ 118,600	
Plug and Abandon Monitoring Wells					
S1 Wells Abandon: 4					
- Develop Design Work Plan	1	LS	$ 5,000	$ 5,000	Site experience
- Well abandonment	4	Each	$ 6,000	$ 24,000	~100ft grout well. Inside casing cutter
- Dispose cuttings/waste off-site	40	Drum	$ 450	$ 18,000	10 drums per well
S2/S3 W Abandon: 5					
- Develop Design Work Plan	1	LS	$ 5,000	$ 5,000	Site experience
- Well abandonment	5	Each	$ 6,000	$ 30,000	~60ft grout well. Inside casing cutter
- Dispose cuttings/waste off-site	50	Drum	$ 450	$ 22,500	10 drums per well
S4 Wells Abandon: 11					
- Develop Design Work Plan	1	LS	$ 5,000	$ 5,000	Site experience
- Well abandonment	11	Each	$ 5,000	$ 55,000	~20ft grout well. Inside casing cutter
- Dispose cuttings/waste off-site	110	Drum	$ 450	$ 49,500	10 drums per well
Tooling of inside casing cutter	1	LS	$ 15,000	$ 15,000	Fabricate fitted inside casing cutter
Transportation for waste disposal	2	One-way	$ 500	$ 1,000	One-way: $20/hr drive for 1 day
SUBTOTAL				$ 230,000	
Reporting					
Prepare and submit Construction Report	1	LS	$ 50,000	$ 50,000	Site experience
SUBTOTAL				$ 50,000	
SUBTOTAL				$ 423,600	
Contingency		25%		$105,900	10% scope + 15% bid
SUBTOTAL				$529,500	
Project Management		10%		$53,000	
Remedial Design		15%		$79,500	
Construction Management		10%		$53,000	
TOTAL CAPITAL COSTS				$715,000	

Groundwater Alternative: CMA G1
GROUNDWATER INTERCEPTOR SYSTEM

COST ESTIMATE SUMMARY G1

ANNUAL O&M COSTS:

Operation, Monitor, Maintenance						
Semi-annual Monitoring Event (spring and fall)	Monitor: 25					25 locations sampled once as a separate semi-annual event
- field work	150	Hour	$	80	$ 12,000	6hr/well (includes preparation, coordination)
- travel and per diem	7	Day	$	100	$ 700	4wells/day
- laboratory	29	Sample	$	60	$ 1,740	1sample/well + 15% for dups, blanks, MS/MSD
- Semi-annual Report	1	LS	$	20,000	$ 20,000	$20k/event
Annual/Bi-annual Monitoring Event	Monitor: 83					25 semiannual + 46 annual + 12 bi-annual (half of 23 biannual)
- field work	498	Hour	$	80	$ 39,840	6hr/well (includes preparation, coordination)
- travel and per diem	21	Day	$	100	$ 2,100	4wells/day
- laboratory	95	Sample	$	60	$ 5,700	1sample/well + 15% for dups, blanks, MS/MSD
- Report	1	LS	$	30,000	$ 30,000	$30k/event
Annual maintenance/repairs						
- paint well covers etc.	10	Hour	$	80	$ 800	Assume 1 day per year
- dedicated pump repair/maintenance						
- labor	50	Hour	$	80	$ 4,000	Assume 1 week per year
- equipment	5	LS	$	3,000	$ 15,000	Assume 5 pump replacements per year
Interceptor Well System Operation						
- Consolidated System Operation for IW-40, IW-43, IW-44, IW-45 and IW-46						
- GAC change out	1	Annual	$	35,000	$ 35,000	Treatment sys. data, assumes air stripper installed
- air stripper maintenance	12	Month	$	3,333	$ 40,000	Treatment sys. estimate, 2x/month clean trays and blower filters
- filtration system maintenance	1	LS	$	75,000	$ 75,000	Full-scale filtration sys., pre-air stripper chemical feed (if needed to address fouling of air stripper)
- electricity for System Operation	1	Annual	$	75,000	$ 75,000	Treatment system data
- building maintenance/inspection	1	LS	$	5,000	$ 5,000	Inspect overhead door, air/heat system. Housekeeping (190x90 Steel bldg, 2 roll-up doors)
- Remote System IW-41, IW-42 and IW-47						
- electricity for System Operation	2	Annual	$	12,000	$ 24,000	Treatment sys. data (IW-41, IW-42)
- system calibration and testing	2	Annual	$	5,000	$ 10,000	Treatment sys. data (totalizer/pressure relief valves)
- routine Building Maintenance	52	Weeks	$	769	$ 40,000	Housekeeping, data collection, visual inspections (Three: 30x30 steel building with 1 roll-up door)
- Plant Interceptor Wells (IW-29, IW-30, IW-31, IW-32, IW-35A, IW-35B, IW-36)						
- recovered gw - deep well disposal	1	LS	$	700,000	$ 700,000	Site experience
- other routine maintenance	1	LS	$	20,000	$ 20,000	Site experience
SUBTOTAL					$ 1,155,900	
SUBTOTAL					$ 1,155,900	
Contingency		25%			$289,000	10% scope + 15% bid
TOTAL O&M COSTS					$1,444,900	

PERIODIC COSTS:

Every Five Years

Monitoring Well System						
- Pump replacements	5	Each	$	900	$ 4,500	pumps w/ tubing & fittings (Geotech Bladder pumps)
- Remove & install bladder pumps	20	hour	$	100	$ 2,000	4hr/pump
- Documentation & Reporting	8	hour	$	100	$ 800	Site experience
IW System: Consolidated Recovery Well System - IW-40, IW-43, IW-44, IW-45 and IW-46						
- Replace air stripper blower	1	Each	$	50,000	$ 50,000	Treatment system estimate
- System upgrades/repairs/replace	1	LS	$	100,000	$ 100,000	valves/piping etc. Treatment system estimate based on performance
- Controller repair/replacement	1	LS	$	2,000	$ 2,000	Site experience
- Recovery well maintenance	1	LS	$	2,000	$ 2,000	descaling/system optimization at one (1) well
- Replace 200gpm submersible pump	1	LS	$	5,000	$ 5,000	(similar cost as 400gpm submersible pump)
- Documentation & Reporting	8	hour	$	100	$ 800	Site experience
Remote Recovery Well System - IW-41, IW-42 and IW-47						
- GAC change out (IW-41, IW-42)	2	Annual	$	10,000	$ 20,000	Treatment system data
- system upgrades/maintenance	2	Annual	$	2,500	$ 5,000	Treatment system O&M data, valves/piping etc.
- Controller repair/replacement	1	LS	$	2,000	$ 2,000	Site experience
- Recovery well maintenance	1	LS	$	2,000	$ 2,000	descaling/system optimization at one (1) well
- Replace 200gpm submersible pump	1	LS	$	5,000	$ 5,000	Site experience
- Documentation & Reporting	8	hour	$	100	$ 800	Site experience
Plant Recovery Well System - (IW-29, IW-30, IW-31, IW-32, IW-35A, IW-35B, IW-36)						
- System Upgrades/repairs/replace	1	LS	$	5,000	$ 5,000	valves/piping etc.
- Controller repair/replacement	1	LS	$	2,000	$ 2,000	Site experience
- Recovery well maintenance	1	LS	$	2,000	$ 2,000	descaling/system optimization at one (1) well
- Replace 200gpm submersible pump	1	LS	$	5,000	$ 5,000	Site experience
- Documentation & Reporting	8	hour	$	100	$ 800	Site experience
SUBTOTAL					$ 216,700	

Groundwater Alternative: CMA G1
GROUNDWATER INTERCEPTOR SYSTEM

COST ESTIMATE SUMMARY G1

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$715,000	$715,000	1.000	$715,000	
Annual O&M Cost	1-30	$43,347,000	$1,444,900	11.926	$17,232,287	
Periodic Cost	5	$216,700	$216,700	0.700	$151,648	
Periodic Cost	10	$216,700	$216,700	0.490	$106,125	
Periodic Cost	15	$216,700	$216,700	0.343	$74,267	
Periodic Cost	20	$216,700	$216,700	0.240	$51,972	
Periodic Cost	25	$216,700	$216,700	0.168	$36,371	
Periodic Cost	30	$216,700	$216,700	0.117	$25,453	
		$45,362,200			$18,393,123	
TOTAL PRESENT VALUE OF ALTERNATIVE					$18,393,100	

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Soil Vapor Alternative: CMA V1
EXISTING ICM (Admin. Bldg., Tech. Center, and Lab)

COST ESTIMATE SUMMARY V1

Site: OCC Wichita Facility
Location: Wichita, Kansas
Phase: CMS (-30% to +50%)
Base Year: 2017
Date: August 16, 2017

Description: Soil Vapor Alternative CMA V1 was designed to minimize the potential for building occupants to be exposed to chemicals present in soil gas in the future. The CMA V1 alternative includes the following elements: Site-wide Administrative Controls; Existing Conditions in V0. No capital costs occur in Year 0. Annual O&M costs (inspection and documentation). Periodic costs (maintenance) in Years 5, 10, 15, 20, 25, 30.

Discount=7.4%

CAPITAL COSTS

No capital costs - Assumed to be part of site-wide institutional controls

TOTAL CAPITAL COSTS $0

ANNUAL O&M COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Operation, Monitor, Maintenance					
Quarterly Inspections, Pressure Monitoring					
- Inspection, monitoring	16	hour	$ 80	$ 1,280	4hr/event
- Equipment rental	4	LS	$ 250	$ 1,000	$250/event
- Documentation and Reporting	8	hour	$ 150	$ 1,200	2hr/event
SUBTOTAL				$ 3,500	
SUBTOTAL				$ 3,500	
Contingency		25%		$900	10% scope + 15% bid
TOTAL O&M COSTS				$4,400	

PERIODIC COSTS:

Every Five Years					
Building Window/Door/Floor Repair & Maintenance					
Weather stripping: 4 exterior doors	4	Each	$ 500	$ 2,000	supplies
Weather stripping: 4 windows	4	Each	$ 250	$ 1,000	supplies
Fill cracks in 10% of building floor	1	LS	$ 500	$ 500	supplies (epoxy)
Labor	40	hour	$ 80	$ 3,200	Site experience
Documentation & reporting	4	hour	$ 150	$ 600	4hr/event
SUBTOTAL				$ 7,300	
Twenty-Five Year					
Building Window/Door/Floor Repair & Maintenance					
Install new HVAC System	1	LS	$ 500,000	$ 500,000	Based on 2010 installation
Plus 5-year periodic cost		(as above)		$ 7,300	
SUBTOTAL				$ 507,300	

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$0	$0	1.000	$0	No capital costs
Annual O&M Cost	1-30	$132,000	$4,400	11.926	$52,476	
Periodic Cost	5	$7,300	$7,300	0.700	$5,109	
Periodic Cost	10	$7,300	$7,300	0.490	$3,575	
Periodic Cost	15	$7,300	$7,300	0.343	$2,502	
Periodic Cost	20	$7,300	$7,300	0.240	$1,751	
Periodic Cost	25	$507,300	$507,300	0.168	$85,145	
Periodic Cost	30	$7,300	$7,300	0.117	$857	
		$675,800			$151,414	

TOTAL PRESENT VALUE OF ALTERNATIVE $151,400

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Soil Vapor Alternative: CMA V2
BUILDING INSPECTION AND MAINTENANCE (Bldgs. 10 & 51)

COST ESTIMATE SUMMARY V2

Site: OCC Wichita Facility
Location: Wichita, Kansas
Phase: CMS (-30% to +50%)
Base Year: 2017
Date: August 16, 2017

Description: Discount=7.4%

Soil Vapor Alternative CMA V2 was designed to minimize the potential for building occupants to be exposed to chemicals present in soil gas beneath the control room floors in Buildings 10 and 51. The CMA V2 alternative includes the following elements: Site-wide Administrative Controls (V1); Baseline inspection and documentation; Development of inspection plan; Review of building plans; Inspection; Maintenance. Capital costs occur in Year 0. Annual O&M costs (inspection and documentation of building conditions). Periodic costs for maintenance repairs in Years 5, 10, 15, 20, 25, 30.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Develop inspection and monitoring plan	1	LS	$ 5,000	$ 5,000	Site experience
Contingency		25%		$1,300	
SUBTOTAL				$6,300	
Project Management		10%		$700	
Remedial Design		0%		$0	
Construction Management		0%		$0	
TOTAL CAPITAL COSTS				$7,000	

ANNUAL O&M COSTS:

Operation, Monitor, Maintenance					
Annual Inspection					
- Inspection, monitoring	4	hour	$ 80	$ 320	4hr/event
- Documentation and Reporting	2	hour	$ 150	$ 300	2hr/event
SUBTOTAL				$ 600	
Contingency		10%		$100	10% scope
TOTAL O&M COSTS				$700	

PERIODIC COSTS:

Every Five Years					
Building Window/Door/Floor Repair & Maintenance					
Weather stripping: 4 exterior doors	2	Each	$ 500	$ 1,000	supplies
Weather stripping: 4 windows	2	Each	$ 250	$ 500	supplies
Fill cracks in 10% of building floor	1	LS	$ 500	$ 500	supplies (epoxy)
Labor	20	hour	$ 80	$ 1,600	Site experience
Documentation & reporting	4	hour	$ 150	$ 600	2hr/event
SUBTOTAL				$ 4,200	

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$7,000	$7,000	1.000	$7,000	
Annual O&M Cost	1-30	$21,000	$700	11.926	$8,349	
Periodic Cost	5	$4,200	$4,200	0.700	$2,939	
Periodic Cost	10	$4,200	$4,200	0.490	$2,057	
Periodic Cost	15	$4,200	$4,200	0.343	$1,439	
Periodic Cost	20	$4,200	$4,200	0.240	$1,007	
Periodic Cost	25	$4,200	$4,200	0.168	$705	
Periodic Cost	30	$4,200	$4,200	0.117	$493	
		$53,200			$23,990	
TOTAL PRESENT VALUE OF ALTERNATIVE					$24,000	

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DNAPL Alternative: CMA D1
VERTICAL RECOVERY WELLS

COST ESTIMATE SUMMARY D1

Site: OCC Wichita Facility
Location: Wichita, Kansas
Phase: CMS (-30% to +50%)
Base Year: 2017
Date: August 16, 2017

Description: DNAPL Alternative CMA D1 was designed to eliminate direct contact exposure to groundwater containing DNAPL. The DNAPL CMA D1 alternative includes the following elements: Administrative controls; Installation and operation of vertical recovery wells; Monitoring; Maintenance. Capital costs occur in Year 0. Annual O&M costs. One periodic cost in year-30.

Discount=7.4%

CAPITAL COSTS

DESCRIPTION	QTY	UNIT		UNIT COST		TOTAL	NOTES
Well Installation							
Mobilization	1	LS	$	7,500	$	7,500	Driller quote: Cascade Drilling ($5,000 in 2014)
Temporary Facilities and Utilities	1	LS	$	5,000	$	5,000	Site experience
H&S Plans and submittals	1	LS	$	5,000	$	5,000	HASP, quality control, etc.
Installation							
- S1 wells (deep)	10	Each	$	13,000	$	130,000	double casing
- S2/S3 wells (shallow)	10	Each	$	8,000	$	80,000	single casing
Oversight of well installation							
- S1 wells (deep)	10	Each	$	3,500	$	35,000	3 days per well (GHD labor)
- S2/S3 wells (shallow)	10	Each	$	2,500	$	25,000	2 days per well (GHD labor)
Well Development							
- S1 wells (deep)	10	Each	$	5,000	$	50,000	Labor: driller and GHD
- S2/S3 wells (shallow)	10	Each	$	5,000	$	50,000	Labor: driller and GHD
Equipment and Materials	20	LS	$	10,000	$	200,000	pump, controllers, tubing, electric, drum, probes
Installation Labor	20	LS	$	7,000	$	140,000	includes mob, per diem, tools and proj. mgmt.
Resurfacing, fence and drum containment	20	LS	$	3,000	$	60,000	Site experience
Demobilization	1	LS	$	-	$	-	Included in mobilization rate
SUBTOTAL					$	787,500	
Monthly Costs							
First 6 months							
DNAPL/Drum Disposal	6	mo.	$	45,000	$	270,000	Sixty 55 gal drums/mo. Oversight for pick-up
Gas Tanks	6	mo.	$	500	$	3,000	Site experience
Reporting/ Maintenance	6	mo.	$	5,000	$	30,000	Site experience
Second 6 months							
DNAPL/Drum Disposal	6	mo.	$	15,000	$	90,000	Site experience
Gas Tanks	6	mo.	$	125	$	750	Site experience
Reporting/ Maintenance	6	mo.	$	2,500	$	15,000	Site experience
SUBTOTAL					$	408,800	
SUBTOTAL					$	1,196,300	
Contingency		25%				$299,100	
SUBTOTAL						$1,495,400	
Project Management		6%				$89,800	
Remedial Design		12%				$179,500	
Construction Management		8%				$119,700	
TOTAL CAPITAL COSTS						$1,884,400	

ANNUAL O&M COSTS:

Operation, Monitoring, Maintenance							
DNAPL/Drum Disposal	1	LS	$	80,000	$	80,000	Site experience
Gas Tanks	1	LS	$	900	$	900	Site experience
Reporting/ Maintenance	1	LS	$	9,000	$	9,000	Site experience
SUBTOTAL					$	89,900	
Contingency		25%				$22,500	10% scope + 15% bid
TOTAL O&M COSTS						$112,400	

PERIODIC COSTS:

Thirty Year							
Well Abandonment							
- 10 deep wells	10	Each	$	9,000	$	90,000	Grout well. Inside casing cutter
- 10 shallow wells	10	Each	$	8,000	$	80,000	Grout well. Inside casing cutter
- tooling	1	LS	$	15,000	$	15,000	Fabricate fitted inside casing cutter
- mobilization	1	LS	$	10,000	$	10,000	Site experience
Reporting/ Maintenance	1	LS	$	10,000	$	10,000	Site experience
					$	205,000	

PRESENT VALUE ANALYSIS:

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
Capital Cost	0	$1,884,400	$1,884,400	1.000	$1,884,400	
Annual O&M Cost	1 - 30	$3,372,000	$112,400	11.926	$1,340,514	
Periodic Cost	1	$0	$0	0.931	$0	
Periodic Cost	10	$0	$0	0.490	$0	
Periodic Cost	15	$0	$0	0.343	$0	
Periodic Cost	20	$0	$0	0.240	$0	
Periodic Cost	25	$0	$0	0.168	$0	
Periodic Cost	30	$205,000	$205,000	0.117	$24,078	
		$5,461,400			$3,248,993	
TOTAL PRESENT VALUE OF ALTERNATIVE					$3,249,000	

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