Ford Motor Company

COMPREHENSIVE PHASE II SITE INVESTIGATION REPORT - GROUNDWATER ADDENDUM

Twin Cities Assembly Plant

St. Paul, Minnesota

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ACRONYMS AND ABBREVIATIONS

1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
1,1,1-TCA	1,1,1-trichloroethane
Arcadis	Arcadis U.S., Inc.
BaP	benzo(a)pyrene
cis-1,2-DCE	*cis*-1,2-dichloroethene
DRO	diesel-range organics
ESA	environmental site assessment
Ford	Ford Motor Company
GRO	gasoline-range organics
GW_{ISV}	groundwater intrusion screening value
IDW	investigation-derived waste
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
PAH	polynuclear aromatic hydrocarbon
PBP	Petroleum Brownfields Program
PID	photoionization detector
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PPE	personal protective equipment
PRP	Petroleum Remediation Program
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
REC	recognized environmental condition
SIR	Site Investigation Report
Site	Twin Cities Assembly Plant

SRV	soil reference value
SVOC	semi volatile organic compound
TAL	Target Analyte List
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
trans-1,2-DCE	*trans*-1,2-dichloroethene
µg/L	microgram(s) per liter
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VIC	Voluntary Investigation & Clean-up
VOC	volatile organic compound
WE	Work Element
WI	Wisconsin
WQS	MPCA water quality standard(s) for surface water

EXECUTIVE SUMMARY

This Comprehensive Phase II Site Investigation Report – Groundwater Addendum (SIR – Groundwater Addendum) was developed by Arcadis U.S., Inc. (Arcadis) on behalf of Ford Motor Company (Ford) for the Twin Cities Assembly Plant (the Site). The objective of this report is to document the site investigation activities and results related to groundwater that have been completed to date under the guidance of the Minnesota Pollution Control Agency (MPCA) Voluntary Investigation and Cleanup (VIC) Program and Petroleum Brownfields Program (PBP). Soil data collected during initial and supplemental investigation activities were reported under separate cover and are not included in this SIR – Groundwater Addendum. Historical and ongoing investigation activities related to Area C, with the exception of groundwater data collected from the Area C monitoring wells, are not included in this SIR – Groundwater Addendum and will be reported under separate cover.

The geology at the Site consists of a relatively thin layer (approximately 5 to 15 feet thick) of unconsolidated overburden that is primarily sands, silts and clays. The unconsolidated overburden is underlain by bedrock consisting of (in descending order): a discontinuous shale layer (Decorah Shale), a limestone/dolostone layer (Platteville Limestone), a continuous shale layer (Glenwood Shale) and a sandstone layer (St. Peter Sandstone). Each shale layer serves as confining units to perched aquifers that are present in the overlying unconsolidated overburden and Platteville Limestone/Dolostone. The St. Peter Sandstone is a regional aquifer that flows in a westerly direction and ultimately discharges to the Mississippi River.

A Phase I Environmental Site Assessment was completed in 2007 which identified several recognized environmental conditions (RECs), historical RECs, and areas of interest. These areas were the focus of numerous Phase II investigations and supplemental investigations completed between 2007 and 2015. Additional supplemental investigations were completed in 2015 and 2016 to complete lateral delineation of groundwater impacts in the overburden that were identified in the SIR as well as install additional St. Peter Sandstone monitoring wells to improve characterization of that aquifer. In addition to the Phase II investigations, Ford also completed a Site Wide monitoring well groundwater sampling event in 2016 to provide groundwater quality data in the three aquifer units on Site.

Groundwater data collected during the Phase II investigation activities were compared to the following applicable screening values:

- Groundwater Intrusion Screening Values (GW_{ISV}s) (perched unconsolidated overburden east of Mississippi River Boulevard [Main Parcel]).
- Surface Water Quality Standards (St. Peter and unconsolidated overburden west of Mississippi River Boulevard [River Parcel]).
- Petroleum Remediation Program (PRP) Guidance Values for direct exposure to groundwater (Platteville)
- Minnesota Department of Health Health-Based Guidance was used if no other more applicable screening values were available (Platteville).

A summary of the compounds that have been detected at least once in groundwater at concentrations exceeding the screening values discussed above is shown in the table below.

Compound	Groundwater > Applicable Screening Values[1]			
	Perched Overburden (Main Parcel)	Perched Platteville Limestone/Dolostone (Main Parcel)	St. Peter Sandstone (Main and River Parcels)	Overburden (River Parcel)
Chlorinated VOCs	Yes	Yes	No	No
Non-chlorinated VOCs	Yes	No	No	Yes
SVOCs/PAHs	Yes	Yes	Yes	Yes
Metals	Not Applicable[2]	Yes	Yes	Yes
PCBs	Not Applicable	No	Yes	Not Applicable
GRO	Not Applicable	Yes	No	Not Applicable
DRO	Not Applicable	Yes	Yes	Not Applicable
Cyanide	Not Applicable	No	Yes	Yes

[1]Applicable Screening Values:
Perched Overburden (Main Parcel) – Groundwater Intrusion Screening Values
Platteville Limestone/Dolostone –MDH Derived Values
St. Peter Sandstone – MPCA Surface Water Class 2B Criteria
Overburden (River Parcel) - MPCA Surface Water Class 2B Criteria

[2] Not Applicable: No applicable screening values exist for the contaminant group.

1 INTRODUCTION

This SIR – Groundwater Addendum was developed by Arcadis on behalf of Ford for the Twin Cities Assembly Plant (the Site). This report is a comprehensive groundwater report that documents all investigation work related to groundwater that has been collected at the site, including information collected during supplemental investigation activities conducted in 2016 after submittal of the initial SIR. The purpose of the supplemental investigations was to provide lateral delineation of groundwater impacts in the overburden that were identified in the SIR, to install additional St. Peter Sandstone monitoring wells to improve characterization of that aquifer, and conduct a Site-wide permanent monitoring well sampling event to provide current groundwater quality data in the three aquifer units on Site.

This SIR - Groundwater Addendum includes an overview of the investigation methodology, activities, and results in accordance with the MPCA VIC and PBP reporting guidelines.

Soil data collected during initial and supplemental investigation activities are not included in this SIR – Groundwater Addendum and were reported under separate cover (Arcadis 2016b). Historical and ongoing investigation activities related to Area C, with the exception of groundwater data collected from the Area C monitoring wells, are not included in this SIR – Groundwater Addendum and will be reported under separate cover.

2 SITE BACKGROUND

The Site is located at 966 South Mississippi River Boulevard in St. Paul, Ramsey County, Minnesota at approximate Latitude (north) 44° 54' 50.8" and Longitude (west) 93° 11' 31.9" (Figure 1). The Site is located in a mixed industrial, commercial and residential use area on the eastern shore of the Mississippi River, along the east side of South Mississippi River Boulevard, south of Ford Parkway, and west of South Cleveland Avenue (Figure 2).

Former operations at the Site consisted of the assembly and painting of cars and trucks, using parts manufactured off site. During World War II, the plant was converted for the production of armored tanks and aircraft engines to support the war effort. From 1978 until plant closure in 2011, assembly operations were limited to light-duty trucks (Ford Ranger). Assembly processes included welding, metal cleaning, painting and curing, windshield and trim installation, and preparation of the vehicles for final delivery. Production buildings and several outbuildings comprised approximately 2,144,930 square feet within the property boundary. The primary production buildings on the main parcel consisted of the Main Assembly Building, which also included a Warehouse, and a Paint Building (Figure 2). In addition, a Wastewater Treatment Plant and Steam Plant west of Mississippi River Boulevard (river parcel) were associated with the former site operations (Figure 2). Manufacturing operations at the Site ceased on December 16, 2011.

2.1 Site History

The Site was vacant undeveloped land prior to construction of the assembly plant. Construction of the original portion of the Main Assembly Building began in 1923, with several additions, which occurred mainly between 1960 and 1978; these added 300,000 square feet to the original building footprint. The Paint Building was constructed in 1985 and was connected to the Main Assembly Building via a 625-foot bridge. The Steam Plant was constructed in 1923 and is approximately 10,400 square feet. A former coal gasification plant was located near the southeast corner of the Steam Plant, but was demolished prior to 1974. The Wastewater Treatment Plant is located adjacent to the Steam Plant, and was constructed in 1984. Additional details on the history of the Site are available in the Phase I Environmental Site Assessment (ESA; Arcadis 2007a).

2.2 Site Geology and Hydrogeology

The general geology and hydrogeology of the Site, based on information identified during the Phase I ESA (Arcadis 2007a) and subsequent investigations, is described below. Data collected to date were also used to develop representative geologic cross sections traversing the Site. A site-wide map of cross section locations is provided on Figure 3.

2.2.1 Geology

At the surface of the Site, a mantle of unconsolidated sediments exists over bedrock terraces. Underlying the unconsolidated material are sedimentary bedrock units that were deposited during the middle of the Ordovician geologic period. The sedimentary units are, in descending order, Decorah Shale, Platteville Limestone/Dolostone, Glenwood Shale, and St. Peter Sandstone on the main parcel. The sedimentary unit is the St. Peter Sandstone on the river parcel. The depth and thicknesses of the bedrock units, as interpreted from boring logs, are illustrated on the geologic cross sections (Figures 4 through 7).

The unconsolidated overburden on the main parcel consists predominately of sandy clay and clayey sand, much of which has been disturbed or reworked over the years due to various construction and demolition activities at the Site. Weathered shale is common and 2 to 5 feet of peat was observed east of the former oil fill area. The weathered shale is a blue-gray clay with varying degrees of fracturing and relic structures associated with the structure of the bedrock. The total thickness of the unconsolidated overburden on the main parcel is variable but generally is between 5 and 15 feet, with the thinner deposits occurring in the eastern portion of the Site where the Decorah Shale subcrops.

The Decorah Shale is the uppermost bedrock unit encountered at the Site on the main parcel. The upper portion of the Decorah Shale, at the contact with the unconsolidated overburden, is highly weathered, but transitions to be a more competent rock unit with depth. The thickness of the Decorah Shale is variable and it appears to be discontinuous across the Site. In general, the Decorah Shale is more prevalent in the eastern portion of the Site and has been eroded away in the western portion of the Site. Underlying the Decorah Shale (or the unconsolidated overburden where the Decorah Shale is absent) is the Platteville Formation. The Platteville Formation, which ranges in thickness from 20 to 30 feet on the main parcel, generally acts as an aquitard that limits vertical flow, although it is known to exhibit secondary permeability due to the development of vertical and bedding plane fractures. The upper portion of the Platteville Formation is typically heavily fractured, the lower portion less so. Perched groundwater in the upper portion of the Platteville often emerges as seeps at the edge of the bluff. The Platteville Limestone/Dolostone lies on top of the Glenwood Shale formation and the contact appears to be gradational. The Glenwood Shale is composed of dark green to gray shale and sandy shale. The formation is thinly laminated and moderately fissile (cleavable) and is approximately 7 feet thick in the areas investigated. Beneath the Glenwood Shale is the St. Peter Sandstone, which is encountered at the Site at approximately 60 to 80 feet below ground surface on the main parcel. The St. Peter Sandstone outcrops along the bluffs of the Mississippi River and continues below the elevation of the riverbed. The sandstone is composed of medium-grained, well-sorted and well-rounded quartzite. It is white to buff in color and is medium to weakly indurated (hardened). The St. Peter formation is as much as 150 feet thick in the Twin Cities area.

The unconsolidated overburden on the river parcel (Figure 2) consists predominately of sands and gravels, approximately 24 to 50 feet thick depending on the location within the river parcel, and in some areas is overlain by mixed fill material consisting of construction debris, industrial waste, and clay. The unconsolidated overburden overlays the St. Peter Sandstone described above. The elevation of the St. Peter Sandstone appears to decrease moving west towards the Mississippi River, and was not encountered in any of the additional borings up to depths of 662 feet above mean sea level.

2.2.2 Hydrogeology

Perched groundwater is found above both of the shale layers described above in both the unconsolidated overburden and the Platteville Limestone/Dolostone on the main parcel. The perched groundwater in the unconsolidated overburden on the main parcel is discontinuous across the Site and of variable thickness. Because of the discontinuous nature of this perched zone there is unlikely to be any meaningful lateral flow. The perched groundwater in the Platteville Limestone/Dolostone is consistently encountered. The total thickness of the saturated zone within the Platteville Limestone/Dolostone is approximately 12 to 23 feet. Groundwater flow direction is generally to the west towards the Mississippi River; however, any water migrating laterally through the Platteville Limestone/Dolostone discharges via seeps on the river bluff just west of Mississippi River Boulevard. Seeps can be intermittently observed on the face of the bluff west of Mississippi River Boulevard.

The uppermost groundwater aquifer is in the St. Peter Sandstone, which is a high-yielding aquifer. Perched groundwater in the overburden and the Platteville Formation is generally isolated from the St. Peter aquifer by the lower member of the Platteville and the Decorah and Glenwood Shale Formations. The upper portion of the St. Peter Sandstone is unsaturated; groundwater in the St. Peter Sandstone is encountered at approximately 100 to 115 feet below ground surface on the main parcel of the Site. Groundwater flow direction is generally to the west towards the Mississippi River, which is the receptor for groundwater originating from the Site; however, based on site-wide monitoring well data, groundwater flow can be locally and seasonally variable particularly close to the river. A potentiometric surface map for the St. Peter aquifer is included as Figure 8, and is based on monitoring wells in-place as of December 2015. A potentiometric surface map for the St. Peter aquifer based on monitoring wells in-place as of June 2016 is included as Figure 9.

The groundwater in the unconsolidated overburden on the river parcel is not hydrogeologically connected to the perched groundwater in the unconsolidated overburden unit on the main parcel. Instead, the groundwater in the unconsolidated overburden on the river parcel is consistently encountered and has a general flow direction to the west towards the Mississippi River. The total thickness of the saturated zone within the unconsolidated overburden on the river parcel is approximately 25 to 35 feet and is underlain by the St. Peter Sandstone. However, based on monitoring well data, the groundwater elevation and flow direction is influenced by the river stage and seasonal control of the river elevation at Lock Dam No. 1. Seasonal control allows for the potential of flooding during high water level events. The average elevation of the Mississippi River, however, is approximately 689 feet above mean sea level.

Additional information on the geology of the Site can be found in the Phase I ESA (Arcadis 2007a) and the Initial Phase II – Exterior Investigation Report (Arcadis 2007b).

3 SUMMARY OF INVESTIGATION ACTIVITIES

Supplemental subsurface investigations including a Site-wide groundwater sampling event have been completed for the Site since submittal of the SIR. The objective of the supplemental investigations was to address data gaps identified during reporting of the previous investigations.

The following is a brief summary of the groundwater investigation activities that have taken place at the Site. A timeline of these investigations is included in Table 1. All groundwater analytical data from these investigations are included within the results discussion, tables, and figures of this SIR – Groundwater Addendum to provide a comprehensive overview of groundwater conditions at the Site. Field notes from groundwater sampling and Phase II subsurface investigations are included in Appendix A.

3.1 Phase I – 2007

Arcadis completed a Phase I ESA at the Site in the first half of 2007 (Arcadis 2007a). During the Phase I, several recognized environmental conditions (RECs), historical RECs, and areas of interest were identified interior and exterior to the building footprints. Based on the results from the Phase I ESA, several of the RECs, historical RECs, and areas of interest of the Site were identified as features for additional Phase II investigations. The location of these features is included on Figure 10, which can be used as a historical reference to provide landmarks for the investigation work described in the following sections. The results and conclusions of this SIR – Groundwater Addendum are not discussed in the context of specific RECs/areas of interest.

3.2 Baseball Fields Phase II – 2007

Arcadis conducted a soil investigation of Feature 139 – Baseball Fields in June and August 2007 to evaluate soil conditions. Feature 139 was identified as a potential battery waste disposal area during the Phase I ESA. The area is approximately 6 acres in size and presently includes three baseball fields, a concession building with restrooms, batting cages, and a practice pitching area. Investigative methods were developed based on MPCA program requirements, knowledge of the site geology, and potential environmental concerns.

A total of two temporary wells were installed and sampled to evaluate groundwater conditions. Discussion of the groundwater analytical results for this investigation is included in Section 6 below.

3.3 Initial Exterior Phase II – 2007

Arcadis conducted the Initial Phase II – Exterior Investigation in June and July 2007. The Site has a total of 32 exterior features identified in the Phase I ESA Report. A total of 12 permanent groundwater monitoring wells and 10 temporary groundwater monitoring wells were installed and sampled to evaluate groundwater conditions at the Site. In addition, three existing monitoring wells already located on site were sampled as part of this investigation. Investigative methods were developed based on MPCA program requirements, knowledge of the site geology and potential environmental concerns.

Results of this investigation were initially reported in the Initial Phase II – Exterior Investigation Report (Arcadis 2007b) and are summarized in Section 6 below.

3.4 Initial Interior Phase II – 2010

The Initial Phase II Interior Investigation began in August 2010 during a temporary production shutdown and focused on the evaluation of accessible interior features identified during the Phase I ESA as historical operations. Forty-two interior site features were identified in the Phase I ESA Report (Arcadis 2007a), which, due to active plant operations, were broken out into two phases (initial and auxiliary). Two temporary groundwater monitoring wells were completed to investigate four features within the Main Assembly Building for groundwater impacts. Due to accessibility restrictions and shallow boring refusal, continuation of the work was postponed until plant closure, which occurred on December 16, 2011.

The results of this investigation were initially presented in the SIR and are discussed in Section 6 below.

3.5 Supplemental Exterior Phase II – 2011 to 2012

Arcadis conducted a Supplemental Phase II Exterior Investigation from August to November 2011 and again in October 2012. This investigation included the installation of borings to provide delineation of impacts observed during the Initial Phase II Exterior investigation and to investigate features identified during the 2007 Phase I ESA that were not addressed during the 2007 Initial Exterior Phase II. Eight permanent groundwater monitoring wells and 10 temporary groundwater monitoring wells were completed to investigate 11 features for groundwater impacts.

Results of this investigation were initially reported in the Supplemental Phase II – Exterior Investigation Report (Revised) (Arcadis 2013a) and are discussed in Section 6 below.

3.6 Auxiliary and Supplemental Interior Phase II – 2012

During May and June 2012, Arcadis continued investigation not completed during the 2010 Initial Interior Phase II. Eleven temporary groundwater monitoring wells were completed to investigate nine features within the Main Assembly Building and Paint Building for groundwater impacts.

The results of this investigation were initially reported in the SIR and are discussed in Section 6 below.

3.7 Work Element 1 – 2013 to 2014

Arcadis implemented the Work Element 1 (WE1) subsurface investigation activities to further evaluate impacts and eliminate data gaps identified during the completion of the Initial and Supplemental Phase II Exterior Investigations, as well as activities completed to date as part of the Initial Interior Investigation (Arcadis 2013b). The WE1 subsurface investigation was conducted concurrently with site demolition activities, and was conducted during two mobilizations as various features became accessible. The first mobilization took place from October to November 2013 with the second mobilization occurring in January 2014. Eighteen temporary groundwater monitoring wells were completed.

Analytical results of these investigations were initially reported in the Subsurface Investigation Work Element 1 – 2013 Initial Mobilization Soil & Groundwater Quality Analytical Results (Arcadis 2014d) report and Work Element 1 – 2013 Second Mobilization Soil & Groundwater Quality Analytical Results (Arcadis 2014e) report and are discussed in Section 6 below.

3.8 Area C Monitoring Well Sampling – 2014 Mississippi River Flooding

In June and early July of 2014, the Minneapolis/St. Paul area received several inches of rain over several weeks, which caused flooding of the Mississippi River near Area C. Following the flood event of the Mississippi River in June 2014, the MPCA requested the permanent monitoring wells surrounding Area C (AMW-05, AMW-05B, AMW-07, AMW-19 and AMW-20) to be gauged weekly as well as sampled monthly for three consecutive months, if accessible. Monitoring wells AMW-19 and AMW-20 were inaccessible due to the flooding and thus were not gauged for two weeks nor sampled during the first month (July 2014). The remaining monitoring wells (AMW-05, AMW-05B, AMW-07) were gauged weekly and sampled monthly, with the exception of AMW-05 which was dry during the last month of sampling (September 2014). Accessible monitoring wells were sampled for volatile organic compounds (VOCs) and dissolved Target Analyte List (TAL) metals. Monitoring well AMW-07 was also sampled for polynuclear aromatic hydrocarbons (PAHs) per MPCA request.

Results of these investigations were initially reported in the Data Collected from Monitoring Wells Located along Mississippi River letters to the MPCA (Arcadis 2014a, Arcadis 2014b, Arcadis 2014c) and are discussed in Section 6 below.

3.9 Work Element 2 – 2014 to 2015

Arcadis implemented the Work Element 2 (WE2) subsurface investigation activities with the purpose of evaluating impacts identified during WE1 and to investigate proposed WE1 locations that were postponed due to access limitations. As with WE1, WE2 was completed in multiple mobilizations. The first mobilization took place in December 2014 and the second mobilization occurred in April 2015. Twenty-nine temporary groundwater monitoring wells were completed.

Analytical data collected during the WE2 subsurface investigation activities were initially reported in the SIR and are discussed in Section 6 below.

3.10 Work Element 3 – 2015

Arcadis implemented the Work Element 3 (WE3) subsurface investigation activities to evaluate impacts identified during the completion of WE2. WE3 was completed in July 2015. Ten temporary groundwater monitoring wells were completed to delineate groundwater impacts identified during previous investigations.

Analytical data collected during the WE3 subsurface investigation activities were initially reported in the SIR and are discussed in Section 6 below.

3.11 Area C Monitoring Well Installation and Sampling – 2015 to 2016

Arcadis installed eight new monitoring wells in the unconsolidated aquifer as part of the Area C Investigation Work Plan to improve the monitoring well network around Area C and to ensure that groundwater quality is adequately monitored (Arcadis 2015). The wells were installed within and around the northwest, west, and southern perimeters of Area C to provide monitoring well coverage in all accessible directions. Two of the monitoring wells are part of a nested pair and provide additional water quality characterization at the base of the unconsolidated aquifer (bedrock interface). The monitoring well installations were completed over two mobilizations in 2015 (September and December). All of the Area C monitoring wells (existing and newly installed in 2015) were sampled in March 2016 consistent with the Area C Investigation Work Plan. A second sampling event was completed in June as part of the Site-wide permanent monitoring well sampling event (described in more detail below).

Analytical results for both sampling events are discussed briefly in Section 6 below. A comprehensive discussion of groundwater quality specific to Area C will be reported under separate cover.

3.12 Supplemental North Parking Area Investigation – 2015 to 2016

ASB-030 was completed in June 2007 as part of the Initial Phase II – Exterior investigation (Arcadis 2007b). A perched groundwater sample collected from three to eight feet below ground surface (ft bgs) detected concentrations of VOCs and semi-volatile organic compounds (SVOCs) above the Minnesota Department of Health (MDH) guidance values as well as detections of diesel range organics (DRO) and gasoline range organics (GRO) exceeding the PRP guidance values.

Permanent monitoring well AMW-17 was installed north of ASB-030 during the Supplemental Phase II – Exterior investigation. A groundwater sample from this well identified VOC, DRO, and GRO impacts. As a result, four additional delineation borings (ASB-0107NW, ASB-0107N, ASB-0107SW, ASB-0107E) were completed surrounding AMW-17. All four locations indicated VOC, DRO, and GRO impacts in the groundwater. One delineation boring (ASB-0216) was completed to the west of ASB-030 and AMW-17 during the Work Element 2 mobilization. A groundwater sample collected from three to eight feet below ground surface detected concentrations of VOCs, SVOCs, GRO, and DRO above the MDH and PRP guidance values. This data was initially reported in the SIR (Arcadis 2016a).

Four additional soil borings (ASB-0228 through ASB-0231) were completed north and south of ASB-0216 in December 2015 and March 2016 to delineate the VOC, GRO, and DRO groundwater impacts discussed above. One delineation boring (ASB-0230) completed to the south was dry and thus no groundwater sample collected. Results of these borings are discussed in Section 6 below.

3.13 St. Peter Bedrock Monitoring Well Installation and Sampling – 2016

Arcadis installed five additional St. Peter Sandstone bedrock monitoring wells in January 2016 to supplement the existing bedrock monitoring well network and to provide upgradient groundwater data for comparison to results of monitoring wells installed west of South Mississippi River Boulevard (closer to the Mississippi River). In addition, monitoring wells were installed to characterize groundwater quality where previous site investigations suggested there was a greater potential for impacts to the St. Peter Sandstone, specifically where elevated chlorinated volatile organic compounds had been identified in the perched unconsolidated overburden unit. Two rounds of groundwater sampling of all five new monitoring wells were completed following installation. The first sampling event was in February 2016 and included analysis of VOCs, dissolved TAL metals, DRO, polychlorinated biphenyls (PCBs), and cyanide.

The second sampling event was completed in March 2016 and only included sampling of the analytes that exhibited at least one exceedance during the first sampling event (VOCs, TAL metals, and DRO). Results of these sampling events are discussed in Section 6 below.

3.14 Site-Wide Permanent Monitoring Well Groundwater Sampling – 2016

Thirty-five permanent monitoring wells were installed across the Site between June 2007 and January 2016 within one of the four saturated geologic units described in Section 2.2.2. Groundwater sampling events were conducted between June 2007 and March 2016 and historically consisted of a subset of the 35 monitoring wells (contingent on the date of monitoring well installation, date of sampling, and/or purpose of investigation) and a range of analytes.

In June 2016, 32 of the 35 permanent monitoring wells on-Site were sampled to provide a current and comprehensive picture of groundwater quality in the four units in accordance with the work plan (Arcadis 2016d). Two monitoring wells within the overburden were removed from the proposed program based on proximity to other wells with similar analytical results. One monitoring well within the St. Peter Sandstone was dry and therefore could not be sampled.

The wells proposed for sampling were selected based on previous analytical results, location and/or previous MPCA-approved work plans. In addition, the analytes that were collected from each well was determined based on the geologic interval in which the monitoring well was screened. Analytical results are discussed in Section 6 below.

4 GENERAL INVESTIGATION METHODOLOGY

This section provides a summary of the means and methods utilized during the subsurface investigations. Field logbook/documentation procedures and the field quality assurance program were implemented in accordance with the approved June 2007 Field Sampling Plan (Arcadis 2007c) and with MPCA-approved work plans. An addendum to Field Sampling Plan Section 3: Location and Sample Nomenclature was completed for the WE1/WE2/WE3 investigations, and is included in Appendix B. Standard operating procedures used to complete this field work are included in Appendix C, when applicable. This section will also reference approved work plans when applicable.

4.1 Utility Clearance

A full utility clearance was performed prior to initiating any subsurface work at the Site. Activities included but were not limited to:

- Notification of Gopher One Call to mark all public utility lines servicing the Site
- Utilizing a private utility locator in the areas identified for subsurface work
- Surficial inspection referencing available utility and historical operational maps for each proposed boring location, if available.

After removing any surficial debris (i.e., asphalt or concrete), a hand auger or hydro-vacuum unit was used to 1) confirm the absence of utilities and 2) investigate the top 5 feet below ground surface if no utilities existed.

4.2 Soil Borings and Temporary Monitoring Wells

Soil borings were advanced using several methods including: hand augers, direct-push, hollow-stem auger and roto-sonic drill rigs in areas of suspected impacts. Each boring was logged continuously by an Arcadis field geologist and screened using a photoionization detector (PID) with an 11.7 electron volt lamp. Soil boring logs were created in the field to identify material encountered for each borehole to total depth using the United Soil Classification System. Digitized soil boring logs are provided in Appendix D.

As stipulated in the initial interior and exterior work plans (Arcadis 2007b, Arcadis 2007c, Arcadis 2010), Area C work plan (Arcadis 2015), and the St. Peter Sandstone work plan (Arcadis 2016c), the total number of borings to be advanced, the depth of exploration, and analytical sampling requirements were developed based on the dimensions, depth and use of each feature. Borings were advanced until the target depth was reached or refusal due to bedrock was encountered. In some areas of the Site, perched groundwater is encountered above or at the interface of the unconsolidated sediments and the bedrock. If potential impacts appeared to extend to the perched groundwater in the unconsolidated overburden (based on visual observations, odors, or PID readings), temporary groundwater monitoring wells were installed and a grab sample was collected.

As discussed in Section 2.2.2, perched groundwater was discontinuous during field investigations and finding locations with sufficient water for collection of a sample was difficult; therefore, temporary groundwater monitoring wells were also installed in boreholes that did not exhibit impacts to provide groundwater analytical in areas with potential data gaps and to delineate potentially impacted groundwater samples from impacted boreholes. Temporary groundwater monitoring wells were constructed of 1-inch diameter, 5-foot-long polyvinyl chloride (PVC) slotted well screens with PVC riser. Temporary wells, with sufficient yield, were purged of at least 1 gallon of groundwater using a peristaltic pump and disposable tubing prior to sampling to minimize turbidity. At least one sample was collected from the shallowest groundwater encountered at each location. Groundwater samples were collected in laboratory-supplied containers and placed on ice pending shipment to the laboratory following standard chain-of-custody procedures. All samples were submitted to TestAmerica Laboratories in North Canton, Ohio for analysis of one or more of the following analytes:

- VOCs using United States Environmental Protection Agency (USEPA) Method 8260;
- SVOCs using USEPA Method 8270;
- PAHs using USEPA Method 8270;
- PCBs using USEPA Method 8082;
- DRO using the WI Modified Method;
- GRO using the Wisconsin (WI) Modified Method;
- Cyanide using USEPA Method 335.4;
- Dissolved and Total TAL Metals using USEPA Method 6010;
- Dissolved and Total Resource Conservation and Recovery Act (RCRA) Metals using USEPA Method 6010/7470;
- Dissolved and Total Lead using USEPA Method 6010; and
- pH using USEPA Method 150.1.

Groundwater samples analyzed for dissolved metals were field filtered using a 0.45-micron disposable filter prior to sample collection. The locations of all temporary monitoring wells are provided on Figure 3. Groundwater sampling logs are included in Appendix E.

Additional details regarding the number of samples, bottles, preservation, etc. for each analytical method is included in Table 2. Upon completion, the borehole was sealed in accordance with MDH guidelines and a Borehole Sealing Record was prepared. Copies of borehole sealing records are in Appendix F. The surface disturbance of each borehole was repaired to match surrounding materials.

4.3 Permanent Groundwater Monitoring Wells

In addition to the permanent monitoring wells installed at the Site between 2007 and 2016 as described below, three groundwater monitoring wells were observed to already exist on the main parcel during the 2007 Phase I activities. The three existing wells (MW-4, MW-5 and MW-6) are located east, west, and southwest of the former hazardous waste storage building, respectively. The locations of all permanent monitoring wells are also illustrated on Figure 3.

4.3.1 Monitoring Well Installation

As of January 2016, thirty-five permanent groundwater monitoring wells have been installed across the Site. The groundwater monitoring wells are screened within the perched unconsolidated overburden, the perched Platteville Limestone/Dolostone, or the St. Peter Sandstone aquifer. The groundwater monitoring wells were installed to evaluate groundwater quality within the site footprint and downgradient towards the Mississippi River (Figure 2).

Boreholes were drilled using either a nominal 4.25-inch inner diameter hollow-stem auger (overburden groundwater monitoring wells) or roto-sonic drilling rig (bedrock groundwater monitoring wells). A dual casing methodology was used during roto-sonic drilling, where the inner casing is drilled past the outer casing, minimizing the potential for vertical migration of constituents. Mud rotary methodology was also used during roto-sonic drilling, where mud drilling fluid is used to circulate soil cuttings to the surface and also create a temporary borehole seal prior to installation of the monitoring well, minimizing the potential for borehole collapse and vertical migration of constituents. Soil samples and rock coring samples were collected continuously for wells installed in 2007 and 2015. Well construction and soil boring logs were prepared as described above, and each unconsolidated soil sample was screened in the field using a PID. Soil samples were not collected during the installation of overburden groundwater monitoring wells in 2011.

Groundwater monitoring wells were installed using various materials over the years in accordance with MDH requirements.

- Overburden wells on the main parcel were constructed with 2-inch diameter, 5-foot long slotted Schedule 40 PVC screens, along with Schedule 40 PVC riser.
- Groundwater monitoring wells installed in the overburden within Area C in 2011 were constructed with 2-inch diameter, 10-foot long slotted Schedule 40 PVC screen and black carbon steel riser.
- The groundwater monitoring well installed in the overburden within Area C in September 2015 (AMW-26) was constructed with 2-inch diameter, 10-foot long continuous stainless steel screen and black carbon steel riser.
- Groundwater monitoring wells installed in the overburden within Area C in December 2015 were constructed with 2-inch diameter, 10-foot long screens, either consisting of Schedule 40 PVC slotted screen and riser or continuous stainless steel screens and riser.
- Platteville Limestone/Dolostone and St. Peter Sandstone groundwater monitoring wells (bedrock monitoring wells) were constructed with 2-inch diameter, 10-foot-long continuous stainless steel screens and black carbon steel riser.
- Surface completions were either flush-mount or stickup, depending on the location.

Each well had a filter sand pack extended to approximately 2 feet above the top of the screened interval. A 2-foot bentonite seal was placed over the sand pack and the remaining well annulus was sealed with cement grout to the surface. The wells were developed (bailing and surging techniques or air lifting) and permitted in accordance with MDH requirements. The well location, ground surface, and top–of-casing elevation for each well were surveyed to the Ramsey County coordinates and 1929 United States Geological Survey Vertical Datum.

A summary of the permanent groundwater monitoring well construction details is included in Table 3. Well construction logs are included in Appendix G.

4.3.2 Monitoring Well Sampling

Each groundwater monitoring well was gauged prior to sampling. During each gauging event, static water levels were collected as well as depth to bottom measurements to determine casing integrity and siltation of the well screens. Monitoring wells were surged to suspend fine particles for purging prior to sampling. A summary of the permanent monitoring well groundwater elevations based on all gauging events (regardless if prior to a sampling event) is included in Table 4.

Groundwater monitoring wells were sampled using the low-flow sampling method in accordance with the USEPA Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (USEPA 1996). Groundwater was purged using a peristaltic pump and dedicated tubing. If water levels exceeded approximately 25 feet below ground surface, monitoring wells were sampled using a dedicated bailer. Monitoring wells sampled with a dedicated bailer utilized the standard purge (three-well volume) technique rather than the low-flow method.

Water quality parameters (pH, temperature, specific conductivity, oxidation reduction potential, and dissolved oxygen) were collected during purging using a multi-parameter flow-through-cell and a separate turbidity meter. Once indicator parameters stabilized during low-flow groundwater sampling, or three well volumes were removed, samples were collected in laboratory-supplied containers and placed on ice pending shipment to the laboratory following standard chain-of-custody procedures. All samples were submitted to TestAmerica Laboratories in North Canton, Ohio of one or more of the following analytes:

- VOCs using USEPA Method 8260
- SVOCs using USEPA Method 8270
- PCBs using USEPA Method 8082
- DRO using the WI Modified Method
- GRO using the WI Modified Method
- Cyanide using USEPA Method 335.4
- Dissolved TAL Metals using USEPA Method 6010
- Total and dissolved RCRA Metals using USEPA Method 6010/ Method 7470
- Total and dissolved Lead using USEPA Method 6010.

All groundwater samples analysed for dissolved metals were field filtered using a 0.45-micron disposable filter prior to sample collection. Groundwater sampling logs are included in Appendix E.

4.4 Decontamination Procedures

Drilling and sampling equipment (e.g., drill rig, drill casings, rods, sample barrel, hand augers, stainless steel spatulas) and any piece of equipment that could have potentially come into contact (directly or indirectly) with impacts were decontaminated on-site. Decontamination protocols were followed per the Field Sampling Plan between boreholes and before leaving the site at the end of the project.

Drilling and sampling equipment were disassembled and immersed in a 2-percent solution of laboratory-grade detergent (e.g., Alconox) and city water. The equipment was then scrubbed to remove any adhering particles and rinsed with distilled water. The clean equipment was then handled with clean disposable gloves to avoid potential contamination. The 2 percent solution of laboratory-grade detergent and city water was changed daily, or more frequently after drilling at highly impacted locations.

Hand augers and stainless steel spatulas were rinsed with a solution of laboratory-grade detergent (e.g., Liquinox) and distilled water. The equipment was then scrubbed to remove any adhering particles and rinsed with distilled water. The clean equipment was then handled with clean disposable gloves to avoid potential contamination.

All decontamination water was containerized as investigation-derived waste (IDW) and disposed of as described in Section 4.5.2.

4.5 Investigation-derived Waste

IDW generated during the course of the subsurface investigations included soil cuttings, purge water, decontamination water, personal protective equipment (PPE) and disposable sampling equipment (i.e., filters, tubing, PVC).

4.5.1 Soil IDW

Soil cuttings generated during the subsurface investigations were placed in a steel roll-off container or 55-gallon drums. Soil cuttings staged in 55-gallon drums were segregated in the field prior to disposal pursuant to field screening results using the following segregation parameters:

- Zero to <100 parts per million
- Greater than 100 parts per million.

One composite sample was collected for characterization from the steel roll-off. One composite sample was collected for laboratory analysis from the segregated staging areas for every five 55-gallon drum of soil cuttings generated. Laboratory analysis was utilized for offsite disposal. Laboratory analysis included one or more of the following:

- Toxicity characteristic leaching procedure (TCLP) VOCs using USEPA Method 1311/8260
- TCLP SVOCs using USEPA Method 1311/8270
- TCLP RCRA Metals using USEPA Method 1311/6010
- PCBs using USEPA Method 8082
- Corrosivity using USEPA Method 9045
- Flashpoint using USEPA Method 1010
- pH using USEPA Method 150.1.

In November 2011, two composite waste characterization samples were collected for the 2011 subsurface investigation activities. One sample consisted of a composite from the two 55-gallon drums and one sample consisted of a composite from the steel roll-off container. The off-site disposal of the soil IDW was organized and conducted by the on-site waste management company (Waste Management, Inc.).

In April 2014, waste characterization samples were collected from the 2013 to 2014-generated soil cuttings to develop a site-specific waste characterization profile for subsequent subsurface investigation soil cuttings IDW. The waste characterization samples consisted of composite samples collected from 12 of the 30 soil IDW 55-gallon drums. The site-specific waste characterization profile was used for off-site disposal of all non-hazardous soil cuttings generated between June 2014 and July 2015. The off-site disposal was facilitated through Waste Management Inc. and transported to the Spruce Ridge Facility in Glencoe, Minnesota.

4.5.2 Purge Water and Decontamination Water IDW

Purge water and decontamination water generated during investigation activities when the assembly plant was operational were temporarily staged on-site within poly tanks or 55-gallon drums. The purge water and decontamination water was then characterized by Waste Management, Inc. and discharged to the facility wastewater treatment system.

Following plant shutdown in December 2011, purge water and decontamination water were drummed for off-site disposal. One composite sample was collected for characterization from the 55-gallon drums. Laboratory analysis was utilized for offsite disposal and included one or more of the following:

- TCLP VOCs using USEPA Method 1311/8260
- TCLP RCRA Metals using USEPA Method 1311/6010
- Corrosivity using USEPA Method 9045
- Flashpoint using USEPA Method 1010
- pH using USEPA Method 9040C.

A site-specific waste characterization profile was also generated for the purge and decontamination water IDW in 2014, and was used for off-site disposal between June 2014 and June 2016. The off-site disposal was facilitated through Waste Management Inc. and transported to the Spruce Ridge Facility in Glencoe, Minnesota.

4.5.3 PPE and Disposable Sampling Equipment IDW

PPE and disposable sampling equipment were placed in the roll-off (2011) and in 55-gallon drums (2012 through 2016) and disposed of off-site after review of subsurface investigation results. A site-specific waste characterization profile was also generated for the PPE and disposable sampling equipment in 2014 based on analytical results for the soil and purge water and decontamination water IDW. The off-site disposal was facilitated through Waste Management Inc. and transported to the Spruce Ridge Facility in Glencoe, Minnesota.

4.6 Surveying

All temporary groundwater borings and permanent groundwater monitoring wells were surveyed for X, Y, and Z (ground surface and top of casing, if applicable) coordinates referencing the National Geodetic Vertical Datum of 1929 and North American Datum of 1983 by Sunde Land Surveying, LLC, a professional Minnesota-certified land surveyor, at the completion of each investigation event.

5 RISK-BASED SCREENING LEVELS

Results of the investigation activities described above were compared to risk-based screening values developed and propagated by the MDH and MPCA. These risk-based levels are only a preliminary screening tool and are not intended to indicate areas of the Site where remediation may be required. Final remediation action levels will be included as part of a Response Action Plan. The risk-based values that will be included in the screening include:

- MPCA Groundwater Intrusion Screening Values (GW_{ISVs}) for vapor intrusion
- MPCA WQS for exposure to surface water (human health via recreational use and aquatic life)
- MPCA PRP Guidance Values for direct contact with petroleum impacted groundwater
- MDH Health-Based Guidance for ingestion of groundwater.

Each of these risk-based screening levels are discussed in more detail below.

5.1 Groundwater Intrusion Screening Values

GW_{ISV}s are screening values developed by the MPCA as a tool for identifying areas where concentrations of volatile compounds in shallow or perched groundwater have the potential to create vapor intrusion concerns in overlying or nearby structures. GW_{ISV}s are not meant to take the place of a soil vapor investigation, but rather to help focus data collection efforts on areas that are most likely to represent a worse-case scenario. Ford intends to conduct a soil gas investigation at the Site prior to site redevelopment, in accordance with an MPCA-approved work plan. In the interim, GW_{ISV}s are used in this Report for a preliminary evaluation of potential soil vapor impacts in the perched overburden unit on the main parcel.

5.2 Surface Water Quality Standards

WQSs are established by the MPCA for protection of beneficial uses of state water resources. WQSs vary based on the classification (e.g., drinking water, aquatic life, recreation) for each surface water body. The stretch of the Mississippi River adjacent to the Site is classified as a 2B, 3C, 4A, 5, and 6 water. Class 2B (Aquatic Life and Recreation beneficial uses) has the strictest surface water standards of those classes and are therefore utilized as the screening standards for groundwater samples collected from the St. Peter Sandstone as well as the unconsolidated overburden aquifer on the river parcel, which, as discussed above, are the groundwater units that discharge to the Mississippi River.

5.3 Petroleum Remediation Program Guidance Values

The PRP has provided guidance values for preliminary screening of groundwater impacted with GRO and DRO. The guidance values for groundwater of 100 micrograms per liter (µg/L) for GRO and DRO was presented during personal communications with Petroleum Brownfields Program staff (Stacey Van Patten pers. com., October 30, 2015).

5.4 MDH Guidance Values for Groundwater

Guidance values for groundwater promulgated by the MDH and adopted by the MPCA include Health Risk Limits, Health Based Values and Risk Assessment Advice. This group of groundwater guidance values will collectively be referred to as MDH-derived values in the context of this report. MDH-derived values are relevant when considering direct exposure to groundwater through ingestion of drinking water. The perched groundwater present in the unconsolidated overburden on the main parcel and in the Platteville Limestone/Dolostone would not be used as a water supply due to its discontinuous nature and/or low yield; therefore, direct exposure via drinking water is not a viable exposure pathway. The St. Peter aquifer could potentially be used as a drinking water source; however, there are no water supply wells between the Site and eventual discharge of the St. Peter aquifer into the Mississippi River, therefore, the direct exposure pathway is again incomplete. For those reasons, MDH-derived values are generally not the appropriate risk-based screening standards with which to compare the site groundwater analytical results; however, MDH-derived values are included in the groundwater analytical table for reference. Due to a lack of alternative standards for comparison, the groundwater samples collected from the perched zone within the Platteville Limestone/Dolostone will be screened against MDH-derived values.

6 GROUNDWATER INVESTIGATION RESULTS AND DISCUSSION

A comprehensive list of the compounds that exceed a screening value (as discussed in Section 5) for each contaminant class is provided in Table 5. Contaminant classes are divided into the following: chlorinated VOCs, non-chlorinated VOCs, SVOCs/PAHs, metals, PCBs, and GRO/DRO, which are shown on Figures 11 through 17, respectively. Note that the permanent monitoring well locations have multiple samples collected over time, but the figures illustrate the most recent analytical results available at each location. For the purposes of this report, the term "chlorinated VOCs" refers to the following compounds:

- 1,1-Dichloroethane (1,1-DCA)
- 1,1,2-Trichloroethane
- 1,1,1,2-Tetrachloroethane
- 1,1,1-Trichloroethane (1,1,1-TCA)
- 1,2-Dichloroethane (1,2-DCA)
- Chloroethane
- 1,1,2,2-Tetrachloroethane
- 1,1-Dichloroethene (1,1-DCE)
- *cis*-1,2-Dichloroethene (cis-1,2-DCE)
- Tetrachloroethene (PCE)
- *trans*-1,2-Dichloroethene (trans-1,2-DCE)
- Trichloroethene (TCE)
- Vinyl chloride.

Groundwater analytical results from temporary groundwater monitoring wells and permanent groundwater monitoring wells are included in Tables 6 and 7, respectively. Laboratory analytical reports are included in Appendix H.

6.1 Chlorinated VOCs

The following chlorinated VOCs were detected in site groundwater:

- 1,1-DCA
- 1,1-DCE
- 1,2-DCA
- cis-1,2-DCE
- PCE

- trans-1,2-DCE
- TCE.

A complete list of the chlorinated VOC detections at the Site is included in Tables 6 and 7. A summary of chlorinated VOC results in groundwater is included on Figure 11.

Perched Overburden Unit (Main Parcel): Eighty-four locations of perched groundwater in the overburden have been sampled for VOCs, including 7 permanent wells and 77 temporary wells. Of the 84 locations sampled, chlorinated solvents were detected in 14 samples. Seven of the 14 samples contained chlorinated VOCs at trace concentrations (e.g., less than 1 µg/l). Slightly higher concentrations of chlorinated VOC were present in the remaining seven perched groundwater samples. The maximum concentration to date of PCE detected in overburden perched groundwater was 14 µg/l; all other PCE detections were at trace concentrations (< 1 µg/l). The maximum concentration of TCE detected to date in overburden perched groundwater was 26 µg/l, followed by 9.6 µg/l and 2.4 µg/l. All other TCE detections were at trace concentrations (< 1 µg/l). See below for a summary of detections and potential sources.

- ASB-036, ASB-037, and AMW-18 were installed in close proximity to each other in a former railroad spur/former coal operations (Features 12 and 47). Each of these samples contained a low concentration of 1,1-DCA (0.39 µg/l, 0.59 µg/l, and 1.2 µg/l, respectively).
- ASB-095, located at a former Dell Park Pit (Feature 100) within the former paint operations area (Feature 104), contained PCE (0.79 µg/l), TCE (0.45 µg/l), cis-1,2-DCE (2.4 µg/l), trans-1,2-DCE (0.10 µg/l).
- ASB-209 and ASB-212, located near former oil/water separators (Feature 89), contained TCE (2.4 µg/l and 0.76 µg/l, respectively). In addition, ASB-212 contained cis-1,2-DCE (0.31 µg/l).
- ASB-215, located near a former pit at the north end of the Main Assembly Building (Feature 97), contained TCE (0.28 µg/l).
- ASB-234, located in the central part of the site in close proximity to tank farm trenches and a former solvent fire (Features 94 and 106, respectively), contained PCE (0.64 µg/l).
- ASB-0326W was located near a former railroad spur (Feature 60). This sample contained PCE (14 µg/l) and TCE (0.3 µg/l).
- ASB-0626, located near former waste solvent underground storage tanks (UST) and former bulk solvents and waste solvent underground storage tanks (Feature 35 and Feature 36, respectively) contained PCE (0.37 µg/l).
- ASB-0904, located near a former pit (Feature 97) within a former nickel plating operations area (Feature 103), contained TCE (9.6 µg/l) and cis-1,2-DCE (1.4 µg/l).
- ASB-0921 was not located near any defined feature and was collected instead to fill a data gap. This sample contained TCE (26 µg/l), cis-1,2-DCE (2.3 µg/l) and 1,1-DCE (1.3 µg/l).
- ASB-1110, located on the river parcel near a former tar decanter house (Feature 154), contained cis-1,2-DCE (0.5 µg/l).

- AMW-15, located east of the former gasoline, Sunoco spirits, and pyroxlin thinner underground storage tanks (USTs; Feature 16), contained 1,2-DCA (6.9J µg/l).

Six of the above overburden perched groundwater sample locations also detected chlorinated VOCs in the soil samples. These six locations include ASB-209, ASB-212, ASB-234, ASB-0626, ASB-0904, and ASB-0921 (Arcadis 2016a). With the exception of ASB-0904 and ASB-0921, the chlorinated VOCs detected in the corresponding soil and groundwater samples were at trace concentrations. At ASB-0904 and ASB-0921, chlorinated VOCs were detected at trace concentrations in the soil samples and at slightly higher concentrations in the groundwater samples.

It should be noted that the laboratory method detection limits (MDLs) for chlorinated VOCs were elevated in a number of overburden perched water samples. This might have masked the detection of chlorinated VOCs at those locations, if present. The high MDLs were associated with perched groundwater samples collected in areas where high concentrations of hydrocarbons or petroleum-related VOCs required dilution of the laboratory sample. These samples were clustered in three general areas of the site: the north parking lot (which includes Feature 5 – Former Location of Gasoline and Diesel Fuel Underground Piping); a small area in the central portion of the Site where a number of Features converge, including but not limited to former petroleum USTs (Feature 16 – Former Gasoline, Sunoco Spirits, and Pyroxlin Thinner USTs, Feature 68 – Battery Charging Trenches, Feature 94 – Tank Farm Trenches, and Feature 104 – Former Paint Operations); and near the former solvent USTs just south of the former Paint Building (Feature 35 – Waste Solvent USTs and Feature 36 – Former Bulk Solvents and Waste Solvent USTs).

PCE and TCE exceeded their respective MDH-derived values in the overburden unit; however, there is no regulatory driver associated with these exceedances as groundwater from the overburden unit is not utilized as drinking water. Instead, as noted in Section 5.1, an exceedance of a GW_{ISV} indicates there is the potential for a vapor intrusion issue in overlying or nearby structures, and will be used as the regulatory driver for the perched overburden on the main parcel. The GW_{ISV} for TCE was exceeded in one sample collected from the perched overburden at ASB-0921, which is in the north half of the former Main Assembly Building. This detection will be considered when developing an upcoming soil gas investigation to be completed prior to property redevelopment. No other chlorinated VOCs exceeded their respective GW_{ISVs} in the perched overburden.

Perched Platteville Limestone/Dolostone Unit: Eight permanent monitoring wells have been installed in the Platteville Formation. A trace concentration (<1 µg/l) of cis-1,2-DCE was detected in AMW-03A during each of five discrete sampling events, with the latest detection during the June 2016 sampling event. Three additional monitoring wells detected chlorinated VOCs during the June 2016 sampling event that did not have detections during any of the previous sampling events. TCE was detected in AMW-08 and AMW-09 at concentrations exceeding the MDH-derived value (5.4 µg/l and 0.44 J µg/l, respectively). Elevated concentrations of both cis-1,2-DCE and TCE (240 J µg/l and 43 J µg/l, respectively) were detected in AMW-06 at concentrations exceeding the MDH-derived values. A slightly elevated concentration of trans-1,2-DCE was also detected at AMW-06, but at a concentration below its MDH-derived value. AMW-06 is located downgradient of two temporary overburden monitoring wells (ASB-0904 and ASB-0921), which also exhibited cis-1,2-DCE and TCE exceedances. No temporary overburden monitoring wells were installed near the three remaining monitoring wells with chlorinated VOC exceedances (AMW-03A, AMW-08, and AMW-09).

Cis-1,2-DCE and TCE exceeded the MDH-derived values in the Platteville Limestone/Dolostone unit. However, there is no regulatory driver associated with these exceedances as groundwater from the Platteville Limestone/Dolostone unit is not utilized as drinking water.

No chlorinated VOCs have been detected in the other five Platteville monitoring wells.

St. Peter Sandstone: Nine permanent monitoring wells have been installed in the St. Peter Sandstone. Six of these are on the main parcel (AMW-03B, AMW-27 through AMW-31) and the other three are located on the river parcel (AMW-05, AMW-05B, and AMW-07).

PCE has been detected in AMW-03B, AMW-05, AMW-05B, AMW-07, and AMW-30, although not consistently and at low concentrations. The maximum concentration of PCE detected in a St. Peter monitoring well on the river parcel was 3.7 µg/l (AMW-05B), and this was an isolated occurrence in September 2008; no PCE was detected in the previous three or subsequent five groundwater samples collected from AMW-05B. Similarly, an isolated detection of PCE (3.2 µg/l) occurred in AMW-03B during the September 2008 sampling event, with no PCE detected during the other previous three or subsequent two sampling events. PCE detected at AMW-05, AMW-07 and AMW-30 have been sporadic and at trace concentrations.

TCE has been consistently detected in AMW-07 at concentrations ranging from 0.43 µg/l to 2.9 µg/l. This well is located on the river parcel in the general area of the former coal gasification plant. TCE was also detected during the three sampling events in 2016 at AMW-29 and AMW-30, each located on the west perimeter of the main parcel. TCE was detected at AMW-29 at concentrations between 7.1 µg/l and 11.4 µg/l, and at AMW-30 at concentrations between 22 µg/l and 34 µg/l. TCE has been detected in AMW-05 and AMW-05B as well, the northernmost monitoring wells on the river parcel. AMW-05, the shallower of the two nested wells, is often dry during sampling events; however, a temporarily higher water table after the June 2014 flood event allowed samples to be collected from this well in July and August 2014. TCE was detected during the two sampling events at 15 µg/l and 3.2 µg/l, respectively. Of the nine samples collected from AMW-05B, a trace concentration (<1 µg/l) of TCE was detected during two sampling events (August 2014 and June 2016). As illustrated on Figure 11, AMW-05 and AMW-05B are downgradient of AMW-30, and as discussed above, have lower concentrations of TCE. AMW-07 is downgradient of AMW-29, and also exhibits lower concentrations of TCE.

River Parcel Overburden: The overburden aquifer in Area C discharges to the Mississippi River, and therefore analytical results are compared to the MPCA Class 2B surface water criteria. Cis-1,2-DCE has been detected in four of the eight monitoring wells installed within and surrounding Area C (AMW-21, AMW-22, AMW-22B, and AMW-26). The maximum concentration detected between the four monitoring wells is 1.8 µg/l at AMW-26; however, none of the detections exceed the MPCA Class 2B surface water criteria.

In summary, chlorinated VOCs are a contaminant of concern in groundwater at the Site only in one location in the perched unconsolidated aquifer. Of the 34 permanent monitoring wells that have been sampled to date for VOCs, chlorinated VOCs have been detected in only 16 of the wells and none of the concentrations exceeded their applicable standard. Of the 77 temporary wells that have been sampled for VOCs, chlorinated solvents were detected in 14 wells and only one analyte (TCE at ASB-0921) exceeded the GW_{ISV}. No chlorinated VOCs detected to date in the St. Peter aquifer or river parcel overburden, which discharge to the Mississippi River, exceed the MPCA Class 2B surface water criteria.

6.2 Non-Chlorinated VOCs

Non-chlorinated VOCs refers to all VOCs on the USEPA Method 8260 reporting list except those compounds that are explicitly listed in Section 6.1. A complete list of the non-chlorinated VOCs that have been detected in groundwater at the Site are included in Tables 6 and 7. A summary of non-chlorinated VOC results in groundwater is included on Figure 12.

Perched Overburden Unit (Main Parcel): Of the 84 locations sampled, non-chlorinated VOCs were detected in 73 samples. Seven of those samples contained non-chlorinated VOCs at only trace concentrations (e.g. < 1 µg/l). Slightly higher concentrations of non-chlorinated VOCs were present in the remaining 66 perched groundwater samples. 1,2,4-TMB; 1,3,5-TMB; benzene; CFC-12; ethylbenzene; naphthalene; and total xylenes exceeded the MDH-derived values in the overburden unit. These constituents are similar to those identified in soil in the same areas, if applicable. However, there is no regulatory driver associated with these exceedances as groundwater from the overburden unit is not utilized as drinking water. Instead, the GW_{ISV} criteria will be used as the regulatory driver for the perched overburden on the main parcel. Groundwater concentrations of non-chlorinated VOCs exceeding their respective GW_{ISVs} are generally clustered in the following areas:

- South of the Paint Building (Former UST Solvent Tank Area)
- East of the Main Assembly Building
- North of the Main Assembly Building (North Parking Area).

South of the Paint Building, in the vicinity of the Former UST Solvent Tank Area, the following constituents were detected in the perched overburden groundwater above the GW_{ISV}: ethylbenzene; m,p-xylene, and o-xylene. These constituents are similar to those identified in soil in the same area.

East of the Main Assembly Building the following constituents were detected in the perched overburden groundwater above the GW_{ISV}s: 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; benzene; ethylbenzene; CFC-12; m,p-xylene; and o-xylene. These constituents are similar to those identified in soil in the same areas.

North of the Main Assembly Building in the North Parking Area, the following constituents were detected in the perched overburden groundwater above the GW_{ISV}s: 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; benzene; m,p-xylene, and o-xylene. These constituents are similar to those identified in soil in the same area.

These exceedances will be considered when developing an upcoming soil gas investigation to be completed prior to property redevelopment. No other chlorinated VOCs exceeded their respective GW_{ISVs} in the perched overburden.

Perched Platteville Limestone/Dolostone Unit: Non-chlorinated VOC detections have been isolated at all eight monitoring wells within the Platteville Limestone with the exception of two constituents, 2-butanone (MEK) and carbon disulfide. One or both constituents was detected at concentrations below their respective MDH-derived values during three consecutive sampling events at AMW-02 and AMW-06 (between December 2007 and September 2008), AMW-08 (between July 2007 and March 2008) and AMW-09 (March and September 2008, June 2016). No other non-chlorinated VOCs were detected consistently in the other Platteville monitoring wells. No non-chlorinated VOCs detected to date in the Platteville Formation exceeded their respective MDH-derived values.

St. Peter Sandstone: Non-chlorinated VOC detections in eight of the nine monitoring wells have been isolated and at concentrations below their respective WQS in the St. Peter Sandstone. Non-chlorinated VOCs were not detected in the remaining well.

River Parcel Overburden: Non-chlorinated VOC detections at nine of the 10 monitoring wells have been isolated and at concentrations below their respective WQS. Ethylbenzene was detected at AMW-25 during both sampling events at concentrations exceeding the WQS (120 µg/l and 95 µg/l, respectively). However, ethylbenzene was not detected in the downgradient wells (AMW-24, AMW-23, AMW-23B and AMW-20). No other non-chlorinated VOCs were detected above their respective WQS in the overburden to the St. Peter Sandstone on the river parcel.

In summary, non-chlorinated VOCs appear to be a contaminant of concern in three primary areas (south of the Paint Building [former solvent UST], east of the Main Assembly Building, and north of the Main Assembly Building [North Parking Area]) in the perched overburden on the main parcel at concentrations that exceed their respective GW_{ISV}s. The constituents that exceeded GW_{ISV}s were one or more of the following: 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; benzene; ethylbenzene; CFC-12; m,p-xylene; and o-xylene. These exceedances will be considered when developing an upcoming vapor intrusion investigation to be completed prior to property redevelopment. Non-chlorinated VOCs do not appear to be a significant contaminant of concern in the Platteville Limestone/Dolostone and St. Peter Sandstone aquifers at the Site. The exceedances of ethylbenzene detected at AMW-25 within the river parcel overburden was not detected in downgradient monitoring wells during the same sampling events.

6.3 SVOCs

A complete list of the SVOCs that have been detected at the Site is included in Tables 6 and 7. A summary of SVOC results in groundwater is included on Figure 13.

Perched Overburden Unit (Main Parcel): Sixty-six locations of perched groundwater in the overburden have been sampled for SVOCs, including eight permanent wells and 58 temporary wells. Of the 66 locations sampled, SVOCs were detected in 51 samples. Thirteen of those samples contained SVOCs at only trace concentrations (e.g., <1 µg/l). Slightly higher concentrations of SVOCs were detected in the remaining 38 perched groundwater samples. Benzo(a)pyrene (BaP), naphthalene, BaP equivalents, bis(2-ethylhexyl)phthalate, and 2-methylnapthalene exceeded the MDH-derived values in the overburden unit. The locations of the samples with these exceedances were clustered in the three same general areas of the Site as the VOCs discussed above: south of the Paint Building (former solvent UST), east of the Main Assembly Building (where a number of Features converge, including but not limited to former petroleum USTs), and north of the Main Assembly Building (North Parking Area). However, there is no regulatory driver associated with these exceedances, as groundwater from the overburden unit is not utilized as drinking water. Instead, the GW_{ISV} criteria will be used as the regulatory driver for the perched overburden on the main parcel. The GW_{ISV} for naphthalene was exceeded in two groundwater samples collected from temporary groundwater monitoring wells set at ASB-001 and ASB-003 located east of the Main Assembly Building; however, naphthalene was below the GW_{ISV} in the samples collected from permanent groundwater monitoring wells (AMW-14 and AMW-12, respectively), which were installed in the same locations. These exceedances will be considered when developing an upcoming soil gas investigation to be completed prior to property redevelopment. No other SVOCs have a GW_{ISV}.

Perched Platteville Limestone/Dolostone Unit: SVOC detections have been isolated at seven of the eight monitoring wells installed in the Platteville Limestone/Dolostone. Bis(2-ethylhexyl)phthalate was the only SVOC detected above the MDH-derived values in the Platteville Limestone/Dolostone from AMW-09 during the December 2007 event with an estimated concentration of 8.8 µg/l; however, samples collected from that well before (July 2007) and after (March and September 2008, June 2016) were below detection limits. As discussed in Section 5.4, groundwater from the Platteville Limestone/Dolostone is not used as a potable water source, but was compared to the MDH-derived values in the absence of an alternative standard. No other SVOCs detected to date in the Platteville Formation exceeded their respective MDH-derived values.

St. Peter Sandstone: Three of the nine monitoring wells (AMW-03B, AMW-05B, and AMW-07) have been sampled for SVOCs. Detected constituents have been sporadic and at trace concentrations. AMW-07 detected anthracene at trace concentrations in June 2016 (0.20 µg/l) and was above the WQS. However, samples collected from that well before 2016 were below detection limits. No other SVOCs have been detected above their respective WQS in the St. Peter Sandstone.

River Parcel Overburden: SVOCs have been detected at seven of the 10 monitoring wells. Five of those monitoring wells had isolated detections of SVOCs at concentrations below their respective WQS. Anthracene and bis(2-ethylhexyl)phthalate were detected exceeding the WQS at AMW-21 in its second sampling event (June 2016) with concentrations of 0.25 µg/l and 6.0 µg/l, respectively. AMW-22 and AMW-22B are downgradient of AMW-21, and did not detect either constituent during the same sampling event. Anthracene, bis(2-ethylhexyl)phthalate, fluoranthene and phenanthrene had detected concentration (1.3 µg/l, 2.3 µg/l, 4.1 µg/l, and 5.2 µg/l, respectively) at AMW-26 exceeding their respective WQS. However, AMW-19, AMW-20, AMW-23 and AMW-23B are downgradient of AMW-26 and did not detect any of the four constituents. No other SVOCs were detected above their respective WQS in the overburden to the St. Peter Sandstone on the river parcel.

In summary, SVOCs appear to be a contaminant of concern in limited areas at the Site. Two temporary well locations detected naphthalene at concentrations exceeding GW_{ISV}s. These exceedances will be considered when developing an upcoming soil gas investigation to be completed prior to property redevelopment. Three groundwater samples exceeded the WQS for anthracene, bis(2-ethylhexyl)phthalate, fluoranthene or phenanthrene in the St. Peter aquifer and river parcel overburden during the most recent sampling event (June 2016). However, downgradient wells did not detect these same constituents at concentrations exceeding the respective WQS. An evaluation of the interaction between groundwater in the St. Peter aquifer and the adjacent Mississippi River will be completed as part of an Area C investigation summary report.

6.4 Metals

Dissolved metals are the preferred analytical method when discussing metals concentrations in groundwater. A complete list of the total and dissolved metals that have been detected at the Site is included in Tables 6 and 7. A summary of dissolved metals results in groundwater is included on Figure 14.

Perched Overburden Unit (Main Parcel): Fifty-nine locations of perched groundwater in the overburden have been sampled for metals, including 8 permanent wells and 51 temporary wells. Of the 59 locations sampled, dissolved metals were detected in 56 sample locations. Groundwater analytical results from the overburden unit were compared to the MDH-derived values as there are no GW_{ISV}s for dissolved metals. However, there is no regulatory driver associated with exceedances, as groundwater from the overburden unit is not utilized as drinking water. The following dissolved metals were detected above the MDH-derived values in the overburden unit: arsenic, manganese, thallium, and vanadium. The locations of the samples with these exceedances were clustered in two of the same general areas of the site as the VOCs and SVOCs discussed above: along the edge of the north parking lot with the Main Assembly Building and east of the Main Assembly Building in a small area where a number of Features converge.

Perched Platteville Limestone/Dolostone Unit: Dissolved metals have been consistently detected at all eight wells. Detected concentrations have exceeded respective MDH-derived values at least once for dissolved manganese and thallium at every well in the Platteville Limestone/Dolostone unit, with the exception of AMW-06. Manganese and thallium were also detected in the overburden exceeding the applicable MDH-derived values. Manganese is detected at concentrations exceeding the MDH-derived value at seven of the eight wells with concentrations ranging from 110 µg/l to 370 µg/l, and appears to be ubiquitous across the Site. Thallium is detected at three wells (AMW-01, AMW-04, and AMW-09) along the north and east perimeter of the Site with concentrations ranging from an estimated 2.1 µg/l to 2.5 µg/l. These wells are not in the same area as the exceedances for thallium in the perched overburden as discussed above.

St. Peter Sandstone: Dissolved metals have been consistently detected at all nine wells. The following dissolved metals have been detected in one or more of the St. Peter Sandstone wells above their applicable WQSs: aluminium (140 to 29,000 µg/l), cobalt (5.1 to 75 µg/l), copper (29 to 190 µg/l), nickel (7.8 to 410 µg/l), selenium (6.0 to 11 µg/l), thallium (2.5 to 5.1 µg/l) and zinc (11 to 396 µg/l).

The following dissolved metals have been detected in five monitoring wells on the main parcel (AMW-27 through AMW-31) above their applicable WQSs in the St. Peter Sandstone: aluminium, cobalt, copper, nickel, thallium and zinc. Two of the main parcel monitoring wells (AMW-29 and AMW-30) detected aluminium, cobalt, copper, and zinc above their applicable WQSs for each sampling event in 2016. Aluminium was also detected above the WQS for each sampling event at AMW-27 and AMW-28. Cobalt and copper were detected above their applicable WQSs sporadically at AMW-27 and AMW-28. Nickel and zinc were detected above their applicable WQSs only at AMW-29 and AMW-30.

Thallium was detected above its WQS along the northwest portion of the main parcel at AMW-30 and AMW-31 for at least one sampling event in 2016. These wells are near AMW-01, a Platteville Limestone/Dolostone well that also detected thallium at a concentration exceeding its applicable screening level.

The following dissolved metals have been detected in the three monitoring wells (AMW-05, AMW-05B, and AMW-07) on the river parcel in the vicinity of the Wastewater Treatment Plant above their applicable WQSs in the St. Peter Sandstone: aluminium, cobalt, and selenium. Selenium was detected above the WQSs once in AMW-05 in July 2014 but was below detection limits during the two subsequent sampling events in August and September of the same year. Cobalt was not detected in AMW-05B in July 2014, but was detected above the WQS in August and September 2014 as well as June 2016. Aluminium and cobalt were each detected at AMW-07 at concentrations above the WQS in samples collected in August and September 2014, but were below the WQSs in July 2014. In 2016, cobalt was detected at concentrations above WQS in March and June, while aluminium was detected above the WQS in June only.

River Parcel Overburden: Dissolved metals have been consistently detected at all 10 wells. Thallium was the only dissolved metal to be detected exceeding its WQS at least once for the following locations: AMW-19, AMW-20, AMW-21, AMW-22, AMW-23, AMW-24, AMW-25 and AMW-26. Thallium was not detected or was detected at concentrations below its WQS in the upgradient St. Peter Sandstone wells AMW-07, AMW-28 and AMW-29; however, thallium was detected at concentrations exceeding its WQS in the upgradient St. Peter Sandstone well AMW-30. The thallium concentrations detected in the St. Peter Sandstone and in the unconsolidated overburden of the river parcel were always at or below 10 µg/L. No areas were identified that had relatively elevated thallium concentrations which suggests that the thallium that was detected is ubiquitous across the site in the deep groundwater. Cobalt was also detected at concentrations exceeding the WQS at AMW-20 between November 2011 and January 2012, but did not exceed during any other sampling event. No other dissolved metal was detected at concentrations that exceeded applicable WQSs.

In summary, metals appear to be a contaminant of concern in portions of the non-perched groundwater (St. Peter Sandstone and unconsolidated overburden at the river parcel) only. Thallium, when detected, is ubiquitous in all four aquifer units at concentrations within the same magnitude (2.1 to 10 µg/l), which exceeds the very low WQS of 0.56 µg/L. Aluminium, cobalt, and selenium were also detected in the St. Peter Sandstone at concentrations exceeding their applicable WQSs. An evaluation of the interaction between groundwater in the St. Peter aquifer and the adjacent Mississippi River will be completed as part of an Area C investigation summary report.

6.5 PCBs

A complete list of the PCBs that have been detected in groundwater is included in Tables 6 and 7. A summary of PCB results in groundwater is included on Figure 15. Analytical results from the overburden unit were compared to MDH-derived values in the absence of applicable GW_{ISV}s.

Perched Overburden Unit: Thirty-five locations of perched unconsolidated groundwater in the overburden have been sampled for PCBs, including six permanent monitoring wells and 29 temporary wells. Of the 35 locations sampled, PCBs were detected in three samples. Groundwater analytical results from the overburden unit were compared to the MDH-derived values as there are no GW_{ISV}s for PCBs. However, there is no regulatory driver associated with exceedances as groundwater from the overburden unit is not utilized as drinking water. Aroclor 1254 and Aroclor 1260 were detected above the MDH-derived values in the overburden unit in one sample from each of the following temporary groundwater monitoring wells: ASB-095, ASB-212, and ASB-234. All three PCB exceedances were located to the east of the Main Assembly Building.

Perched Platteville Limestone/Dolostone Unit: PCBs were not detected above the MDH-derived values in the Platteville Limestone/Dolostone in any of the eight Platteville Formation monitoring wells to date.

St. Peter Sandstone: Each of the St. Peter monitoring wells have been sampled for PCBs during at least two sampling events, with the exception of AMW-05. PCBs have been detected at concentrations exceeding the WQSs at two locations on the river parcel (AMW-05B and AMW-07) in the St. Peter Sandstone. Aroclor 1254 was detected at AMW-05B and Aroclor 1260 was detected at AMW-07 in one sample collected in September 2008. Four previous sampling events in 2007 and 2008 and two subsequent sampling events in 2009 and 2016 did not identify detectable concentrations of PCBs in either well, which indicates that the September 2008 detection was isolated in nature.

River Parcel Overburden: In accordance with the Area C Investigation Work Plan (Arcadis 2015) and the Work Plan for Site-Wide Groundwater Sampling of Permanent Monitoring Wells (Arcadis 2016d), PCB samples have not been collected from the eight monitoring wells screened in the overburden on the river parcel.

In summary, PCBs do not appear to be a significant contaminant of concern in groundwater at the Site. Of the 22 permanent monitoring wells that have been sampled to date, PCBs were detected once at two wells (AMW-05B and AMW-07) during the sampling event in September 2008, and exceeded applicable criteria. Previous and subsequent sampling events did not detect PCBs. Of the 29 temporary wells that have been sampled in the overburden, PCBs were detected in only three wells. The analytical results were compared to MDH-derived values in the absence of applicable GW_{ISV}s. However, there is no regulatory driver associated with these exceedances as groundwater from the overburden unit is not utilized as drinking water.

6.6 GRO/DRO

GRO and DRO were compared to MPCA-specified screening levels of 100 µg/L for both GRO and DRO for drinking water; however, there are no drinking water receptors at the Site. There are no GW_{ISV} or WQS standards for GRO or DRO. A complete list of GRO and DRO detections at the Site is included in Tables 6 and 7. A summary of GRO/DRO results in groundwater are included on Figure 16.

Perched Overburden Unit (Main Parcel): Seventy-four locations of perched groundwater in the overburden have been sampled for GRO and/or DRO, including eight permanent wells and 66 temporary wells. Of the 74 locations sampled, GRO and/or DRO were detected in 69 samples. Both GRO and DRO were detected at concentrations above the specified screening levels in the perched overburden unit in samples collected from both temporary and permanent wells. GRO and DRO detections above the specified screening levels were detected in the overburden unit across the Site. In general, DRO concentrations were relatively higher when compared to GRO. The areas with the highest concentrations (greater than two orders of magnitudes above the specified criteria) of GRO and DRO were north of the Main Assembly Building in the North Parking Lot (ASB-0203S, ASB-0206E, ASB-0207E, ASB-0208S, ASB-0215, and ASB-0216), east of the Main Assembly Building (ASB-001, ASB-003, ASB-037, ASB-0211N, ASB-0223, and ASB-0224) and southeast of the Main Assembly Building near Former Fill Areas A and B (ASB-0416). These are the same locations where source areas with relatively elevated soil concentrations have been identified. GRO concentrations in the perched overburden range from non-detect to 66,000 µg/L and DRO concentrations range from non-detect to 64,000 µg/L.

Platteville Limestone/Dolostone Unit: GRO and DRO have both been detected in the Platteville Limestone/Dolostone at concentrations exceeding the specified screening levels in each well at least once. Concentrations of GRO in this perched limestone aquifer have ranged from an estimated 41 µg/L to 120 µg/L and concentrations of DRO have ranged from an estimated 55 µg/L to 2,300 µg/L. Both ranges of concentrations are generally lower than what has been detected in the overlying perched overburden groundwater discussed above.

St. Peter Sandstone: DRO has been detected at three wells (AMW-03B, AMW-05B and AMW-07) screened in the St. Peter Sandstone on the river parcel, with detected concentrations at AMW-05B and AMW-07 exceeding the MPCA screening level. DRO was detected at AMW-05B with a concentration of 180 µg/L in June 2016. Detected concentrations of DRO at AMW-07 have ranged from 130 µg/L (March 2008 and June 2016) to 210 µg/L (September 2008). DRO has been detected at all five wells screened in the St. Peter Sandstone on the main parcel at concentrations exceeding the MPCA screening level. DRO concentrations range from 180 µg/L to 2,600 µg/L. The two locations with the highest concentrations (AMW-29 and AMW-31) correspond with locations in the overburden with greater than two orders of magnitude above the specified criteria: east of the Main Assembly Building and north of the Main Assembly Building in the North Parking lot.

GRO was detected at AMW-29 and AMW-30 in June 2016 with estimated concentrations of 38 µg/L and 54 µg/L, respectively. No other St. Peter Sandstone monitoring wells detected GRO.

River Parcel Overburden: GRO and DRO have both been detected in the river parcel overburden with concentrations exceeding the specified screening levels. Concentrations of GRO have been detected in three of the ten wells (AMW-23, AMW-23B, and AMW-25) during the June 2016 sampling event, but only exceeded the specified screening level at AMW-25 with a concentration of 10,000 µg/L. Concentrations of DRO have been detected in eight of the ten wells (AMW-19, AMW-20, AMW-21, AMW-22B, AMW-23, AMW-24, AMW-25, and AMW-26) and exceedances have ranged from 110 µg/L to 11,000 µg/L. Concentrations of DRO detected in AMW-22B have historically been lower than detections in upgradient AMW-21. Concentrations of DRO detected in AMW-19 and AMW-20 did not exceed the specified screening level in June 2016, and both are downgradient of monitoring wells with DRO concentration exceedances. Specifically, AMW-19 is downgradient of AMW-26 while AMW-20 is downgradient of AMW-23, AMW-24, and AMW-25.

In summary, GRO and DRO appear to be detected across the Site, regardless of aquifer unit. Of the 35 permanent monitoring wells that have been sampled to date for GRO and/or DRO, detections exceeded applicable criteria at 31 wells. Of the 66 temporary wells that have been sampled for GRO and/or DRO, detections exceeded applicable criteria at 61 wells. The detections of GRO and/or DRO across the Site could be the result of several Features, including but not limited to: Feature 2 (Former Location of Gasoline and Diesel USTs – Removed 1993), Feature 4 (Former Area of Impacted Soil - Leak #10700), Feature 5 (Former Location of Gasoline and Diesel Fuel Underground Piping), Feature 6 (Diesel Meter Shack), Feature 16 (Former Gasoline, Sunoco Spirits, and Pyroxlin Thinner USTs), Feature 59 (Railroad Spur), and Feature 152 (Former Fuel Oil UST). As noted above, there are no drinking water receptors at the Site and there are no GW_{ISV}s or WQS standards for GRO or DRO so they are not considered primary contaminants of concern at the Site.

6.7 Cyanide

A complete list of cyanide detections in site groundwater is included in Tables 6 and 7. A summary of cyanide results in groundwater is included on Figure 17. Analytical results from the overburden unit were compared to MDH-derived values in the absence of applicable GW_{ISV}s.

Perched Overburden Unit (Main Parcel): Ten locations of perched groundwater in the overburden have been sampled for cyanide, including six permanent wells and four temporary wells. Of the 10 locations sampled, cyanide was detected in two samples at concentrations below the MDH standard for the overburden unit. Groundwater analytical results from the overburden unit were compared to the MDH-derived values as there is no GW_{ISV} for cyanide. However, there is no regulatory driver associated with these detections as groundwater from the overburden unit is not utilized as drinking water.

Perched Platteville Limestone/Dolostone Unit: Cyanide was sampled for analysis in all eight Platteville Formation monitoring wells during one sampling event (June 2016) and was only detected in one well (AMW-06). The cyanide detection at AMW-06 was below the MDH-derived values.

St. Peter Sandstone: Cyanide was detected in only two of the nine St. Peter Sandstone monitoring wells. One St. Peter Sandstone monitoring well on the river parcel (AMW-07) detected cyanide at an estimated concentration of 5.9 µg/L in a sample collected in March 2008. This concentration is above the applicable WQS for free cyanide and is located in the vicinity of the former coal gasification plant, southeast of the Wastewater Treatment Plant. Cyanide was not detected in AMW-07 from subsequent sampling events completed in September 2008 and June 2016. Cyanide was also detected on the main parcel at AMW-29 at an estimated concentration of 6.5 µg/L in a sample collected in June 2016. This concentration is also above the applicable WQS for free cyanide and is located upgradient of AMW-07, which did not detect cyanide during that time. No other St. Peter Sandstone monitoring wells detected cyanide.

River Parcel Overburden: Cyanide was collected for one sampling event (June 2016) and detected in only three of the 10 wells (AMW-22, AMW-23, and AMW-24). Each of the detections exceeded the applicable WQS for free cyanide at concentrations of 15 µg/L, 14 µg/L, and 13 µg/L, respectively. All three monitoring wells are located around the perimeter of Area C within the floodplain of the river parcel. However, AMW-20 is downgradient of AMW-23 and AMW-24 and did not detect cyanide during the same sampling event. There is no monitoring well down gradient of AMW-22.

In summary, cyanide does not appear to be a significant contaminant of concern in the perched overburden or Platteville Limestone/Dolostone aquifer units and is a contaminant of concern in only limited areas of the St. Peter Sandstone and unconsolidated overburden at the river parcel. An evaluation of the interaction between groundwater in the St. Peter aquifer and the adjacent Mississippi River will be completed as part of an Area C investigation summary report.

7 SUMMARY AND CONCLUSIONS

Groundwater analytical data was compared to risk-based screening values developed and propagated by the MPCA only as a preliminary screening tool. A comprehensive summary of the compounds that have been detected at least once in groundwater at concentrations exceeding the screening values discussed in the SIR and above is shown in the table below:

Compound	Groundwater > Applicable Screening Values[1]			
	Perched Overburden (Main Parcel)	Perched Platteville Limestone/Dolostone (Main Parcel)	St. Peter Sandstone (Main and River Parcels)	Overburden (River Parcel)
Chlorinated VOCs	Yes	Yes	No	No
Non-chlorinated VOCs	Yes	No	No	Yes
SVOCs/PAHs	Yes	Yes	Yes	Yes
Metals	Not Applicable[2]	Yes	Yes	Yes
PCBs	Not Applicable	No	Yes	Not Applicable
GRO	Not Applicable	Yes	No	Not Applicable
DRO	Not Applicable	Yes	Yes	Not Applicable
Cyanide	Not Applicable	No	Yes	Yes

[1]Applicable Screening Values:
Perched Overburden (Main Parcel) – Groundwater Intrusion Screening Values
Platteville Limestone/Dolostone –MDH Derived Values
St. Peter Sandstone – MPCA Surface Water Class 2B Criteria
Overburden (River Parcel) - MPCA Surface Water Class 2B Criteria
[2] Not Applicable: No applicable screening values exist for the contaminant group.

Areas of the site where groundwater impacts in the perched overburden exceed GW_{ISV}s will be taken into consideration when developing an upcoming vapor intrusion investigation to be completed prior to property redevelopment. Groundwater impacts in the Perched Platteville Limestone/Dolostone that exceed MDH-derived values for drinking water do not currently present any risk because there are no groundwater receptors for that saturated interval. Groundwater impacts that exceed WQS in the St. Peter Sandstone and unconsolidated overburden on the river parcel will be considered for their potential to migrate to the Mississippi River. The results of the historical groundwater investigation discussed in this document will be utilized in conjunction with the comprehensive soil subsurface investigations, reported under separate cover, for development of a Remedial Action Plan for the Site, which will address any remedial actions that may be taken for this Site.

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