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General Motors Corporation

Resource Conservation and Recovery Act (RCRA) Revised Corrective Measures Proposal

NAO Flint Operations Site

ID #MID 005 356 712

May 1, 2008

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Acronyms and Abbreviations

ACGIH	American Conference of Governmental and Industrial Hygienists
ADD	average daily dose
AOI	area of interest
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ATEC	American Testing and Engineering Corporation Associates
AWQC	ambient water quality criteria
BBL	Blasland, Bouck & Lee, Inc.
BCa	Bias-Corrected and Accelerated
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CA 750	Migration of Contaminated Groundwater Under Control
cfs	cubic feet per second
cm/sec	centimeter(s) per second
CSM	Conceptual Site Model
cy	cubic yard(s)
DOCC	Description of Current Conditions
DNAPL	dense nonaqueous phase liquid
EI	Environmental Indicator
ERA	Ecological Risk Assessment
FE	Flammability and Explosivity Criteria
FOIA	Freedom of Information Act
FSP	Field Sampling Plan
G&M	Geraghty & Miller
GAI	Groundwater Acute Inhalation Criteria
GCC	Groundwater Contact Criteria
GIS	geographic information system
gpm	gallons per minute
GM	General Motors Corporation
GSI	Groundwater/Surface Water Interface Criteria
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
HUD	U.S. Department of Housing and Urban Development
IDC	Industrial Direct Contact Criteria

IDW	Industrial Drinking Water Criteria
IGVIA	Industrial Groundwater Volatilization to Indoor Air Inhalation Criteria
IM	interim measure
IPSIC	Industrial Particulate Soil Inhalation Criteria
IRIS	Integrated Risk Information System
ISVIA	Industrial Soil Volatilization to Indoor Air Inhalation Criteria
IVSIC	Industrial Infinite Source Volatile Soil Inhalation Criteria
LADD	lifetime average daily dose
LNAPL	light nonaqueous phase liquid
MDEQ	Michigan Department of Environmental Quality
mg/kg	milligrams per kilogram
MNFI	Michigan Natural Features Inventory
NAO	North American Operations
NCEA	National Center for Environmental Assessment
NE DOCC	Northend Description of Current Conditions
NPDES	National Pollutant Discharge Elimination System
NRC	National Response Center
NREPA	Natural Resources and Environmental Protection Act (1994 PA 451, as amended)
NTU	nephelometric turbidity unit
OSHA	Occupational Safety and Health Administration
PA	Public Act
PAL	Project Analyte List
PEL	Permissible Exposure Limit
PID	photoionization detector
ppm	parts per million
PPRTV	provisional peer reviewed toxicity values
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
RBC	Risk-Based Criteria
RCRA	Resource Conservation and Recovery Act
RDW	Residential Drinking Water Criteria
RfC	chronic inhalation reference concentrations
RfD	USEPA-derived chronic reference doses
RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
SDG	sample delivery group
SE DOCC	Southend Description of Current Conditions
SF	slope factor

SOCDS	State of the Cities Data Systems
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TLV	Threshold Limit Value
TSCA	Toxic Substances Control Act
TPH	total petroleum hydrocarbons
UCL	Upper Confidence Limit
ug/L	micrograms per liter
URF	Unit Risk Factor
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound

1. Introduction

1.1 General

On March 2, 2000 (modified November 8, 2001), the United States Environmental Protection Agency (USEPA) and General Motors Corporation (GM) entered into a Resource Conservation and Recovery Act (RCRA) Section 3008(h) Administrative Order on Consent (AOC) R8H-5-00-02 for the North American Operations (NAO) Flint Operations Site located in Flint, Michigan (the Site). The AOC instructs GM to investigate and, as necessary, stabilize and remediate releases of hazardous waste or hazardous constituents at or from the Site in accordance with the RCRA and relevant USEPA corrective action guidance documentation.

This *Resource Conservation and Recovery Act (RCRA) Revised Corrective Measures Proposal* (Revised CMP) for the Site was prepared by ARCADIS on behalf of GM, and it supersedes GM's previous CMP prepared by Blasland, Bouck & Lee, Inc., an ARCADIS Company (BBL), and submitted to the USEPA on December 22, 2006 (December 2006 CMP). This Revised CMP summarizes interim measures (IMs) initiated at the Site prior to and since the effective date of the AOC, describes proposed final corrective measures for areas of interest (AOIs) identified in the RCRA Facility Investigation (RFI) Phase I and II Reports, and discusses the rationale for the selection of those corrective measures.

The December 2006 CMP was submitted to fulfill conditions set forth under Section VI.3 of the AOC. The USEPA provided GM via letter dated April 17, 2007 comments on the December 2006 CMP. GM responded to USEPA's comments via letter dated October 10, 2007. This Revised CMP incorporates GM's October 10, 2007 responses to USEPA's April 17, 2007 comments on the December 2006 CMP, as well as information discussed with USEPA during a project status meeting held at USEPA's offices in Chicago, Illinois on December 13, 2007, with representatives from USEPA, GM, ARCADIS, and ENVIRON attending (minutes dated January 10, 2008).

This Revised CMP also provides GM's final Closure Plans for areas identified during the RFI to contain the presence of polychlorinated biphenyls (PCBs) at levels that are subject to regulation under the Toxic Substances Control Act (TSCA).

1.2 Overview of RFI Activities

To fulfill the conditions set forth under Section VI.1 of the AOC, GM completed activities necessary to identify and define the nature and extent of releases of hazardous waste or hazardous constituents at or from the Site. These activities have been presented in the following documents:

- *Description of Current Conditions for Areas South of Leith Street* (BBL, 2000a) (SEDOCC);
- *Description of Current Conditions for Areas North of Leith Street* (BBL, 2000b) (NEDOCC);
- *RCRA Facility Investigation Work Plan* (BBL, 2001) (Work Plan);
- *Resource Conservation and Recovery Act Facility Investigation Phase I Report* (BBL, 2002a) (RFI Phase I Report);
- *Resource Conservation and Recovery Act Facility Investigation Phase II Report* (BBL, 2004 & BBL, 2006) (RFI Phase II Report).

The investigation activities and risk assessments included in these documents serve as the basis for much of this Revised CMP, and are incorporated by reference herein. As needed, information previously presented in the SEDOCC, NEDOCC, RFI Phase I Report, and RFI Phase II Report is referenced, restated, or summarized. These documents present a more comprehensive understanding of the Site and the RFI activities that have been conducted at the Site.

1.3 Report Organization

This Revised CMP is organized as follows:

- Section 1 presents a general overview of background information.
- Section 2 provides general Site information, describing the Site location, environmental setting, current and historical operations, land use, demographics, geology, and hydrogeology.

- Section 3 provides a summary of the assessments of Site risks to human health with respect to anticipated current and future land use.

- Section 4 provides an evaluation of the corrective measures considered and the final controls proposed for AOIs with potentially significant risks or that contain TSCA-regulated levels of PCBs.

- Section 5 presents a summary of proposed groundwater monitoring for the Site.

- Section 6 presents the schedule for performing the proposed corrective measures.

- Section 7 lists references used in this document.

2. Environmental Setting

Much of the information regarding the environmental setting (e.g., topography, climate, hydrology, geology, hydrogeology, surface water drainage) of the Site has not changed from what is presented in Section 3 of the RFI Phase I Report and Section 3 of the RFI Phase II Report. This section summarizes the information regarding the environmental setting provided in the RFI Phase I and Phase II Reports. New information obtained since the publication of the RFI Phase II Report has been used as necessary to modify or expand the information included in this section.

2.1 Facility Description

The Site is located at 902 East Leith Street in Flint, Michigan, in Genesee County (see Figures 2-1, 2-2, and 2-3) and encompasses approximately 452 acres of land. It is generally bounded to the north by Stewart Avenue and Pierson Road, to the south by Harriet Street, to the east by James P. Cole Boulevard and CSX Railroad, and to the west by Industrial Avenue and North Street. Current operations are all conducted in the portion of the property located north of Leith Street that is referred to as the Northend. Building demolition has been completed in the portion of the property located south of Leith Street which is referred to as the Southend, and has been performed in portions of the Northend.

A plastics recycling facility is located on the northeast corner of James P. Cole Boulevard and Garfield Avenue, and a Consumers Power Building is located on the southeast corner of James P. Cole Boulevard, between the Site and the Flint River. An idle DuPont facility is located south of Hamilton Avenue, east of the Site. The CSX Railroad and Interstate I-475 are located to the east, between the Site and the Flint River, as well as several other companies, including Bell's Produce, PPG Industries, Kasle Steel/Auto Blankers, Flint Coatings, and Lockhart Chemicals. Flint Plating occupies a corner just north of the Site's industrial wastewater treatment plant. The remaining areas surrounding the Site are generally occupied by residential neighborhoods and other companies including Unit Terminal, Universal Systems, and Associated Truck.

2.2 Historical and Current Operations

Portions of the Site were originally developed in the late 1800s to produce the "horseless carriage." In 1898, Billy Durant and J. Dallas Dort purchased the Imperial Wheel Company, making it a subsidiary of the Durant/Dort Carriage Company. After

Durant/Dort Carriage Company purchased the Imperial Wheel Company, manufacturing operations were relocated to the intersection of Hamilton Avenue and St. John Street (currently James P. Cole Boulevard). The Buick Motor Company was first established in Flint when Flint Wagon Works purchased the company from David Buick in September 1903. In 1903, the Buick Motor Company was relocated from Detroit to the Site, on Hamilton Avenue between Industrial Avenue and St. John Street (now James P. Cole Boulevard).

In addition to the manufacturing of automobiles, in response to World War I, the Buick Motor Company began producing the Liberty Aircraft engine in 1918. Similarly, in response to World War II, the production of automobiles was stopped in 1942, and the Buick complex was converted for the production of military equipment. Current Site operations include machining of ferrous and nonferrous metals, V-6 engine manufacturing, torque converter manufacturing, transmission components manufacturing, engine assembly, and industrial wastewater treatment.

2.3 Location and Topography

The topography of the Site is fairly flat, although the regional topography slopes east-southeast towards the Flint River. The ground surface elevation drops approximately 35 feet between Industrial Avenue at the western property boundary and James P. Cole Boulevard at the eastern property boundary, in close proximity to the Flint River. The river is approximately 100 feet east of the Southend of the Site and approximately 3,000 feet east of the Northend of the Site.

2.4 Climate

Since day-to-day weather is controlled by the movement of pressure systems across the nation, this area seldom experiences prolonged periods of hot, humid weather in the summer or extreme cold during the winter. The prevailing wind is southwesterly, averaging 10 mph. Flint experiences some lake-effect snow. The average mid-day relative humidity varies from 54% in May to 73% in December, and averages 62% annually.

Summers are dominated by moderately warm temperatures with a 1964 to 1993 annual average of 6.6 days exceeding 90°F. An annual average of 139.3 days had minimum temperatures of 32°F or lower. The highest average monthly maximum temperature of 88.8°F was recorded July 1955, and the lowest average monthly minimum temperature of about 4ºF was recorded February 1978.

Precipitation is generally evenly distributed throughout each year with an average annual total for 1942 to 2000 of 31 inches. During this same period, the average wettest month was September, averaging 3.56 inches of precipitation, while the average driest month was February, averaging 1.28 inches of precipitation. Summer precipitation comes mainly in the form of afternoon showers and thundershowers.

The 1942 to 2003 average seasonal snowfall was about 44.9 inches. During the 1964 to 1993 period, 14.3 days per season averaged 1 inch or more of snow on the ground, but this varied greatly from season to season.

2.5 Regional Hydrology

The Flint watershed consists of approximately 1,360 square miles. The median daily discharge flow for the Flint River is approximately 400 cubic feet per second (cfs). Stream flow varies widely as a function of precipitation and runoff throughout the year and from season to season.

The Flint River flows north to south through the City of Flint. The slope is approximately 2 feet per mile through this reach. There are four major tributaries to the Flint River in the study area: Butternut, Kearsley, Thread, and Swartz creeks. Most of the tributary waters flow from upland glacial moraines, and all of the surface waters are receptors of groundwater discharge.

2.6 Regional Geology

The geology of central Genesee County is dominated by two primary stratigraphic units consisting of unconsolidated glacial deposits of Pleistocene age, underlain by sandstone bedrock. The surficial glacial deposits are composed of a sequence of moraines, outwash and glacial channels, lake bed sediments, and till plains. These deposits are underlain by glacial drift or till consisting primarily of clay with lesser amounts of sand and silt. These overburden materials are underlain by bedrock of the Saginaw Formation, consisting of Pennsylvania age sandstones and limestones.

2.6.1 Overburden

The regional landscape of Flint and the surrounding area consists of gently rolling topography. This topography includes a gently sloping ground moraine, broken by several outwash channels and also by numerous end-moraine ridges, some having slightly greater relief than the surrounding ground-moraine topography. Local relief of less than 50 feet is found over areas of several miles. The greatest regional elevation changes are along outwash channels, which are commonly accompanied by steep slopes and are 50 to 100 feet lower than the adjacent ground moraine.

The underlying glacial till deposits are typically fine-grained materials (clays and silts) with low permeability (Wiitala, et al., 1963). The till is grayish brown and poorly sorted. Locally, the till includes lenses and/or layers of more permeable silts and sands that are not extensive horizontally or vertically (Geraghty & Miller [G&M], 1986).

2.6.2 Bedrock

The bedrock geology in the region consists primarily of sandstone and limestone formations characteristic of the eastern-central portion of the Michigan Basin. These Pennsylvanian- and Mississippian-age formations include the Saginaw, Bayport, Michigan, and Marshall formations (Wiitala, et al., 1963). In the Flint area, the Saginaw Formation underlies the glacial till deposits and is composed of sandstone, sandy shale, shale, coal, and limestone. The sandstone layers are the primary source of groundwater from this formation. The Saginaw Formation is the results of cyclical sedimentation processes, and consists of numerous successions of sandstone overlain by sandy shale, gray shale, coal, black shale, and limestone.

2.7 **Regional Hydrogeology**

The regional groundwater flow direction within the sandstone bedrock is generally to the north across Genesee County, with groundwater eventually discharging to Saginaw Bay and Lake Huron (Wiitala, et al., 1963). In the Flint area, groundwater is found within the glacial till, which includes various sand and gravel deposits, and in the underlying bedrock. Groundwater flow within the glacial overburden deposits in the vicinity of the Site is toward the Flint River and its tributaries to the east and southeast. Regionally, two distinct water-bearing zones are identified, as discussed in the following sections:

2.7.1 Glacial Drift Groundwater Zone

Discontinuous sand layers are present within the till, can be fully saturated, and have a higher short-term yield than the glacial till. However, the glacial drift groundwater zone is not used as a source of groundwater due to limited yield available from this zone.

2.7.2 Bedrock Groundwater Zones

Bedrock groundwater zones are found within the Saginaw Formation, Michigan Formation, and Marshall Formation.

The Saginaw Formation is the primary source of groundwater in the Flint area. Several production wells installed in this formation were previously used for industrial and public water supply. As alternative sources of water became available, these wells were taken out of production due to the poor quality (hardness and dissolved solids) of the groundwater.

The Michigan Formation is not considered to be an important source of groundwater in the Flint area. There are no known active production wells that use this formation as a source of groundwater (Huffman and Whited, 1993).

The Marshall Formation provides only a small percentage of the groundwater used in Genesee County. In the Flint area, there are no known active production wells that use this formation as a source of groundwater (Huffman and Whited, 1993).

2.8 Surface Water Hydrology

Surface water drainage patterns at the Site are generally east and southeast, toward the Flint River, which is the nearest surface water body. Paved surfaces, parking lots, and structures cover more than 80% of the Site. The Site operates under the requirements of its National Pollutant Discharge Elimination System (NPDES) Permit (No. MI0001597), which regulates surface water discharges. The Site is drained by 15 storm sewers. Of these, the following 6 outfalls are permitted by the NPDES permit: Outfalls 002, 003, 010, 011, 012, and 100. In addition, these discharges include non-GM drainage flow from other portions of the City of Flint, both upstream and downstream of the Site's storm sewer system.

A general layout and orientation of the storm sewer system is shown on Figure 1 of Appendix F of the Southend DOCC (BBL, 2000a) and Figure 1 of Appendix A of the Northend DOCC (BBL, 2000b).

2.9 Groundwater Use

The Saginaw Formation of bedrock, which underlies the unconsolidated glacial drift in the area of the Site at depths reported to be 60 to 80 ft below ground surface (bgs), was historically the primary source of groundwater in the Flint area. Several production wells in the formation were previously used for industrial and public water supply. As alternative sources of drinking water became available, these wells were taken out of service due to the poor quality of the groundwater (high hardness and dissolved solids values). There are no known active production wells in the City that use the overburden or bedrock formations as a source of groundwater (Huffman and Whited, 1993).

Currently, the City of Flint Department of Public Works supplies drinking water to the City of Flint and Flint Township (MDEQ Website, updated April 2006). The City of Flint Department of Public Works purchases potable water from the City of Detroit, which routes water from a Lake Huron intake to the City of Flint (2002 Water Quality Report, Detroit Water and Sewerage Department).

2.10 **Site Geology**

The subsurface deposits at the Site have been characterized through the completion of numerous soil borings for site-specific investigations. Historical soil boring logs were provided in Appendix A of the RFI Work Plan. During the RFI activities, nearly 500 soil borings were completed to collect soil and groundwater samples for laboratory analyses. Soil boring logs for the RFI activities are provided in Appendix A of the RFI Phase II Report. Geotechnical analyses completed during the RFI are presented in Table 3-1 and Appendix B of the RFI Phase II Report. General cross sections of the major geologic units for the Site were presented in the RFI Phase II Report as Figures 3-1 through 3-7.

The overburden deposits identified at the Site can be grouped into the following units: fill material, silty sand, silty clay, and bedrock. Each of these units is described below.

2.10.1 Fill Material

Fill material is present beneath most areas of the Site due to various construction activities, such as existing or former buildings, loading docks, manufacturing facilities, and material storage areas. Fill material typically consists of sandy deposits. In some areas, the sandy fill material contains other debris, including coal chips, slag fragments, and metal shavings. The fill material is thickest (up to approximately 15 feet) in the vicinity of boring 20-169 (Building 20) on the Northend of the Site. The fill material is thin (approximately 1.5 feet) in the vicinity of boring SBFL3-23 (near

Building 02) on the Southend of the Site, and is absent entirely in scattered areas of limited extent.

2.10.2 Silty Sand

In the Northend of the Site, a silty sand unit of variable thickness is present beneath the fill material. Interbedded with the silty sand unit are discontinuous layers of silt and clay. This silty sand unit generally thins toward the south and is absent in some portions of the Site south of Leith Street. Where present, this unit ranges in thickness from 5 to 25 feet.

2.10.3 Silty Clay

A dense silty clay glacial till deposit underlies the silty sand at the Site. The silty clay till grades to clayey silt in some areas and contains discontinuous sand seams and lenses. The estimated thickness of the glacial till in the Flint area ranges from 50 to 100 feet (Humphrys, 1960).

2.10.4 Bedrock

Bedrock consisting of sandstone, sandy shale, shale, coal, and limestone (Saginaw Formation) is reported to be present beneath the Site at depths of approximately 60 to 80 feet bgs. Bedrock was not encountered in the soil borings completed for the RFI. Sandstone bedrock was encountered at about 60 feet bgs at boring OW-4 (GM-4) near the west side of the Aeration Lagoons (G&M, 1986).

2.11 Site Hydrogeology

The hydrogeology of the Site is characterized by a shallow groundwater zone with a depth to the water table typically ranging from approximately 6 to 16 feet bgs. Site monitoring wells have been installed within shallow overburden deposits consisting of fill, silty sand, silt, and clay. The sandy fill materials and silty sand soil units can be partially or fully saturated depending on the horizontal distribution and depth of soils and seasonal fluctuations in the water table.

The wide variation in the horizontal and vertical distribution of permeable sandy fill materials combined with an underlying low-permeability till unit produces localized water table mounds and perched zones. Also, the location and depth of subsurface structures (e.g., basements), recovery wells, and utilities (e.g., storm sewers) locally affect the depth to the water table and the direction of groundwater movement. Hydraulic conductivity values measured at shallow monitoring wells installed during the RFI in the sandy fill materials and silty sand soil units ranged from approximately 1.3 x 10^{-2} centimeters per second (cm/sec) to 3.3 x 10^{-4} cm/sec, based on specific-capacity tests (see Table 2-2 of RFI Phase II Report). Hydraulic conductivity values measured at shallow monitoring wells installed within silt and clay ranged from approximately 3.1 x 10^{-5} cm/sec to 3.1 x 10^{-6} cm/sec. The variability in the hydraulic conductivity data is due to the heterogeneity of the overburden materials. Nevertheless, the sandy fill and silty sand soil units are considerably more permeable than the silt and clay layers.

The underlying glacial till unit is predominantly a low-permeability unit that even when fully saturated does not readily transmit groundwater. This unit has been characterized as an aquitard based on the unit's low hydraulic conductivity and low yield. Based on the analysis of a Shelby tube sample by a geotechnical laboratory, the vertical hydraulic conductivity of this unit is approximately 7.9 x 10^{-8} cm/sec. Monitoring wells were not installed in the till clay unit during the RFI.

Figures 3-1 through 3-4 of the RFI Phase II Report illustrate Sitewide groundwater contours based on data collected in 2002, 2003 and 2004. Figures 2-4 and 2-5 of this Revised CMP depict groundwater contours for areas of the Site located along its downgradient boundary, based on more recent data collected in October 2007. Groundwater at the Site generally flows toward the Flint River. In the northern portion of the Site (Factory 38 and Factory 36 areas), groundwater flows to the north-northeast. A groundwater ridge, or divide, is present in the vicinity of Stewart Avenue. Groundwater to the south of this divide appears to have an east to southeast flow component. Groundwater flows to the east and southeast in the central portion of the Site (Factory 43, Building 20 areas). In the south central and southern portions of the Site, the direction of groundwater flow is primarily to the east-southeast.

Localized fluctuations in the direction of groundwater flow patterns are observed near subsurface structures (e.g., basements) and utilities that intercept shallow groundwater. Such influences can be observed near Buildings 30 and 70 on the north side of the Site due to a storm sewer. Other manmade features that affect the direction of groundwater are the Leith Street Overpass and the recovery well system operating in the Building 20 Area. Groundwater flow gradients across the Site typically range from 0.01 to 0.02; however, much steeper gradients are present in localized areas of the Site due to the presence of the manmade features discussed above.

Groundwater elevations in several areas of the Site increased between 2001 and 2005. Some of this rise is likely in response to building demolition and the potential change in stormwater management resulting from building demolition. Additional reasons for the rise in groundwater levels may be attributed to the removal of basement sumps and dewatering systems and subsequent recharge through former basement structures. For example, water levels measured within the Building 12 area have risen as much as 4 to 7 feet since Building 12 was razed. Due to the rise in groundwater levels, several well screens as installed no longer intersect the water table. Additional water table monitoring wells were installed in select demolition areas of the Site to enable continued monitoring of light nonaqueous phase liquid (LNAPL) thickness. Figures 2-2 and 2-3 illustrate both the locations of demolished buildings, and the wells in which measurable thickness of LNAPL has been detected.

In 2005, additional monitoring wells were installed in four areas of the Site (Building 36 Area, Building 20 Area, Former Buildings 03, 17, 28, 84, and 94 Area, and Former Building 09 Area), and groundwater elevations were measured. These groundwater elevation measurements are included on Figures 4-4, 4-6, 4-18, and 4-24, respectively, of the RFI Phase II Report. This information was used to support specific conclusions of GM's *RCRA Environmental Indicator CA750 Report Determination of Migration of Contaminated Groundwater under Control* (ENVIRON, September 23, 2005).

There are no active drinking or industrial water production wells at the Site. All potable water is obtained from the City of Flint. G&M (1986) estimated the hydraulic conductivity of the Saginaw Formation bedrock aquifer to be at least two orders of magnitude higher than that of the overlying till.

2.12 Land Use and Demographic Data

The Site occupies approximately 452 acres in Flint, Michigan, in the southeastern portion of Michigan in Genesee County, which is approximately 649 square miles in area. The City of Flint has a population of approximately 143,000, which accounts for 33% of the approximately 437,000 residents of Genesee County. Approximately one-third of the land area of Genesee County is used for agriculture. The City of Flint receives all of its potable water by pipeline from Detroit. The source of the water is Lake Huron, located approximately 60 miles east of the Site.

The Site currently consists of four active manufacturing complexes (Factories 05, 10, 36, and 81), with the remainder either demolished or planned for demolition. Automobile manufacturing operations began at the Site in the early 20th century (1903) and continue currently. Current Site operations, all of which occur on the Northend, include machining of ferrous and nonferrous metals, V-6 engine manufacturing, torque converter manufacturing, transmission components manufacturing, engine assembly, and industrial wastewater treatment. The Site is zoned industrial, and future onsite land use is expected to remain industrial

According to the City of Flint Department of Community & Economic Development documentation provided on the City's website (www.cityofflint.com), the City believes that maintaining industrial activities at the Site is essential to the revitalization of Flint. The majority of the Site is located within the Flint Renaissance Zone, which is a designation established by the State of Michigan that allows for the creation of tax-exempt zones designed to spur commercial and industrial growth in eleven economically distressed Michigan communities.

Current land use patterns near the Site are discussed below, along with trends in the economy, population, and housing in Flint, the City's plans for revitalization, and the implications of these factors for the future land use at the Site. The information discussed below is taken primarily from the following sources:

- U.S. Department of Housing and Urban Development (HUD) State of the Cities Data Systems (SOCDS) database located on the HUD website (www.socds.huduser.org);
- U.S. Bureau of the Census, Census 2000; and
- The City of Flint website (www.cityofflint.com).

2.12.1 Land Use Patterns

Land use in the City of Flint is divided into 15 districts, which include classes of residential, business, commercial, and manufacturing uses as established within the City of Flint Zoning Ordinance (Chapter 50). Figure 3-3 illustrates the zoning districts for the Site and the properties near the Site. The Site is composed of several tax parcels, most of which are zoned "G" – Heavy Manufacturing District, which is summarized from the City's Zoning Ordinance as:

"The "G" Heavy Manufacturing District is intended to accommodate those heavy industries which cannot eliminate entirely objectionable features and influences but which, nevertheless, must be provided for somewhere in the City."

Site parcels not zoned "G" include the following:

Northend

The strip of land located east of Andrew Street and north of Stewart Street (currently used for employee parking) is zoned "B" – Two-Family District, which is summarized from the City's Zoning Ordinance as:

"This district allows one- and two-family homes on 5,000-square foot lots. Multi-family homes, rest homes, hospitals, and customer parking lots are allowed under special conditions."

Three lots located west of Industrial Avenue and north of Leith Street are zoned "C-1" – Multi-Family Walk-Up Apartment District, which is summarized from the City's Zoning Ordinance as:

"This district allows one- and two-family homes, walk-up apartment, fraternities and children's institutions outright; and offices clinics, customer parking lots and funeral homes under special conditions."

Southend

The parcel located west of Industrial Avenue, north of Hamilton Avenue, and south of Oak Park is zoned "C-1" – Multi-Family Walk-Up Apartment District (as described above), and "D-2" – Neighborhood Business District, which is summarized from the City's Zoning Ordinance as:

"It is the purpose of this district to provide principally for convenience goods needs of persons residing in nearby residential areas. Uses permitted outright or conditionally shall be limited to those required to satisfy basic needs for goods and services required daily or frequently."

The parcel located west of Industrial Avenue and south of Hamilton Avenue (Administration Building 1 and associated employee parking lot) is zoned "E" – Heavy Commercial Limited Manufacturing District, which is summarized from the City's Zoning Ordinance as:

"The "E" Heavy Commercial Limited Manufacturing District is intended to accommodate heavy commercial and certain light manufacturing uses which are

generally incompatible with uses appropriate in retail business districts, but to not warrant an exclusive industrial classification."

The parcel located west of Industrial Avenue and south of Harriet Street is zoned "A-2" – Single Family Medium Density District, which is summarized from the City's Zoning Ordinance as:

"This district allows single-family detached dwellings on minimum 5,000-square foot lots. This zone also allows institutional uses such as churches and schools; and two-family dwellings and home occupations under special conditions."

Zoning districts for properties near the Site include: residential districts ("A-2", "B", and "C-1"); business/commercial districts ("D-2", "D-3", "D-5", and "D-6") and manufacturing districts ("E", "F", and "G"). Note that no AOIs are located within those areas of the Site that are zoned for residential and business/commercial use. Other properties located adjacent to the Site also zoned "G" – Heavy Manufacturing District include: PPG industries, Kasle Steel/Auto Blankers, Universal Systems, Flint Coatings, Flint Police Training Building, Consolidated Freightways, Lockhart Chemicals, and the former DuPont Plant, as identified on the Site Plan (Figures 2-2 and 2-3).

2.12.2 Flint Demographics

The City of Flint's economy has historically centered on manufacturing, which peaked during the late 1960's and early 1970's. From 1980 to 1990 (the 1970 census was deemed unreliable by HUD), the percent of jobs in Flint in the manufacturing sector dropped from 52% to 43% based on information summarized in the SOCDS database located on the HUD website. In 1990, the three largest job categories in Flint were the manufacturing industry (employed 43% of working residents), professional services industry (employed 22% of working residents) and the retail trade industry (employed 12% of working residents). Although the manufacturing sector has declined, manufacturing continues to employ the largest percentage of working residents in Flint.

Population has decreased in the City of Flint from approximately 197,000 in 1960 to 125,000 in 2000, which is a decrease of 37%. The following shows Flint's population trend from 1950 to 2000 (HUD, SOCDS).

Year	Population	Change	Percent Change
1950	163,143	NA	NA
1960	196,940	+33,797	+17%
1970	193,380	-3,560	-2%
1980	159,611	-33,769	-17%
1990	140,761	-18,850	-12%
2000	124,943	-15,818	-11%

The decrease in population resulted in a corresponding decrease in demand for housing in Flint. In 2000, there were approximately 55,310 housing units in Flint, of which 28,679 were owner-occupied (HUD, SOCDS). From 1970 to 2000, the number of owner-occupied residences decreased by approximately 13,500 units, while the number of rentals increased by approximately 1,300 units. Of the 55,310 housing units available in 2000, approximately 12%, or 6,560 units, were vacant, which is more than double the vacancy rate in 1970 (HUD, SOCDS).

Of the housing units identified in the 2000 census, only 2% were constructed between 1990 and 2000, and only an additional 11% of the units were constructed between 1970 and 1990. Approximately 18% of the housing units are 30 to 39 years old, with 69% of the units 40 years or older (U.S. Bureau of the Census, Census 2000).

2.13 Expected Future Site Uses

As stated in Section 2.12, the Site currently consists of four active manufacturing complexes (Factories 05, 10, 36, and 81), with the remainder either demolished or inactive. All current Site operations are located on the Northend portion of the Site. The Northend portion of the Site is expected to continue to be used for industrial purposes, with the land zoned “G” – Heavy Manufacturing District. The City of Flint economic development plan expects that the Southend portion of the Site will be developed for industrial use and the current owner, GM, plans to establish a restriction in the property deed to limit future use of the property to Industrial/Commercial II, III, and IV activities only.

3. Summary of Site-Related Risk

3.1 Summary of RFI Site-Related Risk Methods

A human health risk assessment and an ecological risk evaluation were performed as part of the RFI (Sections 6 and 7, respectively, of the RFI Phase II Report). The following sections briefly describe those components of the RFI Phase II Report, as well as supplemental risk evaluations, which were performed since the RFI Phase II Report was submitted.

3.1.1 Human Health Risk Assessment

The scope of the human health risk assessment is summarized in the conceptual site model (CSM) shown in Table 6.1 of the RFI Phase II Report. The CSM identifies the scenarios for potential human exposure under current and reasonably expected future conditions at and around the Site in terms of the potentially exposed populations, the environmental media to which they could be exposed, and the potential routes of exposure. The CSM was developed based on the available Site information and data. The scenarios for potential human exposure were discussed in Section 6.3 of the RFI Phase II Report.

Since the submission of the RFI Phase II Report, GM has supplemented the human health risk assessment with an evaluation of potential exposures to groundwater in the event that areas downgradient of the Site are developed for residential use. This supplemental evaluation is provided in the memorandum entitled "Supplemental Evaluation of Potential Residential Exposure to Groundwater" (Appendix A), and addresses the following hypothetical exposure scenarios:

- Potential future residential exposure to groundwater via vapor intrusion into hypothetical residences with basements in areas downgradient of the Site; and
- Potential future non-potable residential groundwater use (e.g., lawn watering, filling swimming pools, car washing, etc.) downgradient of the Site.

3.1.2 Ecological Risk Assessment

The provisions of a screening-level ecological risk assessment (SLERA), as described by USEPA guidance (USEPA, 1997, 2001), is summarized in Section 7 of the RFI Phase II Report. The initial elements of a SLERA involve the characterization of the environmental setting and contaminants, and the identification of complete exposure pathways (USEPA 1997). The RFI Phase II Report addresses these elements for the Site. The process used in this assessment included a Site visit to characterize habitats and to identify potential exposure pathways for ecological receptors, and a habitat assessment decision matrix to screen habitat characteristics for those areas at or near the Site that may provide terrestrial and aquatic habitats. The matrix approach was used to determine which habitat-bearing areas and pathways would need to be assessed in the SLERA process, if any, and to determine the areas where ecological impacts are negligible because complete exposure pathways do not exist.

Areas of the Site where there is a likelihood of release and a reasonable potential for complete exposure pathways were carried forward for additional ecological risk analysis. Areas of the Site where there is minimal potential for complete exposure pathways required no further assessment in the SLERA process.

As noted in Sections 4.7.3 and 7.1.1.1 of the RFI Phase II Report, GM and USEPA were discussing the need for further investigation of the Flint River in parallel with GM's submission of the RFI Phase II Report. As a result of these discussions, GM conducted sediment sampling in October and November 2006 in the Flint River at locations just upstream of, adjacent to, and downstream from the Site. The results of these sediment sampling activities are presented in context with a SLERA in GM's report entitled *Flint River Sediment Investigation Report* (ARCADIS BBL, April 2007)(sediment investigation report).

3.2 Summary of RFI Site-Related Risk Conclusions

Section 8 of the RFI Phase II Report divides the Site AOIs covered by the RFI into following three categories:

- AOIs requiring no further action;
- AOIs that do not contain LNAPL and require action based on the human health risk assessment; and
- AOIs that contain LNAPL.

Tables 8-1 through 8-3 were based on the assumption that the future use of the Southend would be residential. However, since the completion of the RFI Phase II Report, GM has decided to restrict the future use of the Southend to Industrial and Commercial II, III & IV use scenarios by implementing a deed restriction, even though there are AOIs that meet residential criteria. As such, the entire Site is evaluated based on Industrial and Commercial II, III, and IV use scenarios.

The AOIs have been re-grouped into the following three categories:

- AOIs requiring no further action beyond groundwater and land use restrictions;
- AOIs that require further action because they contain PCBs at levels regulated by TSCA; and
- AOIs that require further action based on the RFI.

Tables 3-1, 3-2, and 3-3 of this Revised CMP summarize the Site AOIs divided per these three categories, respectively, and replace Tables 8-1 through 8-3 of the RFI Phase II Report. The AOIs listed in Tables 3-2 and 3-3 are carried forward for evaluation of remedial measures in Section 4. As discussed in Section 6 of the RFI Phase II Report, the risk estimates for all relevant receptors in each exposure area were compared to the USEPA cumulative cancer risk limit of 10^{-4} and hazard index (HI) limit of 1 for determining whether corrective measures are warranted for each AOI. For lead, the arithmetic mean concentration in each exposure area was compared to the MDEQ industrial lead direct contact criterion of 900 mg/kg.

Since the ecological risks at the Site were deemed negligible, as concluded in Section 7.5 of the RFI Phase II Report, further action at a Site AOI is determined by the results of the human health risk assessment and/or the presence of TSCA-regulated LNAPL plumes. Also, in a letter to GM dated March 14, 2008, the USEPA states, “Based on the sediment sampling results of PCB concentrations in the Flint River as reported in the sediment investigation report and consistent with several discussions with GM, USEPA does not believe that further investigation is warranted for the Flint River.”

The supplemental human health risk evaluations documented in Appendix A, involving hypothetical future residential exposures to groundwater via vapor intrusion and non-potable use downgradient of the Site, indicate that estimated risks from these routes of exposure do not exceed the USEPA cumulative cancer risk limit of 10^{-4} or the HI limit of 1. Thus, this evaluation concluded that further action to address downgradient groundwater is not necessary as part of this Revised CMP.

As discussed in Section 5.3 of the RFI Phase II Report, various LNAPL plumes have been observed at the Site, and an LNAPL monitoring program was conducted for several years to measure the depth of LNAPL and to remove LNAPL from the wells, with the results being reported via Quarterly LNAPL Monitoring Reports that were submitted to the USEPA and Michigan Department of Environmental Quality (MDEQ). This program was completed in December 2004 and the final monitoring report was submitted to the USEPA on January 19, 2005. As a result of this program, the various LNAPL plumes identified at the Site have been demonstrated to be relatively stable; however, GM chose to implement certain IMs to collect LNAPL until final remedial activities were to be proposed.

3.3 Interim Measures and Other Site-Related Activities

IMs have been implemented to recover LNAPL at the majority of the LNAPL areas of the Site before the RFI risk assessment was performed. Four of these areas do not have estimated risks from potential exposure exceeding USEPA's acceptable limits. However, they contain TSCA-regulated levels of PCBs in LNAPL. These four areas are listed below, and associated final remedies are evaluated in Section 4.

- Factory 05 Product Recovery Trench (AOI 05-1)
- Factory 05 Building 43 Product Recovery Wells (AOI 05-5)
- Building 40 Tunnel and Basement (AOI 40-D)
- Factory 81 Area Product Recovery System (AOI 81-2)

Ten other areas are not carried forward for corrective measure evaluation, as the estimated risks from potential exposure did not exceed USEPA's acceptable limits as documented in the RFI Phase II Report, and PCBs are not detected at levels regulated by TSCA. GM, therefore, proposes to terminate operation of these IMs. These areas are listed below.

- Factory 10 Groundwater Treatment System (AOI 10-1)
- Factory 10 Scrapyard Area Product Recovery Trench (AOI 10-4)
- Factory 36 Area Exterior Product Recovery and Treatment System (AOI 36-2)
- Former Tank Farm 37 Product Recovery System (AOI 36-5)
- Building 32 Recovery Wells (AOI 83/84-2)
- Factory 03 Product Recovery Sump (AOI 03-1)
- Building 87/Leith Street Overpass Product Recovery System (AOI 86-1)

- Former Factory 94 Tank Farm (AOI 84-D)
- Former Tank Farm at Building 04 (AOI 04-D)
- Building 12 Area (AOI 12-A)

The RFI Phase II Report also identified two abandoned, partially flooded, tunnels: 1) the Building 32/66 Tunnel and 2) the abandoned utility tunnel associated with former Building 23. Both of these tunnels contain some oil sheens on the water within the tunnel. The risk estimates for potential exposure in these areas do not exceed USEPA's acceptable risk limits, as described in the RFI Phase II Report, and PCBs are not detected at levels regulated by TSCA. These tunnels will be closed as part of future decommissioning activities at the Site, which will include, at a minimum, removing the oil sheens to the extent practical.

4. Proposed Corrective Measures Evaluation

This section presents an evaluation of alternatives for corrective measures for each AOI identified during RFI activities as having either: 1) LNAPL in which TSCA-regulated levels of PCBs were detected; or 2) estimated risks higher than USEPA's acceptable risk limits via exposure to hazardous constituents in soil, groundwater, or LNAPL. As noted in Section 3, lists of these AOIs are presented in Table 3-2 and 3-3, respectively. A summary of the proposed corrective measures for these AOIs is provided in Table 4-1, as well as on Figures 4-1 and 4-2.

The range of remedial alternatives selected to be evaluated was developed primarily based on GM's experience obtained through implementation of Interim Measures at the Site. These alternatives include the following:

- Institutional Controls (including Due Care Provisions)
- Containment (including Surface Covers)
- Excavation
- LNAPL-Only Collection

For each AOI, a combination of these remedial alternatives, appropriate for addressing the identified goals for the AOI, was selected for evaluation.

Implementation costs, annual costs, and periodic costs (i.e., those costs that occur periodically during the life of the project, such as equipment replacement or a closure report) were estimated for each alternative for comparative purposes. The present net worth was also calculated for each alternative, assuming a life cycle of 10 years and a discount rate of 7%. A life cycle of 10 years was used as this is considered to be a reasonable planning horizon for property redevelopment that considers the continuing turn-over at similar facilities to keep up with changing technology and consumer demands. Also, local community interests strongly favor short-term redevelopment of inactive property (e.g., less than 10 years).

4.1 Site-Wide Use Restrictions

Corrective measures were evaluated with the consideration that certain baseline Site-wide use restrictions would be applied as part of the overall final corrective action for the Site. Baseline restrictions would consist of a deed restriction that would be established to prohibit the use of groundwater for any purpose, beyond sampling and other related investigatory testing, and to limit future use of the Site to Industrial/Commercial II, III, and IV activities only.

Based on information included in the RFI Phase II Report and the supplemental human health risk assessment included in Appendix A of this Revised CMP, the identified potential for unacceptable exposure to groundwater at downgradient off-property areas relates solely to drinking water use. Thus, GM proposes to also establish a deed restriction for downgradient offsite property that will prohibit the use of corresponding groundwater for potable uses. City of Flint Ordinance 9, Code of Ordinances, Chapter 46-25 already restricts the installation of drinking water wells in the City of Flint, and Michigan Department of Community Health Rules (Act 368, Part 127) also prohibit the use of groundwater at a depth of less than 25 feet below ground surface within all of Genesee County. As such, it is not anticipated that GM will experience significant difficulty in obtaining the necessary deed restrictions as described.

Additional restrictions above these baseline restrictions may be applied for certain onsite areas as appropriate and determined by the proposed remedy for a particular AOI. These additional restrictions are discussed as appropriate in Sections 4.2 through 4.17.

4.2 **AOI 05-1**

AOI 05-1 consists of the basement area along the southeast portion of Building 43, and is associated with a former metal machining chip processing operation. The RFI soil data from AOI 05-1 indicate that screening criteria were exceeded for lead and manganese, and the RFI groundwater data indicate that no screening criteria were exceeded.

LNAPL has been detected during RFI activities in this area and the physical extent of LNAPL has been defined. Investigations performed in 1994 in response to suspected oil releases in Building 43 (Factory 05 Area) detected LNAPL on the water table along the southeast side of Building 43. To address the LNAPL, three recovery trenches were installed in the Building 43 area in early 1995. These recovery trenches are each approximately 14 feet deep, 3 feet wide, 100 feet long, and backfilled with gravel. LNAPL is recovered from these trenches via 30-inch-diameter recovery wells installed near the midpoint of each recovery trench. Automated belt skimming devices in the recovery wells collect LNAPL from the recovery trenches (with approximately 60% groundwater and 40% LNAPL) and transfer it to a temporary storage tote. Recovered water is periodically allowed to flow back into the recovery well and the recovered

LNAPL is later drummed for disposal. The current belt skimming system is inefficient in removing LNAPL from the recovery wells.

Based on the human health risk assessment for AOI 05-1 documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to soil or LNAPL in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, PCBs were detected in samples of LNAPL collected from the recovery trench system mentioned above at concentrations up to 111 ppm. The presence of PCBs at this concentration requires application of TSCA regulations, and the selected corrective action would also require approval under TSCA. GM chooses to pursue a TSCA risk-based closure, and to evaluate the following corrective action alternatives, for the PCB-containing LNAPL at this AOI.

4.2.1 Alternative 1: Additional Institutional Controls above Baseline

This alternative includes establishing in the deed a notification of the presence of PCBs at this AOI.

4.2.1.1 Estimated Costs

The cost associated with this alternative is estimated to be $5,000 and includes performing a boundary survey of the area and administering the deed restriction.

4.2.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health, based on the risk assessment included in the RFI Phase II Report.

4.2.2 Alternative 2: LNAPL-Only Extraction and Additional Institutional Controls above Baseline

This alternative includes all of the components of Alternative 1, and additionally involves collecting LNAPL from the subsurface and disposing of the collected LNAPL at an appropriate offsite facility. The existing recovery trench system would be upgraded by installing three submersible pumps designed to collect LNAPL in the recovery trench sumps. The pumps would replace the belt skimmers currently used for LNAPL recovery. The collected LNAPL would be stored in drums or other suitable containers located near the recovery trench until sufficient LNAPL is collected to arrange for offsite disposal. Estimated costs assume an LNAPL removal rate of approximately 20 gallons per week.

4.2.2.1 Estimated Costs

The present net worth of this alternative is $343,000 assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost, annual cost, and periodic cost (equipment repair/replacement and preparation of a Corrective Action Completion Report) are assumed to be $74,000, $37,000, and $9,500, respectively.

4.2.2.2 Evaluation Results

Recovery of LNAPL would ultimately reduce the volume of LNAPL and the mass of PCBs present at this AOI, but this result would provide only marginally greater benefit than Alternative 1.

4.2.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Additional Institutional Controls above Baseline**. This is based on the effectiveness of this alternative. Unacceptable risks from potential exposure have not been identified in association with the LNAPL at AOI 05-1. A risk-based closure, as provided in 40 CFR 761.61(c), is requested from the USEPA by GM as part of this CMP. Deed restrictions and notices will remain with the property deed in perpetuity, or until the area has been remediated to TSCA requirements.

4.3 **AOI 05-5**

AOI 05-5 is in the northern and east-central portion of Building 43, and consists of active process machinery, collection trenches, and sumps for both “wet” and “dry” operations. The RFI soil data from AOI 05-5 indicate that no screening criteria were exceeded, and the RFI groundwater data indicate that screening criteria were exceeded for arsenic and nickel.

A release of an estimated 4,000 gallons of cutting oil was identified in April 1997. Three 4-inch-diameter groundwater monitoring wells were installed to the east of the tank from which the release was thought to have occurred. Product was identified in two monitoring wells. Two pneumatic free-product recovery pumps were installed as IMs in the wells. The recovered total fluids were later piped to two product storage tanks located within Building 43. The LNAPL later caused malfunction of the recovery pumps. As such, the system is currently not operating.

Based on the human health risk assessment for AOI 05-5 documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater or LNAPL in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, PCBs were detected in LNAPL samples collected from well RFI-05-11 at a concentration of 160 ppm and from well RW-05-East at a concentration of 130 ppm. The presence of PCBs at this AOI at these concentrations requires application of TSCA regulations, and the selected corrective action would also require approval under TSCA. GM chooses to pursue a TSCA risk-based closure, and to evaluate the following corrective action alternatives, for the PCB-containing LNAPL at this AOI.

4.3.1 Alternative 1: Additional Institutional Controls above Baseline

This alternative includes establishing in the deed a notification of the presence of PCBs at this AOI.

4.3.1.1 Estimated Costs

The cost associated with this alternative is estimated to be $5,000 and includes performing a boundary survey of the area and administering the deed restriction.

4.3.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health, based on the risk assessment included in the RFI Phase II Report.

4.3.2 Alternative 2: LNAPL-Only Extraction and Additional Institutional Controls above Baseline

This alternative includes all of the components of Alternative 1, and additionally involves collecting LNAPL from the subsurface and disposing of the collected LNAPL at an appropriate offsite facility. The existing recovery wells, RW-05-East and RW-05-North, would be used by installing new submersible pumps designed to collect LNAPL. The collected LNAPL would be stored in drums or other suitable containers located near the recovery wells until sufficient LNAPL is collected to arrange for offsite disposal. Estimated costs assume an LNAPL removal rate of approximately 10 gal/week.

4.3.2.1 Estimated Costs

The present net worth of this alternative is $263,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost, annual cost, and periodic cost (equipment repair/replacement and preparation of a Corrective Action Completion Report) are assumed to be $47,000, $29,000, and $22,000, respectively.

4.3.2.2 Evaluation Results

Recovery of LNAPL would ultimately reduce the volume of LNAPL and the mass of PCBs present at this AOI, but this result would provide only marginally greater benefit than Alternative 1.

4.3.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Additional Institutional Controls above Baseline**. This is based on the effectiveness of this alternative. Unacceptable risks from potential exposure have not been identified in association with the LNAPL at AOI 05-5. A risk-based closure, as provided in 40 CFR 761.61(c), is requested from the USEPA by GM as part of this CMP. Deed restrictions and notices will remain with the property deed in perpetuity, or until the area has been remediated to TSCA requirements.

4.4 **AOI 36-1 Gasoline Plume**

AOI 36-1 is located in the northern and central portions of Building 36, and is associated with engine manufacturing and metal machining processes. A gasoline LNAPL plume has been identified to be present in this area, presumably due to historical releases associated with engine testing. This plume is located at the interior of Building 36, and is approximately 75 feet in diameter.

The RFI soil data from AOI 36-1 indicate that screening criteria were exceeded for several VOCs and inorganic constituents, and the RFI groundwater data indicate that screening criteria were exceeded for several VOCs and inorganic constituents.

Based on the human health risk assessment for AOI 36-1 documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, estimates of potential exposure for construction workers who could contact the gasoline LNAPL plume exceed USEPA's cumulative cancer risk and HI limits. In addition, potential exposure of routine workers to vapors from soil and LNAPL via vapor intrusion exceeds USEPA's cumulative cancer risk and HI limits under future commercial/industrial use scenarios that do not require the application of OSHA regulations (non-OSHA use). These risk estimates are primarily attributed to the concentrations of the constituents present in the gasoline plume. Conditions within the current building do meet current OSHA standards related to vapor concentrations in indoor air as discussed in the RFI Phase II Report.

Therefore, the remedial goal for LNAPL at this AOI is to address the potential exposure to construction and routine workers to VOCs from the gasoline plume and soil.

4.4.1 Alternative 1: Additional Institutional Controls above Baseline

This alternative includes establishing a deed restriction that addresses potentially significant risks from volatilization to indoor air in the scenario involving a change in use of the current or future building in this area to a non-OSHA use. The restriction will require that proper precautions be taken as necessary to address potentially significant risks from volatilization to indoor air of constituents in LNAPL and soil, should the use of the existing building be changed or a new building be designed and constructed at this AOI.

4.4.1.1 Estimated Costs

The cost associated with this alternative is estimated to be $5,000 and includes performing a boundary survey of the area and administering the deed restriction.

4.4.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.4.2 Alternative 2: LNAPL-Only Extraction and Additional Institutional Controls above Baseline

This alternative includes all of the components of Alternative 1, and additionally involves collecting LNAPL (gasoline plume only) from the subsurface and disposing of the collected LNAPL at an appropriate offsite facility. For this evaluation, it was assumed that one 6-inch diameter LNAPL recovery well would be installed in the gasoline plume. A submersible pump designed to collect only LNAPL would be installed in the recovery well. In addition, an oleophilic absorbent sock would be installed in existing monitoring well RFI-36-07 for additional LNAPL collection. The collected LNAPL would be stored in drums or other suitable containers located near the recovery well until sufficient LNAPL is collected to arrange for offsite disposal. Estimated costs assume an LNAPL removal rate of approximately 10 gallons per week.

4.4.2.1 Estimated Costs

The present net worth of this alternative is $354,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost, annual cost, and periodic cost are assumed to be $85,000, $37,000, and $15,000, respectively.

4.4.2.2 Evaluation Results

This alternative provides for effective recovery of LNAPL, which may reduce potential exposure of construction workers as well as exposures associated with the future potential routine workers to future non-OSHA use.

4.4.3 Selected Alternative

The selected alternative for this AOI is **Alternative 2: LNAPL-Only Extraction and Additional Institutional Controls above Baseline** due to the technical feasibility of implementation of this alternative and the possibility of reducing potential risks from vapor intrusion. Collection and associated monitoring of LNAPL would continue until it was determined to be no longer practical. Deed restrictions and notices, however, would remain with the property deed in perpetuity, or until the area has been remediated to meet the risk level.

4.5 **AOI 81-1**

AOI 81-1 consists of the basement area beneath the southern and central portions of Building 71B, and is associated with three metal machining chip/cooling and cutting oil filtration/processing operations, as well as an inactive hydraulic elevator, several process waste sumps and tanks, a drum storage area, and a 90-day hazardous waste accumulation area (inactive). The RFI soil data from AOI 81-1 indicate that screening criteria were exceeded for lead.

Based on the human health risk assessment for AOI 81-1 documented in the RFI Phase II Report and summarized in Section 3.2, mean lead concentrations in deep (depth-averaged) soil exceed 900 mg/kg (i.e., MDEQ industrial direct contact criterion). Therefore, the remedial goal for this area is to address the potential exposure to lead in soil greater than 900 mg/kg.

4.5.1 Alternative 1: Additional Institutional Controls above Baseline

This alternative involves implementing additional institutional controls that would provide protection from direct contact to future Site users. The additional institutional controls include establishing a deed restriction limiting excavations in this area. The deed restriction would identify conditions for conducting excavations within the area of soil exceeding 900 mg/kg for lead, and would run with the property in perpetuity, or until soil containing lead concentrations above 900 mg/kg has been remediated

4.5.1.1 Estimated Costs

The cost associated with this alternative is estimated to be $5,000 and includes performing a boundary survey of the area and administering the deed restriction.

4.5.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.5.2 Alternative 2: Excavation

This alternative involves excavating soil exceeding 900 mg/kg for lead, and disposing of this soil offsite at an appropriate facility. Sampling of the soil prior to excavation is included to both better define the appropriate excavation limits and establish proper disposal requirements. The area to be excavated is expected to be no more than 60,000 square feet, and the expected depth of the excavation is 12 feet bgs. Therefore, the approximate volume of soil to be excavated is 27,000 cubic yards. The excavation limits would be established based on the pre-excavation sampling program; therefore, confirmation samples would not be collected upon completion of the excavation. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.5.2.1 Estimated Costs

The estimated cost of this alternative is $8,320,000, assuming that the volume of excavation is 27,000 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.5.2.2 Evaluation Results

This alternative is not considered to be cost-effective compared to Alternative 1, and would not provide significant additional protection from potential future risk to human health.

4.5.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Additional Institutional Controls above Baseline**. This option provides adequate protection for human health, and is easily implemented and reliable. The institutional controls would be implemented as a means of preventing and/or controlling potential exposure pathways to identified potential risks associated with lead concentrations in deep soil (approximately 10 feet bgs) at this AOI. The potential for unacceptable exposures in the future would be mitigated by establishing in the deed limits on future excavation within the area of soil exceeding 900 mg/kg for lead.

4.6 **AOI 81-2 Soil**

AOI 81-2 consists of active metal welding and machining, and torque converter assembly operations performed in Buildings 70, 70B, 71, 71A, 72, 73, 73A, 73B, and 74. The RFI soil data from AOI 81-2 indicate that screening criteria were exceeded for several VOCs and inorganic constituents, and the RFI groundwater data indicate that screening criteria were exceeded for lead and manganese. Compounds exceeding screening criteria at this AOI are contained in a former process pit located immediately beneath the operational floor in the northwest corner of Building 71A (i.e., less than 3 feet below ground surface).

Based on the human health risk assessment for AOI 81-2 documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, estimates of potential exposure of routine workers to soil via direct contact in this area exceeds the USEPA HI limit. In addition, estimates of potential exposure of routine workers to vapors from soil via vapor intrusion exceeds USEPA's HI limit under future commercial/industrial use scenarios that do not require the application of OSHA regulations (non-OSHA use). Conditions within the current building do meet current OSHA standards related to vapor intrusion as discussed in the RFI Phase II Report.

The remedial goal for soil at this AOI is to address potentially significant exposures to concentrations of certain VOCs in soil in a near-surface soil sample at the RFI-81-38.

4.6.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact and vapor intrusion exposure to future Site users. The engineering controls include maintaining the surface cover consistent with existing conditions. The additional institutional controls include establishing a deed restriction that addresses potentially significant risks from volatilization to indoor air in a scenario involving a change in use of the current or future building in this area to a non-OSHA use. The restriction will require that proper precautions be taken as necessary to address potentially significant risks from volatilization to indoor air, should the use of the existing building be changed or a new building be designed and constructed at this AOI. In addition, this deed restriction would require maintenance of a surface cover consistent with current conditions.

4.6.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.6.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.6.2 Alternative 2: Excavation

This alternative involves excavating soil where the concentrations contribute significantly to USEPA's HI limit, and disposing of this soil offsite at an appropriate facility. Sampling of the soil prior to excavation is included to both better define the appropriate excavation limits and establish proper disposal requirements. The approximate area to be excavated is 5,000 square feet, and the expected depth of the excavation is 4 feet bgs. Therefore, the approximate volume of soil to be excavated is 750 cubic yards. The excavation limits would be established based on the pre-excavation sampling program; therefore, confirmation samples would not be collected upon completion of the excavation. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.6.2.1 Estimated Costs

The estimated cost of this alternative is $328,000, assuming that the volume of excavation is 750 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.6.2.2 Evaluation Results

This alternative is not considered to be cost-effective compared to Alternative 1, and would not provide significant additional protection from potential future risk to human health.

4.6.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline**. This option provides adequate protection for human health, and is easily implemented and reliable. These controls would be implemented as a means of preventing and/or controlling potential exposure pathways to identified potential risks associated with VOC concentrations in near-surface soils (up to 4 feet bgs) at this AOI. The potential for unacceptable exposures in the future would be mitigated by establishing in the deed restriction additional conditions for future building use and maintaining soil cover within the area. Because any proposed excavation area would be under operational building floors, excavation in this area would be logistically difficult to execute and significantly more expensive than a similar excavation at an inactive portion of the Site.

4.7 **AOI 81-2 LNAPL**

This area was used for storage of foundry sand and steel from the manufacturing process. Subsequent subsurface investigations in this area indicated the presence of LNAPL containing PCBs. An LNAPL recovery trench was installed as an IM in the area in 1996. This recovery trench is approximately 9 feet deep, 3 feet wide, 200 feet long, and includes perforated pipes and gravel backfill. LNAPL is recovered from the trenches via a 4-foot-diameter recovery well installed near the midpoint of the recovery trench. An automated belt skimming device in the recovery well collects product from the recovery trench and transfers it to a temporary storage tank. The collected product is then transferred to the groundwater treatment facility in Building 20. This system has become ineffective in removing significant quantities of LNAPL due to the lack of recoverable LNAPL within the capture zone of the system. A portion of this LNAPL plume exists outside the area of influence of the existing LNAPL recovery system.

Based on the human health risk assessment for AOI 81-2 documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to subsurface LNAPL in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, PCBs have been detected in LNAPL at this AOI at concentrations greater than 100 ppm. The presence of PCBs at this AOI at such concentrations requires application of toxic substances control act (TSCA) regulations, and the selected corrective action would also require approval under TSCA. GM chooses a TSCA risk-based closure, and to evaluate the following corrective action alternatives, for the PCB-containing LNAPL at this AOI.

4.7.1 Alternative 1: Additional Institutional Controls above Baseline

This alternative includes establishing in the deed a notification of the presence of PCBs at this AOI.

4.7.1.1 Estimated Costs

The cost associated with this alternative is estimated to be $5,000 and includes performing a boundary survey of the area and administering the deed restriction.

4.7.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health, based on the risk assessment included in the RFI Phase II Report.

4.7.2 Alternative 2: LNAPL-Only Extraction and Additional Institutional Controls above Baseline

This alternative includes all of the components of Alternative 1, and additionally involves collecting LNAPL from the subsurface and disposing of the collected LNAPL at an appropriate offsite facility. This alternative would consist of installing two LNAPL recovery wells, located adjacent to monitoring well 70-107R and between monitoring wells 70-101 and 70-103. Submersible pumps designed to collect only LNAPL would be installed in the recovery wells. The collected LNAPL would be stored in drums or other suitable containers located near the wellheads until sufficient LNAPL is collected to arrange for offsite disposal. In addition, oleophilic absorbent socks would be placed in monitoring wells 70-101, 70-103, and 70-107R for additional LNAPL removal. Estimated costs assume an LNAPL removal rate of approximately 20 gallons per week.

4.7.2.1 Estimated Costs

The present net worth of this alternative is $494,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost, annual cost, and periodic cost are assumed to be $111,000, $53,000, and $19,000, respectively.

4.7.2.2 Evaluation Results

Recovery of LNAPL would ultimately reduce the volume of LNAPL and the mass of PCBs present at this AOI, but this result would provide only marginally greater benefit than Alternative 1.

4.7.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Additional Institutional Controls above Baseline**. This is based on the effectiveness of this alternative. Unacceptable risks from potential exposure to LNAPL at AOI 81-2 have not been identified. A risk-based closure, as provided in 40 CFR 761.61(c), is requested from the USEPA by GM as part of this CMP. Deed restrictions and notices will remain with the property deed in perpetuity, or until the area has been remediated to TSCA requirements.

4.8 **AOI 83/84-2 Soil**

AOI 83/84-2 is located in the currently inactive Factory 83/84 area, and consists of areas of various former and existing machining operations in Building 32 (including two basements), including both “wet” and “dry” operations. The RFI soil data from AOI 83/84-2 indicate that industrial screening criteria were exceeded for several PAHs and inorganic constituents, and the RFI groundwater data indicate that screening criteria were exceeded for several VOCs and inorganic constituents.

LNAPL was also observed at this AOI and is addressed in Section 4.9.

Based on the human health risk assessment for AOI 83/34-2 documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, mean lead concentrations in deep soil (up to 9 feet bgs) exceed 900 mg/kg (i.e., MDEQ industrial direct contract criterion). Therefore, the remedial goal for soil at this AOI is to address the lead concentrations in soil greater than 900 mg/kg.

4.8.1 Alternative 1: Additional Institutional Controls above Baseline

This alternative involves implementing additional institutional controls that would provide protection from direct contact to future Site users. The additional institutional control include establishing a deed restriction limiting excavations within the area of soil exceeding 900 mg/kg for lead, and would run with the property in perpetuity, or until soil containing lead concentrations above 900 mg/kg has been remediated.

4.8.1.1 Estimated Costs

The cost associated with this alternative is estimated to be $5,000 and includes performing a boundary survey of the area and administering the deed restriction.

4.8.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.8.2 Alternative 2: Excavation

This alternative involves excavating soil exceeding 900 mg/kg for lead, and disposing of this soil offsite at an appropriate facility. Sampling of the soil prior to excavation is included to both better define the appropriate excavation limits and establish proper disposal requirements. The approximate area to be excavated is 22,500 square feet, and the expected depth of the excavation is 9 feet bgs. Therefore, the approximate volume of soil to be excavated is 7,500 cubic yards. The excavation limits would be established based on the pre-excavation sampling program; therefore, confirmation samples would not be collected upon completion of the excavation. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.8.2.1 Estimated Costs

The estimated cost of this alternative is $961,000, assuming that the volume of excavation is 7,500 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.8.2.2 Evaluation Results

This alternative is not considered to be cost effective, and would not provide significant additional protection from potential future risk to human health.

4.8.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Additional Institutional Controls above Baseline**. This option provides adequate protection for human health, and is easily implemented and reliable. These controls would be implemented as a means of preventing and/or controlling potential exposure pathways to identified potential exposure associated with lead concentrations in deeper soils (up to 9 feet bgs) at this AOI. The potential for unacceptable exposures in the future would be mitigated by establishing in the deed limits on future excavation within the area of soil exceeding 900 mg/kg for lead.

4.9 **AOI 83/84-2 LNAPL**

LNAPL has been observed floating on the surface of groundwater at select monitoring well locations. The physical extent of LNAPL has been defined to be approximately 150 feet in diameter.

Based on the human health risk assessment for AOI 83/84-2 documented in the RFI Phase II Report and summarized in Section 3.2, estimates for potential exposure to subsurface LNAPL in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, PCBs were detected in LNAPL samples collected from monitoring wells RFI-83/84-06 and RFI-83/84-49 at concentrations as high as 62 mg/kg. The presence of PCBs at this concentration requires application of TSCA regulations, and the selected corrective action would also require approval under TSCA. GM chooses to pursue a TSCA risk-based closure, and to evaluate the following corrective action alternatives, for the PCB-containing LNAPL at this AOI.

4.9.1 Alternative 1: Additional Institutional Controls above Baseline

This alternative includes establishing in the deed a notification of the presence of PCBs at this AOI.

4.9.1.1 Estimated Costs

The cost associated with this alternative is estimated to be $5,000 and includes performing a boundary survey of the area and administering the deed restriction.

4.9.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health, based on the risk assessment included in the RFI Phase II Report.

4.9.2 Alternative 2: LNAPL-Only Extraction and Additional Institutional Controls above Baseline

This alternative includes all of the components of Alternative 1, and additionally involves collecting LNAPL from the subsurface and disposing of the collected LNAPL at an appropriate offsite facility. Two LNAPL recovery wells would be installed at AOI 83/84-2, and submersible pumps designed to collect only LNAPL would be installed in the recovery wells. Collected LNAPL would be stored in drums or other suitable containers located near the recovery trench until sufficient LNAPL is collected to arrange for offsite disposal. Estimated costs assume an LNAPL removal rate of approximately 20 gallons per week.

4.9.2.1 Estimated Costs

The present net worth of this alternative is $428,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost, annual cost, and periodic cost are assumed to be $108,000, $44,000, and $19,000, respectively.

4.9.2.2 Evaluation Results

Recovery of LNAPL would ultimately reduce the volume of LNAPL and the mass of PCBs present at this AOI, but this result would provide only marginally greater benefit than Alternative 1.

4.9.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Additional Institutional Controls above Baseline**. This is based on the effectiveness of this alternative. Unacceptable risks from potential exposure have not been identified in association with the LNAPL at AOI 83/84-2. A risk-based closure, as provided in 40 CFR 761.61(c), is requested from the USEPA by GM as part of this CMP. Deed restrictions and notices will remain with the property deed in perpetuity, or until the area has been remediated to TSCA requirements.

4.10 **AOI 83/84-3**

AOI 83/84-3 consists of areas of various former and existing machining operations in Buildings 66A/66D (both "wet" and "dry" operations). The RFI soil data from AOI 83/84-3 indicate that screening criteria were exceeded for lead, and the RFI groundwater data indicate that screening criteria were exceeded for beryllium and lead.

Based on the human health risk assessment for AOI 83/84-3 documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, mean lead concentrations in surface and depth-averaged soil exceed 900 mg/kg (i.e., MDEQ industrial direct contact criterion). Therefore, the remedial goal for this area is to address the potential exposure to lead concentrations in soil greater than 900 mg/kg.

4.10.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to future Site users. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls include establishing a deed restriction limiting excavations within the area of soil exceeding 900 mg/kg for lead. These restrictions would run with the property in perpetuity, or until soil containing lead concentrations above 900 mg/kg has been remediated for the appropriate use scenarios. Per GM's November 21, 2004 response to USEPA's Specific Comment No. 21 of the March 2004 RFI Phase II Report, additional delineation of eastern boundary of contamination in this area will be performed prior to establishing the deed restriction.

4.10.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.10.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.10.2 Alternative 2: Excavation

This alternative involves excavating soil exceeding 900 mg/kg for lead, and disposing of this soil offsite at an appropriate facility. Sampling of the soil prior to excavation is included to both better define the appropriate excavation limits and establish proper disposal requirements. The approximate area to be excavated is 10,400 square feet, and the expected depth of the excavation is 6 feet bgs. Therefore, the approximate volume of soil to be excavated is 2,300 cubic yards. The excavation limits would be established based on the pre-excavation sampling program; therefore, confirmation samples would not be collected upon completion of the excavation. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.10.2.1 Estimated Costs

The estimated cost of this alternative is $641,000, assuming that the volume of excavation is 2,300 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.10.2.2 Evaluation Results

This alternative is not considered to be cost-effective compared to Alternative 1, and would not provide significant additional protection from potential future risk to human health.

4.10.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline**. This option protects human health, and is easily implemented and reliable. These controls would be implemented as a means of preventing and/or controlling potential exposure pathways to identified potential risks associated with lead concentrations in soils (up to 6 feet bgs) at this AOI. The potential for unacceptable exposures in the future would be mitigated by establishing in the deed limits on future excavation within the area of soil exceeding 900 mg/kg for lead.

4.11 **AOI 02-C**

AOI Group 02-C is associated with the former Building 02, and relates to a former sump in the former Materials Laboratory. The RFI soil data from this AOI indicate that the industrial screening criterion was exceeded for lead in near-surface soil sample results from soil boring RFI-02-03.

Based on the human health risk assessment for AOI 02-C documented in the RFI Phase II Report and summarized in Section 3.2, mean lead concentrations in surface soil exceed 900 mg/kg (i.e., MDEQ industrial direct contact criterion). Therefore, the remedial goal for this area is to address the potential exposure to lead concentrations in soil greater than 900 mg/kg.

4.11.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to future Site users. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls include establishing a deed restriction limiting excavations within the area of soil exceeding 900 mg/kg for lead. These restrictions would run with the property in perpetuity, or until soil containing concentrations above 900 mg/kg has been remediated.

4.11.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.11.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.11.2 Alternative 2: Excavation

This alternative involves excavating soil exceeding 900 mg/kg for lead, and disposing of this soil offsite at an appropriate facility. Sampling of the soil prior to excavation is included to both better define the appropriate excavation limits and establish proper disposal requirements. The estimated area to be excavated is 10,600 square feet, and the expected depth of the excavation is 4 feet bgs. Therefore, the estimated volume of soil to be excavated is approximately 1,570 cubic yards.

The excavation limits would be established based on the pre-excavation sampling program; therefore, confirmation samples would not be collected upon completion of the excavation. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.11.2.1 Estimated Costs

The estimated cost of this alternative is $244,000, assuming that the volume of excavation is 1,570 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.11.2.2 Evaluation Results

This alternative is not considered to be cost-effective compared to Alternative 1, and would not provide significant additional protection from potential future risk to human health.

4.11.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline**. This option provides adequate protection for human health, and is easily implemented and reliable. These controls would be implemented as a means of preventing and/or controlling potential exposure pathways to identified potential risks associated with lead concentrations in near-surface soils (less than 4 feet bgs). The potential for unacceptable exposures in the future would be mitigated by establishing in the deed limits on future excavation within the area of soil exceeding 900 mg/kg for lead.

4.12 **AOI 09-A Soil**

AOI Group 09-A is related to the former Building 09, and involves a floor trench/UST that discharged to the process wastewater system, floor trenches over a holding tank in the "vehicle wash area", concrete containment for a former AST, and a former UST. The RFI soil data from AOI Group 09-A indicate that screening criteria were exceeded for benzo(a)pyrene, dibenzo(a,h)anthracene, lead, and manganese, and the RFI groundwater data indicate that screening criteria were exceeded for trichloroethene, vinyl chloride, antimony, and lead.

Based on the human health risk assessment for AOI Group 09-A documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, concentrations of lead in soil exceed 900 mg/kg (i.e., MDEQ industrial direct contact criterion). Notably, this area includes a rather localized area, centralized around offsite soil boring RFI-09-01, which contained lead at a concentration of 120,000 mg/kg. This soil boring is located on property owned by CSX Transportation, Inc. (CSX), immediately east of GM property. In addition, an offsite soil sample collected from soil boring RFI-09-03 exhibited a concentration of benzo(a)pyrene that exceeds USEPA's risk limits for residential exposure. This boring is also located on CSX property, immediately east of GM property. Therefore, the remedial goal for this area is to address the potential exposure to soil with elevated lead and benzo(a)pyrene concentrations.

4.12.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to users of the affected area. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls would include establishing a deed restriction limiting excavations in both GM's and CSX's property deed. The deed restriction would run with the properties in perpetuity, or until the area has been remediated.

4.12.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.12.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report. However, due to the high concentration of lead found at this location and the expected difficulty of obtaining the offsite deed restrictions, excavation may be more appropriate.

4.12.2 Alternative 2: Offsite Excavation and Onsite Engineering and Additional Institutional Controls above Baseline

This alternative includes the excavation and offsite disposal of approximately 900 cubic yards of soil associated with a 5,900 square-foot area. The excavation size is based on the removal of offsite soil on CSX property that contains lead concentrations exceeding 400 mg/kg (i.e., MDEQ residential direct contact criterion) and/or benzo(a)pyrene exceeding 6 mg/kg (i.e., USEPA's risk limit for residential exposure). The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

In addition, this alternative involves implementing engineering controls and additional institutional controls for soil on GM property that contain lead exceeding 900 mg/kg (i.e., MDEQ industrial direct contact criterion) and/or benzo(a)pyrene exceeding the USEPA's risk limit. The engineering controls include maintaining the surface cover consistent with existing conditions. These onsite industrial controls would provide protection from direct contact to future Site users by establishing a deed restriction limiting excavations. The deed restrictions would run with the property in perpetuity, or until the area has been remediated.

4.12.2.1 Estimated Costs

The estimated cost of this alternative is $408,000, assuming that the volume of excavation is 900 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.12.2.2 Evaluation Results

This alternative is considered to provide adequate protection from potential future risk to human health.

4.12.3 Alternative 3: Onsite and Offsite Excavation

This alternative includes the excavation and offsite disposal of approximately 1,800 cubic yards of soil associated with an area of 12,000 square feet. The size of the excavation is based on the removal of soil associated with this AOI (both onsite and offsite) that contains lead exceeding 400 mg/kg (CSX property) or 900 mg/kg (GM property), and/or benzo(a)pyrene exceeding USEPA risk limits. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.12.3.1 Estimated Costs

The estimated cost of this alternative is $621,000, assuming that the volume of excavation is 1,800 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.12.3.2 Evaluation Results

This alternative is not considered to be cost-effective compared to Alternative 2, and would not provide significant additional protection from potential future risk to human health as compared to Alternative 2.

4.12.4 Selected Alternative

The selected alternative for this AOI is **Alternative 2: Offsite Excavation and Onsite Engineering and Additional Institutional Controls above Baseline**. Excavating surface soil is desirable due to its practicability, long-term reliability, and effectiveness. Soil on GM property would be addressed with engineering and additional controls above baseline that would be implemented as a means of preventing and/or controlling potential exposure pathways to identified potential risks. The potential for unacceptable risk to occur in the future would be mitigated by establishing in the deed limits on future excavation within the onsite area. Excavation of both the areas onsite and offsite (Alternative 3) would not provide significant additional protection from potential future risk to human health as compared to Alternative 2.

4.13 AOI 09-B Soil

AOI Group 09-B is associated with the Former Building 31/Hamilton Avenue Tank Farm. An LNAPL plume consisting primarily of gasoline has been identified and delineated in this area and is approximately 75 feet in diameter. The RFI soil data from AOI Group 09-B indicate that industrial screening criteria were exceeded for benzo(a)pyrene and lead, and the RFI groundwater data indicate that industrial screening criteria were exceeded for several VOCs, total PCBs, and several inorganic constituents.

LNAPL at this AOI is addressed in Section 4.14.

Based on the human health risk assessment for AOI Group 09-B documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to groundwater in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, potential exposure to near-surface soil in this area exceeds 900 mg/kg for lead (i.e., MDEQ industrial direct contact criterion). Therefore, the remedial goal for soil at this AOI is to address lead concentrations greater than 900 mg/kg.

4.13.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to future Site users. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls include establishing a deed restriction limiting excavations. These restrictions would run with the property in perpetuity, or until soil containing lead concentrations exceeding 900 mg/kg, have been remediated.

4.13.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.13.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.13.2 Alternative 2: Excavation

This alternative involves excavating soil exceeding 900 mg/kg for lead, and disposing of this soil offsite at an appropriate facility. Sampling of the soil prior to excavation is included to both better define the appropriate excavation limits and establish proper disposal requirements. The approximate area to be excavated is 42,000 square feet, and the expected depth of the excavation is 3 feet bgs. Therefore, the approximate volume of soil to be excavated is 4,650 cubic yards. The excavation limits would be established based on the pre-excavation sampling program; therefore, confirmation samples would not be collected upon completion of the excavation. The resulting excavation would be backfilled with appropriate fill imported from an offsite source.

4.13.2.1 Estimated Costs

The estimated cost of this alternative is $1,070,000, assuming that the volume of excavation is 4,650 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.13.2.2 Evaluation Results

This alternative is not considered to be cost effective compared to Alternative 1, and would not provide significant additional protection from potential future risk to human health.

4.13.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline**. This option provides adequate protection for human health, and is easily implemented and reliable. These controls would be implemented as a means of preventing and/or controlling potential exposure pathways in near-surface soils (up to 3 feet bgs) at this AOI. The potential for unacceptable exposures in the future would be mitigated by establishing in the deed limits on future excavation within the area of soil exceeding 900 mg/kg for lead, as well as for maintaining a surface cover that is consistent with current conditions.

4.14 **AOI 09-B LNAPL**

An LNAPL plume composed of gasoline located at this AOI is approximately 75 feet in diameter.

Based on the human health risk assessment for AOI Group 09-B documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure for future redevelopment construction workers to gasoline LNAPL in this area exceed USEPA's cumulative cancer risk and HI limits. The remedial goal for LNAPL at this AOI is to address the potential exposure of construction workers to LNAPL.

4.14.1 Alternative 1: No Further Action

This alternative involves implementing no further action beyond the corrective measures proposed for soil at this AOI, as described in Section 4.13.1. Such controls would provide protection from direct contact to future Site users.

4.14.1.1 Estimated Costs

There is no cost associated with this alternative.

4.14.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.14.2 Alternative 2: LNAPL-Only Extraction

This alternative involves collecting LNAPL from the subsurface and disposing of the collected LNAPL at an appropriate offsite facility, along with implementing the corrective measures proposed for soil at this AOI, as described in Section 4.13.1.

Two LNAPL recovery wells would be installed at this AOI, and submersible pumps designed to collect only LNAPL would be installed in the recovery wells. Because the Southend buildings have been demolished and active Site utilities are no longer present in this area, a solar-powered controller (or similar) would be used to operate the LNAPL-only extraction pumps. The collected LNAPL would be stored in a drum or other suitable container located near the wellheads until sufficient LNAPL is collected to arrange for offsite disposal. Estimated costs assume an LNAPL removal rate of approximately 20 gallons per week.

4.14.2.1 Estimated Costs

The present net worth of this alternative is $484,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost, annual cost, and periodic cost are assumed to be $86,000, $54,000 and $30,000, respectively.

4.14.2.2 Evaluation Results

This alternative provides effective recovery of LNAPL, which may reduce the potential future impact to human health posed by the presence of LNAPL in the subsurface.

4.14.3 Selected Alternative

The selected alternative for this AOI is **Alternative 2: LNAPL-Only Extraction** due to the technical feasibility and implementation of this alternative. Collection and associated monitoring of LNAPL would continue until it was determined to be no longer practical. Deed restrictions and notices, however, would remain with the property deed in perpetuity, or until the area has been remediated to meet the risk level.

4.15 **AOI 12-A Soil**

AOI Group 12-A is associated with the former Building 12, and relates primarily to several press pits and associated sumps, pits, trenches, and traps. The RFI soil data from these AOIs indicate that screening criteria were exceeded for lead, and the RFI groundwater data indicate that screening criteria were exceeded for tetrachloroethene, vinyl chloride, and lead.

Evidence of LNAPL was discovered in wells located in the northwestern and eastern portions of the former Building 12 (see Figure 3-2). Two stand-alone LNAPL collection systems were installed in July 2003 at wells RFI-12-02 and RFI-12-11D for the purpose of collecting LNAPL in this area. These systems consisted of a pneumatic product skimming pump powered by nitrogen supplied in liquid nitrogen tanks and a battery-powered, solar-charged controller. Collected product was stored in tanks located at each well head. These systems collected very little LNAPL, due to its high viscosity; thus, they were taken out of service in spring of 2004.

Based on the human health risk assessment for AOI Group 12-A documented in the RFI Phase II Report and summarized in Section 3.2, estimates of potential exposure to subsurface groundwater or LNAPL in this area do not exceed USEPA's cumulative cancer risk and HI limits. However, lead concentrations in surface and deep soil exceed 900 mg/kg (i.e., MDEQ industrial direct contact criterion). Therefore, the remedial goal is to address lead concentrations in soil greater than 900 mg/kg.

4.15.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering and additional institutional controls that would provide protection from direct contact to future Site users. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls include establishing a deed restriction limiting excavations within the area of soil exceeding 900 mg/kg for lead. These restrictions would run with the property in perpetuity, or until soil containing lead concentrations above 900 mg/kg has been remediated.

4.15.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.15.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.15.2 Alternative 2: Excavation

This alternative includes the excavation and offsite disposal of approximately 950 cubic yards of soil with lead greater than 900 mg/kg associated with soil boring RFI-12-02; estimated disposal costs assume this soil is characterized as hazardous waste. This alternative also includes the excavation and offsite disposal of approximately 3,400 cubic yards of soil associated with soil borings RFI-12-30, RFI-12-31, RFI-12-33, and RFI-12-35; estimated disposal costs assume this soil is characterized as non-hazardous waste.

4.15.2.1 Estimated Costs

The estimated cost of this alternative is $758,000, assuming that the volume of excavation is 3,400 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.15.2.2 Evaluation Results

This alternative is not considered to be cost-effective compared to Alternative 1, and would not provide significant additional protection from potential future risk to human health.

4.15.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline**. This option provides adequate protection for human health, and is easily implemented and reliable. The engineering and institutional controls would be implemented as a means of preventing and/or controlling potential exposure pathways associated with lead concentrations in deeper soils (6 to 8 feet bgs) at this AOI. The potential for unacceptable exposures in the future would be mitigated by establishing in the deed limits on future excavation within the area of soil exceeding 900 mg/kg for lead.

4.16 **AOI 29-A**

AOI Group 29-A is associated with the former Building 29, and relates to a pit for a cable-operated elevator and former work pads with oil staining. The RFI soil data from this AOI indicate that the industrial screening criterion was exceeded for lead in surface soil.

Based on the human health risk assessment for AOI Group 29-A documented in the RFI Phase II Report and summarized in Section 3.2, potential exposure to surface soil in this area exceeds 900 mg/kg for lead (i.e., MDEQ industrial direct contact criterion). Therefore, the remedial goal for soil at this AOI is to address lead concentrations greater than 900 mg/kg.

4.16.1 Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline

This alternative involves implementing engineering controls and additional institutional controls that would provide protection from direct contact to future Site users. The engineering controls include maintaining the surface cover consistent with existing conditions. The institutional controls include establishing a deed restriction limiting excavations within the area of soil exceeding 900 mg/kg for lead. These restrictions would run with the property in perpetuity, or until soil containing lead concentrations above 900 mg/kg has been remediated.

4.16.1.1 Estimated Costs

The present net worth of this alternative is $15,000, assuming maintenance only for a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

4.16.1.2 Evaluation Results

This alternative provides adequate protection from potential risk to human health based on the risk assessment included in the RFI Phase II Report.

4.16.2 Alternative 2: Excavation

This alternative involves excavating soil exceeding 900 mg/kg for lead, and disposing of this soil offsite at an appropriate facility. Sampling of the soil prior to excavation is included to both better define the appropriate excavation limits and establish proper disposal requirements. The estimated area to be excavated is 15,700 square feet, and the expected depth of the excavation is 4 feet bgs. Therefore, the estimated volume of soil to be excavated is 2,400 cubic yards. The excavation limits would be established based on the pre-excavation sampling program; therefore confirmation samples would not be collected upon completion of the excavation. The resulting excavation would be backfilled with appropriate fill imported from an offsite source. Estimated disposal costs assume soil is characterized as non-hazardous waste.

4.16.2.1 Estimated Costs

The estimated cost of this alternative is $382,000, assuming that the volume of excavation is 2,400 cubic yards. The cost would be lower if the pre-excavation sampling provides a basis for a smaller excavation volume.

4.16.2.2 Evaluation Results

This alternative would not provide significant additional protection from potential future risk to human health.

4.16.3 Selected Alternative

The selected alternative for this AOI is **Alternative 1: Engineering Controls and Additional Institutional Controls above Baseline**. This option protects human health, and is easily implemented and reliable. The engineering and institutional controls would be implemented as a means of preventing and/or controlling potential exposure pathways associated with lead concentrations in near-surface soils (less than 4 feet bgs) at this AOI. The potential for unacceptable exposures in the future would be mitigated by establishing in the deed limits on future excavation within the area of soil exceeding 900 mg/kg for lead.

4.17 **AOI 40-D**

The Former Building 40 tunnel conveyed materials, personnel, and equipment between former Building 40 and former Building 06/16 assembly areas. The tunnel was oriented in the east-west direction and was approximately 260 feet long by 15 feet wide and 8.5 feet high. An L-shaped basement area, approximately 1,900 square feet in size, was located above a portion of the tunnel, and the ceiling of the basement was removed and the area is surrounded by a chain link fence. The top of the tunnel roof (basement floor) was approximately 12 feet below grade. The tunnel was completely flooded with water, and the water level was approximately 4 feet above the floor of the basement.

The basement floor was cleaned in August 1992 using a foam-applied aqueous-based solvent to extract PCBs from the concrete floor and the lower 2 feet of the basement walls. Other activities since then have included removal of small quantities (less than 1 quart) of floating oil from the tunnel and basement.

In GM's report entitled *Cleanup and Disposal of PCB Remediation Waste, Building 40 Tunnel and Basement* (BBL, January 2004) (hereafter referred to as the Cleanup Report), GM outlined plans to remove the basement floor of the former Building 40 by breaking it and allowing it to collapse into the underlying tunnel. The Cleanup Report was submitted to the USEPA for review and approval.

On September 28 and 29, 2004, the basement floor/tunnel ceiling of the former Building 40 tunnel was sampled as outlined in a July 27, 2004 letter from GM to the USEPA.

This sampling was conducted to evaluate the effectiveness of August 1992 remedial activities, as well as other subsequent remedial activities, conducted on the former Building 40 basement floor and tunnel. Details concerning these remedial activities are presented in the Cleanup Report. The results of this sampling indicated no detection of PCBs in the basement floor/tunnel ceiling.

USEPA conditionally approved, via letter on February 1, 2005, the proposed collapse of the former Building 40 basement floor and the filling of the underlying tunnel as outlined by GM in the Cleanup Report. GM responded to USEPA's February 1 conditional approval via electronic mail (email) on March 1, 2005. After a series of subsequent emails and conference calls, USEPA provided a final conditional approval of these activities via letter dated September 13, 2005, with the following conditions:

1. The water level within the basement must be closely monitored during the demolition of the basement floor and backfilling activities. The backfilling of the tunnel must be performed slowly to allow the water within the basement and tunnel to equilibrate with the added fill material, to prevent any flooding in the surrounding area.

2. After collapsing the basement floor into the tunnel, the basement and remaining areas of the tunnel must be backfilled entirely with clean fill material, which may include clean material from other demolition projects onsite and from offsite sources. The backfill material will be considered as the cap or cover for the collapsed floor and tunnel.

3. During the demolition of the basement floor and backfilling activity, GM and its contractor must visually inspect the water for oil sheens that may appear on the surface of the water. Any oil sheen must be sampled and analyzed following the procedure attached to Derek Kaiding's e-mail message to Tammy Moore dated April 22, 2005, and collected and removed through the use of oil absorbent booms or pads. The PCB concentration of the oil must be reported based on the weight of PCBs per the weight of oil sample. If the oil is found to contain less than 50 ppm PCBs, it must be managed as a liquid PCB remediation waste in accordance with 40 CFR $ 761.61(b)(l), and the absorbent boom or pads may be managed as a bulk PCB remediation waste

in accordance with 40 CFR $ 761.61(a)(5)(i)(B)(2)(ii). If the oil is found to contain equal to or greater than 50 ppm PCBs, it must be disposed of in a Toxic Substances Control Act (TSCA) approved PCB incinerator and the absorbent boom or pads must be disposed of in a TSCA approved incinerator or landfill.

4. GM shall record, in accordance with state law, a notation on the deed to the property, or on some other instrument which is normally examined during a title search, that will notify any potential purchaser of the property of the residual PCBs and of the industrial land use restrictions for the property.

5. GM must include the sampling and analysis of the groundwater for PCBs in the long-term groundwater monitoring plan for the area.

On June 12, 2006, Inland Waters Pollution Control (IWPC) mobilized heavy equipment to the Former Building 40 tunnel area and demolished the basement floor. The initial water level in the former basement was approximately 8 feet below the surrounding grade.

The following day (June 13, 2006), a small amount of oil droplets (1 to 4 inches in diameter) were observed floating on the water surface. The oil was sampled and submitted to Merit Laboratories, Inc. of East Lansing, Michigan (Merit) for analysis of PCBs (individual Aroclors) in accordance with the approved procedure on a 24-hour turn-around-time. The analysis indicated that the oil contained PCBs at a concentration of 2.5 ppm. The oil was recovered using oil absorbent booms and pads prior to basement/tunnel backfilling. The booms and pads were containerized in 55-gallon drums and sampled further for waste characterization, which involved the analysis of VOCs, SVOCs, metals, via Toxic Characteristic Leachate Procedure (TCLP), and ignitability, reactivity, and corrosivity.

On June 14, 15, 16, and 21, 2006, IWPC backfilled the basement and underlying tunnel with approximately 1,800 cubic yards (cy) of fill originating from non-contaminated sources.

Per USEPA's September 13, 2005 conditional approval letter and based on the analytical data from the oil and waste characterization of the booms/pads, the oil-soaked booms and pads were disposed of at Citizens Landfill in Grand Blanc, Michigan, on September 5, 2006.

4.17.1 Proposed Corrective Measure

The proposed corrective measure for this AOI is **Additional Institutional Controls above Baseline**, as required by the USEPA in their February 1, 2005 letter (Condition No. 4), that includes establishing in the deed a notification of the presence of residual PCBs.

4.17.2 Estimated Costs

The cost associated with this alternative is estimated to be $5,000 and includes performing a boundary survey of the area and administering the deed restriction.

4.18 Outfall 002 Storm Sewer

As discussed in Sections 3.3.1 and 4.1 of Appendix I of the RFI Phase II Report, evidence of historical groundwater infiltration into Outfall 002 storm sewers has been observed as mineral deposits at pipe joints during video inspection of proposed stretches of the pipe system. Also, the portion of the Outfall 002 storm sewer system between manholes 2-20 and 2-22 runs underneath Stewart Ave. and through an LNAPL area associated with the former Tank Farm 37 UST system (AOI 36-5).

Based on the RFI risk assessment, no unacceptable human health risks were identified for this area. However, certain VOCs were detected in water samples collected from manholes 2-19 and 2-20. The detected VOCs were similar to those detected in groundwater samples surrounding the Outfall 002 storm sewer system in this area. These results suggest that some infiltration of contaminated groundwater is likely occurring. A dissolved groundwater plume containing concentrations of trichloroethene (TCE), and vinyl chloride, as well as LNAPL, exist in the area just upstream of manhole 2-20, and may be the source of the VOCs detected in the sewer. An inspection of the sewer system revealed no evidence of LNAPL infiltration in the area. However, LNAPL sheens are observed at Outfall 002 very intermittently, but may be attributed to manufacturing operations and not subsurface infiltrations. Nonetheless, corrective measures are evaluated below for addressing this potential LNAPL infiltration to this sewer system in the area of the former Tank Farm UST system.

4.18.1 Alternative 1: No Further Action

This alternative involves implementing no further action beyond the existing institutional and engineering controls in place at this portion of the Site. Institutional and engineering controls protect direct contact to potential current and potential future Site users.

4.18.1.1 Estimated Costs

There is no cost associated with this alternative.

4.18.1.2 Evaluation Results

LNAPL infiltration into the Outfall 002 storm sewer has not been observed. However, an observed LNAPL plume located in close proximity to a portion of this storm sewer suggest the potential for LNAPL infiltration into the storm sewer system. This alternative does not address this potential future condition.

4.18.2 Alternative 2: Storm Sewer Lining

This alternative involves lining a portion of the storm sewer with an impermeable material to prevent groundwater infiltration into the system. The Outfall 002 storm sewer system would be lined between manholes 2-20 and 2-22, at the portion of the storm sewer system that is in close proximity to the observed LNAPL plume associated with the Former Tank Farm 37 UST system

The storm sewer would either be slip-lined with a slightly smaller diameter polyvinyl chloride (PVC) pipe with the ends grouted, or lined with a non-invasive, cured-in-place system, which is intended to provide a physical barrier to prevent infiltration into the targeted section of the storm sewer system.

4.18.2.1 Estimated Costs

The estimated cost of this alternative is $337,000.

4.18.2.2 Evaluation Results

This alternative limits the potential for migration of LNAPL, into the Outfall 002 storm sewer system between manholes 2-20 and 2-22.

4.18.3 Selected Alternative

The selected alternative for this AOI is **Alternative 2: Storm Sewer Lining** due to the technical feasibility of this alternative. Although unacceptable human health risks from potential exposure have not been identified for this area, this alternative limits the potential for migration of LNAPL into the Outfall 002 storm sewer system.

An Interim Measure Work Plan was submitted to the USEPA on February 13, 2008, for implementing the selected alternative. The USEPA approved the interim measure in a letter to GM dated April 8, 2008.

4.19 Outfall 003 Storm Sewer

As described in Section 5.7 of the NEDOCC, this overall system consists of two oil/water separators configured to mitigate sheens at Outfall 003 to the Flint River. Additionally, booms are permanently located at Outfall 003 to contain sheens that are not completely contained by the Outfall 003 system oil/water separators. Oil sheens contained by the booms at Outfall 003 are periodically collected and treated at the Factory 10 Groundwater Recovery and Treatment System.

Although this current system is effective in mitigating LNAPL sheens to the Flint River, it is relatively operationally intensive, and select components are not always reliable. As such, this system has been evaluated in comparison with other alternatives.

4.19.1 Alternative 1: Continue Operating Current System

This alternative involves continuing to implement the Outfall 003 oil removal system, which involves collecting LNAPL sheens at the outfall using floating oil booms, and periodic pumping of the collected material into a tanker truck. For this alternative, it is assumed that the pumped oil and water will be taken offsite for treatment and disposal, because the Factory 10 Groundwater Recovery and Treatment System is expected to be turned off within the next two years. The collected LNAPL/water mixture would be taken offsite for treatment and disposal. The cost estimate assumes that the current oil/water separators will be cleaned of sediment that has accumulated since the early 1990's, and a transfer pump and level switch will be replaced in one of the oil/water separators.

For cost comparison purposes, O&M costs were extrapolated for a period of 10 years.

4.19.1.1 Estimated Costs

The present net worth of this alternative is $1,660,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost and annual cost are assumed to be $250,000 and $200,000, respectively.

4.19.1.2 Evaluation Results

As noted above, this alternative requires substantial operations and maintenance to monitor, collect, and treat oil sheens. As such, this alternative is operationally more intensive and not always reliable.

4.19.2 Alternative 2: End-of-Pipe Treatment System

This alternative involves the construction of a new end-of-pipe treatment system to collect LNAPL sheens prior to reaching Outfall 003. The treatment system would consist of the installation of a below-ground self-cleaning bar screen and an oil/water separator in the storm sewer system to remove floating oil during dry weather flows and a portion of wet weather flows. The stormwater treated by these components would then be directed into a detention basin as a polishing step to provide for removal of residual LNAPL, as necessary. After the polishing step, outflow from the detention basin would be directed back to Outfall 003. The recovered debris and LNAPL would be characterized and disposed of at an offsite facility in compliance with applicable waste standards.

4.19.2.1 Estimated Costs

The present net worth of this alternative is $1,640,000 assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost and annual cost are assumed to be $1,362,000 and $40,000, respectively.

4.19.2.2 Evaluation Results

This alternative provides end-of-pipe treatment of stormwater to remove LNAPL sheens prior to discharge to the outfall. This system requires less maintenance and is expected to be more reliable for the removal of oil sheens than Alternative 1.

4.19.3 Selected Alternative

The selected alternative for this AOI is **Alternative 2: End-of-Pipe Treatment System**, due to the technical feasibility of this alternative. This alternative is expected to remove LNAPL sheens prior to discharge to the outfall. In addition, this alternative is expected to require less maintenance and operational needs, and provide a higher degree of reliability than continued operation of the current system as described in Alternative 1.

An Interim Measure Work Plan was submitted to the USEPA on February 13, 2008, for implementing the selected alternative. The USEPA approved the interim measure in a letter to GM dated March 14, 2008.

4.20 **Outfall 004 Storm Sewer**

Currently, an oil removal system is in operation in the Outfall 004 storm sewer system, which involves the collection of oil sheens using floating oil booms at the outfall, and periodic pumping of the collected material into a tanker truck. The collected oil/water mixture is processed at the Factory 10 Groundwater Recovery and Treatment System.

Although this current system is effective in mitigating LNAPL sheens to the Flint River, it requires substantial operations and maintenance to monitor, collect, and treat the collected LNAPL sheens. As such, this system has been evaluated in comparison with other alternatives.

4.20.1 Alternative 1: Continue Operating Current System

This alternative involves continuing to implement the Outfall 003 oil removal system to collect LNAPL sheens using floating oil booms at the outfall, and periodic pumping of the collected material into a tanker truck. For this alternative, it is assumed that the pumped oil and water will be taken offsite for treatment and disposal, because the Factory 10 Groundwater Recovery and Treatment System is expected to be turned off within the next two years. The collected LNAPL/water would be taken offsite for treatment and disposal. For cost comparison purposes, O&M costs were extrapolated for a period of 10 years.

4.20.1.1 Estimated Costs

The present net worth of this alternative is $1,054,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost and annual cost are assumed to be $0 and $150,000, respectively.

4.20.1.2 Evaluation Results

As noted above, this alternative requires substantial operations and maintenance to monitor, collect, and treat oil sheens. As such, this alternative is operationally more intensive and not always reliable.

4.20.2 Alternative 2: End-of-Pipe Treatment System

This alternative involves the construction of a new end-of-pipe treatment system to collect LNAPL sheens prior to reaching Outfall 004. The treatment system would consist of the installation of a below-ground self-cleaning bar screen and an oil/water separator in the storm sewer system to remove floating oil during dry weather flows and a portion of wet weather flows. The recovered debris and LNAPL would be characterized and disposed of at an offsite facility in compliance with applicable waste standards.

For cost comparison purposes, O&M costs were extrapolated for a period of 10 years.

4.20.2.1 Estimated Costs

The present net worth of this alternative is $620,000, assuming a life cycle of 10 years and a discount rate of 7%. The implementation cost and annual cost are assumed to be $478,000 and $20,000, respectively.

4.20.2.2 Evaluation Results

This alternative provides end-of-pipe treatment of stormwater to remove LNAPL sheens prior to discharge to the outfall. This system requires less maintenance and is more reliable for the removal of oil sheens than Alternative 1.

4.20.3 Selected Alternative

The selected alternative for this AOI is **Alternative 2: End-of-Pipe Treatment System**, due to the technical feasibility of this alternative. This alternative is expected to remove LNAPL sheens prior to discharge to the outfall. In addition, this alternative would require less maintenance and provides a higher degree of reliability than continued operation of the current system as described in Alternative 1.

An Interim Measure Work Plan was submitted to the USEPA on February 13, 2008, for implementing the selected alternative. The USEPA approved the interim measure in a letter to GM dated March 14, 2008.

4.21 Outfall 005

Visible sheens have previously been observed at Outfall 005. Inspections of the Outfall 005 storm sewer system revealed that the likely source of the sheens was infiltration into the system near French drain manholes located near the Leith Street underpass. P-traps were installed in two French drain manholes between September and December 2004, and the p-traps have been successful in controlling sheens at Outfall 005.

4.21.1 Proposed Corrective Measure

The proposed corrective measure for this AOI is **Periodic Monitoring** to ensure that the P-traps are operating as designed and holding back the LNAPL from entering the French drain. Annual site visits are proposed.

4.21.2 Estimated Costs

The present net worth of this alternative is $15,000, assuming a life cycle of 10 years and a discount rate of 7%. The annual cost is assumed to be $2,000.

5. Groundwater Monitoring Plan

Manufacturing activities have taken place at the Site since the early to mid 1900's, and the likely time periods between the historical releases of contaminants and current conditions have allowed the subsurface to reach a stable condition. As documented in the RFI Phase I and II Reports, an extensive groundwater characterization program was implemented as part of the RFI. The analytical data from the RFI groundwater characterization further supports the stability of observed groundwater impacts, as discussed in the CA 750 Report. The RFI data were evaluated for risk from potential exposure as part of the human health risk assessment as documented in Section 6 of the RFI Phase II Report, and supplemented in Appendix A of this Revised CMP.

The human health risk assessment determined that the current groundwater conditions do not pose a significant risk under current and reasonably expected future land and groundwater use scenarios at and around the Site. However, as a prudent and conservative measure, GM proposes to continue monitoring groundwater elevations and/or concentrations and/or LNAPL absence, presence, and/or thickness at select monitoring wells for specific durations to confirm subsurface conditions at locations where limited sampling data are available, or where the stability of conditions at the downgradient edge of an impacted area may need further confirmation.

Additional monitoring data are not required within source areas that have been delineated by downgradient monitoring wells, or at downgradient locations where stable concentrations have been demonstrated and concentrations are expected to remain stable.

5.1 Groundwater Monitoring Plan Overview

The proposed groundwater monitoring program includes the collection of groundwater elevations and/or concentrations and/or LNAPL absence, presence, and/or thickness at 42 monitoring wells. The proposed monitoring program is summarized in Table 5-1. Figures 5-1 and 5-2 illustrate the locations of the monitoring wells included in the proposed monitoring program. All activities will be completed in accordance with the Field Sampling Plan (FSP) and Quality Assurance Project Plan (Appendix C of the RFI Work Plan, dated March 30, 2001, as amended [QAPP addendum on May 16, 2005]) and the Health and Safety Plan (HASP) updated June 2005.

Any future modification to Site activities (e.g., future demolition and/or redevelopment) may impact the position of some of the monitoring locations. To accommodate such activities, alternate monitoring wells may be substituted to provide water level and LNAPL thickness measurements, and groundwater sampling locations. Monitoring wells proposed for monitoring as part of this program may also need to be properly abandoned and re-installed at nearby locations to accommodate future Site activities. Substantial modifications to the proposed monitoring program will be presented to USEPA for approval prior to implementation. Examples of such modifications involve the movement of monitoring points a distance of more than 30 feet, elimination or substitution of monitoring locations at greater distances than 30 feet, and the reduction of proposed analytes.

GM plans to properly abandon any existing monitoring wells associated with the Site (onsite or offsite) that are not proposed to be used as part of this proposed monitoring program, unless such wells have been previously identified to either be destroyed or not found.

5.2 Water Level and LNAPL Measurements

Groundwater elevation data have been contoured on a Site-wide basis for a series of monitoring dates, resulting in a comprehensive understanding of Site-related groundwater flow direction. Due to the consistency of the observed groundwater flow patterns, collection of additional Site-wide water level data is not included in the proposed monitoring program. However, in order to confirm that the subsurface distribution of LNAPL does not change in response to the implementation of the CMP, groundwater levels and LNAPL thickness measurements will be made annually at select monitoring wells listed in Table 5-1. Water levels and LNAPL thickness measurements will be compiled for inclusion in annual reports (see reporting information below).

5.3 Groundwater Sampling

To achieve the program objectives, groundwater samples will be collected on an annual basis, from the monitoring wells listed in Table 5-1 and shown on Figures 5-1 and 5-2. Table 5-1 lists 1) the monitoring wells included in the proposed monitoring program; 2) the proposed analytical parameters corresponding to each monitoring well; 3) the proposed duration of monitoring for each monitoring well; and 4) the purpose of each proposed monitoring location. Groundwater samples will be submitted to Merit Laboratories, Inc. of East Lansing, Michigan (or a similar laboratory) for analysis.

Since over 250,000 analytical data points were validated as part of the RFI, with nearly all being acceptable for use in the risk assessments, no further analytical data validation will be performed as part of this program.

5.4 Reporting

A report will be prepared annually to document the results of the proposed monitoring program. The text of each of the annual reports will describe the objectives and scope of each of the sampling events, and will include a summary of the procedures used to complete the sampling. The associated results will be presented using the following methods:

- Analytical data box figures to show the distribution of recent data in context with historical data;
- Summary tables; and
- Graphs to illustrate concentration changes over time (as appropriate).

The resulting data will be compared to historic concentrations, as well as risk-based criteria described in the RFI Phase II Report. Recommendations will also be provided regarding any changes to the number of monitoring wells being monitored, the frequency of measurements and analytical sampling, and/or the analytical parameters. Proposed monitoring well substitutions and replacements, necessitated by Site re-development activities, will also be presented. Again, substantial modifications to the proposed monitoring program will be presented to USEPA for approval prior to implementation. Examples of such modifications are noted above. In the event that a constituent's concentration approaches a risk-based criterion or increases significantly from historic concentrations, the results will be confirmed by re-sampling for that constituent. If the re-sampling confirms the trend, GM will notify the USEPA to discuss potential actions to address the condition.

Each of the annual reports prepared as part of this proposed monitoring program will be submitted to the USEPA within 90 days upon completion of each corresponding annual monitoring event.

6. Schedule

Consistent with the streamlined manner in which GM has conducted all of the phases of corrective action for this Site, GM is proceeding with various aspects of remedies proposed for corrective action outlined in the preceding sections of this Revised CMP as interim measures. Specifically, GM has provided Interim Measure Work Plans (IMWPs) and USEPA has approved IMWP for the following corrective measures, and GM plans to implement the related construction activities later this year:

- Lining of a select section of the Outfall 002 storm sewer system
- Installation of traveling screen, oil-water separator, and stormwater detention pond along the Outfall 003 storm sewer system
- Installation of traveling screen and oil-water separator along the Outfall 004 storm sewer system

As much of the construction work as practicable pertaining to the remedies proposed in the preceding sections of this Revised CMP will be completed within one year after USEPA selects the final remedies, and all remedies will be completed within a reasonable period of time to protect human health.

GM will continue to report project updates, including changes to the above schedule of activities, to USEPA via quarterly reports that are submitted by the 15th day of every month following a quarter.

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Tables

TABLE 3-1

AREAS THAT DO NOT REQUIRE FURTHER ACTION ABOVE BASELINE RESTRICTIONS BASED ON THE RFI

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

AOI:	RFI Section Reference	Description:
02-A	4.5.11	Process Wastewater Sump
02-D	4.5.14	Press Machine Pit
02-E	4.5.15	Former UST
02-F	4.5.16	Hydraulic Oil AST and Pump
03-1	4.4.18	Factory 03 Area
04-A	4.5.23	Process Waste Room and Waste Pit
04-B	4.5.24	Elevator Pits
04-C	4.5.25	Elevator Pit
04-D	4.5.26	Former USTs
05-2	4.4.13	Filtration Room, Oil Room, Below-Grade Vault, and Elevator Pit
05-3	4.4.14	Building 43 Basement Containing Process Waste Oil Sumps and Drains
05-4	4.4.15	Metal Forming Operations, Recirculation Trenches and Sumps
05-6	4.4.17	Active Process Machinery, Collection Trenches, and Sumps
07-1	4.4.35	Former Coal Yard
07-2	4.4.36	Inactive Line "Slacker House" and Inactive Lime Slurry Tank
07-3	4.4.37	Two Elevator Pits and a Bulk Acid AST
10-1	4.4.8	Factory 10 Area; Manufacturing Operations and Several Tanks
10-2	4.4.9	Solid Waste Transfer Area and Former ASTs
10-3	4.4.10	Two Process Waste Oil Sumps
10-4	4.4.11	Factory 10 Area; Scrapyard
02-B	4.5.12	Elevator Pit
12-A LNAPL	4.5.19	Press Pits, Sumps, Trenches, Traps, and Floor Staining
12-B	4.5.20	Truck Loading Dock Drain and Sump
12-C	4.5.21	Sump in Battery Charging Area, Deep Steam Pipe, and a Utility Pit Containing Oil and Water
12-D	4.5.22	Abandoned, Flooded Utility Tunnel
16-A	4.5.27	Vehicle Fill-Up Station, Automatic Transmission Pump House, and a Gas Pump Station
16-B	4.5.28	Elevator Pit
16-C	4.5.29	Hydraulic Motor, Former AST, and Former USTs
16-D	4.5.30	Former UST and Process Wastewater Sump
17-A	4.5.10	Elevator Pit
21-1	4.4.24	Former Metal Chip Briquetting Operations and Current Metal Welding and Tool Grinding Operations
23-A	4.5.17	Process Waste Sumps, Dock Levelers, and Basement Used for Heat Treat Process Water
36-1 Mineral Seal Plume	4.4.2	Factory 36 Area; Engine Manufacturing and Metal Machining Processes
36-2	4.4.3	Metal Chip Processing Area
36-3	4.4.4	Engine Assembly, Waste Oil Collection and Processing, and Former USTs
36-4	4.4.5	Former Metal Machining and Active Engine Assembly
36-5	4.4.6	Former UST Farm and Active AST Farm
38-1	4.4.1	Process Waste Sumps, Trenches, and Former Hydraulic Car Lifts
40-A	4.5.31	Building 16/40 Corridor Area
40-B	4.5.32	Building 16/40 Corridor Area
40-C	4.5.33	Elevator Pit
44-A	4.5.35	Sumps, Pits, Trenches, Drains, Floor Stains, and ASTs
55-1	4.4.7	Industrial Wastewater Treatment Facilities
65-1	4.4.25	Air Compressor Station and a Main Process Waste Pump Station
81-3	4.4.21	Former Foundry Operations, an Elevator Pit and an Inactive Rail Loading Area
81-4	4.4.22	Air Compressor Operations
81-5	4.4.23	Existing and Former ASTs
83/84-1	4.4.26	Former and Existing Machining Operations
83/84-4	4.4.29	Factory 83/84 Area
83/84-5	4.4.30	Former Process Trenches and Pits, and an Inactive Heat Treating Tunnel
83/84-6	4.4.31	Forklift Battery Charging Area and Associated Trench and Pit, and a Drum Storage Area
83/84-7	4.4.32	Underground Storage Tanks
84-A	4.5.6	Elevation Pits, Sumps, Machine Shop, Hydraulic Cylinders, and a Hydraulic Lift
84-B	4.5.7	Sumps, Floor Drains, a Pit, a Flooded Basement, and a Below Grade Vault
84-C	4.5.8	Sumps, a Trench, and an Oil/Water Separator Pit
84-D	4.5.9	Former UST Farm, and AST Farm, and Drum Storage Area
85-1	4.4.33	Building 87/Leith Street
86-1	4.4.34	Building 87/Leith Street
94-A	4.5.1	Sumps and Trenches in Oil Change Pits and Chemical Storage Areas
94-B	4.5.2	Process Sump and Trench
94-C	4.5.3	Hydraulic Oil Storage Area
94-D	4.5.4	Pit for a Cable-Operated Car Elevator
94-E	4.5.6	Car Loading Machinery and Hydraulic Oil Observed on Floor
Other Areas of Interest:		
	4.6.1	Former Aeration Lagoons Area
	4.6.3	Former Administration Building Area (Transformer Yard, Soil Stockpile Area, and Former USTs)
	4.6.2	Harriet Street Area (USTs)
	4.6.5	Former Employee Parking Lot North of Oak Park
	4.6.4	Former Building 94 Employee Parking Lot

TABLE 3-2

AREAS THAT REQUIRE FURTHER ACTION BECAUSE THEY ARE REGULATED UNDER TSCA

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

AOI:	Section Reference	Description:
05-1	4.4.12	Former Metal Machining Chip Processing
05-5	4.4.16	Active Process Machinery, Collection Trenches, and Sumps
40-D	4.5.34	Flooded Basement/Tunnel Area
81-2 LNAPL	4.4.20	Factory 81 Area; Active Metal Welding and Machining and Torque Converter Assembly
83/84-2 LNAPL	4.4.27	Former and Existing Machining Operations

TABLE 3-3

AREAS THAT REQUIRE FURTHER ACTION BASED ON THE RFI

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

AOI:	Section Reference	Description:
02-C	4.5.13	Sump in Materials Laboratory
09-A Soil	4.5.36	Former USTs, Floor Trenches, and Former AST
09-B Soil	4.5.37	Hamilton Ave Tank Farm
09-B LNAPL	4.5.37	Hamilton Ave Tank Farm
12-A Soil	4.5.19	Press Pits, Sumps, Trenches, Traps, and Floor Staining
29-A	4.5.18	Elevator Pit and Observed Oil Staining
36-1 Gasoline Plume	4.4.2	Factory 36 Area; Engine Manufacturing and Metal Machining Processes
81-1	4.4.19	Metal Machining, Chip, Cooling, and Cutting Oil Filtration and Processing, a Hydraulic Elevator, Process Waste Sumps and Tanks, a Drum Storage Area, and an Active Hazardous Waste Accumulation Area
81-2 Soil	4.4.20	Factory 81 Area; Active Metal Welding and Machining and Torque Converter Assembly
83/84-2 Soil	4.4.27	Former and Existing Machining Operations
83/84-3	4.4.28	Former and Existing Machining Operations
Storm Sewer Outfall 002		
Storm Sewer Outfall 003		
Storm Sewer Outfall 004		
Storm Sewer Outfall 005		

TABLE 4-1
SUMMARY OF PROPOSED CORRECTIVE MEASURES

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

AOI	Description of AOI	Proposed Corrective Measure*
02-C	Sump in Materials Laboratory	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
05-1	Former Metal Machining Chip Processing	Additional institutional controls above baseline, including a deed restriction notification of presence of PCBs
05-5	Active Process Machinery, Collection Trenches, and Sumps	Additional institutional controls above baseline, including a deed restriction notification of presence of PCBs
09-A Soil	Former USTs, Floor Trenches, and Former AST	Offsite Excavation and Onsite Engineering and Additional Institiutional Controls above Baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
09-B Soil	Hamilton Avenue Tank Farm	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
09-B LNAPL	Hamilton Avenue Tank Farm	LNAPL-only extraction
12-A Soil	Press Pits, Sumps, Trenches, Traps, and Floor Staining	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
29-A	Elevator Pit and Observed Oil Staining	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
36-1 Gasoline Plume	Factory 36 Area; Engine Manufacturing and Metal Machining Processes	LNAPL-only extraction and additional institutional controls above baseline, including a deed restriction limiting excavation and prohibiting future non-OSHA use of current and future buildings
40-D	Flooded Basement/Tunnel Area	Additional institutional controls above baseline, including a deed restriction notification of potential presence of residual PCBs
81-1	Metal Machining, Chip, Cooling, and Cutting Oil Filtration and Processing, a Hydraulic Elevator, Process Waste Sumps and Tanks, a Drum Storage Area, and an Active Hazardous Waste Accumulation Area	Additional institutional controls above baseline, including a deed restriction limiting excavation

TABLE 4-1
SUMMARY OF PROPOSED CORRECTIVE MEASURES

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

AOI	Description of AOI	Proposed Corrective Measure*
81-2 Soil	Factory 81 Area; Active Metal Welding and Machining and Torque Converter Assembly	Engineering controls and additional institutional controls above baseline, including a deed restriction prohibiting future non-OSHA use of current and future buildings; and maintaining the surface cover consistent with current conditions
81-2 LNAPL	Factory 81 Area; Active Metal Welding and Machining and Torque Converter Assembly	Additional institutional controls above baseline, including a deed restriction notification of presence of PCBs
83/84-2 Soil	Former and Existing Machining Operations	Additional institutional controls above baseline, including a deed restriction limiting excavation
83/84-2 LNAPL	Former and Existing Machining Operations	Additional institutional controls above baseline, including a deed restriction notification of presence of PCBs
83/84-3	Former and Existing Machining Operations	Engineering controls and additional institutional controls above baseline, including a deed restriction limiting excavation and maintaining the surface cover consistent with current conditions
	Outfall 002	Lining of portion of storm sewer pipe
	Outfall 003	End-of-pipe stormwater treatment system
	Outfall 004	End-of-pipe stormwater treatment system
	Outfall 005	Periodic monitoring of P-traps

Note:

* = Baseline Site-wide use restrictions include limiting future use to Industrial and Commercial II, III, & IV activities, and prohibiting all groundwater use onsite and potable groundwater use offsite.

TABLE 5-1
GROUNDWATER MONITORING PLAN

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

Well I.D.	AOI	Onsite/ Offsite	CA 750 Monitoring Location (Groundwater Sampling)	Analytical Constituents to be Monitored	Previous Monitoring Purpose	Previously Detected in Groundwater at Concentrations Above Drinking Water Criteria	Monitoring Date of Constituent(s) of Concern							Rationale
							2001	2002	2003	2004	2005	2006	2007	
RFI-02-14	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	NA								Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
RFI-02-15	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	NA								Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
RFI-02-17	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	NA								Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
RFI-02-18	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	NA								Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
RFI-02-19	02-B	onsite		NA	Monitor LNAPL in AOI-02B.	None					April (VOCs)			Monitor LNAPL presence/absence/thickness in AOI-02B for two years following initiation of CMP to document plume stability.
43-166	05-1 and 05-06	onsite		VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-05-1 and 05-6).	As	September	December						Upon USEPA's approval of the shutdown of the recovery system, monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events, to document plume stability.
43-167	05-1 and 05-06	onsite		VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-05-1 and 05-6).	As	September							Upon USEPA's approval of the shutdown of the recovery system, monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events, to document plume stability.
43-168	05-1 and 05-06	onsite		NA	Monitor LNAPL downgradient of AOI-05-1 and 05-6 following LNAPL recovery system shutdown.	None	September	December						Upon USEPA's approval of the shutdown of the recovery system, LNAPL thickness/absence/thickness downgradient of AOI-05-1 and 5-6 will be monitored for two years, to document plume stability.
43-140	05-1 and 05-06	onsite		VOCs	Monitoring TCE concentrations in AOI-05-6.	TCE	September	June	April	October			November (VOCs)	TCE concentrations increased from 0.025 ppm in September 2001 to 0.25 ppm in October 2004. Monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events. Although not part of the CA 750 groundwater monitoring program, this well was sampled in fall 2007 for VOCs and the concentration of TCE was consistent with historical results. This well will be sampled in fall 2008 and if the results are consistent with the 2007 results, the monitoring well will be removed from the CMP groundwater monitoring program.
31-8	09-B	onsite		NA	Monitor LNAPL downgradient of AOI-09-B.	Benzene, ethylbenzene, Pb	September	June						Upon USEPA's approval of the LNAPL recovery activities, LNAPL presence/absence/thickness downgradient of AOI-09-B will be monitored for two years, to document plume stability.
RFI-09-09	09-B	onsite		VOCs	monitoring location at downgradient edge of LNAPL impacted area (AOI-09-B).	None	September	June	March					Upon USEPA's approval of the LNAPL recovery activities, monitoring well will be sampled annually for two years, to document plume stability.
RFI-09-44	09-B	onsite		NA	Monitor LNAPL downgradient of AOI-09-B.	None			March	October				Upon USEPA's approval of the LNAPL recovery activities, LNAPL presence/absence/thickness downgradient of AOI-09-B will be monitored for two years, to document plume stability.
RFI-09-45R	09-B	onsite		NA	Monitor LNAPL downgradient of AOI-09-B.	None		December						Upon USEPA's approval of the LNAPL recovery activities, monitoring well will be sampled annually for two years, to document plume stability.
RFI-09-46	09-B	offsite	X	VOCs	Monitoring benzene concentrations in AOI-09-B	Benzene (Xylenes were detected above GSI criteria)		December	April	October			June and October (VOCs)	Monitoring well will be sampled annual until concentrations of VOCs are below drinking water criteria or are stable and below GSI criteria for two consecutive monitoring events.
RFI-09-48	09-B	offsite	X	VOCs	Monitoring downgradient site conditions	None			April	October	December (VOCs)	November (VOCs)	April, June, November (VOCs)	Monitoring well will be sampled annually for VOCs until concentrations of VOCs are stable or below criteria for two consecutive monitoring events in monitoring well RFI-09-46.
RFI-09-52	09-B	onsite		NA	Monitor LNAPL downgradient of AOI-09-B.	None			September					Upon USEPA's approval of the LNAPL recovery activities, LNAPL presence/absence/thickness downgradient of AOI-09-B will be monitored for two years, to document plume stability.

See Notes on Page 4

TABLE 5-1
GROUNDWATER MONITORING PLAN

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

Well I.D.	AOI	Onsite/ Offsite	CA 750 Monitoring Location (Groundwater Sampling)	Analytical Constituents to be Monitored	Previous Monitoring Purpose	Previously Detected in Groundwater at Concentrations Above Drinking Water Criteria	Monitoring Date of Constituent(s) of Concern							Rationale
							2001	2002	2003	2004	2005	2006	2007	
RFI-03-04	03-1	onsite		VOCs	Monitoring VOC concentrations downgradient of LNAPL plume (AOI-10-1 and 10-4)	As	September						November (VOCs)	Although VOCs were not detected above drinking water criteria in September 2001, the well has only been sampled for VOCs once. Monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events upon USEPA's approval of the shutdown of the recovery system to document plume stability. Arsenic was detected at concentrations above the drinking water criteria, however, the extent has been defined by downgradient monitoring points.
20-FP10R (replaces 20-FP10)	10-1 and 10-3	onsite	X	VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-10-1 and 10-4).	Benzene	September	February				November (VOCs)	October (20-FP10R) VOCs	Monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events upon USEPA's approval of the shutdown of the recovery system to document plume stability.
20-145	10-1 and 10-4	onsite		NA	Monitor LNAPL downgradient of AOI-10-1 and 10-4 following LNAPL recovery system shutdown.	VC	September	June						Upon USEPA's approval of the shutdown of the recovery system, LNAPL presence/absence/thickness downgradient of AOI-10-1 and 10-4 will be monitored for two years, to document plume stability.
20-165	10-1 and 10-4	onsite		NA	Monitor LNAPL downgradient of AOI-10-1 and 10-4 following LNAPL recovery system shutdown.	NA								Upon USEPA's approval of the shutdown of the recovery system, LNAPL presence/absence/thickness downgradient of AOI-10-1 and 10-4 will be monitored for two years, to document plume stability.
20-FP11R	10-1 and 10-4	onsite		NA	Monitor LNAPL downgradient of AOI-10-1 and 10-4 following LNAPL recovery system shutdown.	NA								Upon USEPA's approval of the shutdown of the recovery system, LNAPL presence/absence/thickness downgradient of AOI-10-1 and 10-4 will be monitored for two years, to document plume stability.
20-FP-9R	10-1 and 10-4	onsite		NA	Monitor LNAPL downgradient of AOI-10-1 and 10-4 following LNAPL recovery system shutdown.	NA								Upon USEPA's approval of the shutdown of the recovery system, LNAPL presence/absence/thickness downgradient of AOI-10-1 and 10-4 will be monitored for two years, to document plume stability.
RFI-16-04R	16-C	onsite		PCBs	Monitoring PCB concentrations near the Building 40 Tunnel, as part of TSCA closure (AOI-40-D).	NA							October (PCBs)	Monitoring well will be sampled for PCBs until concentrations are stable for two consecutive monitoring events. Although not part of the CA 750 groundwater monitoring program, this well was sampled in fall 2007 for PCBs and PCBs were not detected. This well will be sampled in fall 2008 and if PCBs are not detected, it will be removed from the CMP groundwater monitoring program.
RFI-36-09	36-1	onsite		VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-36-5) and benzene concentrations in AOI-36-5.	None	September						April (VOCs)	Following the lining of the adjacent sewer line, monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events, to document plume stability.
RFI-36-07	36-1	onsite		NA	Monitor LNAPL in AOI-36-1.	NA								Upon USEPA's approval of the LNAPL recovery activities, LNAPL presence/absence/thickness downgradient of AOI-36-1 will be monitored for two years, to document plume stability.
RFI-36-19	36-1	offsite	X	VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-36-2).	None	September			October	December (VOCs)		June and October (VOCs)	Upon USEPA's approval of the shutdown of the recovery system, monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events, to document plume stability.
RFI-36-37	36-1	offsite	X	VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-36-2).	VC and Benzene	September	June			June (VOCs)		June and October (VOCs)	Upon USEPA's approval of the shutdown of the recovery system, monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events, to document plume stability.
RFI-36-48	36-1	offsite	X	VOCs	Off-site; location at downgradient edge of VOC impacted area (AOI-36-1).	VC		December			February, June, and December (VOCs)		September (VOCs)	Concentration vinyl chloride have increased from 0.004 ppm (June 2005) to 0.064 ppm (December 2005). Monitoring well will be sampled annually until concentrations of VOCs are stable or decreasing for two consecutive monitoring events.

See Notes on Page 4

TABLE 5-1
GROUNDWATER MONITORING PLAN

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

Well I.D.	AOI	Onsite/ Offsite	CA 750 Monitoring Location (Groundwater Sampling)	Analytical Constituents to be Monitored	Previous Monitoring Purpose	Previously Detected in Groundwater at Concentrations Above Drinking Water Criteria	Monitoring Date of Constituent(s) of Concern							Rationale
							2001	2002	2003	2004	2005	2006	2007	
20-100	36-5	onsite		VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-36-5) and benzene concentrations in AOI-36-5.	None	September							Following the lining of the sewer, monitoring well will be sampled annually until VOC concentrations are stable or below drinking water criteria for two consecutive monitoring events, to document plume stability.
20-501	36-5	onsite		NA	Monitor LNAPL downgradient of AOI-36-5 following LNAPL recovery system shutdown.	NA								Following the lining of the sewer, LNAPL presence/absence/thickness downgradient of AOI-36-5 will be monitored for two years, to document plume stability.
20-506	36-5	onsite		NA	Monitor LNAPL downgradient of AOI-36-5 following LNAPL recovery system shutdown.	NA								Following the lining of the sewer, LNAPL presence/absence/thickness downgradient of AOI-36-5 will be monitored for two years, to document plume stability.
RFI-36-13	36-5	onsite		NA	Monitor LNAPL downgradient of AOI-36-5 following LNAPL recovery system shutdown.	TCE and VC	November	June						Following the lining of the sewer, LNAPL presence/absence/thickness downgradient of AOI-36-5 will be monitored for two years, to document plume stability.
RFI-36-14	36-5	onsite	X	VOCs	Monitoring location at downgradient edge of LNAPL impacted area (AOI-36-5).	Be and Ni	October	June		October		November (VOCs)	October (VOCs)	Following the lining of the storm sewer, monitoring well will be sampled annually until VOC concentrations are stable or below drinking water criteria for two consecutive monitoring events, to document plume stability. Beryllium concentrations have been below drinking water criteria for the last three monitoring events and nickel concentrations have been below drinking water criteria for the last four monitoring events.
40-303R	40-D	onsite		PCBs	Monitoring PCB and VOCs concentrations near the Building 40 Tunnel, as part of TSCA closure (AOI-40-D).	As and Pb	December (VOCs, PCBs, and Inorganics)	June (VOCs and Inorganics)	March (VOCs and Inorganics)	October (VOCs and Inorganics)			October (PCBs)	Monitoring well was sampled for PCBs in December 2001 and PCBs were not detected above drinking water criteria. Monitoring well will be sampled annually for PCBs until concentrations of PCBs are stable for two consecutive monitoring events. VOCs were not detected above drinking water criteria for the last four monitoring events. Although not part of the CA 750 groundwater monitoring program, this well was sampled for PCBs in fall 2007 and PCBs were not detected. This well will be sampled for PCBs in fall 2008 and if the results are consistent with the 2007 results, the well will be removed from the CMP groundwater monitoring program. Concentrations of arsenic have been stable during the two monitoring events.
40-304	40-D	onsite		PCBs	Monitoring PCB concentrations near the Building 40 Tunnel, as part of TSCA closure (AOI-40-D).	VC	September						October (PCBs)	Monitoring well was sampled for PCBs in September 2001 and PCBs were not detected above drinking water criteria. Monitoring well will be sampled annually for PCBs until concentrations of PCBs are stable or non-dect for two consecutive monitoring events. Although not part of the CA 750 groundwater monitoring program, this well was sampled for PCBs in fall 2007 and PCBs were not detected. This well will be sampled in fall 2008 and if the results are consistent with the fall 2007 results, the well will be removed from the CMP groundwater monitoring program.

See Notes on Page 4

TABLE 5-1
GROUNDWATER MONITORING PLAN

CORRECTIVE MEASURES PROPOSAL
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS
FLINT, MICHIGAN

Well I.D.	AOI	Onsite/ Offsite	CA 750 Monitoring Location (Groundwater Sampling)	Analytical Constituents to be Monitored	Previous Monitoring Purpose	Previously Detected in Groundwater at Concentrations Above Drinking Water Criteria	Monitoring Date of Constituent(s) of Concern 2001	2002	2003	2004	2005	2006	2007	Rationale
RFI-81-45	81-1	onsite		NA	Monitor LNAPL downgradient of AOI-81-1 following LNAPL recovery system shutdown.	NA								Upon USEPA's approval of the shutdown of the recovery system, LNAPL presence/absence/thickness downgradient of AOI-81-1 will be monitored for two years, to document plume stability.
70-164	81-2	offsite		NA	Monitor LNAPL downgradient of AOI-81-1 following LNAPL recovery system shutdown.	NA								Upon USEPA's approval of the shutdown of the recovery system, LNAPL presence/absence/thickness downgradient of AOI-81-1 will be monitored for two years, to document plume stability.
70-165	81-2	onsite		VOCs and Pb	Monitoring lead concentrations in AOI-81-02	Pb	September	June (Pb)	March (Pb)	October			October (VOCs and Pb)	Lead concentrations increased from 0.0023 ppm in June 2002 to 0.055 ppm October 2004. Monitoring well will be sampled annually until lead concentrations are stable or decreasing for two consecutive monitoring events. Although not part of the CA 750 groundwater monitoring program, this well was sampled in fall 2007 for lead and concentrations of lead were consistent with historical results. Upon USEPA's approval of the shutdown of the recovery system, monitoring well will be sampled annually until VOCs are stable or decreasing for two consecutive monitoring events, to document plume stability.
RFI-81-50	81-2	onsite	X	VOCs and Pb	Monitoring lead concentrations in AOI-81-02 and monitoring location downgradient of LNAPL plume.	None						November (VOCs)	October (VOCs and Pb)	Upon USEPA's approval of the shutdown of the recovery system, monitoring well will be sampled annually until VOC concentrations are stable or decreasing for two consecutive monitoring events, to document plume stability. Monitoring well will be sampled annually for lead until the concentrations are stable or decreasing for two consecutive monitoring events. Downgradient monitoring point for monitoring well 70-165 which has increasing concentrations of lead. Although not part of the CA 750 monitoring program for lead analysis, this well was sampled from lead in fall 2007 and lead was not detected. This well will be sampled for lead in fall 2008 and if the results are consistent with the 2007 results, lead will be removed from the CMP groundwater monitoring program.
RFI-81-51	81-3	onsite		VOCs	Monitoring conditions downgradient of AOI-81-50.	cis 1,2 DCE and VC					April (VOCs)		October (VOCs)	Monitoring well will be sampled annually for VOCs until concentrations of VOCs are stable or decreasing for two consecutive monitoring events. Although not part of the CA 750 groundwater monitoring program, this well was sampled in fall 2007 for VOCs and the results were consistent with historical concentrations. This well will be sampled in fall 2008 and if the results are consistent with the 2007 results, it will be removed from the CMP groundwater monitoring program.
RFI-84-06R	84-D	onsite	X	VOCs	Monitoring downgradient edge of VOC impacted area (AOI-84-D).	Benzene (Ag and CN were detected above GSI criteria)			April		April (cyanide only); and July and December (VOCs)	November (VOCs)	April, June, October (VOCs)	VOCs will be monitored until concentrations are stable or decreasing for two monitoring events. Cyanide concentrations have been stable for the last two monitoring events.
87-FP-4	86-1	onsite		VOCs	Monitoring downgradient edge of VOC impacted area (AOI-86-1).	TCE				October			November (VOCs)	Monitoring well will be sampled annually for VOCs until VOC concentrations are stable or decreasing for two consecutive monitoring events. Although not part of the CA 750 groundwater monitoring program, this well was sampled in fall 2007 for VOCs and no VOCs were detected above the drinking water criteria. This well will be sampled in fall 2008 and if the results are consistent with the 2007 results, the monitoring well will be removed from the CMP groundwater monitoring program.

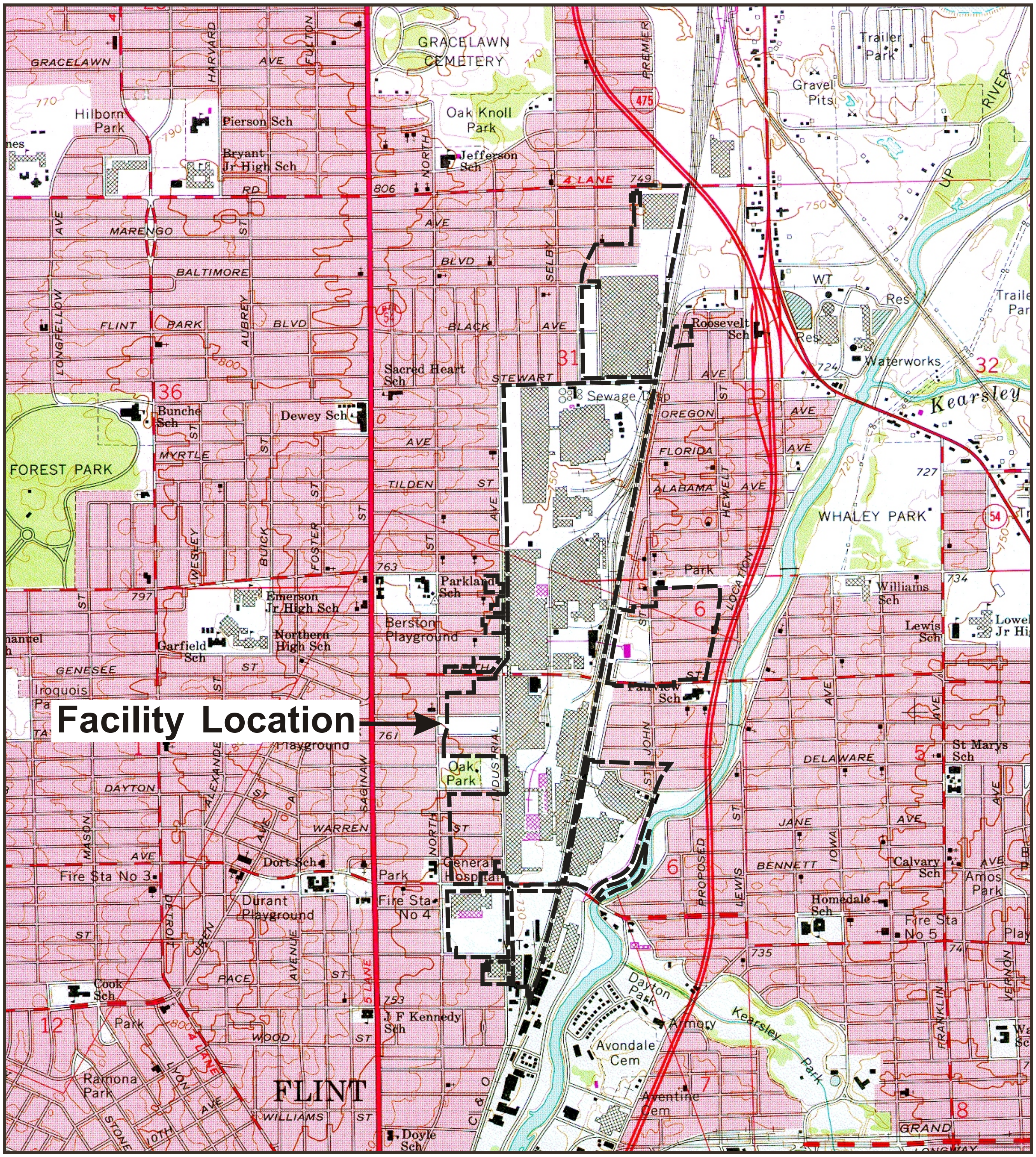
Notes:

Ag = silver	VOCs = Volatile Organic Compounds	AOI = Area of Interest	ppm = parts per million
As = Arsenic	PCBs= Polychlorinated Biphenyls	CMP = Corrective Measures Proposal	
Be = Beryllium	cis 1, 2 DCE = cis 1,2-Dichlorethene	LNAPL = light nonaqueous phase liquid	
CN = cyanide	1,2-DCA = 1,2-Dichlorethane	USEPA = United States Environmental Protection Agency	
Pb = Lead	TCE = Trichloroethene	GSI = Groundwater Surface Water Interface Part 201 Criteria	
Ni = Nickel	VC = vinyl chloride	TSCA = Toxic Substances Control Act	

1. Groundwater/Surface Water (GSI) criteria compared to samples located within 500 feet of the Flint River.
2. The following monitoring wells had exceedances of the GSI criteria: RFI-09-46 (xylene) and RFI-84-06R (Ag and Cyanide).
3. All monitoring wells included in the program will be checked for the presence/absence/thickness of LNAPL.
4. NA; Not applicable, LNAPL monitoring location.

ARCADIS

Figures



REFERENCE: Base Map Source: USGS 7.5 Min. Topo. Quad., Flint North, Mich. (1969, Photorevised 1975).

2000' 0 2000'

Approximate Scale: 1" = 2000'

Area Enlargement

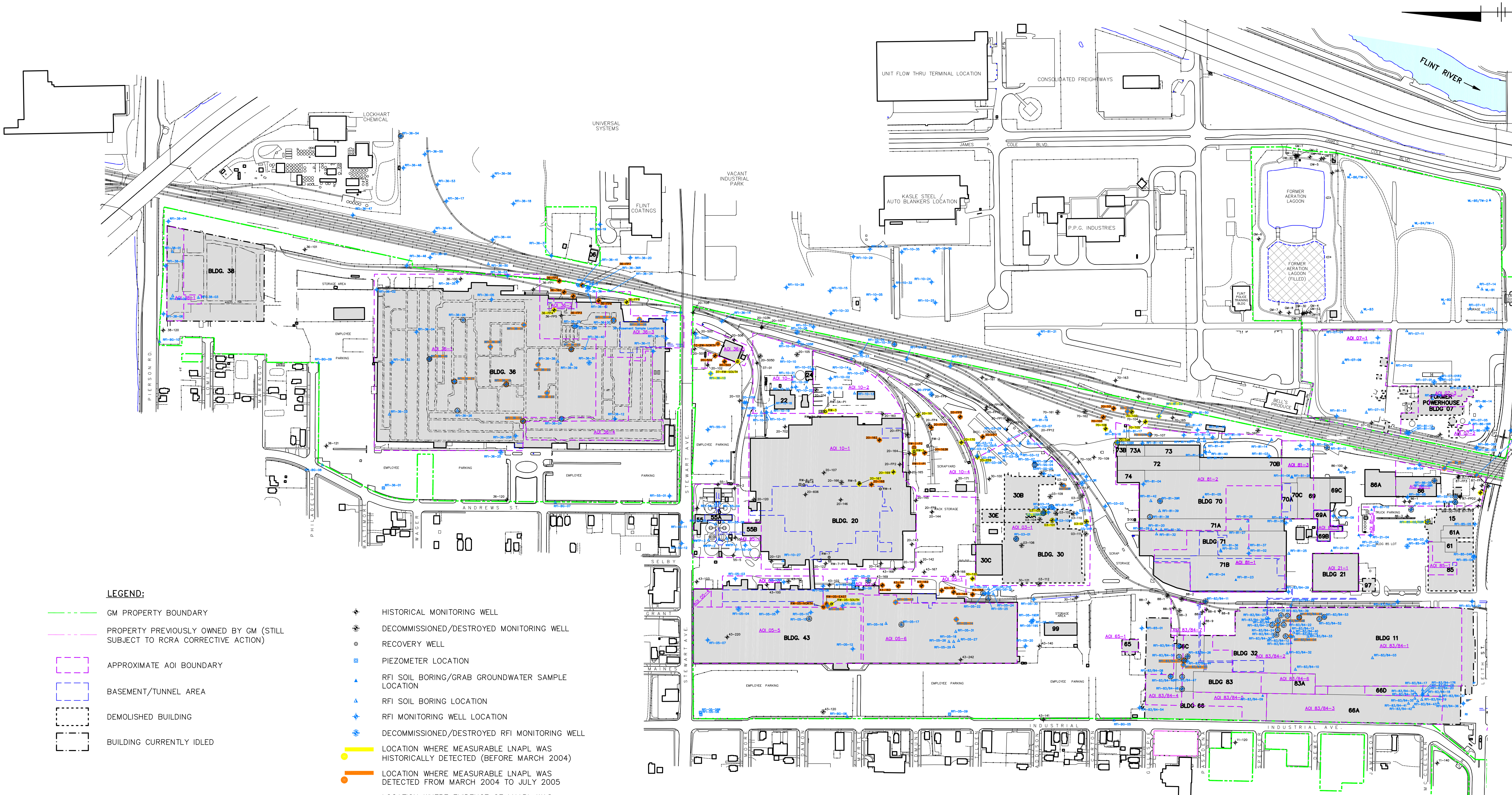
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

SITE LOCATION MAP

ARCADIS

FIGURE
2-1

05/01/08 SYR-141ENV-DJH
B0064410/0000/18500/CDR/64410n01.CDR



LEGEND:

- GM PROPERTY BOUNDARY
- PROPERTY PREVIOUSLY OWNED BY GM (STILL SUBJECT TO RCRA CORRECTIVE ACTION)
- APPROXIMATE AOI BOUNDARY
- BASEMENT/TUNNEL AREA
- DEMOLISHED BUILDING
- BUILDING CURRENTLY IDLED
- HISTORICAL MONITORING WELL
- DECOMMISSIONED/DESTROYED MONITORING WELL
- RECOVERY WELL
- PIEZOMETER LOCATION
- RFI SOIL BORING/GRAB GROUNDWATER SAMPLE LOCATION
- RFI SOIL BORING LOCATION
- RFI MONITORING WELL LOCATION
- DECOMMISSIONED/DESTROYED RFI MONITORING WELL
- LOCATION WHERE MEASURABLE LNAPL WAS HISTORICALLY DETECTED (BEFORE MARCH 2004)
- LOCATION WHERE MEASURABLE LNAPL WAS DETECTED FROM MARCH 2004 TO JULY 2005
- LOCATION WHERE EVIDENCE OF LNAPL WAS OBSERVED IN SOIL

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ INC., DATED APRIL 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.

0 250' 500'
APPROXIMATE GRAPHIC SCALE

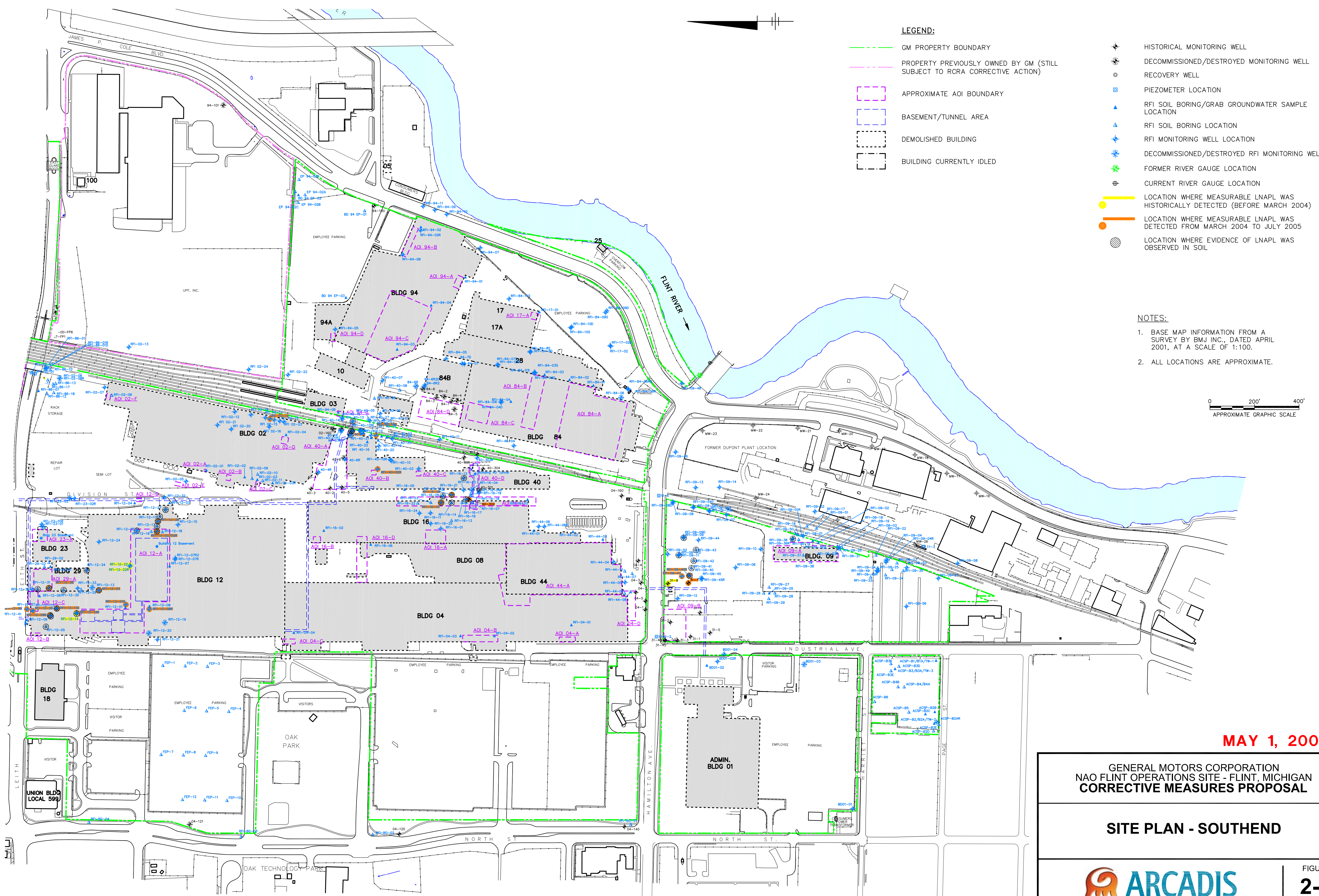
MAY 1, 2008

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

SITE PLAN - NORTHEND

ARCADIS

FIGURE
2-2



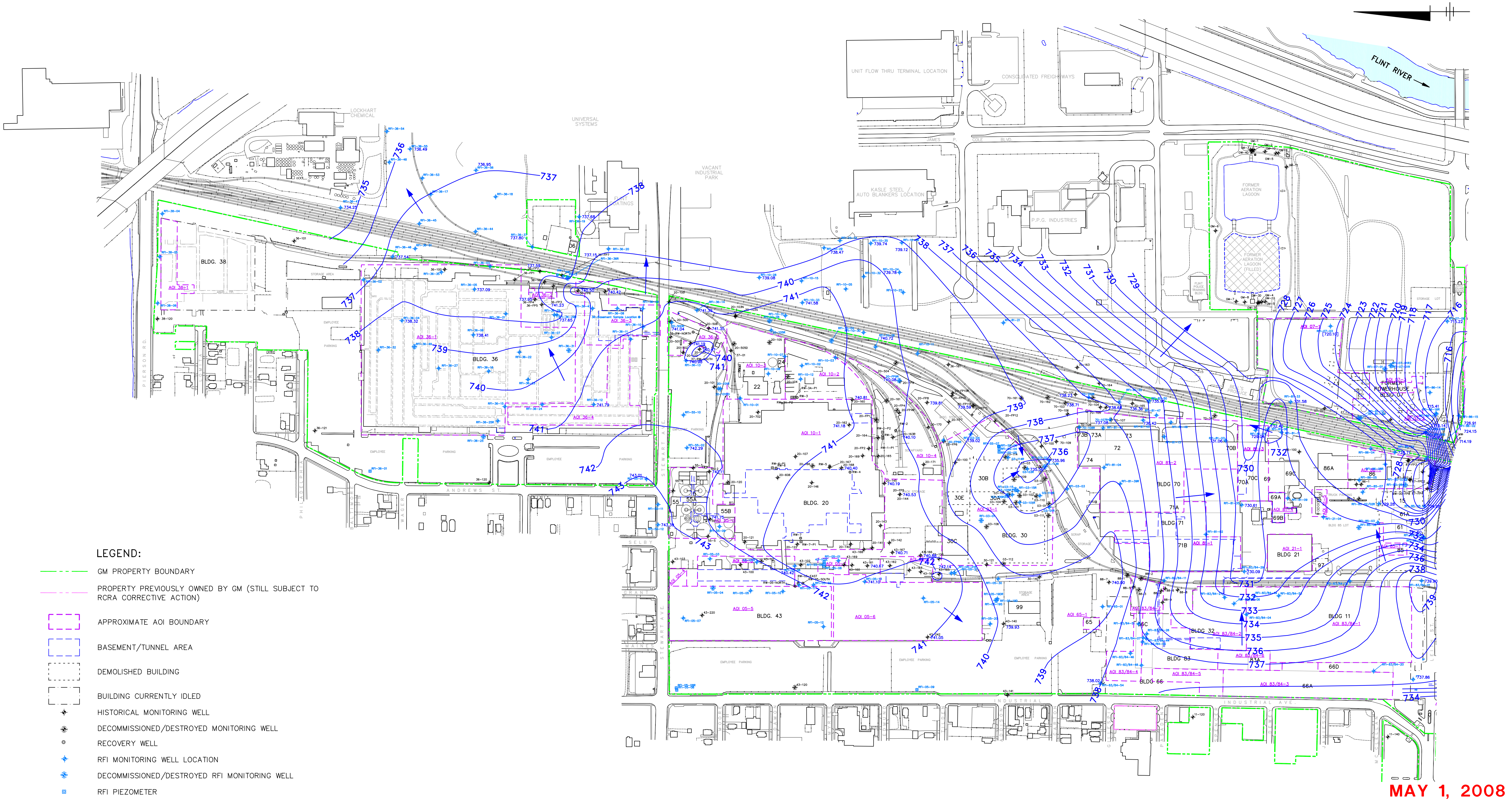
MAY 1, 2008

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

SITE PLAN - SOUTHEND

ARCADIS

FIGURE **2-3**



LEGEND:

- GM PROPERTY BOUNDARY
- PROPERTY PREVIOUSLY OWNED BY GM (STILL SUBJECT TO RCRA CORRECTIVE ACTION)
- APPROXIMATE AOI BOUNDARY
- BASEMENT/TUNNEL AREA
- DEMOLISHED BUILDING
- BUILDING CURRENTLY IDLED
- HISTORICAL MONITORING WELL
- DECOMMISSIONED/DESTROYED MONITORING WELL
- RECOVERY WELL
- RFI MONITORING WELL LOCATION
- DECOMMISSIONED/DESTROYED RFI MONITORING WELL
- RFI PIEZOMETER
- 715.54 GROUNDWATER ELEVATION (IN FEET)
- 726 OCTOBER 2007 GROUNDWATER ELEVATION CONTOUR (IN FEET) (DASHED WHERE INFERRED)
- GENERALIZED FLOW DIRECTION
- [728.37] ANOMALOUS GROUNDWATER ELEVATION (IN FEET), NOT USED TO GENERATE GROUNDWATER ELEVATION CONTOURS

0 250' 500'
APPROXIMATE GRAPHIC SCALE

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ, INC. DATED APRIL 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

GROUNDWATER ELEVATION CONTOUR MAP - NORTHEND

ARCADIS

FIGURE
2-4

CITY: SYRACUSE DIV/GROUP: 85 DB: GMS LD: GMS PM:(Reqd) LYR: ON=*;OFF=*REF* (SHD-BUILDING *HIST_SB *INAPL
G:\CAD\ACT\B0064410\0000\18500\DWG\CMP\64410W01.DWG LAYOUT: 2-4 SAVED: 5/1/2008 5:15 PM ACADVER: 17.0S (LMS TECH) PAGESETUP: C-LD2B-PDF-TABLOID PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 5/6/2008 1:15 PM BY: STOWELL, GARY
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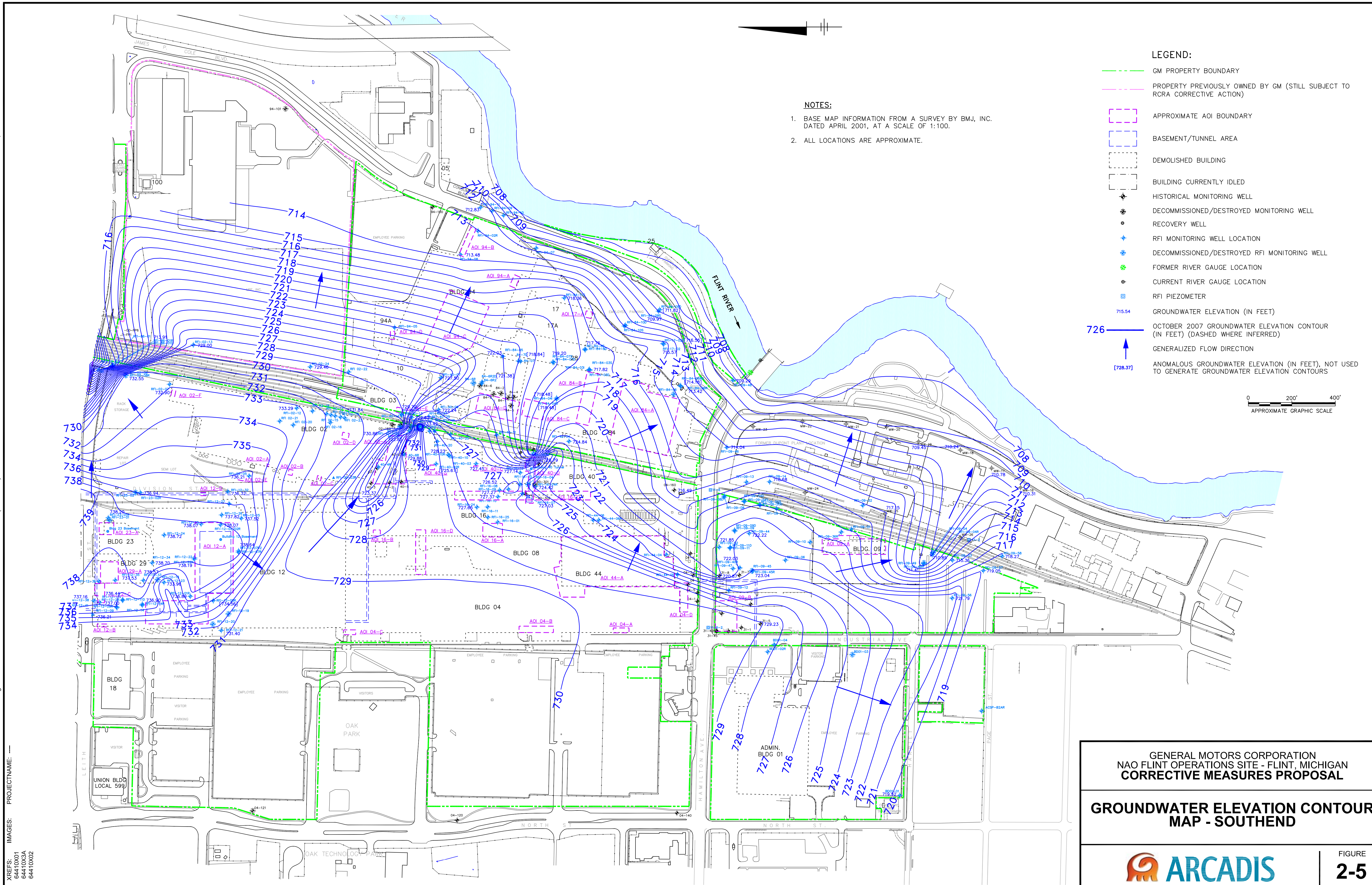
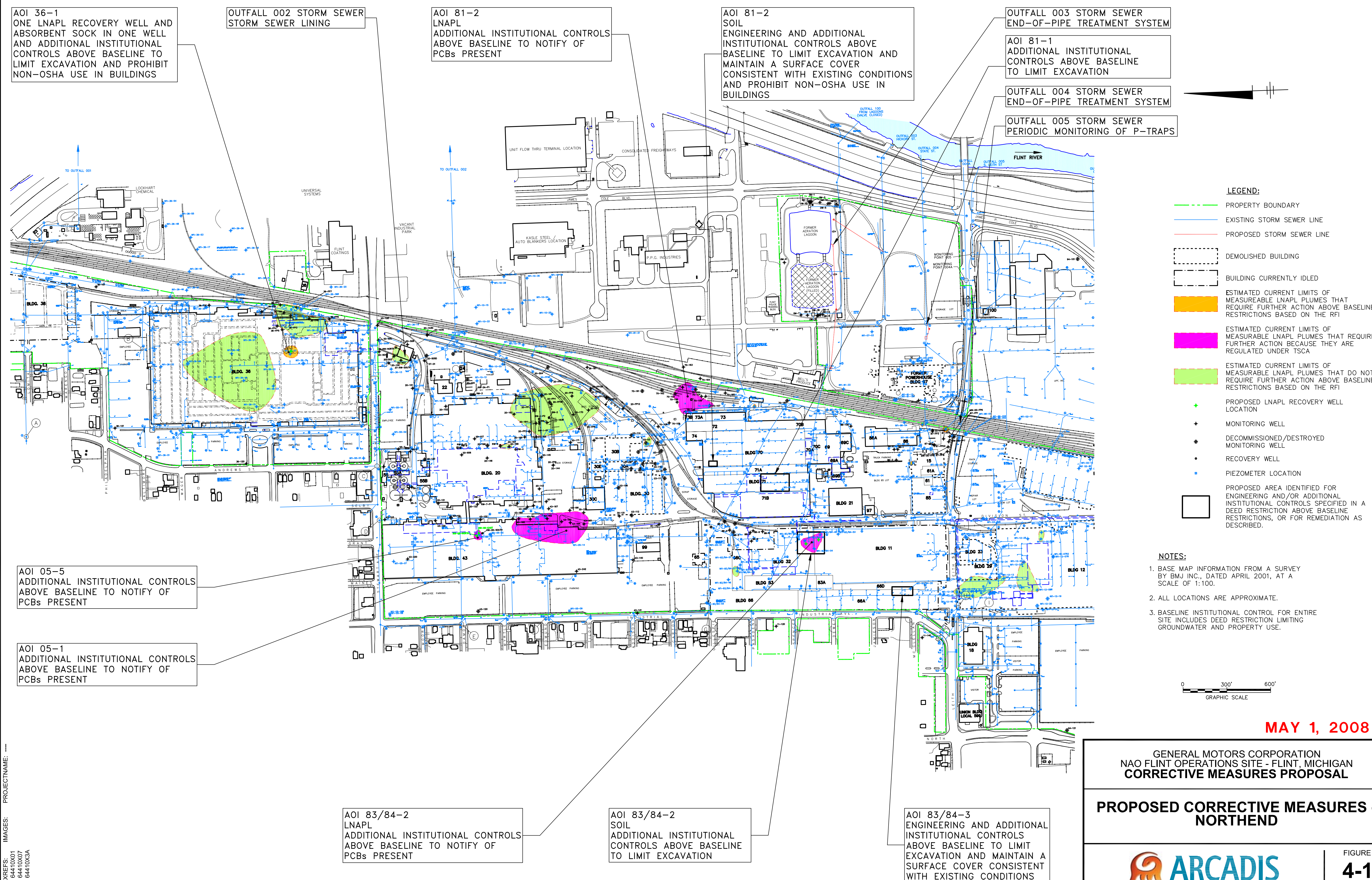

NOTES:
1. BASE MAP INFORMATION FROM A SURVEY BY BMJ, INC. DATED APRIL 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.
LEGEND:
GM PROPERTY BOUNDARY
PROPERTY PREVIOUSLY OWNED BY GM (STILL SUBJECT TO RCRA CORRECTIVE ACTION)
APPROXIMATE AOI BOUNDARY
BASEMENT/TUNNEL AREA
DEMOLISHED BUILDING
BUILDING CURRENTLY IDLED
HISTORICAL MONITORING WELL
DECOMMISSIONED/DESTROYED MONITORING WELL
RECOVERY WELL
RFI MONITORING WELL LOCATION
DECOMMISSIONED/DESTROYED RFI MONITORING WELL
FORMER RIVER GAUGE LOCATION
CURRENT RIVER GAUGE LOCATION
RFI PIEZOMETER
715.54 GROUNDWATER ELEVATION (IN FEET)
726 OCTOBER 2007 GROUNDWATER ELEVATION CONTOUR (IN FEET) (DASHED WHERE INFERRED)
GENERALIZED FLOW DIRECTION
[728.37] ANOMALOUS GROUNDWATER ELEVATION (IN FEET), NOT USED TO GENERATE GROUNDWATER ELEVATION CONTOURS
0 200' 400'
APPROXIMATE GRAPHIC SCALE
FLINT RIVER
BLDG 03
BLDG 02
BLDG 40
BLDG 16
BLDG 08
BLDG 44
BLDG 04
BLDG 23
BLDG 29
BLDG 12
BLDG 09
BLDG 18
BLDG 84
UNION BLDG LOCAL 599
ADMIN. BLDG 01
OAK PARK
DIVISION ST
INDUSTRIAL AVE
NORTH ST
HAMILTON AVE
GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL
GROUNDWATER ELEVATION CONTOUR MAP - SOUTHEND
ARCADIS
FIGURE 2-5



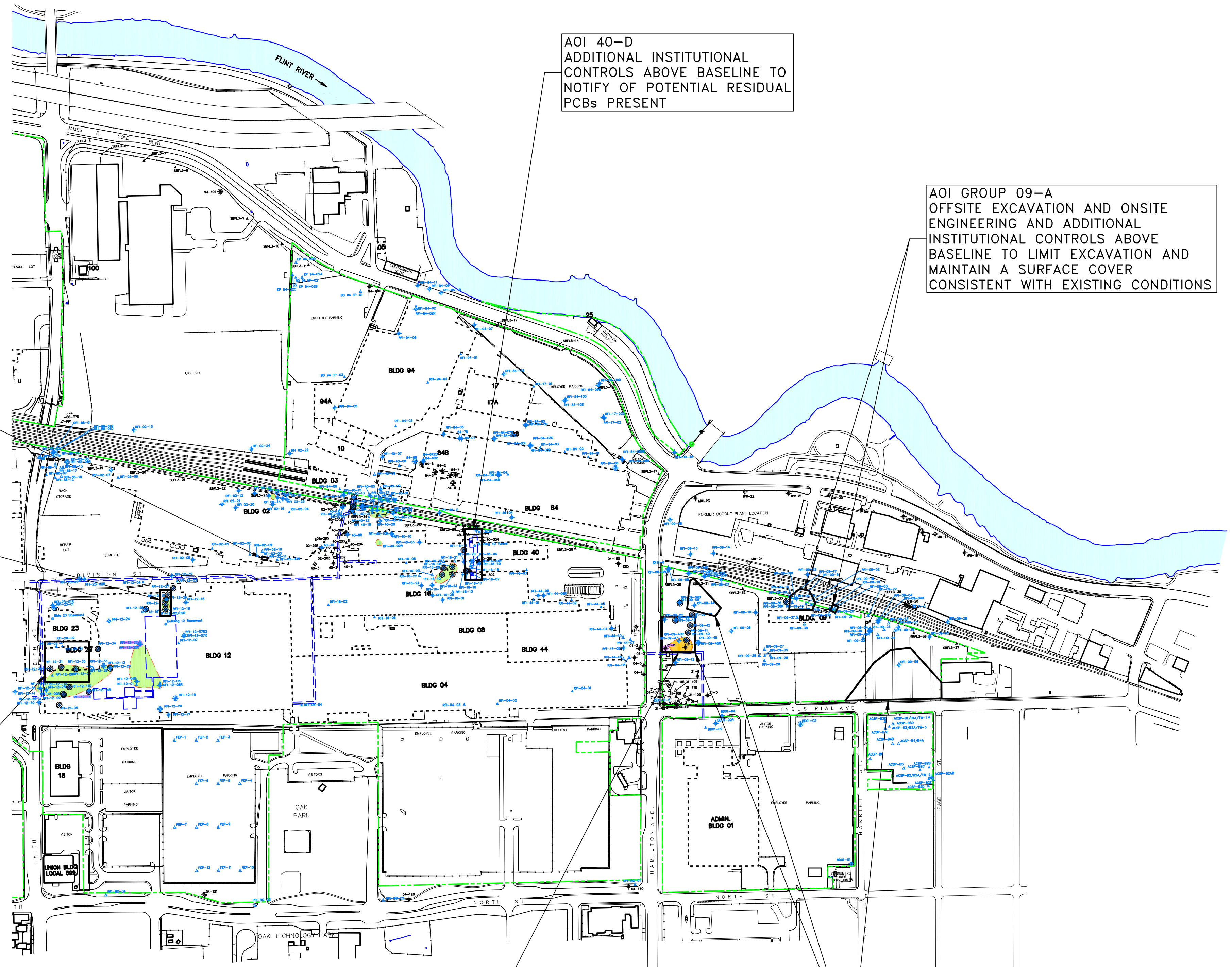
MAY 1, 2008

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

PROPOSED CORRECTIVE MEASURES - NORTHEND

ARCADIS

FIGURE **4-1**



AOI 40–D
ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO NOTIFY OF POTENTIAL RESIDUAL PCBs PRESENT

AOI GROUP 09–A
OFFSITE EXCAVATION AND ONSITE ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION AND MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

AOI GROUP 02–C
ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION AND MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

AOI GROUP 12–A
ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION, MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

AOI GROUP 29–A
ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION AND MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

AOI GROUP 09–B
LNAPL
TWO LNAPL RECOVERY WELLS AND ABSORBENT SOCKS IN FOUR WELLS

AOI GROUP 09–B
SOIL
ENGINEERING AND ADDITIONAL INSTITUTIONAL CONTROLS ABOVE BASELINE TO LIMIT EXCAVATION AND MAINTAIN A SURFACE COVER CONSISTENT WITH EXISTING CONDITIONS

LEGEND:

- PROPERTY BOUNDARY
- DEMOLISHED BUILDING
- BUILDING CURRENTLY IDLED
- ESTIMATED CURRENT LIMITS OF MEASUREABLE LNAPL PLUMES THAT REQUIRE FURTHER ACTION ABOVE BASELINE RESTRICTIONS BASED ON THE RFI
- ESTIMATED CURRENT LIMITS OF MEASURABLE LNAPL PLUMES THAT DO NOT REQUIRE FURTHER ACTION ABOVE BASELINE RESTRICTIONS BASED ON THE RFI
- MONITORING WELL
- DECOMMISSIONED/DESTROYED MONITORING WELL
- RECOVERY WELL
- PIEZOMETER LOCATION
- PROPOSED AREA IDENTIFIED FOR ENGINEERING AND/OR ADDITIONAL INSTITUTIONAL CONTROLS SPECIFIED IN A DEED RESRTICTIONS, ABOVE BASELINE RESTRICTION, OR FOR REMEDIATION AS DESCRIBED.
- PROPOSED LNAPL RECOVERY WELL LOCATION

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ INC., DATED APRIL 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.
3. BASELINE INSTITUTIONAL CONTROL FOR ENTIRE SITE INCLUDES DEED RESTRICTION LIMITING GROUNDWATER AND PROPERTY USE.

0 300' 600'
GRAPHIC SCALE

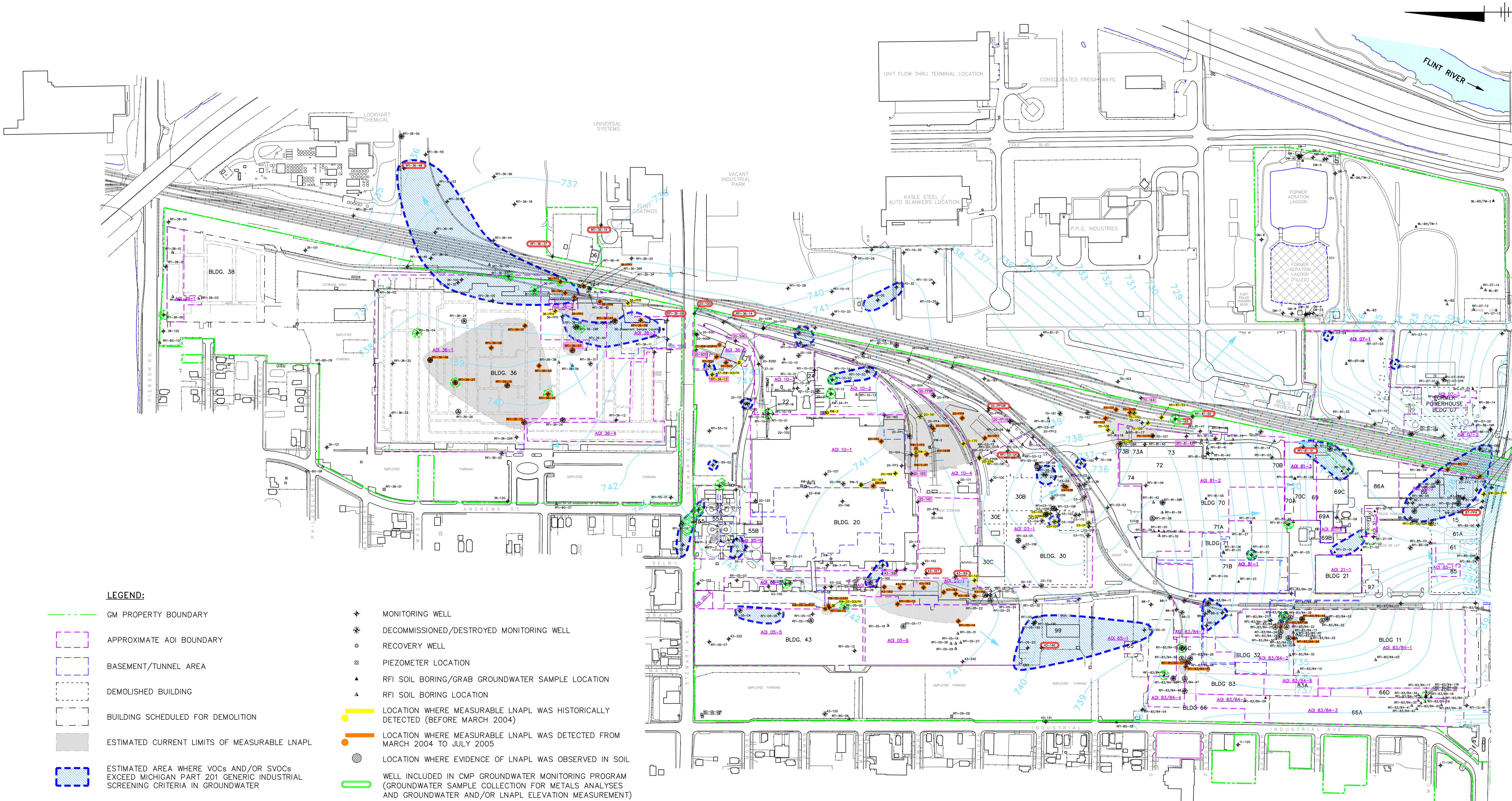
MAY 1, 2008

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

PROPOSED CORRECTIVE MEASURES - SOUTHEND

ARCADIS

FIGURE
4-2



MAY 1, 2008

LEGEND:

- GM PROPERTY BOUNDARY
- APPROXIMATE AOI BOUNDARY
- BASEMENT/TUNNEL AREA
- DEMOLISHED BUILDING
- BUILDING SCHEDULED FOR DEMOLITION
- ESTIMATED CURRENT LIMITS OF MEASURABLE LNAPL
- ESTIMATED AREA WHERE VOCs AND/OR SVOCs EXCEED MICHIGAN PART 201 GENERIC INDUSTRIAL SCREENING CRITERIA IN GROUNDWATER
- ESTIMATED AREA WHERE INORGANICS EXCEED MICHIGAN PART 201 GENERIC INDUSTRIAL SCREENING CRITERIA IN GROUNDWATER
- MONITORING WELL
- DECOMMISSIONED/DESTROYED MONITORING WELL
- RECOVERY WELL
- PIEZOMETER LOCATION
- RFI SOIL BORING/GRAB GROUNDWATER SAMPLE LOCATION
- RFI SOIL BORING LOCATION
- LOCATION WHERE MEASURABLE LNAPL WAS HISTORICALLY DETECTED (BEFORE MARCH 2004)
- LOCATION WHERE MEASURABLE LNAPL WAS DETECTED FROM MARCH 2004 TO JULY 2005
- LOCATION WHERE EVIDENCE OF LNAPL WAS OBSERVED IN SOIL
- WELL INCLUDED IN CMP GROUNDWATER MONITORING PROGRAM (GROUNDWATER SAMPLE COLLECTION FOR METALS ANALYSES AND GROUNDWATER AND/OR LNAPL ELEVATION MEASUREMENT)
- WELL INCLUDED IN CMP GROUNDWATER MONITORING PROGRAM (GROUNDWATER SAMPLE COLLECTION FOR VOCs ANALYSES AND GROUNDWATER AND/OR LNAPL ELEVATION MEASUREMENT)
- LNAPL MONITORING LOCATION ONLY
- GENERALIZED GROUNDWATER FLOW DIRECTION
- 739 OCTOBER 2007 GROUNDWATER ELEVATION CONTOUR (IN FEET)

0 250' 500'
APPROXIMATE GRAPHIC SCALE

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ INC., DATED APRIL 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.
3. ANALYTICAL DATA SHOWN ARE FROM MOST RECENT SAMPLING EVENT AT EACH LOCATION (THROUGH SEPTEMBER 23, 2005). ESTIMATED LIMITS OF MEASURABLE LNAPL BASED ON MEASUREMENTS FROM MARCH 2004 TO JULY 2005.

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

GROUNDWATER MONITORING LOCATIONS - NORTHEND

ARCADIS

FIGURE
5-1

CITY: SYRACUSE DIV/GROUP: 141 DB: GMS PM:(Reqd) LYR:(Opt)ON=*;OFF=REF* ISHD-BUILDING IHIST_SB PAGESETUP: C-LD2B-PDF-TABLOID PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 5/6/2008 1:03 PM BY: STOWELL, GARY
G:\CAD\GE-CAD\C-ACT\B0020434\0000\00001\DWG\H20434H20.dwg LAYOUT: 5-1 SAVED: 5/6/2008 8:30 AM ACADVER: 17.0S (LMS TECH)
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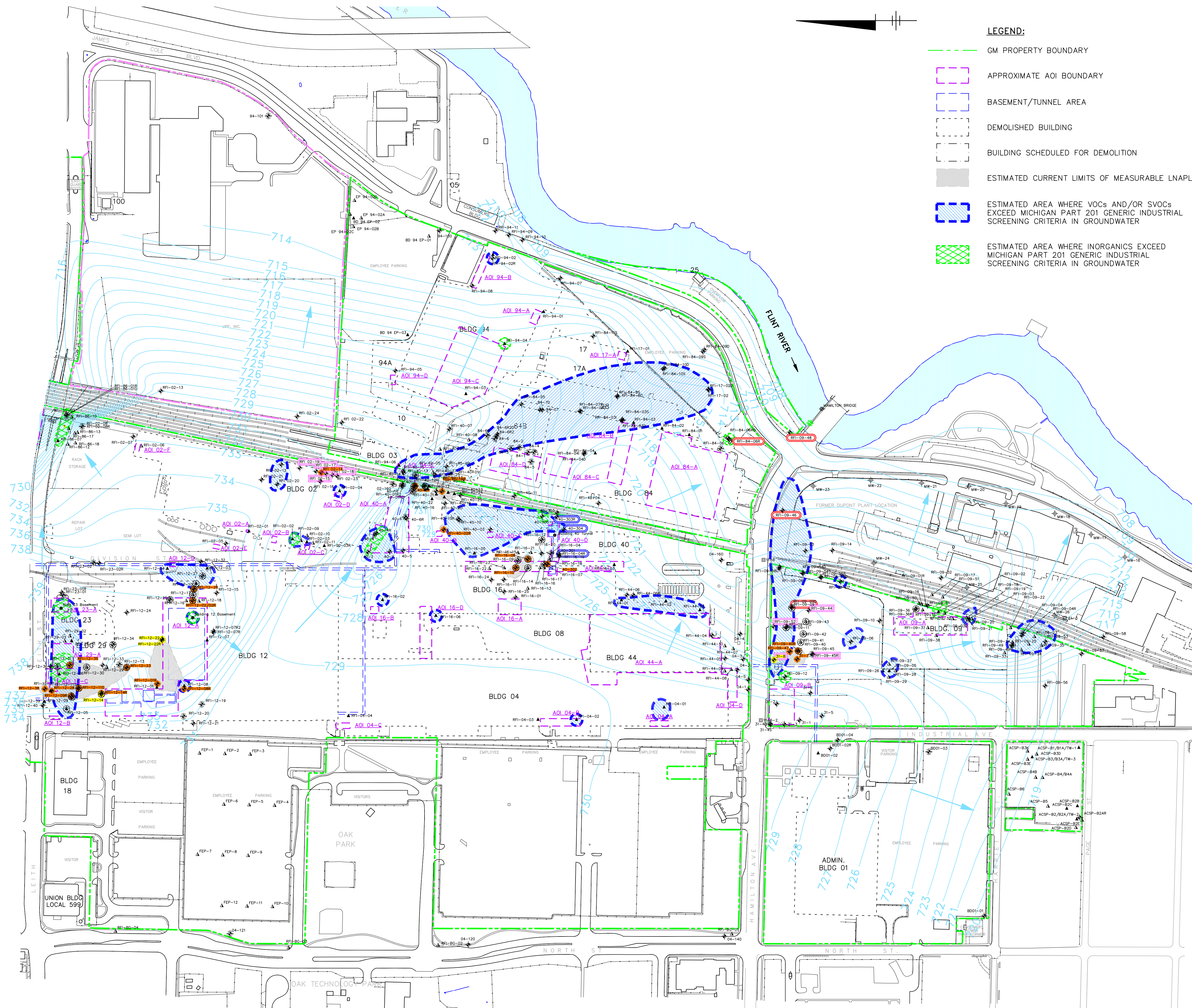

LEGEND:

- GM PROPERTY BOUNDARY
- APPROXIMATE AOI BOUNDARY
- BASEMENT/TUNNEL AREA
- DEMOLISHED BUILDING
- BUILDING SCHEDULED FOR DEMOLITION
- ESTIMATED CURRENT LIMITS OF MEASURABLE LNAPL
- ESTIMATED AREA WHERE VOCs AND/OR SVOCs EXCEED MICHIGAN PART 201 GENERIC INDUSTRIAL SCREENING CRITERIA IN GROUNDWATER
- ESTIMATED AREA WHERE INORGANICS EXCEED MICHIGAN PART 201 GENERIC INDUSTRIAL SCREENING CRITERIA IN GROUNDWATER
- HISTORICAL MONITORING WELL
- DECOMMISSIONED/DESTROYED MONITORING WELL
- RECOVERY WELL
- PIEZOMETER LOCATION
- RFI SOIL BORING/GRAB GROUNDWATER SAMPLE LOCATION
- RFI SOIL BORING LOCATION
- LOCATION WHERE MEASURABLE LNAPL WAS HISTORICALLY DETECTED (BEFORE MARCH 2004)
- LOCATION WHERE MEASURABLE LNAPL WAS DETECTED FROM MARCH 2004 TO JULY 2005
- LOCATION WHERE EVIDENCE OF LNAPL WAS OBSERVED IN SOIL
- WELL INCLUDED IN CMP GROUNDWATER MONITORING PROGRAM (GROUNDWATER SAMPLE COLLECTION FOR METALS ANALYSES AND GROUNDWATER ELEVATION MEASUREMENT)
- WELL INCLUDED IN CMP GROUNDWATER MONITORING PROGRAM (GROUNDWATER SAMPLE COLLECTION FOR VOCs ANALYSES AND GROUNDWATER AND/OR LNAPL ELEVATION MEASUREMENT)
- WELL INCLUDED IN CMP GROUNDWATER MONITORING PROGRAM (GROUNDWATER SAMPLE COLLECTION FOR PCBs ANALYSES AND GROUNDWATER AND/OR LNAPL ELEVATION MEASUREMENT)
- LNAPL MONITORING LOCATION ONLY
- GENERALIZED GROUNDWATER FLOW DIRECTION
- 726 OCTOBER 2007 GROUNDWATER ELEVATION CONTOUR (IN FEET)

NOTES:

1. BASE MAP INFORMATION FROM A SURVEY BY BMJ INC., DATED APRIL 2001, AT A SCALE OF 1:100.
2. ALL LOCATIONS ARE APPROXIMATE.
3. ANALYTICAL DATA SHOWN ARE FROM MOST RECENT SAMPLING EVENT AT EACH LOCATION (THROUGH SEPTEMBER 23, 2005). ESTIMATED LIMITS OF MEASURABLE LNAPL BASED ON MEASUREMENTS FROM MARCH 2004 TO JULY 2005.

0 200' 400'
APPROXIMATE GRAPHIC SCALE

MAY 1, 2008

GENERAL MOTORS CORPORATION
NAO FLINT OPERATIONS SITE - FLINT, MICHIGAN
CORRECTIVE MEASURES PROPOSAL

GROUNDWATER MONITORING LOCATIONS - SOUTHEND

ARCADIS

FIGURE
5-2

CITY: SYRACUSE DIV/GROUP: 141 DB: GMS PM:(Reqd) LYR: ON=*;OFF=*REF* (SHD-BUILDING, (HIST_SB ACADVER: 17.0S (LMS TECH) PAGESETUP: C-LD2B-PDF-TABLOID PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 5/6/2008 1:06 PM BY: STOWELL, GARY
G:\CAD\GE-CAD\C-ACT\B0020434\0000\00001\DWG\HI20434H20.dwg LAYOUT: 5-2 SAVED: 5/6/2008 8:30 AM
XREFS: 64410X01 64410X3A 64410X06 64410X02 IMAGES: PROJECTNAME: ----

ARCADIS

Appendix A

Supplemental Evaluation of Potential Residential Exposure to Groundwater

CONTENTS

Tables

Attachments

A1 INTRODUCTION

This appendix discusses a supplemental evaluation of additional scenarios for potential residential exposure to groundwater via vapor intrusion and via non-potable use of groundwater in support of the RCRA Corrective Action for the General Motors Corporation (GM) North American Operations (NAO) Flint Operations Site located at 902 East Leith Street in Flint, Michigan (the Site). There are currently no residents on or downgradient of any part of the site; however, GM may consider redeveloping areas of the Site south of Leith Street (the Southend) for future residential use. In addition, part of the area downgradient (east) of the Site is zoned for residential use (classes A-2, B, and C-1) and could be redeveloped for residential use in the future.

The Revised RFI Phase II Report evaluated potential future residential exposure to groundwater via vapor intrusion into possible future residential slab-on-grade buildings at the Southend and at areas downgradient of the Site. Potential exposures downgradient of the Site were conservatively evaluated by estimating cumulative cancer risk and HI using maximum concentrations in groundwater at the AOIs that are located at the downgradient edge of the Site. Risk estimates for the AOIs at the Southend and at the Northend are presented in Sections 6.5.2.5 and 6.5.2.7 of the Revised RFI Phase II Report (BBL 2006), respectively. The discussion in these Sections shows that potential vapor intrusion into future residential buildings from groundwater would not result in an unacceptable risk to residents. The risk estimates presented in the Revised RFI Phase II Report are based on a slab-on-grade residence because much of the Southend and portions of the Northend have depths to groundwater that are less than 6 feet. However, the groundwater at much of the area downgradient of the Northend is approximately 10 feet below ground surface and potential future construction of residential buildings with basements would therefore be possible. This appendix evaluates potential exposures of residents to groundwater via vapor intrusion into hypothetical residences with basements in areas downgradient of the Northend.

Potential use of groundwater was not evaluated in the Revised RFI Phase II because the City of Flint Department of Public Works supplies drinking water to the City of Flint and Flint Township, which includes the areas at and around the Site. In addition, a City of Flint ordinance prohibits the installation of drinking water wells (Ordinance 9, Code of Ordinances, Chapter 46-25). However, the ordinance does not prohibit installation of groundwater wells for non-potable uses (e.g., watering lawns, filling pools, washing cars, etc.). Although no non-potable wells are known to exist in the vicinity of the Site, it is possible for non-potable groundwater wells to be installed downgradient of the Site in the future. It is also possible for non-potable groundwater wells to be installed on the Southend of the site in the future if no restriction will be implemented to prohibit installation of wells for non-potable groundwater use. This supplemental evaluation provides an assessment of potential future residential exposure to groundwater for a non-potable "kiddie pool" scenario.

A2 METHODOLOGY

Exposures from groundwater volatilization and migration into potential future downgradient residential buildings with basements are evaluated as discussed in Section G6.2 of the Revised RFI Phase II Report with the following modifications to model inputs. In this evaluation the depth to groundwater is assumed to be 3 m (approximately 10 ft), and the occupied depth below ground is assumed to be 2 m (MDEQ default basement height). The depth to groundwater of 3 m was chosen as a conservative estimate based on actual groundwater levels at the Northend. All other building parameters and exposure factors are MDEQ/USEPA defaults that were discussed in the Revised RFI Phase II Report. The calculation of risk-based criteria used to estimate cumulative cancer risk and noncancer hazard indices (HIs) is shown in Attachment 1.

Potential future exposures associated with residential non-potable groundwater use are evaluated using a hypothetical scenario where groundwater is used to fill a backyard wading pool ("kiddie" pool). This scenario represents a reasonable worst case, in which the estimated exposure is expected to be higher than those associated with other non-potable uses (e.g., watering lawns, washing cars, etc.). Potential routes of exposure evaluated as part of this kiddie pool scenario include incidental ingestion, dermal contact, and inhalation of vapors. The calculation of the risk-based criteria used to estimate cumulative risks for this scenario are discussed in Attachment 2.

A3 RESULTS

Table 1 presents the bounding cumulative cancer risks and noncancer HIs for potential vapor intrusion from groundwater into potential future residential buildings with basements in the AOIs adjacent to the downgradient boundary of the Northend. These bounding risk estimates are based on the maximum detected groundwater concentrations from all groundwater sampling in each AOI. Risk estimates for potential vapor intrusion from groundwater into a residence with a basement do not exceed the USEPA risk limit of 10^{-4} or HI limit of 1 (USEPA 1991b) in any AOI along the downgradient boundary at the Northend.

Potential vapor intrusion into potential future slab-on-grade residential buildings in the residential-zoned area downgradient of part of the Southend would result in exposures no greater than those in potential future slab-on-grade residential buildings on the Southend. This potential exposure was evaluated in Section 6.5.2.5 of the Revised RFI Phase II Report (BBL 2006), which showed that no area at the Southend has risk estimates that exceed the USEPA risk limit of 10^{-4} or HI limit of 1.

Table 2 presents the bounding cumulative cancer risks and HIs for the kiddie pool scenario in the AOIs adjacent to the downgradient boundary of the Northend and the AOIs at the Southend. The bounding risk estimates are based on the maximum detected groundwater concentrations at each AOI. These risk estimates for non-potable use of groundwater do not exceed the USEPA risk limit of 10^{-4} or HI limit of 1 in any AOI at the downgradient boundary of the Northend except AOI 36-1. The cumulative cancer risk estimate at AOI 36-1 is driven by a benzo(a)pyrene concentration of 0.00055 mg/L sampled on 2/26/2002 from monitoring well RFI-36-29R, which is over 200 feet from the site boundary and over 1500 feet from the nearest residential-zoned area. This concentration is equal to the method detection limit and qualified as estimated (J-qualified), and is the only detection of benzo(a)pyrene in ground water at any well during the site investigation. The duplicate sample at this location was also non-detect for benzo(a)pyrene. The maximum detected concentration of benzo(a)pyrene in the deepest soil samples in AOI 36-1 is 0.05 mg/kg. Based on the soil-water distribution coefficient (K_d) of 2030 L/kg for benzo(a)pyrene in deep soil and the conservative methodology for evaluating the leaching pathway (USEPA 1996), the maximum groundwater concentration that could leach from this soil is 8×10^{-6} mg/L, which is over 60 times smaller than the detected concentration. Benzo(a)pyrene was not detected in NAPL in AOI 36-1. If benzo(a)pyrene were present in NAPL at its maximum method detection limit of 270 mg/kg, based on the octanol-water partition coefficient (K_{ow}) of 1.3×10^{6} L/kg for benzo(a)pyrene, the maximum groundwater concentration that would be in equilibrium with this NAPL is 0.00018 mg/L, which is three times smaller than the detected concentration. It is therefore questionable whether benzo(a)pyrene is present in RFI-36-29R. Even if benzo(a)pyrene is present in groundwater at this location, the chemical is highly hydrophobic and fairly immobile in groundwater, and therefore it would be unlikely to migrate in significant quantities for long distances. Excluding the benzo(a)pyrene concentration in RFI-36-29R, the cumulative cancer risk for non-potable use of groundwater from other chemicals at AOI 36-1 would be 6×10^{-5}, which is less than the USEPA cumulative risk limit.

The bounding risk estimates for non-potable groundwater use do not exceed the cumulative risk limit of 10^{-4} or the HI limit of 1 at the Southend except at AOIs 09-B, 40-A, and 44-A, where the HI is greater than 1. However, when the constituents that contribute most significantly to the HI at AOI 40-A are segregated by target organ, as shown in Table 3, the segregated HIs do not exceed the limit of 1. Also, the most significant contributors to the HIs at AOIs 09-B and 44-A were detected at wells in which lower concentrations were detected in later sampling. If risks are calculated based on the maximum concentration detected in the most recent sample at any well in these AOIs, the resulting HI values at AOI 09-B and 44-A are 0.8 and 0.09 respectively, which are less than the USEPA HI limit of 1.

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Table 1: Bounding Cumulative Cancer Risk and Hazard Index for Residential Exposure to Groundwater by Vapor Intrusion at the Downgradient Areas of the Northend
GMC: NAO Flint Operations Site, Flint, Michigan

Area	AOI	Basement Residential Vapor Intrusion Risk	Basement Residential Vapor Intrusion HI
GM-North	07-1	2E-08	4E-04
GM-North	10-2	6E-07	1E-02
GM-North	10-3	4E-06	3E-02
GM-North	36-1	2E-06	2E-02
GM-North	36-2	1E-05	1E-01
GM-North	36-3	1E-05	2E-01
GM-North	38-1	2E-09	2E-04
GM-North	81-2	8E-09	5E-04
GM-North	81-3	5E-07	5E-03
GM-North	Aeration Lagoon	0E+00	4E-09

Table 2: Bounding Cumulative Cancer Risk and Hazard Index for Non-potable Use of Groundwater
GMC: NAO Flint Operations Site, Flint, Michigan

Area	AOI	Nonpotable Use Risk	Nonpotable Use HI
GM-North	07-1	6E-07	6E-03
GM-North	10-2	2E-05	1E-01
GM-North	10-3	7E-05	1E-01
GM-North	36-1	**2E-04**	3E-01
GM-North	36-2	8E-05	6E-01
GM-North	36-3	7E-05	1E+00
GM-North	38-1	1E-06	3E-02
GM-North	81-2	2E-05	5E-02
GM-North	81-3	1E-05	6E-02
GM-North	Aeration Lagoon	6E-06	3E-02
GM-South	02-B	3E-09	7E-03
GM-South	02-E	8E-06	5E-01
GM-South	02-F	5E-06	3E-01
GM-South	04-D	8E-06	4E-01
GM-South	09-A	7E-06	3E-01
GM-South	09-B	8E-05	**3E+00**
GM-South	12-A	1E-05	1E-01
GM-South	12-B	3E-06	2E-01
GM-South	16-A	1E-06	1E-02
GM-South	16-C	8E-06	1E-01
GM-South	17-A	5E-06	3E-02
GM-South	23-A	4E-06	1E-02
GM-South	40-A	1E-04	**2E+00**
GM-South	40-B	1E-06	1E-02
GM-South	40-C	1E-06	2E-02
GM-South	40-D	2E-05	5E-01
GM-South	44-A	4E-05	**2E+00**
GM-South	84-A	1E-05	5E-02
GM-South	84-D	3E-05	3E-01
GM-South	94-B	3E-06	1E-01
GM-South	94-D	2E-07	2E-03
GM-South	BD01	1E-06	1E-02
GM-South	Build 94 Parking Lot	9E-10	8E-05
GM-South	Harriet Street	2E-06	2E-02

Notes:

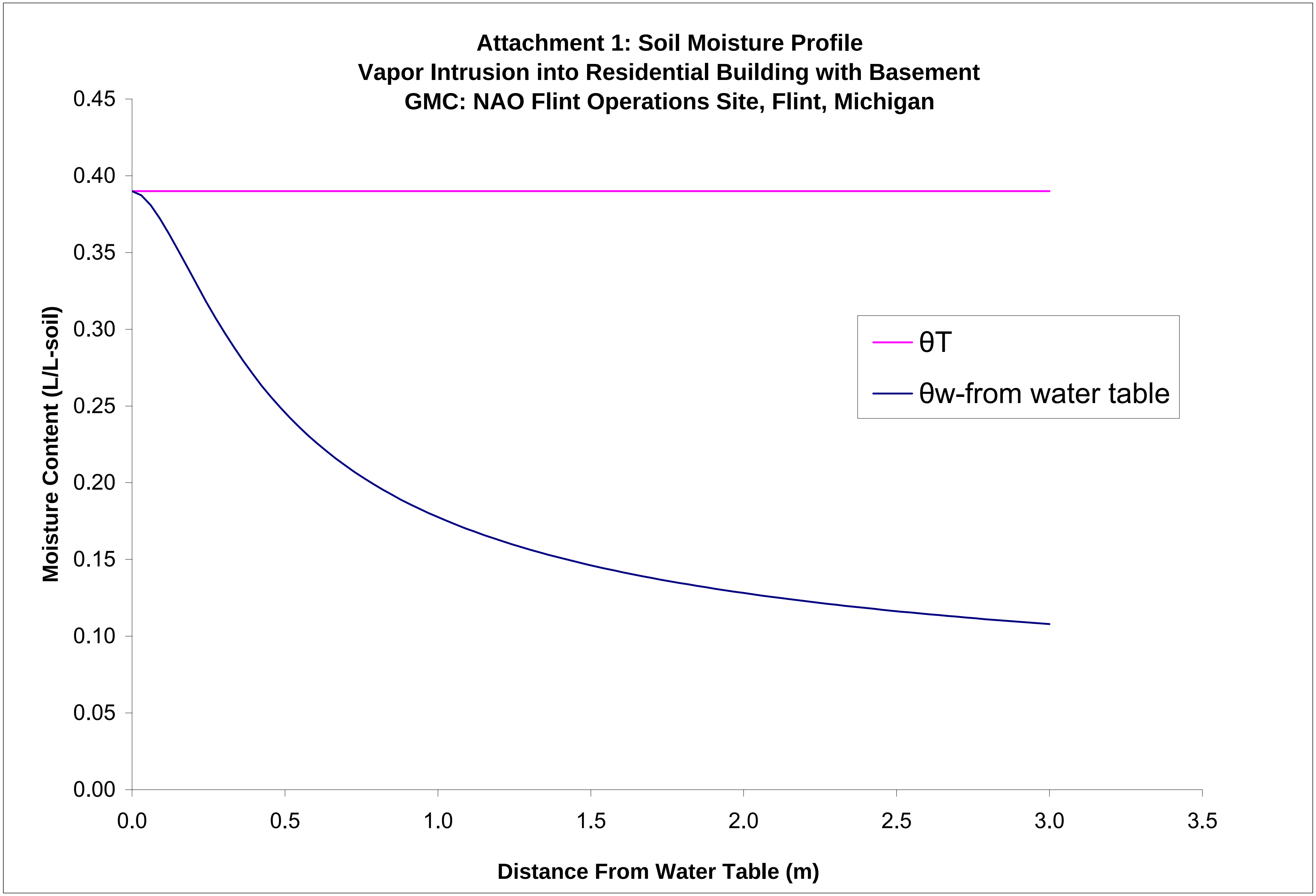
1. Values highlighted in bold are above the USEPA risk limits of 10^{-4} or 1 for cancer risk and HI, respectively.

2. Exposures associated with non-potable groundwater use are evaluated using a scenario in which groundwater is used to fill a backyard wading pool (“kiddie” pool). Potential routes of exposure include incidental ingestion, dermal contact, and inhalation of vapors.

Table 3: Summary of Noncancer Risk Drivers for Non-potable Use Exposure to Groundwater at AOI-40A GMC: NAO Flint Operations Site, Flint, Michigan							
AOI	Chem Group	Chemical	CASRN	HQ	Controlling Pathway	Target Organ	Reference
40-A	VOC	Benzene	71-43-2	6E-01	Dermal Contact	Immune system (lymphocyte count)	IRIS
40-A	PCB	PCBs (total)	1336-36-3	4E-01	Dermal Contact	Meibomian glands; toenails; ocular exudate; immune system (IgG/IgM antibody response)	Surrogate to Aroclor 1254 toxicity from IRIS
40-A	INORG	Arsenic	7440-38-2	4E-01	Incidental Ingestion	Skin	IRIS
40-A		All other compounds		1E-01	Varies	Varies	Varies
Notes:							
IRIS - USEPA's Integrated Risk Information System on-line database.							

Attachment 1

Evaluation of Vapor Intrusion from Groundwater into Potential Residential Buildings with Basements


Attachment 1: Soil Moisture Profile
Vapor Intrusion into Residential Building with Basement
GMC: NAO Flint Operations Site, Flint, Michigan
Moisture Content (L/L-soil)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Distance From Water Table (m)
θT
θw-from water table

Attachment 1: Vapor Intrusion into Residential Building with Basement from Groundwater GMC: NAO Flint Operations Site, Flint, Michigan									
Chem Group	**Chemical**	**CASRN**	D_{air} (m^2/d)	D_{water} (m^2/d)	**H** (unitless)	D_{crack} (m^2/d)	D_{eff}^T (m^2/d)	α_∞	C_{bldg} (L-water/m^3)
VOC	Acetone	67-64-1	1.07E+00	9.85E-05	7.95E-04	3.66E-02	2.19E-02	1.16E-05	9.23E-06
VOC	Benzene	71-43-2	7.60E-01	8.47E-05	1.14E-01	2.38E-02	7.91E-04	6.44E-06	7.35E-04
VOC	Bromodichloromethane	75-27-4	2.57E-01	9.16E-05	3.28E-02	8.11E-03	1.32E-03	7.91E-06	2.59E-04
VOC	2-Butanone	78-93-3	6.98E-01	8.47E-05	1.14E-03	2.37E-02	1.36E-02	1.14E-05	1.30E-05
VOC	Carbon Disulfide	75-15-0	8.99E-01	8.64E-05	6.20E-01	2.81E-02	2.43E-04	3.16E-06	1.96E-03
VOC	Carbon Tetrachloride	56-23-5	6.74E-01	7.60E-05	6.25E-01	2.11E-02	2.04E-04	2.77E-06	1.73E-03
VOC	Chlorobenzene	108-90-7	6.31E-01	7.52E-05	7.60E-02	1.97E-02	9.13E-04	6.87E-06	5.22E-04
VOC	Chloroethane	75-00-3	2.34E+00	9.94E-05	1.80E-01	7.31E-02	8.65E-04	6.71E-06	1.21E-03
VOC	Chloroform	67-66-3	8.99E-01	8.64E-05	7.50E-02	2.81E-02	1.13E-03	7.48E-06	5.61E-04
VOC	Chloromethane	74-87-3	1.09E+00	5.62E-05	1.80E-01	3.40E-02	4.65E-04	4.87E-06	8.78E-04
VOC	Cumene	98-82-8	5.62E-01	6.13E-05	2.66E-01	1.75E-02	3.13E-04	3.78E-06	1.01E-03
VOC	Cyclohexane	110-82-7	7.25E-01	7.86E-05	3.98E+00	2.26E-02	5.20E-05	8.53E-07	3.40E-03
VOC	Dibromochloromethane	124-48-1	1.69E-01	9.07E-05	1.61E-02	5.43E-03	1.69E-03	8.55E-06	1.37E-04
VOC	1,2-Dichlorobenzene	95-50-1	5.96E-01	6.83E-05	3.90E-02	1.87E-02	1.32E-03	7.91E-06	3.08E-04
VOC	1,3-Dichlorobenzene	541-73-1	5.98E-01	6.79E-05	6.33E-02	1.87E-02	9.50E-04	6.98E-06	4.42E-04
VOC	1,4-Dichlorobenzene	106-46-7	5.96E-01	6.83E-05	4.98E-02	1.87E-02	1.12E-03	7.46E-06	3.72E-04
VOC	Dichlorodifluoromethane	75-71-8	6.91E-01	6.91E-05	7.01E+00	2.16E-02	3.02E-05	5.10E-07	3.57E-03
VOC	1,1-Dichloroethane	75-34-3	6.41E-01	9.07E-05	1.15E-01	2.00E-02	7.84E-04	6.42E-06	7.38E-04
VOC	1,2-Dichloroethane	107-06-2	8.99E-01	8.55E-05	2.01E-02	2.82E-02	2.73E-03	9.59E-06	1.92E-04
VOC	1,1-Dichloroethene	75-35-4	7.78E-01	8.99E-05	5.35E-01	2.43E-02	2.69E-04	3.40E-06	1.82E-03
VOC	cis-1,2-Dichloroethene	156-59-2	6.36E-01	9.76E-05	8.35E-02	1.99E-02	1.03E-03	7.21E-06	6.02E-04
VOC	trans-1,2-Dichloroethene	156-60-5	6.11E-01	1.03E-04	1.93E-01	1.91E-02	5.87E-04	5.56E-06	1.07E-03
VOC	1,2-Dichloropropane	78-87-5	6.76E-01	7.54E-05	5.75E-02	2.11E-02	1.13E-03	7.49E-06	4.31E-04
VOC	Ethyl Benzene	100-41-4	6.48E-01	6.74E-05	1.62E-01	2.03E-02	5.00E-04	5.08E-06	8.21E-04
VOC	2-Hexanone	591-78-6			3.58E-02				
VOC	Methyl Acetate	79-20-9	8.27E-01	9.50E-05	1.85E-03	2.71E-02	1.18E-02	1.13E-05	2.10E-05
VOC	Methyl tert-butyl ether	1634-04-4	7.42E-01	8.73E-05	1.20E-02	2.34E-02	3.57E-03	1.01E-05	1.21E-04
VOC	4-Methyl-2-pentanone	108-10-1	6.48E-01	6.74E-05	2.82E-03	2.08E-02	6.87E-03	1.09E-05	3.07E-05
VOC	Methylcyclohexane	108-87-2	6.35E-01	7.36E-05	8.78E+00	1.98E-02	2.61E-05	4.44E-07	3.90E-03
VOC	Methylene Chloride	75-09-2	8.73E-01	1.01E-04	4.49E-02	2.73E-02	1.77E-03	8.66E-06	3.89E-04
VOC	Styrene	100-42-5	6.13E-01	6.91E-05	5.65E-02	1.92E-02	1.05E-03	7.27E-06	4.11E-04
VOC	Tetrachloroethene	127-18-4	6.22E-01	7.08E-05	3.77E-01	1.94E-02	2.76E-04	3.47E-06	1.31E-03
VOC	Toluene	108-88-3	7.52E-01	7.43E-05	1.36E-01	2.35E-02	6.33E-04	5.78E-06	7.86E-04

Attachment 1: Vapor Intrusion into Residential Building with Basement from Groundwater GMC: NAO Flint Operations Site, Flint, Michigan									
Chem Group	Chemical	CASRN	D_{air} (m^2/d)	D_{water} (m^2/d)	H (unitless)	D_{crack} (m^2/d)	D_{eff}^T (m^2/d)	α_∞	C_{bldg} (L-water/m^3)
VOC	1,2,4-Trichlorobenzene	120-82-1	2.59E-01	7.11E-05	2.91E-02	8.16E-03	1.22E-03	7.69E-06	2.24E-04
VOC	1,1,1-Trichloroethane	71-55-6	6.74E-01	7.60E-05	3.53E-01	2.11E-02	3.13E-04	3.78E-06	1.33E-03
VOC	1,1,2-Trichloroethane	79-00-5	6.74E-01	7.60E-05	1.87E-02	2.12E-02	2.39E-03	9.33E-06	1.74E-04
VOC	Trichloroethene	79-01-6	6.83E-01	7.86E-05	2.11E-01	2.13E-02	4.68E-04	4.89E-06	1.03E-03
VOC	Trichlorofluoromethane	75-69-4	7.52E-01	8.38E-05	1.98E+00	2.35E-02	9.41E-05	1.46E-06	2.89E-03
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	6.74E-01	7.08E-05	9.83E+00	2.11E-02	2.36E-05	4.02E-07	3.95E-03
VOC	1,2,4-Trimethylbenzene	95-63-6	5.24E-01	6.84E-05	1.26E-01	1.64E-02	5.68E-04	5.46E-06	6.87E-04
VOC	1,3,5-Trimethylbenzene	108-67-8	5.20E-01	7.49E-05	1.20E-01	1.63E-02	6.25E-04	5.74E-06	6.90E-04
VOC	Vinyl Chloride	75-01-4	9.16E-01	1.06E-04	5.55E-01	2.86E-02	3.10E-04	3.75E-06	2.08E-03
VOC	Xylenes (total)	1330-20-7	6.74E-01	7.56E-05	1.38E-01	2.11E-02	6.15E-04	5.69E-06	7.86E-04
SVOC	Acenaphthene	83-32-9	3.64E-01	6.64E-05	3.18E-03	1.19E-02	4.98E-03	1.05E-05	3.35E-05
SVOC	Acenaphthylene	208-96-8	3.88E-01	6.03E-05	2.31E-03	1.28E-02	5.81E-03	1.07E-05	2.48E-05
SVOC	Acetophenone	98-86-2	6.91E-01	6.91E-05	2.19E-04	2.97E-02	3.31E-02	1.17E-05	2.56E-06
SVOC	Anthracene	120-12-7	2.80E-01	6.69E-05	1.34E-03	1.00E-02	7.41E-03	1.10E-05	1.46E-05
SVOC	Atrazine	1912-24-9	2.24E-01	5.76E-05	1.25E-07	1.18E+01	2.76E+01	1.33E-04	1.66E-08
SVOC	Benzaldehyde	100-52-7	6.23E-01	7.84E-05	4.86E-04	2.36E-02	2.07E-02	1.16E-05	5.64E-06
SVOC	Benzo(a)anthracene	56-55-3	4.41E-01	7.78E-05	6.85E-05	4.27E-02	7.96E-02	1.19E-05	8.13E-07
SVOC	Benzo(a)pyrene	50-32-8	3.72E-01	7.78E-05	2.32E-05	9.73E-02	2.11E-01	1.19E-05	2.76E-07
SVOC	Benzo(b)fluoranthene	205-99-2	1.95E-01	4.80E-05	2.28E-03	6.64E-03	3.84E-03	1.02E-05	2.31E-05
SVOC	Benzo(g,h,i)perylene	191-24-2	1.88E-01	4.54E-05	2.88E-06	4.08E-01	9.47E-01	1.28E-05	3.69E-08
SVOC	Benzo(k)fluoranthene	207-08-9	1.95E-01	4.80E-05	1.70E-05	7.82E-02	1.74E-01	1.19E-05	2.03E-07
SVOC	Biphenyl	92-52-4	3.49E-01	7.04E-05	6.13E-03	1.12E-02	3.46E-03	1.00E-05	6.14E-05
SVOC	bis(2-Chloroethoxy)methane	111-91-1	3.77E-01	7.31E-05	3.47E-06	5.48E-01	1.27E+00	1.38E-05	4.79E-08
SVOC	bis(2-Chloroethyl) ether	111-44-4	5.98E-01	6.51E-05	3.69E-04	2.32E-02	2.15E-02	1.16E-05	4.28E-06
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	3.03E-01	3.16E-05	2.09E-06	3.95E-01	9.12E-01	1.27E-05	2.66E-08
SVOC	Butylbenzylphthalate	85-68-7	1.50E-01	4.17E-05	2.59E-05	4.59E-02	1.01E-01	1.19E-05	3.07E-07
SVOC	Caprolactam	105-60-2	5.98E-01	7.77E-05	1.03E-07	1.93E+01	4.50E+01	2.14E-04	2.20E-08
SVOC	Carbazole	86-74-8	3.37E-01	6.07E-05	3.13E-07	4.96E+00	1.16E+01	5.97E-05	1.87E-08
SVOC	4-Chloro-3-methylphenol	59-50-7	5.24E-01	8.22E-05	8.15E-06	2.73E-01	6.17E-01	1.22E-05	9.92E-08
SVOC	2-Chloronaphthalene	91-58-7	4.25E-01	7.59E-05	6.42E-03	1.36E-02	3.83E-03	1.02E-05	6.52E-05
SVOC	2-Chlorophenol	95-57-8	4.33E-01	8.17E-05	8.00E-03	1.38E-02	3.54E-03	1.00E-05	8.04E-05
SVOC	Chrysene	218-01-9	2.14E-01	5.37E-05	1.94E-03	7.40E-03	4.68E-03	1.05E-05	2.03E-05
SVOC	Dibenz(a,h)anthracene	53-70-3	1.75E-01	4.48E-05	3.02E-07	3.79E+00	8.87E+00	4.71E-05	1.42E-08

Attachment 1: Vapor Intrusion into Residential Building with Basement from Groundwater GMC: NAO Flint Operations Site, Flint, Michigan									
Chem Group	Chemical	CASRN	D_{air} (m^2/d)	D_{water} (m^2/d)	H (unitless)	D_{crack} (m^2/d)	D_{eff}^T (m^2/d)	α_∞	C_{bldg} (L-water/m^3)
SVOC	Dibenzofuran	132-64-9	2.06E-01	5.18E-05	2.57E-04	1.16E-02	1.69E-02	1.15E-05	2.96E-06
SVOC	2,4-Dichlorophenol	120-83-2	2.99E-01	7.58E-05	6.50E-05	3.91E-02	7.79E-02	1.19E-05	7.71E-07
SVOC	Diethylphthalate	84-66-2	2.21E-01	5.49E-05	9.25E-06	1.58E-01	3.61E-01	1.20E-05	1.11E-07
SVOC	2,4-Dimethylphenol	105-67-9	5.05E-01	7.51E-05	4.10E-05	6.25E-02	1.23E-01	1.19E-05	4.88E-07
SVOC	Dimethylphthalate	131-11-3	4.91E-01	5.43E-05	2.15E-06	6.61E-01	1.53E+00	1.47E-05	3.16E-08
SVOC	Di-n-butylphthalate	84-74-2	3.78E-01	6.79E-05	1.93E-08	9.00E+01	2.11E+02	9.75E-04	1.88E-08
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	2.38E-01	5.97E-05	8.73E-06	1.82E-01	4.15E-01	1.20E-05	1.05E-07
SVOC	2,4-Dinitrotoluene	121-14-2	1.75E+00	6.10E-05	1.90E-06	8.74E-01	1.97E+00	1.66E-05	3.16E-08
SVOC	2,6-Dinitrotoluene	606-20-2	2.83E-01	6.27E-05	1.53E-05	1.13E-01	2.53E-01	1.19E-05	1.83E-07
SVOC	Di-n-octylphthalate	117-84-0	1.30E-01	3.09E-05	1.37E-03	4.65E-03	3.39E-03	9.97E-06	1.37E-05
SVOC	Fluoranthene	206-44-0	2.61E-01	5.49E-05	3.30E-04	1.24E-02	1.57E-02	1.15E-05	3.79E-06
SVOC	Fluorene	86-73-7	3.14E-01	6.81E-05	1.31E-03	1.11E-02	7.95E-03	1.10E-05	1.44E-05
SVOC	Formaldehyde	50-00-0	1.56E+00	1.73E-04	6.95E-06	6.83E-01	1.53E+00	1.49E-05	1.03E-07
SVOC	Hexachlorobutadiene	87-68-3	4.85E-01	5.32E-05	1.67E-01	1.51E-02	3.80E-04	4.30E-06	7.18E-04
SVOC	Hexachlorocyclopentadiene	77-47-4	1.39E-01	6.23E-05	5.55E-01	4.35E-03	1.26E-04	1.88E-06	1.04E-03
SVOC	Hexachloroethane	67-72-1	2.16E-02	5.88E-05	7.95E-02	6.94E-04	2.19E-04	2.93E-06	2.33E-04
SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	1.64E-01	4.89E-05	3.28E-05	4.32E-02	9.37E-02	1.19E-05	3.90E-07
SVOC	Isophorone	78-59-1	5.38E-01	5.84E-05	1.36E-04	2.78E-02	3.81E-02	1.18E-05	1.60E-06
SVOC	2-Methylnaphthalene	91-57-6	4.18E-01	6.70E-05	1.06E-02	1.32E-02	2.62E-03	9.51E-06	1.01E-04
SVOC	Methylphenol (total)	1319-77-3	6.39E-01	8.64E-05	1.77E-05	1.45E-01	3.10E-01	1.19E-05	2.11E-07
SVOC	Naphthalene	91-20-3	5.10E-01	6.48E-05	9.90E-03	1.61E-02	2.90E-03	9.70E-06	9.60E-05
SVOC	2-Nitroaniline	88-74-4	6.31E-01	6.91E-05	3.27E-06	5.60E-01	1.28E+00	1.39E-05	4.53E-08
SVOC	Nitrobenzene	98-95-3	6.57E-01	7.43E-05	4.92E-04	2.44E-02	2.03E-02	1.16E-05	5.70E-06
SVOC	2-Nitrophenol	88-75-5	4.66E-01	6.78E-05	1.94E-04	2.35E-02	3.16E-02	1.17E-05	2.27E-06
SVOC	4-Nitrophenol	100-02-7	5.40E-01	8.30E-05	8.48E-09	2.50E+02	5.84E+02	2.69E-03	2.28E-08
SVOC	N-Nitrosodiphenylamine	86-30-6	2.70E-01	5.49E-05	1.03E-04	2.21E-02	3.90E-02	1.18E-05	1.21E-06
SVOC	N-Nitroso-di-n-propylamine	621-64-7	4.71E-01	7.06E-05	4.62E-05	5.37E-02	1.04E-01	1.19E-05	5.49E-07
SVOC	2,2'-oxybis(1-Chloropropane)	108-60-1	5.20E-01	5.54E-05	2.39E-03	1.68E-02	6.15E-03	1.08E-05	2.58E-05
SVOC	Pentachlorophenol	87-86-5	4.84E-01	5.27E-05	5.00E-07	2.70E+00	6.31E+00	3.55E-05	1.78E-08
SVOC	Phenanthrene	85-01-8	3.24E-01	6.45E-05	4.76E-04	1.36E-02	1.46E-02	1.14E-05	5.45E-06
SVOC	Phenol	108-95-2	7.08E-01	7.86E-05	8.15E-06	2.68E-01	5.96E-01	1.21E-05	9.90E-08
SVOC	Pyrene	129-00-0	2.35E-01	6.26E-05	2.26E-04	1.44E-02	2.24E-02	1.16E-05	2.62E-06
SVOC	2,4,5-Trichlorophenol	95-95-4	2.51E-01	6.07E-05	8.90E-05	2.53E-02	4.75E-02	1.18E-05	1.05E-06

Attachment 1: Vapor Intrusion into Residential Building with Basement from Groundwater GMC: NAO Flint Operations Site, Flint, Michigan									
Chem Group	**Chemical**	**CASRN**	**D_{air}** (m^2/d)	**D_{water}** (m^2/d)	**H** (unitless)	**D_{crack}** (m^2/d)	**D_{eff}^T** (m^2/d)	**α_∞**	**C_{bldg}** (L-water/m^3)
SVOC	2,4,6-Trichlorophenol	88-06-2	2.75E-01	5.40E-05	1.60E-04	1.72E-02	2.70E-02	1.17E-05	1.86E-06
PCB	PCBs (total)	1336-36-3	1.75E-01	4.32E-05	4.09E-02	5.48E-03	6.21E-04	5.72E-06	2.34E-04
INORG	Antimony	7440-36-0							
INORG	Arsenic	7440-38-2							
INORG	Barium	7440-39-3							
INORG	Beryllium	7440-41-7							
INORG	Cadmium	7440-43-9							
INORG	Chromium (total)	7440-47-3							
INORG	Chromium III	16065-83-1							
INORG	Chromium VI	18540-29-9							
INORG	Cobalt	7440-48-4							
INORG	Copper	7440-50-8							
INORG	Cyanide (total)	57-12-5							
INORG	Fluoride	16984-48-8							
INORG	Lead	7439-92-1							
INORG	Manganese	7439-96-5							
INORG	Mercury	7439-97-6	2.65E-01	5.44E-05	1.45E-01	8.29E-03	3.58E-04	4.13E-06	6.00E-04
INORG	Nickel	7440-02-0							
INORG	Selenium	7782-49-2							
INORG	Silver	7440-22-4							
INORG	Thallium	7440-28-0							
INORG	Vanadium	7440-62-2							
INORG	Zinc	7440-66-6							
Notes:	**Crack Soil and Building Characteristics**								
	SCS Soil texture class	Loamy Sand							
	Bulk density	kg/L	ρ_b	1.62					
	Total porosity	L/L-soil	θ	0.390					
	Water-filled porosity	L/L-soil	θ_w	0.189					
	Air-filled porosity	L/L-soil	θ_a	0.201					
	Residual saturation	L/L-soil	θ_r	0.049					

Attachment 1: Vapor Intrusion into Residential Building with Basement from Groundwater GMC: NAO Flint Operations Site, Flint, Michigan									
Chem Group	**Chemical**	**CASRN**	D_{air} (m^2/d)	D_{water} (m^2/d)	**H** (unitless)	D_{crack} (m^2/d)	D_{eff}^{T} (m^2/d)	α_{∞}	C_{bldg} (L-water/m^3)
	Hydraulic conductivity	cm/s	**K**	1.2E-03					
	Dynamic viscosity of water	g/cm-s	μ	0.01307					
	Density of water	g/cm^3	ρ_w	1.0					
	Gravitational acceleration	cm/s^2	**g**	980.7					
	Intrinsic permeability	cm^2	**k**	1.6E-08					
	Relative saturation	unitless	S_e	0.411					
	van Genuchten N	unitless	**N**	1.746					
	van Genuchten M	unitless	**M**	0.427					
	Relative air permeability	unitless	k_{rg}	0.685					
	Permeability to vapor	cm^2	k_v	1.1E-08					
	Distance from building foundation to source	m	L_T	0.85					
	Bldg foundation thickness	m	L_{crack}	0.15					
	Bldg foundation length	m		10.56					
	Bldg foundation width	m		10.56					
	Bldg occupied height	m		4.88					
	Bldg occupied volume	m^3		544.19					
	Occupied depth below ground	m		2.0					
	Bldg area for vapor intrusion	m^2	A_B	196.0					
	Ratio of A_{crack} to A_B		η	1E-04					
	Area of cracks	m^2	A_{crack}	2.11E-02					
	Air exchange rate	$hour^{-1}$	**ac/h**	1.0					
	Building ventilation rate	m^3/d	Q_{bldg}	1.31E+04					
	Pressure difference between outdoors-indoors	$kg/m\text{-}s^2$	ΔP	1.0					
	Air viscosity	kg/m-s	μ	1.8E-05					
	Crack length (bldg perimeter)	m	X_{crack}	42.24					
	Crack depth below ground	m	Z_{crack}	2.15					
	Crack radius	m	r_{crack}	5E-04					
	Soil gas flow rate into bldg	m^3/d	Q_{soil}	1.56E-01					

Attachment 1: Risk-Based Cancer Criteria for Residential Exposure to Groundwater via Vapor Intrusion (Residential Building with Basement)
GMC: NAO Flint Operations Site, Flint, Michigan

				Vapor Inhalation		
Chem Group	Chemical	CASRN	Carc Class	C_{air} (mg/m^3)	URF (m^3/mg)	RBC (mg/l)
VOC	Acetone	67-64-1	ID	9.23E-06		
VOC	Benzene	71-43-2	A	7.35E-04	7.8E-03	4.2E+00
VOC	Bromodichloromethane	75-27-4	B2	2.59E-04	1.8E-02	5.3E+00
VOC	2-Butanone	78-93-3	ID	1.30E-05		
VOC	Carbon Disulfide	75-15-0		1.96E-03		
VOC	Carbon Tetrachloride	56-23-5	B2	1.73E-03	1.5E-02	9.4E-01
VOC	Chlorobenzene	108-90-7	D	5.22E-04		
VOC	Chloroethane	75-00-3		1.21E-03		
VOC	Chloroform	67-66-3	B2	5.61E-04	2.3E-02	1.9E+00
VOC	Chloromethane	74-87-3	D	8.78E-04		
VOC	Cumene	98-82-8	D	1.01E-03		
VOC	Cyclohexane	110-82-7	ID	3.40E-03		
VOC	Dibromochloromethane	124-48-1	C	1.37E-04	2.4E-02	7.4E+00
VOC	1,2-Dichlorobenzene	95-50-1	D	3.08E-04		
VOC	1,3-Dichlorobenzene	541-73-1	D	4.42E-04		
VOC	1,4-Dichlorobenzene	106-46-7	C	3.72E-04	6.3E-03	1.0E+01
VOC	Dichlorodifluoromethane	75-71-8		3.57E-03		
VOC	1,1-Dichloroethane	75-34-3	C	7.38E-04		
VOC	1,2-Dichloroethane	107-06-2	B2	1.92E-04	2.6E-02	4.9E+00
VOC	1,1-Dichloroethene	75-35-4	C	1.82E-03		
VOC	cis-1,2-Dichloroethene	156-59-2	D	6.02E-04		
VOC	trans-1,2-Dichloroethene	156-60-5		1.07E-03		
VOC	1,2-Dichloropropane	78-87-5	B2	4.31E-04		
VOC	Ethyl Benzene	100-41-4	D	8.21E-04		
VOC	2-Hexanone	591-78-6				
VOC	Methyl Acetate	79-20-9		2.10E-05		
VOC	Methyl tert-butyl ether	1634-04-4		1.21E-04		
VOC	4-Methyl-2-pentanone	108-10-1	ID	3.07E-05		
VOC	Methylcyclohexane	108-87-2		3.90E-03		
VOC	Methylene Chloride	75-09-2	B2	3.89E-04	4.7E-04	1.3E+02
VOC	Styrene	100-42-5		4.11E-04		
VOC	Tetrachloroethene	127-18-4	C-B2	1.31E-03	3.1E-03	6.1E+00
VOC	Toluene	108-88-3	D	7.86E-04		
VOC	1,2,4-Trichlorobenzene	120-82-1	D	2.24E-04		
VOC	1,1,1-Trichloroethane	71-55-6	D	1.33E-03		
VOC	1,1,2-Trichloroethane	79-00-5	C	1.74E-04	1.6E-02	8.7E+00
VOC	Trichloroethene	79-01-6	C-B2	1.03E-03	1.7E-03	1.4E+01
VOC	Trichlorofluoromethane	75-69-4		2.89E-03		
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		3.95E-03		
VOC	1,2,4-Trimethylbenzene	95-63-6	ID	6.87E-04		
VOC	1,3,5-Trimethylbenzene	108-67-8	ID	6.90E-04		
VOC	Vinyl Chloride	75-01-4	A	2.08E-03	8.8E-03	1.3E+00
VOC	Xylenes (total)	1330-20-7	ID	7.86E-04		
SVOC	Acenaphthene	83-32-9		3.35E-05		
SVOC	Acenaphthylene	208-96-8	D	2.48E-05		
SVOC	Acetophenone	98-86-2	D	2.56E-06		
SVOC	Anthracene	120-12-7	D	1.46E-05		

Attachment 1: Risk-Based Cancer Criteria for Residential Exposure to Groundwater via Vapor Intrusion (Residential Building with Basement)
GMC: NAO Flint Operations Site, Flint, Michigan

				Vapor Inhalation		
Chem Group	Chemical	CASRN	Carc Class	C_{air} (mg/m^3)	URF (m^3/mg)	RBC (mg/l)
SVOC	Atrazine	1912-24-9	C	1.66E-08	6.3E-02	2.3E+04
SVOC	Benzaldehyde	100-52-7		5.64E-06		
SVOC	Benzo(a)anthracene	56-55-3	B2	8.13E-07	8.9E-02	3.4E+02
SVOC	Benzo(a)pyrene	50-32-8	B2	2.76E-07	8.9E-01	9.9E+01
SVOC	Benzo(b)fluoranthene	205-99-2	B2	2.31E-05	8.9E-02	1.2E+01
SVOC	Benzo(g,h,i)perylene	191-24-2	D	3.69E-08		
SVOC	Benzo(k)fluoranthene	207-08-9	B2	2.03E-07	8.9E-03	1.4E+04
SVOC	Biphenyl	92-52-4	D	6.14E-05		
SVOC	bis(2-Chloroethoxy)methane	111-91-1	D	4.79E-08		
SVOC	bis(2-Chloroethyl) ether	111-44-4	B2	4.28E-06	3.3E-01	1.7E+01
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	B2	2.66E-08	4.0E-03	2.3E+05
SVOC	Butylbenzylphthalate	85-68-7	C	3.07E-07	5.4E-04	1.5E+05
SVOC	Caprolactam	105-60-2		2.20E-08		
SVOC	Carbazole	86-74-8	B2	1.87E-08	5.7E-03	2.3E+05
SVOC	4-Chloro-3-methylphenol	59-50-7		9.92E-08		
SVOC	2-Chloronaphthalene	91-58-7		6.52E-05		
SVOC	2-Chlorophenol	95-57-8		8.04E-05		
SVOC	Chrysene	218-01-9	B2	2.03E-05	8.9E-04	1.4E+03
SVOC	Dibenz(a,h)anthracene	53-70-3	B2	1.42E-08	8.9E-01	1.9E+03
SVOC	Dibenzofuran	132-64-9	D	2.96E-06		
SVOC	2,4-Dichlorophenol	120-83-2		7.71E-07		
SVOC	Diethylphthalate	84-66-2	D	1.11E-07		
SVOC	2,4-Dimethylphenol	105-67-9		4.88E-07		
SVOC	Dimethylphthalate	131-11-3	D	3.16E-08		
SVOC	Di-n-butylphthalate	84-74-2	D	1.88E-08		
SVOC	4,6-Dinitro-2-methylphenol	534-52-1		1.05E-07		
SVOC	2,4-Dinitrotoluene	121-14-2	B2	3.16E-08		
SVOC	2,6-Dinitrotoluene	606-20-2	B2	1.83E-07	1.9E-01	6.9E+02
SVOC	Di-n-octylphthalate	117-84-0		1.37E-05		
SVOC	Fluoranthene	206-44-0	D	3.79E-06		
SVOC	Fluorene	86-73-7	D	1.44E-05		
SVOC	Formaldehyde	50-00-0	B1	1.03E-07	1.3E-02	1.8E+04
SVOC	Hexachlorobutadiene	87-68-3	C	7.18E-04	2.2E-02	1.5E+00
SVOC	Hexachlorocyclopentadiene	77-47-4	E	1.04E-03		
SVOC	Hexachloroethane	67-72-1	C	2.33E-04	4.0E-03	2.6E+01
SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	B2	3.90E-07	8.9E-02	7.0E+02
SVOC	Isophorone	78-59-1	C	1.60E-06		
SVOC	2-Methylnaphthalene	91-57-6	ID	1.01E-04		
SVOC	Methylphenol (total)	1319-77-3		2.11E-07		
SVOC	Naphthalene	91-20-3	C	9.60E-05		
SVOC	2-Nitroaniline	88-74-4		4.53E-08		
SVOC	Nitrobenzene	98-95-3	D	5.70E-06		
SVOC	2-Nitrophenol	88-75-5		2.27E-06		
SVOC	4-Nitrophenol	100-02-7		2.28E-08		
SVOC	N-Nitrosodiphenylamine	86-30-6	B2	1.21E-06		
SVOC	N-Nitroso-di-n-propylamine	621-64-7	B2	5.49E-07	2.0E+00	2.2E+01
SVOC	2,2'-oxybis(1-Chloropropane)	108-60-1	C	2.58E-05	1.0E-02	9.4E+01

Attachment 1: Risk-Based Cancer Criteria for Residential Exposure to Groundwater via Vapor Intrusion (Residential Building with Basement)
GMC: NAO Flint Operations Site, Flint, Michigan

				Vapor Inhalation		
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**C_{air}** (mg/m^3)	**URF** (m^3/mg)	**RBC** (mg/l)
SVOC	Pentachlorophenol	87-86-5	B2	1.78E-08	3.4E-02	4.0E+04
SVOC	Phenanthrene	85-01-8	D	5.45E-06		
SVOC	Phenol	108-95-2	ID	9.90E-08		
SVOC	Pyrene	129-00-0	D	2.62E-06		
SVOC	2,4,5-Trichlorophenol	95-95-4		1.05E-06		
SVOC	2,4,6-Trichlorophenol	88-06-2	B2	1.86E-06	3.1E-03	4.2E+03
PCB	PCBs (total)	1336-36-3	B2	2.34E-04	5.7E-01	1.8E-01
INORG	Antimony	7440-36-0				
INORG	Arsenic	7440-38-2	A		4.3E+00	
INORG	Barium	7440-39-3	D			
INORG	Beryllium	7440-41-7	B1		2.4E+00	
INORG	Cadmium	7440-43-9	B1		1.8E+00	
INORG	Chromium (total)	7440-47-3			1.2E+01	
INORG	Chromium III	16065-83-1	D			
INORG	Chromium VI	18540-29-9	A		1.2E+01	
INORG	Cobalt	7440-48-4	B1		2.8E+00	
INORG	Copper	7440-50-8	D			
INORG	Cyanide (total)	57-12-5	D			
INORG	Fluoride	16984-48-8				
INORG	Lead	7439-92-1	B2			
INORG	Manganese	7439-96-5	D			
INORG	Mercury	7439-97-6	D	6.00E-04		
INORG	Nickel	7440-02-0	A		2.4E-01	
INORG	Selenium	7782-49-2	D			
INORG	Silver	7440-22-4	D			
INORG	Thallium	7440-28-0				
INORG	Vanadium	7440-62-2				
INORG	Zinc	7440-66-6	D			

Note:
Target cancer risk of 1E-05.

Attachment 1: Risk-Based Noncancer Criteria for Residential Exposure to Groundwater via Vapor Intrusion (Residential Building with Basement)
GMC: NAO Flint Operations Site, Flint, Michigan

				Vapor Inhalation		
Chem Group	Chemical	CASRN	Carc Class	C_{air} (mg/m^3)	RfC (mg/m^3)	RBC (mg/l)
VOC	Acetone	67-64-1	ID	9.23E-06	3.2E+00	3.6E+05
VOC	Benzene	71-43-2	A	7.35E-04	3.0E-02	4.3E+01
VOC	Bromodichloromethane	75-27-4	B2	2.59E-04	7.0E-02	2.8E+02
VOC	2-Butanone	78-93-3	ID	1.30E-05	5.0E+00	4.0E+05
VOC	Carbon Disulfide	75-15-0		1.96E-03	7.0E-01	3.7E+02
VOC	Carbon Tetrachloride	56-23-5	B2	1.73E-03		
VOC	Chlorobenzene	108-90-7	D	5.22E-04	6.0E-02	1.2E+02
VOC	Chloroethane	75-00-3		1.21E-03	1.0E+01	8.6E+03
VOC	Chloroform	67-66-3	B2	5.61E-04	5.0E-02	9.3E+01
VOC	Chloromethane	74-87-3	D	8.78E-04	9.0E-02	1.1E+02
VOC	Cumene	98-82-8	D	1.01E-03	4.0E-01	4.2E+02
VOC	Cyclohexane	110-82-7	ID	3.40E-03	6.0E+00	1.8E+03
VOC	Dibromochloromethane	124-48-1	C	1.37E-04	7.0E-02	5.3E+02
VOC	1,2-Dichlorobenzene	95-50-1	D	3.08E-04	2.0E-01	6.8E+02
VOC	1,3-Dichlorobenzene	541-73-1	D	4.42E-04	1.4E-01	3.3E+02
VOC	1,4-Dichlorobenzene	106-46-7	C	3.72E-04	8.0E-01	2.2E+03
VOC	Dichlorodifluoromethane	75-71-8		3.57E-03	2.0E-01	5.8E+01
VOC	1,1-Dichloroethane	75-34-3	C	7.38E-04	5.0E-01	7.1E+02
VOC	1,2-Dichloroethane	107-06-2	B2	1.92E-04	5.0E-03	2.7E+01
VOC	1,1-Dichloroethene	75-35-4	C	1.82E-03	2.0E-01	1.1E+02
VOC	cis-1,2-Dichloroethene	156-59-2	D	6.02E-04	3.5E-02	6.1E+01
VOC	trans-1,2-Dichloroethene	156-60-5		1.07E-03	6.0E-02	5.8E+01
VOC	1,2-Dichloropropane	78-87-5	B2	4.31E-04	4.0E-03	9.7E+00
VOC	Ethyl Benzene	100-41-4	D	8.21E-04	1.0E+00	1.3E+03
VOC	2-Hexanone	591-78-6			5.0E-03	
VOC	Methyl Acetate	79-20-9		2.10E-05	3.5E+00	1.7E+05
VOC	Methyl tert-butyl ether	1634-04-4		1.21E-04	3.0E+00	2.6E+04
VOC	4-Methyl-2-pentanone	108-10-1	ID	3.07E-05	3.0E+00	1.0E+05
VOC	Methylcyclohexane	108-87-2		3.90E-03	3.0E+00	8.0E+02
VOC	Methylene Chloride	75-09-2	B2	3.89E-04	3.0E+00	8.0E+03
VOC	Styrene	100-42-5		4.11E-04	1.0E+00	2.5E+03
VOC	Tetrachloroethene	127-18-4	C-B2	1.31E-03	4.0E-01	3.2E+02
VOC	Toluene	108-88-3	D	7.86E-04	5.0E+00	6.6E+03
VOC	1,2,4-Trichlorobenzene	120-82-1	D	2.24E-04	2.0E-01	9.3E+02
VOC	1,1,1-Trichloroethane	71-55-6	D	1.33E-03	2.2E+00	1.7E+03
VOC	1,1,2-Trichloroethane	79-00-5	C	1.74E-04		
VOC	Trichloroethene	79-01-6	C-B2	1.03E-03		
VOC	Trichlorofluoromethane	75-69-4		2.89E-03	7.0E-01	2.5E+02
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		3.95E-03	3.0E+01	7.9E+03
VOC	1,2,4-Trimethylbenzene	95-63-6	ID	6.87E-04	6.0E-03	9.1E+00
VOC	1,3,5-Trimethylbenzene	108-67-8	ID	6.90E-04	6.0E-03	9.1E+00
VOC	Vinyl Chloride	75-01-4	A	2.08E-03	1.0E-01	5.0E+01
VOC	Xylenes (total)	1330-20-7	ID	7.86E-04	1.0E-01	1.3E+02
SVOC	Acenaphthene	83-32-9		3.35E-05	2.1E-01	6.5E+03
SVOC	Acenaphthylene	208-96-8	D	2.48E-05	1.1E-01	4.4E+03
SVOC	Acetophenone	98-86-2	D	2.56E-06	3.5E-01	1.4E+05
SVOC	Anthracene	120-12-7	D	1.46E-05		

Attachment 1: Risk-Based Noncancer Criteria for Residential Exposure to Groundwater via Vapor Intrusion (Residential Building with Basement)
GMC: NAO Flint Operations Site, Flint, Michigan

Chem Group	Chemical	CASRN	Carc Class	Vapor Inhalation C_{air} (mg/m^3)	RfC (mg/m^3)	RBC (mg/l)
SVOC	Atrazine	1912-24-9	C	1.66E-08	1.2E-01	7.7E+06
SVOC	Benzaldehyde	100-52-7		5.64E-06	3.5E-01	6.5E+04
SVOC	Benzo(a)anthracene	56-55-3	B2	8.13E-07		
SVOC	Benzo(a)pyrene	50-32-8	B2	2.76E-07		
SVOC	Benzo(b)fluoranthene	205-99-2	B2	2.31E-05		
SVOC	Benzo(g,h,i)perylene	191-24-2	D	3.69E-08	1.1E-01	3.0E+06
SVOC	Benzo(k)fluoranthene	207-08-9	B2	2.03E-07		
SVOC	Biphenyl	92-52-4	D	6.14E-05	1.8E-01	3.0E+03
SVOC	bis(2-Chloroethoxy)methane	111-91-1	D	4.79E-08		
SVOC	bis(2-Chloroethyl) ether	111-44-4	B2	4.28E-06		
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	B2	2.66E-08	7.0E-02	2.7E+06
SVOC	Butylbenzylphthalate	85-68-7	C	3.07E-07	7.0E-01	2.4E+06
SVOC	Caprolactam	105-60-2		2.20E-08	1.8E+00	8.3E+07
SVOC	Carbazole	86-74-8	B2	1.87E-08		
SVOC	4-Chloro-3-methylphenol	59-50-7		9.92E-08		
SVOC	2-Chloronaphthalene	91-58-7		6.52E-05	2.8E-01	4.5E+03
SVOC	2-Chlorophenol	95-57-8		8.04E-05	1.8E-02	2.3E+02
SVOC	Chrysene	218-01-9	B2	2.03E-05		
SVOC	Dibenz(a,h)anthracene	53-70-3	B2	1.42E-08		
SVOC	Dibenzofuran	132-64-9	D	2.96E-06	7.0E-03	2.5E+03
SVOC	2,4-Dichlorophenol	120-83-2		7.71E-07	1.1E-02	1.4E+04
SVOC	Diethylphthalate	84-66-2	D	1.11E-07	2.8E+00	2.6E+07
SVOC	2,4-Dimethylphenol	105-67-9		4.88E-07	7.0E-02	1.5E+05
SVOC	Dimethylphthalate	131-11-3	D	3.16E-08		
SVOC	Di-n-butylphthalate	84-74-2	D	1.88E-08		
SVOC	4,6-Dinitro-2-methylphenol	534-52-1		1.05E-07	3.5E-04	3.5E+03
SVOC	2,4-Dinitrotoluene	121-14-2	B2	3.16E-08		
SVOC	2,6-Dinitrotoluene	606-20-2	B2	1.83E-07	3.5E-03	2.0E+04
SVOC	Di-n-octylphthalate	117-84-0		1.37E-05		
SVOC	Fluoranthene	206-44-0	D	3.79E-06	1.4E-01	3.9E+04
SVOC	Fluorene	86-73-7	D	1.44E-05	1.4E-01	1.0E+04
SVOC	Formaldehyde	50-00-0	B1	1.03E-07		
SVOC	Hexachlorobutadiene	87-68-3	C	7.18E-04		
SVOC	Hexachlorocyclopentadiene	77-47-4	E	1.04E-03	2.0E-04	2.0E-01
SVOC	Hexachloroethane	67-72-1	C	2.33E-04		
SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	B2	3.90E-07		
SVOC	Isophorone	78-59-1	C	1.60E-06		
SVOC	2-Methylnaphthalene	91-57-6	ID	1.01E-04	3.0E-03	3.1E+01
SVOC	Methylphenol (total)	1319-77-3		2.11E-07		
SVOC	Naphthalene	91-20-3	C	9.60E-05	3.0E-03	3.3E+01
SVOC	2-Nitroaniline	88-74-4		4.53E-08	2.0E-04	4.6E+03
SVOC	Nitrobenzene	98-95-3	D	5.70E-06	2.0E-03	3.7E+02
SVOC	2-Nitrophenol	88-75-5		2.27E-06		
SVOC	4-Nitrophenol	100-02-7		2.28E-08		
SVOC	N-Nitrosodiphenylamine	86-30-6	B2	1.21E-06		
SVOC	N-Nitroso-di-n-propylamine	621-64-7	B2	5.49E-07		
SVOC	2,2'-oxybis(1-Chloropropane)	108-60-1	C	2.58E-05		

Attachment 1: Risk-Based Noncancer Criteria for Residential Exposure to Groundwater via Vapor Intrusion (Residential Building with Basement)
GMC: NAO Flint Operations Site, Flint, Michigan

				Vapor Inhalation		
Chem Group	**Chemical**	**CASRN**	**Carc Class**	C_{air} (mg/m^3)	**RfC** (mg/m^3)	**RBC** (mg/l)
SVOC	Pentachlorophenol	87-86-5	B2	1.78E-08	1.1E-01	6.2E+06
SVOC	Phenanthrene	85-01-8	D	5.45E-06	1.1E-01	2.0E+04
SVOC	Phenol	108-95-2	ID	9.90E-08		
SVOC	Pyrene	129-00-0	D	2.62E-06	1.1E-01	4.2E+04
SVOC	2,4,5-Trichlorophenol	95-95-4		1.05E-06		
SVOC	2,4,6-Trichlorophenol	88-06-2	B2	1.86E-06		
PCB	PCBs (total)	1336-36-3	B2	2.34E-04		
INORG	Antimony	7440-36-0			1.4E-03	
INORG	Arsenic	7440-38-2	A			
INORG	Barium	7440-39-3	D			
INORG	Beryllium	7440-41-7	B1		2.0E-05	
INORG	Cadmium	7440-43-9	B1		2.0E-04	
INORG	Chromium (total)	7440-47-3			1.0E-04	
INORG	Chromium III	16065-83-1	D		5.3E+00	
INORG	Chromium VI	18540-29-9	A		1.0E-04	
INORG	Cobalt	7440-48-4	B1		2.0E-05	
INORG	Copper	7440-50-8	D		1.4E-01	
INORG	Cyanide (total)	57-12-5	D		7.0E-02	
INORG	Fluoride	16984-48-8				
INORG	Lead	7439-92-1	B2			
INORG	Manganese	7439-96-5	D		5.0E-05	
INORG	Mercury	7439-97-6	D	6.00E-04	3.0E-04	5.2E-01
INORG	Nickel	7440-02-0	A			
INORG	Selenium	7782-49-2	D		1.8E-02	
INORG	Silver	7440-22-4	D		1.0E-05	
INORG	Thallium	7440-28-0			2.5E-04	
INORG	Vanadium	7440-62-2			2.5E-02	
INORG	Zinc	7440-66-6	D		1.1E+00	

Note:
Target hazard quotient of 1.

Attachment 2

Evaluation of Non-potable Groundwater Exposure in Kiddie Pool

Attachment 2
Evaluation of Non-potable Groundwater Exposure in Kiddie Pool

Potential future exposures associated with residential non-potable groundwater use are evaluated using a hypothetical scenario where groundwater is used to fill a backyard wading pool ("kiddie" pool). This scenario represents a reasonable worst case, in which the estimated exposure is expected to be higher than those associated with other non-potable uses (e.g., watering lawns, washing cars). Potential routes of exposure in this kiddie pool scenario include incidental ingestion, dermal contact, and inhalation of vapors. The cancer risk and HQ estimates for these exposure routes are calculated using risk-based criteria (RBC) in a manner analogous to the method discussed in Section G2.1 of the Revised RFI Phase II Report (BBL 2006). The RBCs for this scenario are calculated using the equations for RBC that are shown in Section G2.1 and the exposure factors and normalized concentrations discussed below. References cited in this Attachment are listed at the end of the main text.

Exposure Factors

Exposure Frequency and Duration

The exposure frequency for the kiddie pool scenario is 32 days/year, which is based on 4 days per week for the 2 months during the summer when the average daily temperature is above 70 degrees Fahrenheit in Detroit, Michigan (NOAA 2004). Residents are assumed to be exposed to groundwater for 30 years (6 years as children and 24 years as adults). This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time that residents would actually spend using groundwater at the Site. USEPA has recommended the use of these values for evaluating high-end residential exposures (USEPA 1991a).

Incidental Water Ingestion

The rate of 0.05 L/hour is the USEPA-recommended value for ingestion of water while swimming (USEPA 1989).

Dermal Contact Rate

The exposed skin surface areas of 6,880 cm^2 and 18,150 cm^2 are based on the median total skin areas for evaluating high-end contact with water by children and adults, respectively (USEPA 1997). Child and adult residents are assumed to wade in the pool for 2 hours per event, and one event per day, based on professional judgment. The absorbed dose for organic chemicals is estimated using the nonsteady-state approach (USEPA 2004), which is more conservative than the steady-state approach (USEPA 1989), particularly for hydrophobic chemicals. The permeability coefficient (Kp) for dermal absorption of organic chemicals from groundwater is estimated following USEPA guidance (USEPA 2004).

Water Concentration in Kiddie Pool

The model for estimating vapor emission from a residential kiddie pool is based on models for estimating vapor emissions from open-top batch tanks (USEPA 1995b). The residential kiddie pool is modeled as a 6-ft diameter tank that is 9 inches deep, and is assumed to be filled with groundwater once per day. The concentration of volatile organic chemicals in the kiddie pool water decreases over time as the chemicals volatilize into the air. The average concentration over a period *t* is given by:

$$\overline{C_w} = C_{w,o} \frac{d}{K \cdot t}\left(1 - e^{-K\,t/d}\right)$$

where $C_{w,o}$ is the initial concentration, d is the depth of water in the pool and K is the chemical's overall mass transfer coefficient (USEPA 1995c). K is calculated was follows:

$$K = \frac{k_l \cdot H\ k_g}{k_l + H\ k_g}$$

where H is the Henry's law constant, and k_l and k_g are the liquid-phase and gas-phase mass transfer coefficients given by the following equations:

$$k_l = 10^{-6} + 144 \cdot 10^{-4}\left(0.01\,u_{10}\,\sqrt{6.1 + 0.63\,u_{10}}\right)^{2.2}\ Sc_l^{\ -0.5}$$

$$k_g = 4.82 \cdot 10^{-3}\ u_{10}^{\ 0.78}\ Sc_g^{\ -0.67}\ d_e^{\ -0.11}$$

where Sc_l and Sc_g are liquid-phase and gas-phase Schmidt numbers, d_e is the effective diameter of the water surface (m), and u_{10} is wind speed at 10 m above the water surface, which is 4.6 m/s based on the annual average wind speed in Flint, Michigan (NOAA 2004).

Air Concentration from Kiddie Pool

The concentration of the chemical in air at the water surface is given by the following:

$$C_{air} = \overline{C}_w \cdot K \cdot (C/Q)$$

The *C/Q* term is estimated using SCREEN3 (USEPA 1995a) for a 6-foot by 6-foot kiddie pool. The SCREEN3 area-source algorithm is used with reasonable worst-case meteorological conditions (stability class D) to estimate a maximum 1-hour air concentration at ground level. This air concentration is expected to be higher than actual air concentrations to which individuals would be exposed while in the kiddie pool.

Attachment 2: Exposure Factors for Nonpotable Use
GMC: NAO Flint Operations Site, Flint, Michigan

		Resident Child	Resident Adult
Incidental Ingestion in Kiddie Pool			
Drinking Rate (L-water/hr)	DR	0.05	0.05
Exposure Time (hr/d)	ET	2	2
Exposure Frequency (d/yr)	EF	32	32
Exposure Duration (yr)	ED	6	24
Body Weight (kg-bw)	BW	15	70
Averaging Time, carc (d)	AT_c	25,550	25,550
Averaging Time, noncarc (d)	AT_{nc}	10,950	10,950
Dermal Contact in Kiddie Pool			
Event Time (hours)	t	2	2
Skin Surface Area (cm^2)	SA	6,880	18,150
Events per Day	EV	1	1
Exposure Frequency (d/yr)	EF	32	32
Expoure Duration (y)	ED	6	24
Body Weight (kg-bw)	BW	15	70
Averaging Time, canc (d)	AT_c	25,550	25,550
Averaging Time, noncanc (d)	AT_{nc}	10,950	10,950
Ambient Air Inhalation - Vapor in Kiddie Pool			
Fraction Contacted (unitless)	FC	1.0	1.0
Exposure Time (h exposed/h in a day)	ET	2/24	2/24
Exposure Frequency (d/yr)	EF	32	32
Exposure Duration (yr)	ED	6	24
Averaging Time, carc (d)	AT_c	25,550	25,550
Averaging Time, noncarc (d)	AT_{nc}	10,950	10,950

Attachment 2: Normalized Vapor Flux (mg/m2-s per mg/L) from Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

Chem Group	Chemical	CASRN	H (unitless)	D_{air} (cm^2/s)	D_{water} (cm^2/s)	Sc_L (unitless)	Sc_G (unitless)	k_L (m/s)	k_G (m/s)	K_L (m/s)	C_{avg}/C_0 (unitless)	J_L (L/m^2-s)
VOC	Acetone	67-64-1	1.59E-03	1.24E-01	1.14E-05	7.83E+02	1.22E+00	7.45E-06	1.27E-02	5.45E-06	4.24E-01	2.31E-03
VOC	Benzene	71-43-2	2.28E-01	8.80E-02	9.80E-06	9.11E+02	1.71E+00	6.98E-06	1.01E-02	6.96E-06	3.53E-01	2.45E-03
VOC	Bromodichloromethane	75-27-4	6.56E-02	2.98E-02	1.06E-05	8.42E+02	5.06E+00	7.22E-06	4.90E-03	7.06E-06	3.49E-01	2.46E-03
VOC	Bromoform	75-25-2	2.19E-02	1.49E-02	1.03E-05	8.67E+02	1.01E+01	7.13E-06	3.08E-03	6.45E-06	3.75E-01	2.41E-03
VOC	Bromomethane	74-83-9	2.56E-01	7.28E-02	1.21E-05	7.38E+02	2.07E+00	7.64E-06	8.92E-03	7.62E-06	3.28E-01	2.50E-03
VOC	2-Butanone	78-93-3	2.28E-03	8.08E-02	9.80E-06	9.11E+02	1.87E+00	6.98E-06	9.57E-03	5.29E-06	4.33E-01	2.29E-03
VOC	Carbon Disulfide	75-15-0	1.24E+00	1.04E-01	1.00E-05	8.93E+02	1.45E+00	7.04E-06	1.13E-02	7.03E-06	3.50E-01	2.46E-03
VOC	Carbon Tetrachloride	56-23-5	1.25E+00	7.80E-02	8.80E-06	1.01E+03	1.93E+00	6.66E-06	9.34E-03	6.66E-06	3.65E-01	2.43E-03
VOC	Chlorobenzene	108-90-7	1.52E-01	7.30E-02	8.70E-06	1.03E+03	2.07E+00	6.63E-06	8.94E-03	6.60E-06	3.68E-01	2.43E-03
VOC	Chloroethane	75-00-3	3.60E-01	2.71E-01	1.15E-05	7.77E+02	5.57E-01	7.47E-06	2.15E-02	7.47E-06	3.33E-01	2.49E-03
VOC	Chloroform	67-66-3	1.50E-01	1.04E-01	1.00E-05	8.93E+02	1.45E+00	7.04E-06	1.13E-02	7.01E-06	3.51E-01	2.46E-03
VOC	Chloromethane	74-87-3	3.60E-01	1.26E-01	6.50E-06	1.37E+03	1.20E+00	5.87E-06	1.29E-02	5.86E-06	4.02E-01	2.36E-03
VOC	Cumene	98-82-8	5.32E-01	6.50E-02	7.10E-06	1.26E+03	2.32E+00	6.09E-06	8.27E-03	6.08E-06	3.92E-01	2.38E-03
VOC	Cyclohexane	110-82-7	7.97E+00	8.39E-02	9.10E-06	9.81E+02	1.80E+00	6.76E-06	9.81E-03	6.76E-06	3.61E-01	2.44E-03
VOC	1,2-Dibromo-3-chloropropane	96-12-8	6.01E-03	8.00E-02	8.00E-06	1.12E+03	1.89E+00	6.40E-06	9.50E-03	5.75E-06	4.08E-01	2.35E-03
VOC	Dibromochloromethane	124-48-1	3.21E-02	1.96E-02	1.05E-05	8.50E+02	7.70E+00	7.19E-06	3.70E-03	6.78E-06	3.60E-01	2.44E-03
VOC	1,2-Dibromoethane	106-93-4	3.04E-02	8.00E-02	8.00E-06	1.12E+03	1.89E+00	6.40E-06	9.50E-03	6.26E-06	3.83E-01	2.40E-03
VOC	1,2-Dichlorobenzene	95-50-1	7.79E-02	6.90E-02	7.90E-06	1.13E+03	2.19E+00	6.37E-06	8.61E-03	6.31E-06	3.81E-01	2.40E-03
VOC	1,3-Dichlorobenzene	541-73-1	1.27E-01	6.92E-02	7.86E-06	1.14E+03	2.18E+00	6.35E-06	8.62E-03	6.32E-06	3.80E-01	2.40E-03
VOC	1,4-Dichlorobenzene	106-46-7	9.96E-02	6.90E-02	7.90E-06	1.13E+03	2.19E+00	6.37E-06	8.61E-03	6.32E-06	3.80E-01	2.40E-03
VOC	Dichlorodifluoromethane	75-71-8	1.40E+01	8.00E-02	8.00E-06	1.12E+03	1.89E+00	6.40E-06	9.50E-03	6.40E-06	3.77E-01	2.41E-03
VOC	1,1-Dichloroethane	75-34-3	2.30E-01	7.42E-02	1.05E-05	8.50E+02	2.03E+00	7.19E-06	9.04E-03	7.16E-06	3.45E-01	2.47E-03
VOC	1,2-Dichloroethane	107-06-2	4.01E-02	1.04E-01	9.90E-06	9.02E+02	1.45E+00	7.01E-06	1.13E-02	6.90E-06	3.55E-01	2.45E-03
VOC	1,1-Dichloroethene	75-35-4	1.07E+00	9.00E-02	1.04E-05	8.59E+02	1.68E+00	7.16E-06	1.03E-02	7.15E-06	3.45E-01	2.47E-03
VOC	1,2-Dichloroethene (total)	540-59-0	3.85E-01	7.07E-02	1.19E-05	7.50E+02	2.13E+00	7.59E-06	8.75E-03	7.57E-06	3.30E-01	2.49E-03
VOC	cis-1,2-Dichloroethene	156-59-2	1.67E-01	7.36E-02	1.13E-05	7.90E+02	2.05E+00	7.42E-06	8.99E-03	7.38E-06	3.36E-01	2.48E-03
VOC	trans-1,2-Dichloroethene	156-60-5	3.85E-01	7.07E-02	1.19E-05	7.50E+02	2.13E+00	7.59E-06	8.75E-03	7.57E-06	3.30E-01	2.49E-03
VOC	1,2-Dichloropropane	78-87-5	1.15E-01	7.82E-02	8.73E-06	1.02E+03	1.93E+00	6.64E-06	9.36E-03	6.60E-06	3.68E-01	2.43E-03
VOC	1,3-Dichloropropene (total)	542-75-6	7.26E-01	6.26E-02	1.00E-05	8.93E+02	2.41E+00	7.04E-06	8.06E-03	7.03E-06	3.50E-01	2.46E-03
VOC	cis-1,3-Dichloropropene	10061-01-5	1.45E-01	8.00E-02	8.00E-06	1.12E+03	1.89E+00	6.40E-06	9.50E-03	6.37E-06	3.78E-01	2.41E-03
VOC	trans-1,3-Dichloropropene	10061-02-6	6.54E-02	6.26E-02	1.00E-05	8.93E+02	2.41E+00	7.04E-06	8.06E-03	6.94E-06	3.53E-01	2.45E-03
VOC	Ethyl Benzene	100-41-4	3.23E-01	7.50E-02	7.80E-06	1.14E+03	2.01E+00	6.33E-06	9.10E-03	6.32E-06	3.80E-01	2.40E-03
VOC	2-Hexanone	591-78-6	7.15E-02									
VOC	Methyl Acetate	79-20-9	3.71E-03	9.57E-02	1.10E-05	8.12E+02	1.58E+00	7.33E-06	1.07E-02	6.19E-06	3.86E-01	2.39E-03
VOC	Methyl tert-butyl ether	1634-04-4	2.40E-02	8.59E-02	1.01E-05	8.84E+02	1.76E+00	7.07E-06	9.97E-03	6.86E-06	3.57E-01	2.45E-03
VOC	4-Methyl-2-pentanone	108-10-1	5.64E-03	7.50E-02	7.80E-06	1.14E+03	2.01E+00	6.33E-06	9.10E-03	5.64E-06	4.14E-01	2.33E-03
VOC	Methylcyclohexane	108-87-2	1.76E+01	7.35E-02	8.52E-06	1.05E+03	2.05E+00	6.57E-06	8.98E-03	6.57E-06	3.69E-01	2.43E-03
VOC	Methylene Chloride	75-09-2	8.98E-02	1.01E-01	1.17E-05	7.63E+02	1.49E+00	7.53E-06	1.11E-02	7.47E-06	3.33E-01	2.49E-03
VOC	Styrene	100-42-5	1.13E-01	7.10E-02	8.00E-06	1.12E+03	2.12E+00	6.40E-06	8.77E-03	6.36E-06	3.78E-01	2.41E-03
VOC	1,1,2,2-Tetrachloroethane	79-34-5	1.41E-02	7.10E-02	7.90E-06	1.13E+03	2.12E+00	6.37E-06	8.77E-03	6.05E-06	3.93E-01	2.38E-03

Attachment 2: Normalized Vapor Flux (mg/m2-s per mg/L) from Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

Chem Group	Chemical	CASRN	H (unitless)	D_{air} (cm^2/s)	D_{water} (cm^2/s)	Sc_L (unitless)	Sc_G (unitless)	k_L (m/s)	k_G (m/s)	K_L (m/s)	C_{avg}/C_0 (unitless)	J_L (L/m^2-s)
VOC	Tetrachloroethene	127-18-4	7.54E-01	7.20E-02	8.20E-06	1.09E+03	2.09E+00	6.47E-06	8.86E-03	6.46E-06	3.74E-01	2.42E-03
VOC	Toluene	108-88-3	2.72E-01	8.70E-02	8.60E-06	1.04E+03	1.73E+00	6.60E-06	1.01E-02	6.58E-06	3.69E-01	2.43E-03
VOC	1,2,4-Trichlorobenzene	120-82-1	5.82E-02	3.00E-02	8.23E-06	1.09E+03	5.03E+00	6.48E-06	4.93E-03	6.33E-06	3.80E-01	2.40E-03
VOC	1,1,1-Trichloroethane	71-55-6	7.05E-01	7.80E-02	8.80E-06	1.01E+03	1.93E+00	6.66E-06	9.34E-03	6.66E-06	3.65E-01	2.43E-03
VOC	1,1,2-Trichloroethane	79-00-5	3.74E-02	7.80E-02	8.80E-06	1.01E+03	1.93E+00	6.66E-06	9.34E-03	6.54E-06	3.70E-01	2.42E-03
VOC	Trichloroethene	79-01-6	4.22E-01	7.90E-02	9.10E-06	9.81E+02	1.91E+00	6.76E-06	9.42E-03	6.75E-06	3.62E-01	2.44E-03
VOC	Trichlorofluoromethane	75-69-4	3.96E+00	8.70E-02	9.70E-06	9.21E+02	1.73E+00	6.95E-06	1.01E-02	6.94E-06	3.53E-01	2.45E-03
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1.97E+01	7.80E-02	8.20E-06	1.09E+03	1.93E+00	6.47E-06	9.34E-03	6.47E-06	3.74E-01	2.42E-03
VOC	1,2,4-Trimethylbenzene	95-63-6	2.52E-01	6.06E-02	7.92E-06	1.13E+03	2.49E+00	6.37E-06	7.89E-03	6.35E-06	3.79E-01	2.41E-03
VOC	1,3,5-Trimethylbenzene	108-67-8	2.40E-01	6.02E-02	8.67E-06	1.03E+03	2.51E+00	6.62E-06	7.86E-03	6.60E-06	3.68E-01	2.43E-03
VOC	Vinyl Chloride	75-01-4	1.11E+00	1.06E-01	1.23E-05	7.26E+02	1.42E+00	7.70E-06	1.15E-02	7.69E-06	3.25E-01	2.50E-03
VOC	Xylenes (total)	1330-20-7	2.76E-01	7.80E-02	8.75E-06	1.02E+03	1.93E+00	6.65E-06	9.34E-03	6.63E-06	3.67E-01	2.43E-03
SVOC	Acenaphthene	83-32-9	6.36E-03	4.21E-02	7.69E-06	1.16E+03	3.58E+00	6.29E-06	6.18E-03	5.43E-06	4.25E-01	2.31E-03
SVOC	Acenaphthylene	208-96-8	4.62E-03	4.49E-02	6.98E-06	1.28E+03	3.36E+00	6.04E-06	6.45E-03	5.02E-06	4.48E-01	2.25E-03
SVOC	Acetophenone	98-86-2	4.37E-04	8.00E-02	8.00E-06	1.12E+03	1.89E+00	6.40E-06	9.50E-03	2.52E-06	6.45E-01	1.62E-03
SVOC	Anthracene	120-12-7	2.67E-03	3.24E-02	7.74E-06	1.15E+03	4.66E+00	6.31E-06	5.19E-03	4.34E-06	4.92E-01	2.13E-03
SVOC	Atrazine	1912-24-9	2.50E-07	2.59E-02	6.67E-06	1.34E+03	5.82E+00	5.93E-06	4.46E-03	1.11E-09	1.00E+00	1.11E-06
SVOC	Benzaldehyde	100-52-7	9.73E-04	7.21E-02	9.07E-06	9.85E+02	2.09E+00	6.75E-06	8.86E-03	3.79E-06	5.32E-01	2.01E-03
SVOC	Benzo(a)anthracene	56-55-3	1.37E-04	5.10E-02	9.00E-06	9.92E+02	2.96E+00	6.73E-06	7.03E-03	8.42E-07	8.56E-01	7.21E-04
SVOC	Benzo(a)pyrene	50-32-8	4.63E-05	4.30E-02	9.00E-06	9.92E+02	3.51E+00	6.73E-06	6.27E-03	2.78E-07	9.49E-01	2.64E-04
SVOC	Benzo(b)fluoranthene	205-99-2	4.55E-03	2.26E-02	5.56E-06	1.61E+03	6.67E+00	5.50E-06	4.07E-03	4.24E-06	4.98E-01	2.11E-03
SVOC	Benzo(g,h,i)perylene	191-24-2	5.76E-06	2.17E-02	5.26E-06	1.70E+03	6.95E+00	5.38E-06	3.97E-03	2.28E-08	9.96E-01	2.27E-05
SVOC	Benzo(k)fluoranthene	207-08-9	3.40E-05	2.26E-02	5.56E-06	1.61E+03	6.67E+00	5.50E-06	4.07E-03	1.35E-07	9.75E-01	1.32E-04
SVOC	Biphenyl	92-52-4	1.23E-02	4.04E-02	8.15E-06	1.10E+03	3.73E+00	6.45E-06	6.01E-03	5.93E-06	3.99E-01	2.36E-03
SVOC	bis(2-Chloroethoxy)methane	111-91-1	6.95E-06	4.36E-02	8.46E-06	1.06E+03	3.46E+00	6.55E-06	6.33E-03	4.37E-08	9.92E-01	4.33E-05
SVOC	bis(2-Chloroethyl) ether	111-44-4	7.38E-04	6.92E-02	7.53E-06	1.19E+03	2.18E+00	6.24E-06	8.62E-03	3.15E-06	5.85E-01	1.84E-03
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	4.18E-06	3.51E-02	3.66E-06	2.44E+03	4.30E+00	4.65E-06	5.47E-03	2.28E-08	9.96E-01	2.27E-05
SVOC	4-Bromophenyl-phenyl ether	101-55-3	4.78E-03	2.61E-02	6.80E-06	1.31E+03	5.78E+00	5.98E-06	4.49E-03	4.68E-06	4.69E-01	2.19E-03
SVOC	Butylbenzylphthalate	85-68-7	5.17E-05	1.74E-02	4.83E-06	1.85E+03	8.67E+00	5.20E-06	3.42E-03	1.71E-07	9.68E-01	1.66E-04
SVOC	Caprolactam	105-60-2	2.06E-07	6.92E-02	8.99E-06	9.93E+02	2.18E+00	6.72E-06	8.62E-03	1.78E-09	1.00E+00	1.78E-06
SVOC	Carbazole	86-74-8	6.26E-07	3.90E-02	7.03E-06	1.27E+03	3.87E+00	6.06E-06	5.87E-03	3.67E-09	9.99E-01	3.67E-06
SVOC	4-Chloro-3-methylphenol	59-50-7	1.63E-05	6.06E-02	9.51E-06	9.39E+02	2.49E+00	6.89E-06	7.89E-03	1.26E-07	9.77E-01	1.23E-04
SVOC	4-Chloroaniline	106-47-8	1.36E-05	4.83E-02	1.01E-05	8.84E+02	3.12E+00	7.07E-06	6.78E-03	9.10E-08	9.83E-01	8.94E-05
SVOC	2-Chloronaphthalene	91-58-7	1.28E-02	4.92E-02	8.79E-06	1.02E+03	3.07E+00	6.66E-06	6.86E-03	6.19E-06	3.86E-01	2.39E-03
SVOC	2-Chlorophenol	95-57-8	1.60E-02	5.01E-02	9.46E-06	9.44E+02	3.01E+00	6.87E-06	6.95E-03	6.47E-06	3.73E-01	2.42E-03
SVOC	4-Chlorophenyl-phenyl ether	7005-72-3	8.99E-03	2.84E-02	7.65E-06	1.17E+03	5.32E+00	6.28E-06	4.74E-03	5.47E-06	4.22E-01	2.31E-03
SVOC	Chrysene	218-01-9	3.88E-03	2.48E-02	6.21E-06	1.44E+03	6.08E+00	5.76E-06	4.34E-03	4.29E-06	4.95E-01	2.12E-03
SVOC	Dibenz(a,h)anthracene	53-70-3	6.03E-07	2.02E-02	5.18E-06	1.72E+03	7.47E+00	5.35E-06	3.78E-03	2.28E-09	1.00E+00	2.28E-06
SVOC	Dibenzofuran	132-64-9	5.15E-04	2.38E-02	6.00E-06	1.49E+03	6.34E+00	5.68E-06	4.22E-03	1.57E-06	7.54E-01	1.18E-03
SVOC	3,3'-Dichlorobenzidine	91-94-1	1.64E-07	1.94E-02	6.74E-06	1.32E+03	7.77E+00	5.96E-06	3.68E-03	6.03E-10	1.00E+00	6.03E-07

US EPA ARCHIVE DOCUMENT

Attachment 2: Normalized Vapor Flux (mg/m2-s per mg/L) from Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

Chem Group	Chemical	CASRN	H (unitless)	D_{air} (cm^2/s)	D_{water} (cm^2/s)	Sc_L (unitless)	Sc_G (unitless)	k_L (m/s)	k_G (m/s)	K_L (m/s)	C_{avg}/C_0 (unitless)	J_L (L/m^2-s)
SVOC	2,4-Dichlorophenol	120-83-2	1.30E-04	3.46E-02	8.77E-06	1.02E+03	4.36E+00	6.65E-06	5.42E-03	6.37E-07	8.89E-01	5.66E-04
SVOC	Diethylphthalate	84-66-2	1.85E-05	2.56E-02	6.35E-06	1.41E+03	5.89E+00	5.81E-06	4.43E-03	8.08E-08	9.85E-01	7.96E-05
SVOC	2,4-Dimethylphenol	105-67-9	8.20E-05	5.84E-02	8.69E-06	1.03E+03	2.58E+00	6.63E-06	7.70E-03	5.76E-07	8.99E-01	5.18E-04
SVOC	Dimethylphthalate	131-11-3	4.29E-06	5.68E-02	6.29E-06	1.42E+03	2.66E+00	5.79E-06	7.56E-03	3.22E-08	9.94E-01	3.20E-05
SVOC	Di-n-butylphthalate	84-74-2	3.85E-08	4.38E-02	7.86E-06	1.14E+03	3.44E+00	6.35E-06	6.35E-03	2.44E-10	1.00E+00	2.44E-07
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.75E-05	2.76E-02	6.91E-06	1.29E+03	5.46E+00	6.02E-06	4.66E-03	8.02E-08	9.85E-01	7.90E-05
SVOC	2,4-Dinitrophenol	51-28-5	1.82E-05	2.73E-02	9.06E-06	9.86E+02	5.53E+00	6.75E-06	4.62E-03	8.31E-08	9.84E-01	8.18E-05
SVOC	2,4-Dinitrotoluene	121-14-2	3.80E-06	2.03E-01	7.06E-06	1.26E+03	7.43E-01	6.07E-06	1.77E-02	6.67E-08	9.88E-01	6.58E-05
SVOC	2,6-Dinitrotoluene	606-20-2	3.06E-05	3.27E-02	7.26E-06	1.23E+03	4.61E+00	6.14E-06	5.22E-03	1.56E-07	9.71E-01	1.51E-04
SVOC	Di-n-octylphthalate	117-84-0	2.74E-03	1.51E-02	3.58E-06	2.49E+03	9.99E+00	4.61E-06	3.11E-03	2.99E-06	5.99E-01	1.79E-03
SVOC	Fluoranthene	206-44-0	6.60E-04	3.02E-02	6.35E-06	1.41E+03	4.99E+00	5.81E-06	4.95E-03	2.09E-06	6.91E-01	1.45E-03
SVOC	Fluorene	86-73-7	2.61E-03	3.63E-02	7.88E-06	1.13E+03	4.16E+00	6.36E-06	5.60E-03	4.43E-06	4.85E-01	2.15E-03
SVOC	Formaldehyde	50-00-0	1.39E-05	1.80E-01	2.00E-05	4.47E+02	8.38E-01	9.54E-06	1.64E-02	2.22E-07	9.59E-01	2.13E-04
SVOC	Hexachlorobenzene	118-74-1	5.41E-02	5.42E-02	5.91E-06	1.51E+03	2.78E+00	5.64E-06	7.32E-03	5.56E-06	4.18E-01	2.32E-03
SVOC	Hexachlorobutadiene	87-68-3	3.34E-01	5.61E-02	6.16E-06	1.45E+03	2.69E+00	5.74E-06	7.49E-03	5.73E-06	4.09E-01	2.34E-03
SVOC	Hexachlorocyclopentadiene	77-47-4	1.11E+00	1.61E-02	7.21E-06	1.24E+03	9.37E+00	6.13E-06	3.25E-03	6.12E-06	3.90E-01	2.38E-03
SVOC	Hexachloroethane	67-72-1	1.59E-01	2.50E-03	6.80E-06	1.31E+03	6.03E+01	5.98E-06	9.32E-04	5.75E-06	4.08E-01	2.34E-03
SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	6.56E-05	1.90E-02	5.66E-06	1.58E+03	7.94E+00	5.54E-06	3.63E-03	2.28E-07	9.58E-01	2.19E-04
SVOC	Isophorone	78-59-1	2.72E-04	6.23E-02	6.76E-06	1.32E+03	2.42E+00	5.96E-06	8.04E-03	1.60E-06	7.50E-01	1.20E-03
SVOC	2-Methylnaphthalene	91-57-6	2.12E-02	4.84E-02	7.75E-06	1.15E+03	3.12E+00	6.31E-06	6.79E-03	6.05E-06	3.93E-01	2.38E-03
SVOC	Methylphenol (total)	1319-77-3	3.54E-05	7.40E-02	1.00E-05	8.93E+02	2.04E+00	7.04E-06	9.02E-03	3.05E-07	9.45E-01	2.88E-04
SVOC	2-Methylphenol	95-48-7	4.92E-05	7.40E-02	8.30E-06	1.08E+03	2.04E+00	6.50E-06	9.02E-03	4.15E-07	9.25E-01	3.84E-04
SVOC	4-Methylphenol	106-44-5	3.24E-05	7.40E-02	1.00E-05	8.93E+02	2.04E+00	7.04E-06	9.02E-03	2.80E-07	9.49E-01	2.66E-04
SVOC	Naphthalene	91-20-3	1.98E-02	5.90E-02	7.50E-06	1.19E+03	2.56E+00	6.23E-06	7.75E-03	5.99E-06	3.96E-01	2.37E-03
SVOC	2-Nitroaniline	88-74-4	6.53E-06	7.30E-02	8.00E-06	1.12E+03	2.07E+00	6.40E-06	8.94E-03	5.78E-08	9.89E-01	5.72E-05
SVOC	3-Nitroaniline	99-09-2	5.89E-06									
SVOC	4-Nitroaniline	100-01-6	8.46E-08	5.79E-02	8.58E-06	1.04E+03	2.61E+00	6.59E-06	7.65E-03	6.47E-10	1.00E+00	6.47E-07
SVOC	Nitrobenzene	98-95-3	9.84E-04	7.60E-02	8.60E-06	1.04E+03	1.98E+00	6.60E-06	9.18E-03	3.81E-06	5.30E-01	2.02E-03
SVOC	2-Nitrophenol	88-75-5	3.87E-04	5.39E-02	7.85E-06	1.14E+03	2.80E+00	6.35E-06	7.29E-03	1.95E-06	7.07E-01	1.38E-03
SVOC	4-Nitrophenol	100-02-7	1.70E-08	6.25E-02	9.61E-06	9.29E+02	2.41E+00	6.92E-06	8.05E-03	1.37E-10	1.00E+00	1.37E-07
SVOC	N-Nitrosodiphenylamine	86-30-6	2.05E-04	3.12E-02	6.35E-06	1.41E+03	4.83E+00	5.81E-06	5.06E-03	8.80E-07	8.51E-01	7.48E-04
SVOC	N-Nitroso-di-n-propylamine	621-64-7	9.23E-05	5.45E-02	8.17E-06	1.09E+03	2.77E+00	6.46E-06	7.35E-03	6.14E-07	8.92E-01	5.48E-04
SVOC	2,2'-oxybis(1-Chloropropane)	108-60-1	4.78E-03	6.02E-02	6.41E-06	1.39E+03	2.51E+00	5.83E-06	7.86E-03	5.05E-06	4.46E-01	2.25E-03
SVOC	Pentachlorophenol	87-86-5	1.00E-06	5.60E-02	6.10E-06	1.46E+03	2.69E+00	5.72E-06	7.48E-03	7.47E-09	9.99E-01	7.46E-06
SVOC	Phenanthrene	85-01-8	9.52E-04	3.75E-02	7.47E-06	1.20E+03	4.02E+00	6.22E-06	5.72E-03	2.90E-06	6.07E-01	1.76E-03
SVOC	Phenol	108-95-2	1.63E-05	8.20E-02	9.10E-06	9.81E+02	1.84E+00	6.76E-06	9.66E-03	1.54E-07	9.71E-01	1.50E-04
SVOC	Pyrene	129-00-0	4.51E-04	2.72E-02	7.24E-06	1.23E+03	5.55E+00	6.14E-06	4.61E-03	1.55E-06	7.56E-01	1.18E-03
SVOC	2,4,5-Trichlorophenol	95-95-4	1.78E-04	2.91E-02	7.03E-06	1.27E+03	5.18E+00	6.06E-06	4.83E-03	7.52E-07	8.70E-01	6.55E-04
SVOC	2,4,6-Trichlorophenol	88-06-2	3.19E-04	3.18E-02	6.25E-06	1.43E+03	4.74E+00	5.77E-06	5.12E-03	1.27E-06	7.94E-01	1.01E-03
PCB	PCBs (total)	1336-36-3	8.17E-02	2.02E-02	5.00E-06	1.79E+03	7.47E+00	5.27E-06	3.78E-03	5.18E-06	4.39E-01	2.27E-03

Attachment 2: Normalized Vapor Flux (mg/m2-s per mg/L) from Kiddie Pool GMC: NAO Flint Operations Site, Flint, Michigan													
Chem Group	**Chemical**	**CASRN**	**H** (unitless)	**D_{air}** (cm^2/s)	**D_{water}** (cm^2/s)	**Sc_L** (unitless)	**Sc_G** (unitless)	**k_L** (m/s)	**k_G** (m/s)	**K_L** (m/s)	**C_{avg}/C_0** (unitless)	**J_L** (L/m^2-s)
INORG	Antimony	7440-36-0										
INORG	Arsenic	7440-38-2										
INORG	Barium	7440-39-3										
INORG	Beryllium	7440-41-7										
INORG	Cadmium	7440-43-9										
INORG	Chromium (total)	7440-47-3										
INORG	Chromium III	16065-83-1										
INORG	Chromium VI	18540-29-9										
INORG	Cobalt	7440-48-4										
INORG	Copper	7440-50-8										
INORG	Cyanide (total)	57-12-5										
INORG	Fluoride	16984-48-8										
INORG	Lead	7439-92-1										
INORG	Manganese	7439-96-5										
INORG	Mercury	7439-97-6	2.90E-01	3.07E-02	6.30E-06	1.42E+03	4.91E+00	5.79E-06	5.00E-03	5.77E-06	4.07E-01	2.35E-03
INORG	Nickel	7440-02-0										
INORG	Selenium	7782-49-2										
INORG	Silver	7440-22-4										
INORG	Thallium	7440-28-0										
INORG	Vanadium	7440-62-2										
INORG	Zinc	7440-66-6										
Notes:					**Basis**							
	Water density	ρ_w	1.00E+00	g/cm^3	constant							
	Water viscosity	μ_w	8.93E-03	g/cm-s	constant							
	Air density	ρ_a	1.20E-03	g/cm^3	constant							
	Air viscosity	μ_a	1.81E-04	g/cm-s	constant							
	Wind speed	u_{10}	10.2	mph	annual mean wind speed in Flint MI (NOAA 2004)							
	Wind speed	u_{10}	4.6	m/s	annual mean wind speed in Flint MI (NOAA 2004)							
	Friction velocity	**u**	0.14	m/s	calculated							
	Pool effective diameter	d_e	2.1	m	calculated							
	Pool water surface area	**A**	3.3	m^2	assumed 6 ft diameter							
	Pool water depth	**d**	0.23	m	assumed 3/4 ft deep							
	Pool water volume	**V**	0.76	m^3	calculated							
	Fetch-to-depth ratio	**F/D**	9.0		calculated							
	Averaging period	**t**	1.0	day	assumed							

Attachment 2: Nonsteady State Dermal Absorption of Chemical from Water in Kiddie Pool GMC: NAO Flint Operations Site, Flint, Michigan													
Chem Group	**Chemical**	**CASRN**	**MW** (g/mole)	**Log K_{ow}** (unitless)	**K_p** (cm/hr)	**B** (unitless)	**τ** (hr)	**c**	**b**	**ts** (hr)	**FA** (unitless)	**DA** (L/cm^2-event)
VOC	Acetone	67-64-1	5.81E+01	-2.40E-01	5.20E-04	1.53E-03	2.22E-01	3.34E-01	3.04E-01	5.34E-01	1.00E+00	1.27E-06
VOC	Benzene	71-43-2	7.81E+01	2.13E+00	1.47E-02	5.01E-02	2.88E-01	3.68E-01	3.34E-01	6.91E-01	1.00E+00	3.70E-05
VOC	Bromodichloromethane	75-27-4	1.64E+02	2.10E+00	4.66E-03	2.29E-02	8.70E-01	3.49E-01	3.17E-01	2.09E+00	1.00E+00	1.70E-05
VOC	Bromoform	75-25-2	2.53E+02	2.35E+00	2.17E-03	1.32E-02	2.74E+00	3.42E-01	3.11E-01	6.57E+00	1.00E+00	1.40E-05
VOC	Bromomethane	74-83-9	9.49E+01	1.19E+00	2.84E-03	1.07E-02	3.58E-01	3.40E-01	3.10E-01	8.58E-01	1.00E+00	7.68E-06
VOC	2-Butanone	78-93-3	7.21E+01	2.80E-01	9.57E-04	3.13E-03	2.66E-01	3.35E-01	3.05E-01	6.40E-01	1.00E+00	2.42E-06
VOC	Carbon Disulfide	75-15-0	7.61E+01	2.00E+00	1.24E-02	4.16E-02	2.81E-01	3.62E-01	3.29E-01	6.74E-01	1.00E+00	3.11E-05
VOC	Carbon Tetrachloride	56-23-5	1.54E+02	2.73E+00	1.38E-02	6.59E-02	7.64E-01	3.79E-01	3.45E-01	1.83E+00	1.00E+00	4.84E-05
VOC	Chlorobenzene	108-90-7	1.13E+02	2.86E+00	2.87E-02	1.17E-01	4.49E-01	4.15E-01	3.79E-01	1.08E+00	1.00E+00	8.00E-05
VOC	Chloroethane	75-00-3	6.45E+01	1.43E+00	6.06E-03	1.87E-02	2.42E-01	3.46E-01	3.15E-01	5.80E-01	1.00E+00	1.49E-05
VOC	Chloroform	67-66-3	1.19E+02	1.92E+00	6.29E-03	2.64E-02	4.90E-01	3.51E-01	3.20E-01	1.18E+00	1.00E+00	1.86E-05
VOC	Chloromethane	74-87-3	5.05E+01	1.92E+00	1.53E-02	4.18E-02	2.02E-01	3.62E-01	3.29E-01	4.84E-01	1.00E+00	3.58E-05
VOC	Cumene	98-82-8	1.20E+02	3.50E+00	6.85E-02	2.89E-01	4.95E-01	5.47E-01	5.10E-01	1.19E+00	1.00E+00	1.93E-04
VOC	Cyclohexane	110-82-7	8.42E+01	3.44E+00	9.98E-02	3.52E-01	3.11E-01	5.99E-01	5.65E-01	7.47E-01	1.00E+00	2.30E-04
VOC	1,2-Dibromo-3-chloropropane	96-12-8	2.36E+02	2.63E+00	4.10E-03	2.42E-02	2.21E+00	3.50E-01	3.18E-01	5.32E+00	1.00E+00	2.38E-05
VOC	Dibromochloromethane	124-48-1	2.08E+02	2.17E+00	2.92E-03	1.62E-02	1.54E+00	3.44E-01	3.13E-01	3.70E+00	1.00E+00	1.42E-05
VOC	1,2-Dibromoethane	106-93-4	1.88E+02	1.60E+00	1.60E-03	8.43E-03	1.19E+00	3.39E-01	3.08E-01	2.84E+00	1.00E+00	6.81E-06
VOC	1,2-Dichlorobenzene	95-50-1	1.47E+02	3.43E+00	4.37E-02	2.04E-01	7.00E-01	4.81E-01	4.42E-01	1.68E+00	1.00E+00	1.46E-04
VOC	1,3-Dichlorobenzene	541-73-1	1.47E+02	3.38E+00	4.05E-02	1.89E-01	7.00E-01	4.69E-01	4.31E-01	1.68E+00	1.00E+00	1.35E-04
VOC	1,4-Dichlorobenzene	106-46-7	1.47E+02	3.42E+00	4.31E-02	2.01E-01	7.00E-01	4.78E-01	4.40E-01	1.68E+00	1.00E+00	1.44E-04
VOC	Dichlorodifluoromethane	75-71-8	1.21E+02	2.16E+00	8.88E-03	3.76E-02	5.00E-01	3.59E-01	3.27E-01	1.20E+00	1.00E+00	2.63E-05
VOC	1,1-Dichloroethane	75-34-3	9.90E+01	1.79E+00	6.72E-03	2.57E-02	3.77E-01	3.51E-01	3.19E-01	9.04E-01	1.00E+00	1.83E-05
VOC	1,2-Dichloroethane	107-06-2	9.90E+01	1.47E+00	4.13E-03	1.58E-02	3.77E-01	3.44E-01	3.13E-01	9.04E-01	1.00E+00	1.13E-05
VOC	1,1-Dichloroethene	75-35-4	9.69E+01	2.13E+00	1.16E-02	4.38E-02	3.67E-01	3.63E-01	3.30E-01	8.81E-01	1.00E+00	3.10E-05
VOC	1,2-Dichloroethene (total)	540-59-0	9.69E+01	1.86E+00	7.67E-03	2.90E-02	3.67E-01	3.53E-01	3.21E-01	8.81E-01	1.00E+00	2.07E-05
VOC	cis-1,2-Dichloroethene	156-59-2	9.69E+01	1.86E+00	7.67E-03	2.90E-02	3.67E-01	3.53E-01	3.21E-01	8.81E-01	1.00E+00	2.07E-05
VOC	trans-1,2-Dichloroethene	156-60-5	9.69E+01	2.07E+00	1.06E-02	4.00E-02	3.67E-01	3.60E-01	3.28E-01	8.81E-01	1.00E+00	2.83E-05
VOC	1,2-Dichloropropane	78-87-5	1.13E+02	1.97E+00	7.37E-03	3.01E-02	4.51E-01	3.54E-01	3.22E-01	1.08E+00	1.00E+00	2.12E-05
VOC	1,3-Dichloropropene (total)	542-75-6	1.11E+02	2.00E+00	7.92E-03	3.21E-02	4.40E-01	3.55E-01	3.23E-01	1.06E+00	1.00E+00	2.25E-05
VOC	cis-1,3-Dichloropropene	10061-01-5	1.11E+02	1.41E+00	3.23E-03	1.31E-02	4.40E-01	3.42E-01	3.11E-01	1.06E+00	1.00E+00	9.25E-06
VOC	trans-1,3-Dichloropropene	10061-02-6	1.11E+02	1.98E+00	7.68E-03	3.11E-02	4.40E-01	3.54E-01	3.22E-01	1.06E+00	1.00E+00	2.19E-05
VOC	Ethyl Benzene	100-41-4	1.06E+02	3.14E+00	4.76E-02	1.89E-01	4.13E-01	4.69E-01	4.30E-01	9.92E-01	1.00E+00	1.27E-04
VOC	2-Hexanone	591-78-6	1.00E+02	1.38E+00	3.55E-03	1.37E-02	3.83E-01	3.42E-01	3.12E-01	9.18E-01	1.00E+00	9.75E-06
VOC	Methyl Acetate	79-20-9	7.41E+01	1.80E-01	8.02E-04	2.65E-03	2.73E-01	3.35E-01	3.05E-01	6.56E-01	1.00E+00	2.04E-06
VOC	Methyl tert-butyl ether	1634-04-4	8.82E+01	1.24E+00	3.35E-03	1.21E-02	3.28E-01	3.41E-01	3.11E-01	7.87E-01	1.00E+00	8.84E-06
VOC	4-Methyl-2-pentanone	108-10-1	1.00E+02	1.19E+00	2.66E-03	1.02E-02	3.83E-01	3.40E-01	3.10E-01	9.18E-01	1.00E+00	7.32E-06
VOC	Methylcyclohexane	108-87-2	9.82E+01	2.96E+00	4.04E-02	1.54E-01	3.73E-01	4.43E-01	4.05E-01	8.95E-01	1.00E+00	1.05E-04
VOC	Methylene Chloride	75-09-2	8.49E+01	1.25E+00	3.54E-03	1.26E-02	3.14E-01	3.42E-01	3.11E-01	7.55E-01	1.00E+00	9.25E-06
VOC	Styrene	100-42-5	1.04E+02	2.94E+00	3.61E-02	1.42E-01	4.03E-01	4.34E-01	3.96E-01	9.67E-01	1.00E+00	9.63E-05

Attachment 2: Nonsteady State Dermal Absorption of Chemical from Water in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

Chem Group	Chemical	CASRN	MW (g/mole)	Log K_{ow} (unitless)	K_p (cm/hr)	B (unitless)	τ (hr)	c	b	ts (hr)	FA (unitless)	DA (L/cm^2-event)
VOC	1,1,2,2-Tetrachloroethane	79-34-5	1.68E+02	2.39E+00	6.88E-03	3.43E-02	9.16E-01	3.57E-01	3.24E-01	2.20E+00	1.00E+00	2.57E-05
VOC	Tetrachloroethene	127-18-4	1.66E+02	2.67E+00	1.08E-02	5.35E-02	8.92E-01	3.70E-01	3.37E-01	2.14E+00	1.00E+00	3.99E-05
VOC	Toluene	108-88-3	9.21E+01	2.75E+00	3.16E-02	1.16E-01	3.45E-01	4.15E-01	3.79E-01	8.28E-01	1.00E+00	8.08E-05
VOC	1,2,4-Trichlorobenzene	120-82-1	1.81E+02	4.01E+00	6.77E-02	3.51E-01	1.09E+00	5.97E-01	5.64E-01	2.62E+00	1.00E+00	2.76E-04
VOC	1,1,1-Trichloroethane	71-55-6	1.33E+02	2.48E+00	1.23E-02	5.46E-02	5.87E-01	3.71E-01	3.37E-01	1.41E+00	1.00E+00	3.85E-05
VOC	1,1,2-Trichloroethane	79-00-5	1.33E+02	2.05E+00	6.40E-03	2.84E-02	5.87E-01	3.53E-01	3.21E-01	1.41E+00	1.00E+00	2.02E-05
VOC	Trichloroethene	79-01-6	1.31E+02	2.71E+00	1.79E-02	7.89E-02	5.72E-01	3.88E-01	3.53E-01	1.37E+00	1.00E+00	5.53E-05
VOC	Trichlorofluoromethane	75-69-4	1.37E+02	2.53E+00	1.26E-02	5.68E-02	6.18E-01	3.72E-01	3.39E-01	1.48E+00	1.00E+00	4.03E-05
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1.87E+02	3.16E+00	1.72E-02	9.07E-02	1.18E+00	3.96E-01	3.61E-01	2.83E+00	1.00E+00	7.31E-05
VOC	1,2,4-Trimethylbenzene	95-63-6	1.20E+02	3.63E+00	8.37E-02	3.53E-01	4.95E-01	5.99E-01	5.66E-01	1.19E+00	1.00E+00	2.34E-04
VOC	1,3,5-Trimethylbenzene	108-67-8	1.20E+02	4.00E+00	1.47E-01	6.19E-01	4.95E-01	8.25E-01	8.44E-01	1.98E+00	1.00E+00	4.04E-04
VOC	Vinyl Chloride	75-01-4	6.25E+01	1.50E+00	6.92E-03	2.10E-02	2.35E-01	3.48E-01	3.16E-01	5.65E-01	1.00E+00	1.69E-05
VOC	Xylenes (total)	1330-20-7	1.06E+02	3.17E+00	4.96E-02	1.97E-01	4.13E-01	4.75E-01	4.36E-01	9.92E-01	1.00E+00	1.32E-04
SVOC	Acenaphthene	83-32-9	1.54E+02	3.92E+00	8.39E-02	4.01E-01	7.68E-01	6.39E-01	6.10E-01	1.84E+00	1.00E+00	2.96E-04
SVOC	Acenaphthylene	208-96-8	1.52E+02	3.94E+00	8.87E-02	4.21E-01	7.48E-01	6.56E-01	6.30E-01	1.80E+00	1.00E+00	3.09E-04
SVOC	Acetophenone	98-86-2	1.20E+02	1.58E+00	3.72E-03	1.57E-02	4.95E-01	3.44E-01	3.13E-01	1.19E+00	1.00E+00	1.11E-05
SVOC	Anthracene	120-12-7	1.78E+02	4.55E+00	1.60E-01	8.23E-01	1.05E+00	1.01E+00	1.11E+00	4.03E+00	1.00E+00	6.41E-04
SVOC	Atrazine	1912-24-9	2.16E+02	2.61E+00	5.18E-03	2.93E-02	1.70E+00	3.53E-01	3.21E-01	4.07E+00	1.00E+00	2.64E-05
SVOC	Benzaldehyde	100-52-7	1.06E+02	1.48E+00	3.82E-03	1.52E-02	4.13E-01	3.44E-01	3.13E-01	9.92E-01	1.00E+00	1.07E-05
SVOC	Benzo(a)anthracene	56-55-3	2.28E+02	5.70E+00	4.83E-01	2.80E+00	2.00E+00	2.89E+00	6.32E+00	8.39E+00	9.00E-01	2.40E-03
SVOC	Benzo(a)pyrene	50-32-8	2.52E+02	6.11E+00	6.60E-01	4.03E+00	2.72E+00	4.10E+00	1.20E+01	1.18E+01	8.00E-01	3.41E-03
SVOC	Benzo(b)fluoranthene	205-99-2	2.52E+02	6.20E+00	7.57E-01	4.62E+00	2.72E+00	4.68E+00	1.55E+01	1.19E+01	8.00E-01	3.90E-03
SVOC	Benzo(g,h,i)perylene	191-24-2	2.76E+02	7.23E+00	1.00E+00	6.39E+00	3.71E+00	6.44E+00	2.84E+01	1.65E+01	7.00E-01	5.27E-03
SVOC	Benzo(k)fluoranthene	207-08-9	2.52E+02	6.20E+00	7.57E-01	4.62E+00	2.72E+00	4.68E+00	1.55E+01	1.19E+01	8.00E-01	3.90E-03
SVOC	Biphenyl	92-52-4	1.54E+02	4.09E+00	1.09E-01	5.19E-01	7.68E-01	7.38E-01	7.30E-01	1.84E+00	1.00E+00	3.86E-04
SVOC	bis(2-Chloroethoxy)methane	111-91-1	1.73E+02	1.26E+00	1.16E-03	5.85E-03	9.79E-01	3.37E-01	3.07E-01	2.35E+00	1.00E+00	4.47E-06
SVOC	bis(2-Chloroethyl) ether	111-44-4	1.43E+02	1.21E+00	1.58E-03	7.25E-03	6.65E-01	3.38E-01	3.08E-01	1.60E+00	1.00E+00	5.24E-06
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	3.91E+02	7.30E+00	6.77E-01	5.15E+00	1.62E+01	5.20E+00	1.89E+01	7.10E+01	4.00E-01	4.26E-03
SVOC	4-Bromophenyl-phenyl ether	101-55-3	2.49E+02	4.28E+00	4.26E-02	2.59E-01	2.61E+00	5.24E-01	4.85E-01	6.27E+00	1.00E+00	2.69E-04
SVOC	Butylbenzylphthalate	85-68-7	3.12E+02	4.84E+00	4.42E-02	3.00E-01	5.90E+00	5.57E-01	5.20E-01	1.42E+01	9.00E-01	3.78E-04
SVOC	Caprolactam	105-60-2	1.13E+02	-1.90E-01	2.76E-04	1.13E-03	4.52E-01	3.34E-01	3.04E-01	1.09E+00	1.00E+00	8.01E-07
SVOC	Carbazole	86-74-8	1.67E+02	3.59E+00	4.30E-02	2.14E-01	9.08E-01	4.88E-01	4.49E-01	2.18E+00	1.00E+00	1.60E-04
SVOC	4-Chloro-3-methylphenol	59-50-7	1.43E+02	3.10E+00	2.80E-02	1.29E-01	6.61E-01	4.24E-01	3.87E-01	1.59E+00	1.00E+00	9.14E-05
SVOC	4-Chloroaniline	106-47-8	1.28E+02	1.85E+00	5.09E-03	2.21E-02	5.45E-01	3.48E-01	3.17E-01	1.31E+00	1.00E+00	1.56E-05
SVOC	2-Chloronaphthalene	91-58-7	1.63E+02	4.12E+00	1.02E-01	5.00E-01	8.56E-01	7.22E-01	7.10E-01	2.05E+00	1.00E+00	3.69E-04
SVOC	2-Chlorophenol	95-57-8	1.29E+02	2.15E+00	7.93E-03	3.46E-02	5.52E-01	3.57E-01	3.25E-01	1.32E+00	1.00E+00	2.44E-05
SVOC	4-Chlorophenyl-phenyl ether	7005-72-3	2.05E+02	4.08E+00	5.58E-02	3.07E-01	1.47E+00	5.62E-01	5.26E-01	3.53E+00	1.00E+00	2.65E-04
SVOC	Chrysene	218-01-9	2.28E+02	5.70E+00	4.83E-01	2.80E+00	2.00E+00	2.89E+00	6.32E+00	8.39E+00	9.00E-01	2.40E-03
SVOC	Dibenz(a,h)anthracene	53-70-3	2.78E+02	6.69E+00	1.00E+00	6.42E+00	3.81E+00	6.46E+00	2.86E+01	1.69E+01	7.00E-01	5.34E-03

Attachment 2: Nonsteady State Dermal Absorption of Chemical from Water in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

Chem Group	Chemical	CASRN	MW (g/mole)	Log K_{ow} (unitless)	K_p (cm/hr)	B (unitless)	τ (hr)	c	b	ts (hr)	FA (unitless)	DA (L/cm^2-event)
SVOC	Dibenzofuran	132-64-9	1.68E+02	4.39E+00	1.43E-01	7.14E-01	9.20E-01	9.08E-01	9.61E-01	3.57E+00	1.00E+00	5.36E-04
SVOC	3,3'-Dichlorobenzidine	91-94-1	2.53E+02	3.51E+00	1.26E-02	7.69E-02	2.75E+00	3.86E-01	3.52E-01	6.60E+00	1.00E+00	8.14E-05
SVOC	2,4-Dichlorophenol	120-83-2	1.63E+02	3.08E+00	2.09E-02	1.03E-01	8.60E-01	4.05E-01	3.69E-01	2.06E+00	1.00E+00	7.57E-05
SVOC	Diethylphthalate	84-66-2	2.22E+02	2.50E+00	4.03E-03	2.31E-02	1.85E+00	3.49E-01	3.17E-01	4.43E+00	1.00E+00	2.14E-05
SVOC	2,4-Dimethylphenol	105-67-9	1.22E+02	2.36E+00	1.18E-02	5.03E-02	5.08E-01	3.68E-01	3.35E-01	1.22E+00	1.00E+00	3.52E-05
SVOC	Dimethylphthalate	131-11-3	1.94E+02	1.87E+00	2.22E-03	1.19E-02	1.29E+00	3.41E-01	3.11E-01	3.09E+00	1.00E+00	9.85E-06
SVOC	Di-n-butylphthalate	84-74-2	2.78E+02	4.61E+00	4.83E-02	3.10E-01	3.81E+00	5.64E-01	5.28E-01	9.14E+00	9.00E-01	3.31E-04
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	1.98E+02	2.12E+00	3.09E-03	1.67E-02	1.35E+00	3.45E-01	3.14E-01	3.25E+00	1.00E+00	1.40E-05
SVOC	2,4-Dinitrophenol	51-28-5	1.84E+02	1.55E+00	1.56E-03	8.12E-03	1.13E+00	3.39E-01	3.08E-01	2.71E+00	1.00E+00	6.46E-06
SVOC	2,4-Dinitrotoluene	121-14-2	1.82E+02	2.01E+00	3.21E-03	1.67E-02	1.10E+00	3.45E-01	3.13E-01	2.64E+00	1.00E+00	1.32E-05
SVOC	2,6-Dinitrotoluene	606-20-2	1.82E+02	1.87E+00	2.60E-03	1.35E-02	1.10E+00	3.42E-01	3.12E-01	2.64E+00	1.00E+00	1.06E-05
SVOC	Di-n-octylphthalate	117-84-0	3.91E+02	8.06E+00	1.00E+00	7.60E+00	1.62E+01	7.64E+00	3.95E+01	7.25E+01	3.00E-01	4.72E-03
SVOC	Fluoranthene	206-44-0	2.02E+02	5.12E+00	2.80E-01	1.53E+00	1.43E+00	1.66E+00	2.41E+00	5.68E+00	1.00E+00	1.31E-03
SVOC	Fluorene	86-73-7	1.66E+02	4.21E+00	1.12E-01	5.54E-01	8.97E-01	7.68E-01	7.68E-01	2.15E+00	1.00E+00	4.13E-04
SVOC	Formaldehyde	50-00-0	3.00E+01	3.50E-01	1.83E-03	3.86E-03	1.55E-01	3.36E-01	3.06E-01	3.72E-01	1.00E+00	4.22E-06
SVOC	Hexachlorobenzene	118-74-1	2.85E+02	5.89E+00	3.11E-01	2.02E+00	4.14E+00	2.13E+00	3.67E+00	1.69E+01	8.00E-01	1.98E-03
SVOC	Hexachlorobutadiene	87-68-3	2.61E+02	4.81E+00	8.21E-02	5.10E-01	3.03E+00	7.31E-01	7.21E-01	7.28E+00	9.00E-01	5.03E-04
SVOC	Hexachlorocyclopentadiene	77-47-4	2.73E+02	5.39E+00	1.70E-01	1.08E+00	3.54E+00	1.24E+00	1.51E+00	1.37E+01	9.00E-01	1.12E-03
SVOC	Hexachloroethane	67-72-1	2.37E+02	4.00E+00	3.27E-02	1.93E-01	2.23E+00	4.73E-01	4.34E-01	5.34E+00	1.00E+00	1.91E-04
SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	2.76E+02	6.65E+00	1.00E+00	6.39E+00	3.71E+00	6.44E+00	2.84E+01	1.65E+01	7.00E-01	5.27E-03
SVOC	Isophorone	78-59-1	1.38E+02	1.70E+00	3.53E-03	1.60E-02	6.25E-01	3.44E-01	3.13E-01	1.50E+00	1.00E+00	1.14E-05
SVOC	2-Methylnaphthalene	91-57-6	1.42E+02	3.86E+00	8.94E-02	4.10E-01	6.58E-01	6.46E-01	6.19E-01	1.58E+00	1.00E+00	2.89E-04
SVOC	Methylphenol (total)	1319-77-3	1.08E+02	1.96E+00	7.73E-03	3.09E-02	4.24E-01	3.54E-01	3.22E-01	1.02E+00	1.00E+00	2.17E-05
SVOC	2-Methylphenol	95-48-7	1.08E+02	1.99E+00	8.09E-03	3.23E-02	4.24E-01	3.55E-01	3.23E-01	1.02E+00	1.00E+00	2.27E-05
SVOC	4-Methylphenol	106-44-5	1.08E+02	1.92E+00	7.27E-03	2.91E-02	4.24E-01	3.53E-01	3.21E-01	1.02E+00	1.00E+00	2.05E-05
SVOC	Naphthalene	91-20-3	1.28E+02	3.36E+00	5.01E-02	2.18E-01	5.49E-01	4.92E-01	4.53E-01	1.32E+00	1.00E+00	1.49E-04
SVOC	2-Nitroaniline	88-74-4	1.38E+02	1.85E+00	4.44E-03	2.01E-02	6.24E-01	3.47E-01	3.16E-01	1.50E+00	1.00E+00	1.44E-05
SVOC	3-Nitroaniline	99-09-2	1.38E+02	1.37E+00	2.14E-03	9.68E-03	6.24E-01	3.40E-01	3.09E-01	1.50E+00	1.00E+00	6.94E-06
SVOC	4-Nitroaniline	100-01-6	1.38E+02	1.39E+00	2.21E-03	9.98E-03	6.24E-01	3.40E-01	3.09E-01	1.50E+00	1.00E+00	7.15E-06
SVOC	Nitrobenzene	98-95-3	1.23E+02	1.84E+00	5.31E-03	2.27E-02	5.14E-01	3.49E-01	3.17E-01	1.23E+00	1.00E+00	1.60E-05
SVOC	2-Nitrophenol	88-75-5	1.39E+02	1.79E+00	4.00E-03	1.82E-02	6.32E-01	3.46E-01	3.14E-01	1.52E+00	1.00E+00	1.30E-05
SVOC	4-Nitrophenol	100-02-7	1.39E+02	1.91E+00	4.80E-03	2.18E-02	6.32E-01	3.48E-01	3.17E-01	1.52E+00	1.00E+00	1.56E-05
SVOC	N-Nitrosodiphenylamine	86-30-6	1.98E+02	3.16E+00	1.50E-02	8.11E-02	1.35E+00	3.89E-01	3.55E-01	3.25E+00	1.00E+00	6.82E-05
SVOC	N-Nitroso-di-n-propylamine	621-64-7	1.30E+02	1.40E+00	2.48E-03	1.09E-02	5.64E-01	3.41E-01	3.10E-01	1.35E+00	1.00E+00	7.74E-06
SVOC	2,2'-oxybis(1-Chloropropane)	108-60-1	1.71E+02	2.45E+00	7.23E-03	3.64E-02	9.55E-01	3.58E-01	3.26E-01	2.29E+00	1.00E+00	2.76E-05
SVOC	Pentachlorophenol	87-86-5	2.66E+02	5.09E+00	1.17E-01	7.34E-01	3.26E+00	9.26E-01	9.88E-01	1.26E+01	9.00E-01	7.43E-04
SVOC	Phenanthrene	85-01-8	1.78E+02	4.46E+00	1.40E-01	7.18E-01	1.05E+00	9.12E-01	9.67E-01	4.06E+00	1.00E+00	5.59E-04
SVOC	Phenol	108-95-2	9.41E+01	1.48E+00	4.46E-03	1.67E-02	3.54E-01	3.45E-01	3.13E-01	8.49E-01	1.00E+00	1.20E-05
SVOC	Pyrene	129-00-0	2.02E+02	5.11E+00	2.75E-01	1.51E+00	1.43E+00	1.64E+00	2.36E+00	5.67E+00	1.00E+00	1.29E-03

Attachment 2: Nonsteady State Dermal Absorption of Chemical from Water in Kiddie Pool GMC: NAO Flint Operations Site, Flint, Michigan													
Chem Group	**Chemical**	**CASRN**	**MW** (g/mole)	**Log K_{ow}** (unitless)	**K_p** (cm/hr)	**B** (unitless)	**τ** (hr)	**c**	**b**	**ts** (hr)	**FA** (unitless)	**DA** (L/cm^2-event)
SVOC	2,4,5-Trichlorophenol	95-95-4	1.97E+02	3.90E+00	4.66E-02	2.52E-01	1.34E+00	5.18E-01	4.79E-01	3.22E+00	1.00E+00	2.11E-04
SVOC	2,4,6-Trichlorophenol	88-06-2	1.97E+02	3.70E+00	3.44E-02	1.86E-01	1.34E+00	4.67E-01	4.28E-01	3.22E+00	1.00E+00	1.56E-04
PCB	PCBs (total)	1336-36-3	3.28E+02	6.50E+00	4.50E-01	3.13E+00	7.22E+00	3.22E+00	7.67E+00	3.06E+01	7.00E-01	3.31E-03
INORG	Antimony	7440-36-0	1.22E+02		1.00E-03							2.00E-06
INORG	Arsenic	7440-38-2	7.49E+01		1.00E-03							2.00E-06
INORG	Barium	7440-39-3	1.37E+02		1.00E-03							2.00E-06
INORG	Beryllium	7440-41-7	9.01E+00		1.00E-03							2.00E-06
INORG	Cadmium	7440-43-9	1.12E+02		1.00E-03							2.00E-06
INORG	Chromium (total)	7440-47-3	5.20E+01		2.00E-03							4.00E-06
INORG	Chromium III	16065-83-1	5.20E+01		1.00E-03							2.00E-06
INORG	Chromium VI	18540-29-9	5.20E+01		2.00E-03							4.00E-06
INORG	Cobalt	7440-48-4	5.89E+01		4.00E-04							8.00E-07
INORG	Copper	7440-50-8	6.35E+01		1.00E-03							2.00E-06
INORG	Cyanide (total)	57-12-5	2.60E+01		1.00E-03							2.00E-06
INORG	Fluoride	16984-48-8	0.00E+00		1.00E-03							2.00E-06
INORG	Lead	7439-92-1	2.07E+02		1.00E-04							2.00E-07
INORG	Manganese	7439-96-5	5.49E+01		1.00E-03							2.00E-06
INORG	Mercury	7439-97-6	2.01E+02		1.00E-03							2.00E-06
INORG	Nickel	7440-02-0	5.87E+01		2.00E-04							4.00E-07
INORG	Selenium	7782-49-2	7.90E+01		1.00E-03							2.00E-06
INORG	Silver	7440-22-4	1.08E+02		6.00E-04							1.20E-06
INORG	Thallium	7440-28-0	2.04E+02		1.00E-03							2.00E-06
INORG	Vanadium	7440-62-2	5.09E+01		1.00E-03							2.00E-06
INORG	Zinc	7440-66-6	6.54E+01		6.00E-04							1.20E-06
Note:	Event Time (Residential Kiddie Pool scenario)		hours	**t**	2							

Attachment 2: Risk Based Cancer Criteria for Exposure to Groundwater in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

				Incidental Ingestion			Dermal Contact				Vapor Inhalation			
Chem Group	Chemical	CASRN	Carc Class	LADD (mg/kg/d)	SF_{oral} $(mg/kg/d)^{-1}$	RBC (mg/l)	DA (L/cm^2-event)	LADD (mg/kg/d)	SF_{derm} $(mg/kg/d)^{-1}$	RBC (mg/l)	C_{air} (mg/m^3)	URF (m^3/mg)	RBC (mg/l)	Combined RBC (mg/l)
VOC	Acetone	67-64-1	ID	3.94E-05			1.27E-06	6.06E-06			4.99E-03			
VOC	Benzene	71-43-2	A	3.28E-05	5.5E-02	5.5E+00	3.70E-05	1.47E-04	5.5E-02	1.2E+00	5.30E-03	7.8E-03	2.2E+02	1.0E+00
VOC	Bromodichloromethane	75-27-4	B2	3.25E-05	6.2E-02	5.0E+00	1.70E-05	6.66E-05	6.2E-02	2.4E+00	5.32E-03	1.8E-02	9.7E+01	1.6E+00
VOC	Bromoform	75-25-2	B2	3.48E-05	7.9E-03	3.6E+01	1.40E-05	5.90E-05	7.9E-03	2.1E+01	5.22E-03	1.1E-03	1.5E+03	1.3E+01
VOC	Bromomethane	74-83-9	D	3.05E-05			7.68E-06	2.83E-05			5.39E-03			
VOC	2-Butanone	78-93-3	ID	4.02E-05			2.42E-06	1.18E-05			4.94E-03			
VOC	Carbon Disulfide	75-15-0		3.25E-05			3.11E-05	1.22E-04			5.31E-03			
VOC	Carbon Tetrachloride	56-23-5	B2	3.40E-05	1.3E-01	2.3E+00	4.84E-05	1.99E-04	1.3E-01	3.9E-01	5.25E-03	1.5E-02	1.1E+02	3.3E-01
VOC	Chlorobenzene	108-90-7	D	3.42E-05			8.00E-05	3.31E-04			5.24E-03			
VOC	Chloroethane	75-00-3		3.10E-05	2.9E-03	1.1E+02	1.49E-05	5.58E-05	2.9E-03	6.2E+01	5.38E-03			4.0E+01
VOC	Chloroform	67-66-3	B2	3.26E-05			1.86E-05	7.33E-05			5.31E-03	2.3E-02	7.5E+01	7.5E+01
VOC	Chloromethane	74-87-3	D	3.74E-05			3.58E-05	1.62E-04			5.09E-03			
VOC	Cumene	98-82-8	D	3.64E-05			1.93E-04	8.48E-04			5.14E-03			
VOC	Cyclohexane	110-82-7	ID	3.36E-05			2.30E-04	9.34E-04			5.27E-03			
VOC	1,2-Dibromo-3-chloropropane	96-12-8	B2	3.79E-05	1.4E+00	1.9E-01	2.38E-05	1.09E-04	1.4E+00	6.5E-02	5.07E-03	6.9E-04	2.3E+03	4.9E-02
VOC	Dibromochloromethane	124-48-1	C	3.35E-05	8.4E-02	3.6E+00	1.42E-05	5.75E-05	8.4E-02	2.1E+00	5.27E-03	2.4E-02	7.0E+01	1.3E+00
VOC	1,2-Dibromoethane	106-93-4	LC	3.56E-05	2.0E+00	1.4E-01	6.81E-06	2.93E-05	2.0E+00	1.7E-01	5.18E-03	6.0E-01	2.7E+00	7.5E-02
VOC	1,2-Dichlorobenzene	95-50-1	D	3.54E-05			1.46E-04	6.25E-04			5.19E-03			
VOC	1,3-Dichlorobenzene	541-73-1	D	3.54E-05			1.35E-04	5.79E-04			5.19E-03			
VOC	1,4-Dichlorobenzene	106-46-7	C	3.54E-05	2.4E-02	1.2E+01	1.44E-04	6.14E-04	2.4E-02	6.8E-01	5.19E-03	6.3E-03	2.6E+02	6.4E-01
VOC	Dichlorodifluoromethane	75-71-8		3.50E-05			2.63E-05	1.11E-04			5.21E-03			
VOC	1,1-Dichloroethane	75-34-3	C	3.21E-05			1.83E-05	7.09E-05			5.33E-03			
VOC	1,2-Dichloroethane	107-06-2	B2	3.30E-05	9.1E-02	3.3E+00	1.13E-05	4.51E-05	9.1E-02	2.4E+00	5.29E-03	2.6E-02	6.5E+01	1.4E+00
VOC	1,1-Dichloroethene	75-35-4	C	3.21E-05			3.10E-05	1.20E-04			5.33E-03			
VOC	1,2-Dichloroethene (total)	540-59-0		3.07E-05			2.07E-05	7.67E-05			5.39E-03			
VOC	cis-1,2-Dichloroethene	156-59-2	D	3.13E-05			2.07E-05	7.83E-05			5.36E-03			
VOC	trans-1,2-Dichloroethene	156-60-5		3.07E-05			2.83E-05	1.05E-04			5.39E-03			
VOC	1,2-Dichloropropane	78-87-5	B2	3.42E-05	6.8E-02	4.3E+00	2.12E-05	8.75E-05	6.8E-02	1.7E+00	5.24E-03			1.2E+00
VOC	1,3-Dichloropropene (total)	542-75-6	B2	3.26E-05	1.0E-01	3.1E+00	2.25E-05	8.86E-05	1.0E-01	1.1E+00	5.31E-03	4.0E-03	4.3E+02	8.2E-01
VOC	cis-1,3-Dichloropropene	10061-01-5		3.52E-05	1.0E-01	2.8E+00	9.25E-06	3.93E-05	1.0E-01	2.5E+00	5.20E-03	4.0E-03	4.1E+02	1.3E+00
VOC	trans-1,3-Dichloropropene	10061-02-6		3.29E-05			2.19E-05	8.68E-05			5.30E-03			
VOC	Ethyl Benzene	100-41-4	D	3.54E-05			1.27E-04	5.42E-04			5.19E-03			
VOC	2-Hexanone	591-78-6		9.30E-05			9.75E-06	1.10E-04						
VOC	Methyl Acetate	79-20-9		3.59E-05			2.04E-06	8.85E-06			5.16E-03			
VOC	Methyl tert-butyl ether	1634-04-4		3.32E-05			8.84E-06	3.54E-05			5.29E-03			
VOC	4-Methyl-2-pentanone	108-10-1	ID	3.85E-05			7.32E-06	3.40E-05			5.04E-03			
VOC	Methylcyclohexane	108-87-2		3.43E-05			1.05E-04	4.34E-04			5.24E-03			
VOC	Methylene Chloride	75-09-2	B2	3.10E-05	7.5E-03	4.3E+01	9.25E-06	3.46E-05	7.5E-03	3.8E+01	5.38E-03	4.7E-04	3.8E+03	2.0E+01
VOC	Styrene	100-42-5		3.52E-05			9.63E-05	4.10E-04			5.20E-03			
VOC	1,1,2,2-Tetrachloroethane	79-34-5	C	3.65E-05	2.0E-01	1.4E+00	2.57E-05	1.14E-04	2.0E-01	4.4E-01	5.14E-03	5.8E-02	2.7E+01	3.3E-01
VOC	Tetrachloroethene	127-18-4	C-B2	3.48E-05	5.2E-02	5.5E+00	3.99E-05	1.68E-04	5.2E-02	1.1E+00	5.22E-03	3.1E-03	5.3E+02	9.5E-01

Attachment 2: Risk Based Cancer Criteria for Exposure to Groundwater in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

				Incidental Ingestion			Dermal Contact				Vapor Inhalation			
Chem Group	Chemical	CASRN	Carc Class	LADD (mg/kg/d)	SF_{oral} $(mg/kg/d)^{-1}$	RBC (mg/l)	DA (L/cm^2-event)	LADD (mg/kg/d)	SF_{derm} $(mg/kg/d)^{-1}$	RBC (mg/l)	C_{air} (mg/m^3)	URF (m^3/mg)	RBC (mg/l)	Combined RBC (mg/l)
VOC	Toluene	108-88-3	D	3.43E-05			8.08E-05	3.35E-04			5.24E-03			
VOC	1,2,4-Trichlorobenzene	120-82-1	D	3.53E-05			2.76E-04	1.18E-03			5.19E-03			
VOC	1,1,1-Trichloroethane	71-55-6	D	3.40E-05			3.85E-05	1.58E-04			5.25E-03			
VOC	1,1,2-Trichloroethane	79-00-5	C	3.45E-05	5.7E-02	5.1E+00	2.02E-05	8.40E-05	5.7E-02	2.1E+00	5.23E-03	1.6E-02	1.0E+02	1.5E+00
VOC	Trichloroethene	79-01-6	C-B2	3.36E-05	1.1E-02	2.7E+01	5.53E-05	2.25E-04	1.1E-02	4.0E+00	5.27E-03	1.7E-03	9.9E+02	3.5E+00
VOC	Trichlorofluoromethane	75-69-4		3.29E-05			4.03E-05	1.60E-04			5.30E-03			
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		3.48E-05			7.31E-05	3.07E-04			5.22E-03			
VOC	1,2,4-Trimethylbenzene	95-63-6	ID	3.52E-05			2.34E-04	9.96E-04			5.20E-03			
VOC	1,3,5-Trimethylbenzene	108-67-8	ID	3.42E-05			4.04E-04	1.67E-03			5.24E-03			
VOC	Vinyl Chloride	75-01-4	A	3.03E-05	1.4E+00	2.4E-01	1.69E-05	6.17E-05	1.4E+00	1.2E-01	5.40E-03	8.8E-03	2.1E+02	7.8E-02
VOC	Xylenes (total)	1330-20-7	ID	3.41E-05			1.32E-04	5.43E-04			5.25E-03			
SVOC	Acenaphthene	83-32-9		3.95E-05			2.96E-04	1.41E-03			4.98E-03			
SVOC	Acenaphthylene	208-96-8	D	4.17E-05			3.09E-04	1.55E-03			4.86E-03			
SVOC	Acetophenone	98-86-2	D	6.00E-05			1.11E-05	8.01E-05			3.51E-03			
SVOC	Anthracene	120-12-7	D	4.57E-05			6.41E-04	3.54E-03			4.60E-03			
SVOC	Atrazine	1912-24-9	C	9.30E-05	2.2E-01	4.8E-01	2.64E-05	2.97E-04	2.2E-01	1.5E-01	2.41E-06	6.3E-02	2.1E+04	1.2E-01
SVOC	Benzaldehyde	100-52-7		4.95E-05			1.07E-05	6.42E-05			4.35E-03			
SVOC	Benzo(a)anthracene	56-55-3	B2	7.97E-05	7.3E-01	1.7E-01	2.40E-03	2.31E-02	7.3E-01	5.9E-04	1.56E-03	8.9E-02	2.7E+01	5.9E-04
SVOC	Benzo(a)pyrene	50-32-8	B2	8.83E-05	7.3E+00	1.6E-02	3.41E-03	3.63E-02	7.3E+00	3.8E-05	5.71E-04	8.9E-01	6.7E+00	3.8E-05
SVOC	Benzo(b)fluoranthene	205-99-2	B2	4.63E-05	7.3E-01	3.0E-01	3.90E-03	2.19E-02	7.3E-01	6.3E-04	4.57E-03	8.9E-02	1.6E+01	6.3E-04
SVOC	Benzo(g,h,i)perylene	191-24-2	D	9.26E-05			5.27E-03	5.90E-02			4.89E-05			
SVOC	Benzo(k)fluoranthene	207-08-9	B2	9.07E-05	7.3E-02	1.5E+00	3.90E-03	4.28E-02	7.3E-02	3.2E-03	2.85E-04	8.9E-03	1.3E+03	3.2E-03
SVOC	Biphenyl	92-52-4	D	3.71E-05			3.86E-04	1.73E-03			5.11E-03			
SVOC	bis(2-Chloroethoxy)methane	111-91-1	D	9.23E-05			4.47E-06	4.98E-05			9.35E-05			
SVOC	bis(2-Chloroethyl) ether	111-44-4	B2	5.44E-05	1.1E+00	1.7E-01	5.24E-06	3.44E-05	1.1E+00	2.6E-01	3.98E-03	3.3E-01	4.2E+00	1.0E-01
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	B2	9.26E-05	1.4E-02	7.7E+00	4.26E-03	4.77E-02	1.4E-02	1.5E-02	4.90E-05	4.0E-03	1.6E+04	1.5E-02
SVOC	4-Bromophenyl-phenyl ether	101-55-3	D	4.37E-05			2.69E-04	1.42E-03			4.74E-03			
SVOC	Butylbenzylphthalate	85-68-7	C	9.01E-05	1.9E-03	5.8E+01	3.78E-04	4.11E-03	1.9E-03	1.3E+00	3.58E-04	5.4E-04	1.7E+04	1.3E+00
SVOC	Caprolactam	105-60-2		9.30E-05			8.01E-07	9.00E-06			3.83E-06			
SVOC	Carbazole	86-74-8	B2	9.30E-05	2.0E-02	5.4E+00	1.60E-04	1.80E-03	2.0E-02	2.8E-01	7.93E-06	5.7E-03	7.1E+04	2.6E-01
SVOC	4-Chloro-3-methylphenol	59-50-7		9.09E-05			9.14E-05	1.00E-03			2.66E-04			
SVOC	4-Chloroaniline	106-47-8		9.15E-05	5.4E-02	2.0E+00	1.56E-05	1.73E-04	5.4E-02	1.1E+00	1.93E-04	1.5E-02	1.1E+03	7.0E-01
SVOC	2-Chloronaphthalene	91-58-7		3.59E-05			3.69E-04	1.60E-03			5.16E-03			
SVOC	2-Chlorophenol	95-57-8		3.47E-05			2.44E-05	1.02E-04			5.22E-03			
SVOC	4-Chlorophenyl-phenyl ether	7005-72-3		3.93E-05			2.65E-04	1.26E-03			4.99E-03			
SVOC	Chrysene	218-01-9	B2	4.60E-05	7.3E-03	3.0E+01	2.40E-03	1.33E-02	7.3E-03	1.0E-01	4.59E-03	8.9E-04	1.6E+03	1.0E-01
SVOC	Dibenz(a,h)anthracene	53-70-3	B2	9.30E-05	7.3E+00	1.5E-02	5.34E-03	6.00E-02	7.3E+00	2.3E-05	4.92E-06	8.9E-01	7.3E+02	2.3E-05
SVOC	Dibenzofuran	132-64-9	D	7.02E-05			5.36E-04	4.55E-03			2.56E-03			
SVOC	3,3'-Dichlorobenzidine	91-94-1	B2	9.30E-05	4.5E-01	2.4E-01	8.14E-05	9.15E-04	4.5E-01	2.4E-02	1.30E-06	1.3E-01	1.9E+04	2.2E-02
SVOC	2,4-Dichlorophenol	120-83-2		8.27E-05			7.57E-05	7.57E-04			1.22E-03			
SVOC	Diethylphthalate	84-66-2	D	9.16E-05			2.14E-05	2.37E-04			1.72E-04			

Attachment 2: Risk Based Cancer Criteria for Exposure to Groundwater in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

				Incidental Ingestion			Dermal Contact				Vapor Inhalation			
Chem Group	Chemical	CASRN	Carc Class	LADD (mg/kg/d)	SF_{oral} $(mg/kg/d)^{-1}$	RBC (mg/l)	DA (L/cm^2-event)	LADD (mg/kg/d)	SF_{derm} $(mg/kg/d)^{-1}$	RBC (mg/l)	C_{air} (mg/m^3)	URF (m^3/mg)	RBC (mg/l)	Combined RBC (mg/l)
SVOC	2,4-Dimethylphenol	105-67-9		8.36E-05			3.52E-05	3.55E-04			1.12E-03			
SVOC	Dimethylphthalate	131-11-3	D	9.25E-05			9.85E-06	1.10E-04			6.92E-05			
SVOC	Di-n-butylphthalate	84-74-2	D	9.30E-05			3.31E-04	3.73E-03			5.28E-07			
SVOC	4,6-Dinitro-2-methylphenol	534-52-1		9.16E-05			1.40E-05	1.55E-04			1.71E-04			
SVOC	2,4-Dinitrophenol	51-28-5		9.16E-05			6.46E-06	7.15E-05			1.77E-04			
SVOC	2,4-Dinitrotoluene	121-14-2	B2	9.19E-05	6.8E-01	1.6E-01	1.32E-05	1.46E-04	6.8E-01	1.0E-01	1.42E-04			6.2E-02
SVOC	2,6-Dinitrotoluene	606-20-2	B2	9.04E-05	6.8E-01	1.6E-01	1.06E-05	1.16E-04	6.8E-01	1.3E-01	3.27E-04	1.9E-01	5.2E+01	7.1E-02
SVOC	Di-n-octylphthalate	117-84-0		5.57E-05			4.72E-03	3.18E-02			3.87E-03			
SVOC	Fluoranthene	206-44-0	D	6.43E-05			1.31E-03	1.01E-02			3.12E-03			
SVOC	Fluorene	86-73-7	D	4.51E-05			4.13E-04	2.25E-03			4.64E-03			
SVOC	Formaldehyde	50-00-0	B1	8.92E-05			4.22E-06	4.55E-05			4.60E-04	1.3E-02	5.6E+02	5.6E+02
SVOC	Hexachlorobenzene	118-74-1	B2	3.89E-05	1.6E+00	1.6E-01	1.98E-03	9.28E-03	1.6E+00	6.7E-04	5.02E-03	4.6E-01	3.3E+00	6.7E-04
SVOC	Hexachlorobutadiene	87-68-3	C	3.81E-05	7.8E-02	3.4E+00	5.03E-04	2.31E-03	7.8E-02	5.5E-02	5.06E-03	2.2E-02	7.0E+01	5.4E-02
SVOC	Hexachlorocyclopentadiene	77-47-4	E	3.63E-05			1.12E-03	4.93E-03			5.15E-03			
SVOC	Hexachloroethane	67-72-1	C	3.80E-05	1.4E-02	1.9E+01	1.91E-04	8.74E-04	1.4E-02	8.2E-01	5.06E-03	4.0E-03	3.9E+02	7.8E-01
SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	B2	8.91E-05	7.3E-01	1.5E-01	5.27E-03	5.68E-02	7.3E-01	2.4E-04	4.72E-04	8.9E-02	8.0E+01	2.4E-04
SVOC	Isophorone	78-59-1	C	6.98E-05	9.5E-04	1.5E+02	1.14E-05	9.65E-05	9.5E-04	1.1E+02	2.59E-03			6.3E+01
SVOC	2-Methylnaphthalene	91-57-6	ID	3.66E-05			2.89E-04	1.27E-03			5.13E-03			
SVOC	Methylphenol (total)	1319-77-3		8.79E-05			2.17E-05	2.31E-04			6.22E-04			
SVOC	2-Methylphenol	95-48-7	C	8.61E-05			2.27E-05	2.37E-04			8.30E-04			
SVOC	4-Methylphenol	106-44-5	C	8.83E-05			2.05E-05	2.18E-04			5.75E-04			
SVOC	Naphthalene	91-20-3	C	3.68E-05			1.49E-04	6.63E-04			5.12E-03			
SVOC	2-Nitroaniline	88-74-4		9.20E-05			1.44E-05	1.60E-04			1.24E-04			
SVOC	3-Nitroaniline	99-09-2	C	9.30E-05	2.1E-02	5.1E+00	6.94E-06	7.80E-05	2.1E-02	6.1E+00				2.8E+00
SVOC	4-Nitroaniline	100-01-6	C	9.30E-05	2.1E-02	5.1E+00	7.15E-06	8.04E-05	2.1E-02	5.9E+00	1.40E-06			2.7E+00
SVOC	Nitrobenzene	98-95-3	D	4.93E-05			1.60E-05	9.51E-05			4.36E-03			
SVOC	2-Nitrophenol	88-75-5		6.58E-05			1.30E-05	1.03E-04			2.98E-03			
SVOC	4-Nitrophenol	100-02-7		9.30E-05			1.56E-05	1.75E-04			2.95E-07			
SVOC	N-Nitrosodiphenylamine	86-30-6	B2	7.92E-05	4.9E-03	2.6E+01	6.82E-05	6.52E-04	4.9E-03	3.1E+00	1.62E-03			2.8E+00
SVOC	N-Nitroso-di-n-propylamine	621-64-7	B2	8.30E-05	7.0E+00	1.7E-02	7.74E-06	7.77E-05	7.0E+00	1.8E-02	1.18E-03	2.0E+00	1.5E+00	8.8E-03
SVOC	2,2'-oxybis(1-Chloropropane)	108-60-1	C	4.15E-05	7.0E-02	3.4E+00	2.76E-05	1.38E-04	7.0E-02	1.0E+00	4.87E-03	1.0E-02	1.5E+02	7.9E-01
SVOC	Pentachlorophenol	87-86-5	B2	9.29E-05	1.2E-01	9.0E-01	7.43E-04	8.34E-03	1.2E-01	1.0E-02	1.61E-05	3.4E-02	5.8E+03	9.9E-03
SVOC	Phenanthrene	85-01-8	D	5.65E-05			5.59E-04	3.82E-03			3.81E-03			
SVOC	Phenol	108-95-2	ID	9.04E-05			1.20E-05	1.31E-04			3.23E-04			
SVOC	Pyrene	129-00-0	D	7.04E-05			1.29E-03	1.09E-02			2.54E-03			
SVOC	2,4,5-Trichlorophenol	95-95-4		8.10E-05			2.11E-04	2.06E-03			1.41E-03			
SVOC	2,4,6-Trichlorophenol	88-06-2	B2	7.38E-05	1.1E-02	1.2E+01	1.56E-04	1.39E-03	1.1E-02	6.5E-01	2.18E-03	3.1E-03	5.9E+02	6.2E-01
PCB	PCBs (total)	1336-36-3	B2	4.08E-05	2.0E+00	1.2E-01	3.31E-03	1.63E-02	2.0E+00	3.1E-04	4.91E-03	5.7E-01	2.6E+00	3.1E-04
INORG	Antimony	7440-36-0		9.30E-05			2.00E-06	2.25E-05						
INORG	Arsenic	7440-38-2	A	9.30E-05	1.5E+00	7.2E-02	2.00E-06	2.25E-05	1.5E+00	3.0E-01		4.3E+00		5.8E-02
INORG	Barium	7440-39-3	D	9.30E-05			2.00E-06	2.25E-05						

Attachment 2: Risk Based Cancer Criteria for Exposure to Groundwater in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

				Incidental Ingestion			Dermal Contact				Vapor Inhalation			
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**LADD** (mg/kg/d)	**SF_{oral}** $(mg/kg/d)^{-1}$	**RBC** (mg/l)	**DA** $(L/cm^2$-event)	**LADD** (mg/kg/d)	**SF_{derm}** $(mg/kg/d)^{-1}$	**RBC** (mg/l)	**C_{air}** (mg/m^3)	**URF** (m^3/mg)	**RBC** (mg/l)	**Combined RBC** (mg/l)
INORG	Beryllium	7440-41-7	B1	9.30E-05			2.00E-06	2.25E-05				2.4E+00		
INORG	Cadmium	7440-43-9	B1	9.30E-05			2.00E-06	2.25E-05				1.8E+00		
INORG	Chromium (total)	7440-47-3		9.30E-05			4.00E-06	4.50E-05				1.2E+01		
INORG	Chromium III	16065-83-1	D	9.30E-05			2.00E-06	2.25E-05						
INORG	Chromium VI	18540-29-9	A	9.30E-05			4.00E-06	4.50E-05				1.2E+01		
INORG	Cobalt	7440-48-4	B1	9.30E-05			8.00E-07	8.99E-06				2.8E+00		
INORG	Copper	7440-50-8	D	9.30E-05			2.00E-06	2.25E-05						
INORG	Cyanide (total)	57-12-5	D	9.30E-05			2.00E-06	2.25E-05						
INORG	Fluoride	16984-48-8		9.30E-05			2.00E-06	2.25E-05						
INORG	Lead	7439-92-1	B2	9.30E-05			2.00E-07	2.25E-06						
INORG	Manganese	7439-96-5	D	9.30E-05			2.00E-06	2.25E-05						
INORG	Mercury	7439-97-6	D	3.78E-05			2.00E-06	9.15E-06			5.07E-03			
INORG	Nickel	7440-02-0	A	9.30E-05			4.00E-07	4.50E-06				2.4E-01		
INORG	Selenium	7782-49-2	D	9.30E-05			2.00E-06	2.25E-05						
INORG	Silver	7440-22-4	D	9.30E-05			1.20E-06	1.35E-05						
INORG	Thallium	7440-28-0		9.30E-05			2.00E-06	2.25E-05						
INORG	Vanadium	7440-62-2		9.30E-05			2.00E-06	2.25E-05						
INORG	Zinc	7440-66-6	D	9.30E-05			1.20E-06	1.35E-05						

Note:
Target cancer risk of 1E-05.

Attachment 2: Risk Based Noncancer Criteria for Exposure to Groundwater in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

				Incidental Ingestion			Dermal Contact				Vapor Inhalation			
Chem Group	Chemical	CASRN	Carc Class	ADD (mg/kg/d)	RfD_{oral} (mg/kg/d)	RBC (mg/l)	DA (L/cm^2-event)	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	RBC (mg/l)	C_{air} (mg/m^3)	RfC (mg/m^3)	RBC (mg/l)	Combined RBC (mg/l)
VOC	Acetone	67-64-1	ID	9.20E-05	9.0E-01	9.8E+03	1.27E-06	1.41E-05	9.0E-01	6.4E+04	4.99E-03	3.2E+00	2.0E+05	8.1E+03
VOC	Benzene	71-43-2	A	7.66E-05	4.0E-03	5.2E+01	3.70E-05	3.42E-04	4.0E-03	1.2E+01	5.30E-03	3.0E-02	2.2E+03	9.5E+00
VOC	Bromodichloromethane	75-27-4	B2	7.57E-05	2.0E-02	2.6E+02	1.70E-05	1.55E-04	2.0E-02	1.3E+02	5.32E-03	7.0E-02	5.2E+03	8.5E+01
VOC	Bromoform	75-25-2	B2	8.13E-05	2.0E-02	2.5E+02	1.40E-05	1.38E-04	2.0E-02	1.5E+02	5.22E-03			9.1E+01
VOC	Bromomethane	74-83-9	D	7.12E-05	1.4E-03	2.0E+01	7.68E-06	6.61E-05	1.4E-03	2.1E+01	5.39E-03	5.0E-03	3.9E+02	9.9E+00
VOC	2-Butanone	78-93-3	ID	9.39E-05	6.0E-01	6.4E+03	2.42E-06	2.75E-05	6.0E-01	2.2E+04	4.94E-03	5.0E+00	3.2E+05	4.9E+03
VOC	Carbon Disulfide	75-15-0		7.59E-05	1.0E-01	1.3E+03	3.11E-05	2.85E-04	1.0E-01	3.5E+02	5.31E-03	7.0E-01	5.2E+04	2.8E+02
VOC	Carbon Tetrachloride	56-23-5	B2	7.93E-05	7.0E-04	8.8E+00	4.84E-05	4.64E-04	7.0E-04	1.5E+00	5.25E-03			1.3E+00
VOC	Chlorobenzene	108-90-7	D	7.99E-05	2.0E-02	2.5E+02	8.00E-05	7.72E-04	2.0E-02	2.6E+01	5.24E-03	6.0E-02	4.3E+03	2.3E+01
VOC	Chloroethane	75-00-3		7.23E-05	4.0E-01	5.5E+03	1.49E-05	1.30E-04	4.0E-01	3.1E+03	5.38E-03	1.0E+01	7.6E+05	2.0E+03
VOC	Chloroform	67-66-3	B2	7.62E-05	1.0E-02	1.3E+02	1.86E-05	1.71E-04	1.0E-02	5.8E+01	5.31E-03	5.0E-02	3.7E+03	4.0E+01
VOC	Chloromethane	74-87-3	D	8.73E-05			3.58E-05	3.77E-04			5.09E-03	9.0E-02	6.0E+03	6.0E+03
VOC	Cumene	98-82-8	D	8.50E-05	1.0E-01	1.2E+03	1.93E-04	1.98E-03	1.0E-01	5.1E+01	5.14E-03	4.0E-01	2.7E+04	4.8E+01
VOC	Cyclohexane	110-82-7	ID	7.84E-05			2.30E-04	2.18E-03			5.27E-03	6.0E+00	4.3E+05	4.3E+05
VOC	1,2-Dibromo-3-chloropropane	96-12-8	B2	8.85E-05			2.38E-05	2.55E-04			5.07E-03	2.0E-04	1.3E+01	1.3E+01
VOC	Dibromochloromethane	124-48-1	C	7.82E-05	2.0E-02	2.6E+02	1.42E-05	1.34E-04	2.0E-02	1.5E+02	5.27E-03	7.0E-02	5.0E+03	9.2E+01
VOC	1,2-Dibromoethane	106-93-4	LC	8.31E-05	9.0E-03	1.1E+02	6.81E-06	6.84E-05	9.0E-03	1.3E+02	5.18E-03	9.0E-03	6.2E+02	5.4E+01
VOC	1,2-Dichlorobenzene	95-50-1	D	8.27E-05	9.0E-02	1.1E+03	1.46E-04	1.46E-03	9.0E-02	6.2E+01	5.19E-03	2.0E-01	1.4E+04	5.8E+01
VOC	1,3-Dichlorobenzene	541-73-1	D	8.26E-05	9.0E-02	1.1E+03	1.35E-04	1.35E-03	9.0E-02	6.7E+01	5.19E-03	1.4E-01	9.7E+03	6.2E+01
VOC	1,4-Dichlorobenzene	106-46-7	C	8.26E-05	3.0E-02	3.6E+02	1.44E-04	1.43E-03	3.0E-02	2.1E+01	5.19E-03	8.0E-01	5.5E+04	2.0E+01
VOC	Dichlorodifluoromethane	75-71-8		8.18E-05	2.0E-01	2.4E+03	2.63E-05	2.60E-04	2.0E-01	7.7E+02	5.21E-03	2.0E-01	1.4E+04	5.6E+02
VOC	1,1-Dichloroethane	75-34-3	C	7.49E-05	1.0E-01	1.3E+03	1.83E-05	1.65E-04	1.0E-01	6.0E+02	5.33E-03	5.0E-01	3.7E+04	4.1E+02
VOC	1,2-Dichloroethane	107-06-2	B2	7.71E-05	2.0E-02	2.6E+02	1.13E-05	1.05E-04	2.0E-02	1.9E+02	5.29E-03	5.0E-03	3.6E+02	8.4E+01
VOC	1,1-Dichloroethene	75-35-4	C	7.49E-05	5.0E-02	6.7E+02	3.10E-05	2.81E-04	5.0E-02	1.8E+02	5.33E-03	2.0E-01	1.5E+04	1.4E+02
VOC	1,2-Dichloroethene (total)	540-59-0		7.15E-05	9.0E-03	1.3E+02	2.07E-05	1.79E-04	9.0E-03	5.0E+01	5.39E-03	3.2E-02	2.4E+03	3.5E+01
VOC	cis-1,2-Dichloroethene	156-59-2	D	7.30E-05	1.0E-02	1.4E+02	2.07E-05	1.83E-04	1.0E-02	5.5E+01	5.36E-03	3.5E-02	2.7E+03	3.9E+01
VOC	trans-1,2-Dichloroethene	156-60-5		7.15E-05	2.0E-02	2.8E+02	2.83E-05	2.45E-04	2.0E-02	8.2E+01	5.39E-03	6.0E-02	4.6E+03	6.2E+01
VOC	1,2-Dichloropropane	78-87-5	B2	7.98E-05			2.12E-05	2.04E-04			5.24E-03	4.0E-03	2.8E+02	2.8E+02
VOC	1,3-Dichloropropene (total)	542-75-6	B2	7.60E-05	3.0E-02	3.9E+02	2.25E-05	2.07E-04	3.0E-02	1.5E+02	5.31E-03	2.0E-02	1.5E+03	9.9E+01
VOC	cis-1,3-Dichloropropene	10061-01-5		8.20E-05	3.0E-02	3.7E+02	9.25E-06	9.17E-05	3.0E-02	3.3E+02	5.20E-03	2.0E-02	1.4E+03	1.5E+02
VOC	trans-1,3-Dichloropropene	10061-02-6		7.67E-05			2.19E-05	2.03E-04			5.30E-03			
VOC	Ethyl Benzene	100-41-4	D	8.26E-05	1.0E-01	1.2E+03	1.27E-04	1.26E-03	1.0E-01	7.9E+01	5.19E-03	1.0E+00	6.9E+04	7.4E+01
VOC	2-Hexanone	591-78-6		2.17E-04	4.0E-02	1.8E+02	9.75E-06	2.56E-04	4.0E-02	1.6E+02		5.0E-03		8.5E+01
VOC	Methyl Acetate	79-20-9		8.39E-05	1.0E+00	1.2E+04	2.04E-06	2.06E-05	1.0E+00	4.8E+04	5.16E-03	3.5E+00	2.4E+05	9.2E+03
VOC	Methyl tert-butyl ether	1634-04-4		7.74E-05			8.84E-06	8.27E-05			5.29E-03	3.0E+00	2.2E+05	2.2E+05
VOC	4-Methyl-2-pentanone	108-10-1	ID	8.98E-05			7.32E-06	7.94E-05			5.04E-03	3.0E+00	2.0E+05	2.0E+05
VOC	Methylcyclohexane	108-87-2		8.01E-05			1.05E-04	1.01E-03			5.24E-03	3.0E+00	2.1E+05	2.1E+05
VOC	Methylene Chloride	75-09-2	B2	7.23E-05	6.0E-02	8.3E+02	9.25E-06	8.08E-05	6.0E-02	7.4E+02	5.38E-03	3.0E+00	2.3E+05	3.9E+02
VOC	Styrene	100-42-5		8.22E-05	2.0E-01	2.4E+03	9.63E-05	9.56E-04	2.0E-01	2.1E+02	5.20E-03	1.0E+00	7.0E+04	1.9E+02
VOC	1,1,2,2-Tetrachloroethane	79-34-5	C	8.52E-05	6.0E-02	7.0E+02	2.57E-05	2.65E-04	6.0E-02	2.3E+02	5.14E-03			1.7E+02

Attachment 2: Risk Based Noncancer Criteria for Exposure to Groundwater in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

				Incidental Ingestion			Dermal Contact				Vapor Inhalation			
Chem Group	Chemical	CASRN	Carc Class	ADD (mg/kg/d)	RfD_{oral} (mg/kg/d)	RBC (mg/l)	DA (L/cm^2-event)	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	RBC (mg/l)	C_{air} (mg/m^3)	RfC (mg/m^3)	RBC (mg/l)	Combined RBC (mg/l)
VOC	Tetrachloroethene	127-18-4	C-B2	8.12E-05	1.0E-02	1.2E+02	3.99E-05	3.91E-04	1.0E-02	2.6E+01	5.22E-03	4.0E-01	2.8E+04	2.1E+01
VOC	Toluene	108-88-3	D	8.00E-05	8.0E-02	1.0E+03	8.08E-05	7.81E-04	8.0E-02	1.0E+02	5.24E-03	5.0E+00	3.5E+05	9.3E+01
VOC	1,2,4-Trichlorobenzene	120-82-1	D	8.24E-05	1.0E-02	1.2E+02	2.76E-04	2.75E-03	1.0E-02	3.6E+00	5.19E-03	2.0E-01	1.4E+04	3.5E+00
VOC	1,1,1-Trichloroethane	71-55-6	D	7.93E-05	2.8E-01	3.5E+03	3.85E-05	3.69E-04	2.8E-01	7.6E+02	5.25E-03	2.2E+00	1.6E+05	6.2E+02
VOC	1,1,2-Trichloroethane	79-00-5	C	8.04E-05	4.0E-03	5.0E+01	2.02E-05	1.96E-04	4.0E-03	2.0E+01	5.23E-03			1.4E+01
VOC	Trichloroethene	79-01-6	C-B2	7.85E-05	6.0E-03	7.6E+01	5.53E-05	5.24E-04	6.0E-03	1.1E+01	5.27E-03			1.0E+01
VOC	Trichlorofluoromethane	75-69-4		7.67E-05	3.0E-01	3.9E+03	4.03E-05	3.74E-04	3.0E-01	8.0E+02	5.30E-03	7.0E-01	5.1E+04	6.6E+02
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		8.11E-05	3.0E+01	3.7E+05	7.31E-05	7.16E-04	3.0E+01	4.2E+04	5.22E-03	3.0E+01	2.1E+06	3.7E+04
VOC	1,2,4-Trimethylbenzene	95-63-6	ID	8.22E-05	5.0E-02	6.1E+02	2.34E-04	2.32E-03	5.0E-02	2.2E+01	5.20E-03	6.0E-03	4.2E+02	2.0E+01
VOC	1,3,5-Trimethylbenzene	108-67-8	ID	7.99E-05	5.0E-02	6.3E+02	4.04E-04	3.89E-03	5.0E-02	1.3E+01	5.24E-03	6.0E-03	4.3E+02	1.2E+01
VOC	Vinyl Chloride	75-01-4	A	7.06E-05	3.0E-03	4.2E+01	1.69E-05	1.44E-04	3.0E-03	2.1E+01	5.40E-03	1.0E-01	7.8E+03	1.4E+01
VOC	Xylenes (total)	1330-20-7	ID	7.96E-05	2.0E-01	2.5E+03	1.32E-04	1.27E-03	2.0E-01	1.6E+02	5.25E-03	1.0E-01	7.1E+03	1.5E+02
SVOC	Acenaphthene	83-32-9		9.22E-05	6.0E-02	6.5E+02	2.96E-04	3.30E-03	6.0E-02	1.8E+01	4.98E-03	2.1E-01	1.4E+04	1.8E+01
SVOC	Acenaphthylene	208-96-8	D	9.72E-05	3.0E-02	3.1E+02	3.09E-04	3.63E-03	3.0E-02	8.3E+00	4.86E-03	1.1E-01	6.6E+03	8.0E+00
SVOC	Acetophenone	98-86-2	D	1.40E-04	1.0E-01	7.1E+02	1.11E-05	1.87E-04	1.0E-01	5.3E+02	3.51E-03	3.5E-01	2.1E+04	3.0E+02
SVOC	Anthracene	120-12-7	D	1.07E-04	3.0E-01	2.8E+03	6.41E-04	8.27E-03	3.0E-01	3.6E+01	4.60E-03			3.6E+01
SVOC	Atrazine	1912-24-9	C	2.17E-04	3.5E-02	1.6E+02	2.64E-05	6.92E-04	3.5E-02	5.1E+01	2.41E-06	1.2E-01	7.0E+06	3.8E+01
SVOC	Benzaldehyde	100-52-7		1.15E-04	1.0E-01	8.7E+02	1.07E-05	1.50E-04	1.0E-01	6.7E+02	4.35E-03	3.5E-01	2.1E+04	3.7E+02
SVOC	Benzo(a)anthracene	56-55-3	B2	1.86E-04			2.40E-03	5.39E-02			1.56E-03			
SVOC	Benzo(a)pyrene	50-32-8	B2	2.06E-04			3.41E-03	8.48E-02			5.71E-04			
SVOC	Benzo(b)fluoranthene	205-99-2	B2	1.08E-04			3.90E-03	5.10E-02			4.57E-03			
SVOC	Benzo(g,h,i)perylene	191-24-2	D	2.16E-04	3.0E-02	1.4E+02	5.27E-03	1.38E-01	3.0E-02	2.2E-01	4.89E-05	1.1E-01	2.9E+05	2.2E-01
SVOC	Benzo(k)fluoranthene	207-08-9	B2	2.12E-04			3.90E-03	9.98E-02			2.85E-04			
SVOC	Biphenyl	92-52-4	D	8.65E-05	5.0E-02	5.8E+02	3.86E-04	4.04E-03	5.0E-02	1.2E+01	5.11E-03	1.8E-01	1.2E+04	1.2E+01
SVOC	bis(2-Chloroethoxy)methane	111-91-1	D	2.15E-04			4.47E-06	1.16E-04			9.35E-05			
SVOC	bis(2-Chloroethyl) ether	111-44-4	B2	1.27E-04			5.24E-06	8.04E-05			3.98E-03			
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	B2	2.16E-04	2.0E-02	9.3E+01	4.26E-03	1.11E-01	2.0E-02	1.8E-01	4.90E-05	7.0E-02	2.0E+05	1.8E-01
SVOC	4-Bromophenyl-phenyl ether	101-55-3	D	1.02E-04			2.69E-04	3.31E-03			4.74E-03			
SVOC	Butylbenzylphthalate	85-68-7	C	2.10E-04	2.0E-01	9.5E+02	3.78E-04	9.59E-03	2.0E-01	2.1E+01	3.58E-04	7.0E-01	2.8E+05	2.0E+01
SVOC	Caprolactam	105-60-2		2.17E-04	5.0E-01	2.3E+03	8.01E-07	2.10E-05	5.0E-01	2.4E+04	3.83E-06	1.8E+00	6.2E+07	2.1E+03
SVOC	Carbazole	86-74-8	B2	2.17E-04			1.60E-04	4.19E-03			7.93E-06			
SVOC	4-Chloro-3-methylphenol	59-50-7		2.12E-04			9.14E-05	2.34E-03			2.66E-04			
SVOC	4-Chloroaniline	106-47-8		2.13E-04	4.0E-03	1.9E+01	1.56E-05	4.03E-04	4.0E-03	9.9E+00	1.93E-04	1.4E-02	1.0E+04	6.5E+00
SVOC	2-Chloronaphthalene	91-58-7		8.38E-05	8.0E-02	9.5E+02	3.69E-04	3.74E-03	8.0E-02	2.1E+01	5.16E-03	2.8E-01	1.9E+04	2.1E+01
SVOC	2-Chlorophenol	95-57-8		8.11E-05	5.0E-03	6.2E+01	2.44E-05	2.39E-04	5.0E-03	2.1E+01	5.22E-03	1.8E-02	1.2E+03	1.5E+01
SVOC	4-Chlorophenyl-phenyl ether	7005-72-3		9.17E-05			2.65E-04	2.93E-03			4.99E-03			
SVOC	Chrysene	218-01-9	B2	1.07E-04			2.40E-03	3.11E-02			4.59E-03			
SVOC	Dibenz(a,h)anthracene	53-70-3	B2	2.17E-04			5.34E-03	1.40E-01			4.92E-06			
SVOC	Dibenzofuran	132-64-9	D	1.64E-04	2.0E-03	1.2E+01	5.36E-04	1.06E-02	2.0E-03	1.9E-01	2.56E-03	7.0E-03	5.0E+02	1.9E-01
SVOC	3,3'-Dichlorobenzidine	91-94-1	B2	2.17E-04			8.14E-05	2.14E-03			1.30E-06			

Attachment 2: Risk Based Noncancer Criteria for Exposure to Groundwater in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

				Incidental Ingestion			Dermal Contact				Vapor Inhalation			
Chem Group	Chemical	CASRN	Carc Class	ADD (mg/kg/d)	RfD_{oral} (mg/kg/d)	RBC (mg/l)	DA (L/cm^2-event)	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	RBC (mg/l)	C_{air} (mg/m^3)	RfC (mg/m^3)	RBC (mg/l)	Combined RBC (mg/l)
SVOC	2,4-Dichlorophenol	120-83-2		1.93E-04	3.0E-03	1.6E+01	7.57E-05	1.77E-03	3.0E-03	1.7E+00	1.22E-03	1.1E-02	1.3E+03	1.5E+00
SVOC	Diethylphthalate	84-66-2	D	2.14E-04	8.0E-01	3.7E+03	2.14E-05	5.53E-04	8.0E-01	1.4E+03	1.72E-04	2.8E+00	2.3E+06	1.0E+03
SVOC	2,4-Dimethylphenol	105-67-9		1.95E-04	2.0E-02	1.0E+02	3.52E-05	8.29E-04	2.0E-02	2.4E+01	1.12E-03	7.0E-02	9.5E+03	1.9E+01
SVOC	Dimethylphthalate	131-11-3	D	2.16E-04			9.85E-06	2.57E-04			6.92E-05			
SVOC	Di-n-butylphthalate	84-74-2	D	2.17E-04	1.0E-01	4.6E+02	3.31E-04	8.69E-03	1.0E-01	1.2E+01	5.28E-07			1.1E+01
SVOC	4,6-Dinitro-2-methylphenol	534-52-1		2.14E-04	1.0E-04	4.7E-01	1.40E-05	3.63E-04	1.0E-04	2.8E-01	1.71E-04	3.5E-04	2.8E+02	1.7E-01
SVOC	2,4-Dinitrophenol	51-28-5		2.14E-04	2.0E-03	9.4E+00	6.46E-06	1.67E-04	2.0E-03	1.2E+01	1.77E-04			5.3E+00
SVOC	2,4-Dinitrotoluene	121-14-2	B2	2.14E-04	2.0E-03	9.3E+00	1.32E-05	3.41E-04	2.0E-03	5.9E+00	1.42E-04			3.6E+00
SVOC	2,6-Dinitrotoluene	606-20-2	B2	2.11E-04	1.0E-03	4.7E+00	1.06E-05	2.71E-04	1.0E-03	3.7E+00	3.27E-04	3.5E-03	1.5E+03	2.1E+00
SVOC	Di-n-octylphthalate	117-84-0		1.30E-04	4.0E-02	3.1E+02	4.72E-03	7.41E-02	4.0E-02	5.4E-01	3.87E-03			5.4E-01
SVOC	Fluoranthene	206-44-0	D	1.50E-04	4.0E-02	2.7E+02	1.31E-03	2.37E-02	4.0E-02	1.7E+00	3.12E-03	1.4E-01	8.9E+03	1.7E+00
SVOC	Fluorene	86-73-7	D	1.05E-04	4.0E-02	3.8E+02	4.13E-04	5.26E-03	4.0E-02	7.6E+00	4.64E-03	1.4E-01	8.5E+03	7.5E+00
SVOC	Formaldehyde	50-00-0	B1	2.08E-04	2.0E-01	9.6E+02	4.22E-06	1.06E-04	2.0E-01	1.9E+03	4.60E-04			6.4E+02
SVOC	Hexachlorobenzene	118-74-1	B2	9.07E-05	8.0E-04	8.8E+00	1.98E-03	2.17E-02	8.0E-04	3.7E-02	5.02E-03			3.7E-02
SVOC	Hexachlorobutadiene	87-68-3	C	8.88E-05	2.0E-04	2.3E+00	5.03E-04	5.40E-03	2.0E-04	3.7E-02	5.06E-03			3.6E-02
SVOC	Hexachlorocyclopentadiene	77-47-4	E	8.46E-05	6.0E-03	7.1E+01	1.12E-03	1.15E-02	6.0E-03	5.2E-01	5.15E-03	2.0E-04	1.4E+01	5.0E-01
SVOC	Hexachloroethane	67-72-1	C	8.86E-05	1.0E-03	1.1E+01	1.91E-04	2.04E-03	1.0E-03	4.9E-01	5.06E-03			4.7E-01
SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	B2	2.08E-04			5.27E-03	1.32E-01			4.72E-04			
SVOC	Isophorone	78-59-1	C	1.63E-04	2.0E-01	1.2E+03	1.14E-05	2.25E-04	2.0E-01	8.9E+02	2.59E-03			5.2E+02
SVOC	2-Methylnaphthalene	91-57-6	ID	8.53E-05	4.0E-03	4.7E+01	2.89E-04	2.97E-03	4.0E-03	1.3E+00	5.13E-03	3.0E-03	2.0E+02	1.3E+00
SVOC	Methylphenol (total)	1319-77-3		2.05E-04	5.0E-02	2.4E+02	2.17E-05	5.39E-04	5.0E-02	9.3E+01	6.22E-04			6.7E+01
SVOC	2-Methylphenol	95-48-7	C	2.01E-04	5.0E-02	2.5E+02	2.27E-05	5.52E-04	5.0E-02	9.1E+01	8.30E-04			6.6E+01
SVOC	4-Methylphenol	106-44-5	C	2.06E-04	5.0E-03	2.4E+01	2.05E-05	5.10E-04	5.0E-03	9.8E+00	5.75E-04			7.0E+00
SVOC	Naphthalene	91-20-3	C	8.60E-05	2.0E-02	2.3E+02	1.49E-04	1.55E-03	2.0E-02	1.3E+01	5.12E-03	3.0E-03	2.0E+02	1.2E+01
SVOC	2-Nitroaniline	88-74-4		2.15E-04	3.0E-03	1.4E+01	1.44E-05	3.73E-04	3.0E-03	8.1E+00	1.24E-04	2.0E-04	2.2E+02	5.0E+00
SVOC	3-Nitroaniline	99-09-2	C	2.17E-04	3.0E-04	1.4E+00	6.94E-06	1.82E-04	3.0E-04	1.6E+00		1.0E-03		7.5E-01
SVOC	4-Nitroaniline	100-01-6	C	2.17E-04	3.0E-03	1.4E+01	7.15E-06	1.88E-04	3.0E-03	1.6E+01	1.40E-06	4.0E-03	3.9E+05	7.4E+00
SVOC	Nitrobenzene	98-95-3	D	1.15E-04	5.0E-04	4.3E+00	1.60E-05	2.22E-04	5.0E-04	2.3E+00	4.36E-03	2.0E-03	1.2E+02	1.5E+00
SVOC	2-Nitrophenol	88-75-5		1.53E-04			1.30E-05	2.41E-04			2.98E-03			
SVOC	4-Nitrophenol	100-02-7		2.17E-04			1.56E-05	4.09E-04			2.95E-07			
SVOC	N-Nitrosodiphenylamine	86-30-6	B2	1.85E-04	2.0E-02	1.1E+02	6.82E-05	1.52E-03	2.0E-02	1.3E+01	1.62E-03			1.2E+01
SVOC	N-Nitroso-di-n-propylamine	621-64-7	B2	1.94E-04			7.74E-06	1.81E-04			1.18E-03			
SVOC	2,2'-oxybis(1-Chloropropane)	108-60-1	C	9.69E-05	4.0E-02	4.1E+02	2.76E-05	3.23E-04	4.0E-02	1.2E+02	4.87E-03			9.5E+01
SVOC	Pentachlorophenol	87-86-5	B2	2.17E-04	3.0E-02	1.4E+02	7.43E-04	1.95E-02	3.0E-02	1.5E+00	1.61E-05	1.1E-01	8.9E+05	1.5E+00
SVOC	Phenanthrene	85-01-8	D	1.32E-04	3.0E-02	2.3E+02	5.59E-04	8.90E-03	3.0E-02	3.4E+00	3.81E-03	1.1E-01	6.2E+03	3.3E+00
SVOC	Phenol	108-95-2	ID	2.11E-04	3.0E-01	1.4E+03	1.20E-05	3.06E-04	3.0E-01	9.8E+02	3.23E-04			5.8E+02
SVOC	Pyrene	129-00-0	D	1.64E-04	3.0E-02	1.8E+02	1.29E-03	2.55E-02	3.0E-02	1.2E+00	2.54E-03	1.1E-01	7.5E+03	1.2E+00
SVOC	2,4,5-Trichlorophenol	95-95-4		1.89E-04	1.0E-01	5.3E+02	2.11E-04	4.81E-03	1.0E-01	2.1E+01	1.41E-03			2.0E+01
SVOC	2,4,6-Trichlorophenol	88-06-2	B2	1.72E-04	1.0E-04	5.8E-01	1.56E-04	3.24E-03	1.0E-04	3.1E-02	2.18E-03			2.9E-02
PCB	PCBs (total)	1336-36-3	B2	9.52E-05	2.0E-05	2.1E-01	3.31E-03	3.81E-02	2.0E-05	5.3E-04	4.91E-03			5.2E-04

Attachment 2: Risk Based Noncancer Criteria for Exposure to Groundwater in Kiddie Pool
GMC: NAO Flint Operations Site, Flint, Michigan

				Incidental Ingestion			Dermal Contact				Vapor Inhalation			
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**ADD** (mg/kg/d)	**RfD_{oral}** (mg/kg/d)	**RBC** (mg/l)	**DA** (L/cm^2-event)	**ADD** (mg/kg/d)	**RfD_{derm}** (mg/kg/d)	**RBC** (mg/l)	**C_{air}** (mg/m^3)	**RfC** (mg/m^3)	**RBC** (mg/l)	**Combined RBC** (mg/l)
INORG	Antimony	7440-36-0		2.17E-04	4.0E-04	1.8E+00	2.00E-06	5.25E-05	4.0E-04	7.6E+00		1.4E-03		1.5E+00
INORG	Arsenic	7440-38-2	A	2.17E-04	3.0E-04	1.4E+00	2.00E-06	5.25E-05	3.0E-04	5.7E+00				1.1E+00
INORG	Barium	7440-39-3	D	2.17E-04	7.0E-02	3.2E+02	2.00E-06	5.25E-05	7.0E-02	1.3E+03				2.6E+02
INORG	Beryllium	7440-41-7	B1	2.17E-04	2.0E-03	9.2E+00	2.00E-06	5.25E-05	2.0E-03	3.8E+01		2.0E-05		7.4E+00
INORG	Cadmium	7440-43-9	B1	2.17E-04	1.0E-03	4.6E+00	2.00E-06	5.25E-05	1.0E-03	1.9E+01		2.0E-04		3.7E+00
INORG	Chromium (total)	7440-47-3		2.17E-04	3.0E-03	1.4E+01	4.00E-06	1.05E-04	3.0E-03	2.9E+01		1.0E-04		9.3E+00
INORG	Chromium III	16065-83-1	D	2.17E-04	1.5E+00	6.9E+03	2.00E-06	5.25E-05	1.5E+00	2.9E+04		5.3E+00		5.6E+03
INORG	Chromium VI	18540-29-9	A	2.17E-04	3.0E-03	1.4E+01	4.00E-06	1.05E-04	3.0E-03	2.9E+01		1.0E-04		9.3E+00
INORG	Cobalt	7440-48-4	B1	2.17E-04	2.0E-02	9.2E+01	8.00E-07	2.10E-05	2.0E-02	9.5E+02		2.0E-05		8.4E+01
INORG	Copper	7440-50-8	D	2.17E-04	4.0E-02	1.8E+02	2.00E-06	5.25E-05	4.0E-02	7.6E+02		1.4E-01		1.5E+02
INORG	Cyanide (total)	57-12-5	D	2.17E-04	2.0E-02	9.2E+01	2.00E-06	5.25E-05	2.0E-02	3.8E+02		7.0E-02		7.4E+01
INORG	Fluoride	16984-48-8		2.17E-04			2.00E-06	5.25E-05						
INORG	Lead	7439-92-1	B2	2.17E-04			2.00E-07	5.25E-06						
INORG	Manganese	7439-96-5	D	2.17E-04	1.4E-01	6.4E+02	2.00E-06	5.25E-05	1.4E-01	2.7E+03		5.0E-05		5.2E+02
INORG	Mercury	7439-97-6	D	8.83E-05	3.0E-04	3.4E+00	2.00E-06	2.13E-05	3.0E-04	1.4E+01	5.07E-03	3.0E-04	2.0E+01	2.4E+00
INORG	Nickel	7440-02-0	A	2.17E-04	2.0E-02	9.2E+01	4.00E-07	1.05E-05	2.0E-02	1.9E+03				8.8E+01
INORG	Selenium	7782-49-2	D	2.17E-04	5.0E-03	2.3E+01	2.00E-06	5.25E-05	5.0E-03	9.5E+01		1.8E-02		1.9E+01
INORG	Silver	7440-22-4	D	2.17E-04	5.0E-03	2.3E+01	1.20E-06	3.15E-05	5.0E-03	1.6E+02		1.0E-05		2.0E+01
INORG	Thallium	7440-28-0		2.17E-04	7.0E-05	3.2E-01	2.00E-06	5.25E-05	7.0E-05	1.3E+00		2.5E-04		2.6E-01
INORG	Vanadium	7440-62-2		2.17E-04	7.0E-03	3.2E+01	2.00E-06	5.25E-05	7.0E-03	1.3E+02		2.5E-02		2.6E+01
INORG	Zinc	7440-66-6	D	2.17E-04	3.0E-01	1.4E+03	1.20E-06	3.15E-05	3.0E-01	9.5E+03		1.1E+00		1.2E+03

Note:
Target hazard quotient of 1.