CORRECTIVE MEASURES PROPOSAL

CENTERPOINT BUSINESS CAMPUS
PONTIAC, MICHIGAN

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS

TABLE OF CONTENTS

Page

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Alex Rothchild
LFR
Aug 05, 2009 13:48

LIST OF FIGURES
(Following Text)

LIST OF TABLES
(Following Text)

LIST OF APPENDICES

LIST OF ACRONYMS

ABB	ABB Environmental Services, Inc.
AMSL	above mean sea level
AOI	Area of Interest
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CDM	Camp Dresser and McKee
CMP	Corrective Measures Proposal
CRA	Conestoga-Rovers & Associates, Inc.
cy	cubic yards
DCC	Direct Contact Criteria
DWC	Drinking Water Criteria
ENVIRON	ENVIRON International Corporation
GCC	Groundwater Contact Criteria
GCPC	Groundwater Contact Protection Criteria
GM	General Motors Corporation
GSI	Groundwater Surface Water Interface
GSIC	Groundwater Surface Water Interface Criteria
IM	Interim Measure
LEL	Lower Explosive Limit
LNAPL	light non-aqueous phase liquid
LUST	Leaking Underground Storage Tank
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MPE	multi-phase extraction
NCDC	National Climatic Data Center
NERI	Northeast Research Institute, Inc.
NFA	No Further Action
PCB	polychlorinated biphenyl
PID	photoionization detector

LIST OF ACRONYMS

PNA	polynuclear aromatics
Progressive	Progressive Environmental Consulting & Engineering, Inc.
PSIC	Particulate Soil Inhalation Criteria
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SVIIC	Soil Volatilization to Indoor Air Inhalation Criteria
SVOC	Semi-Volatile Organic Compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCL	Target Compound List
U.S. EPA	United States Environmental Protection Agency
USTs	underground storage tanks
VOCs	volatile organic compounds
VSIC	Infinite Source Volatile Soil Inhalation Criteria
WWES	WW Engineering and Science
WWTP	wastewater treatment plant

1.0 INTRODUCTION

1.1 PURPOSE

This Resource Conservation and Recovery Act (RCRA) Corrective Measures Proposal (CMP) is for the General Motors Corporation (GM) Centerpoint Business Campus located in Pontiac, Michigan (Facility). The Facility location is presented on Figure 1.1. The United States Environmental Protection Agency (U.S. EPA) Identification Number for the Facility is MID 005 356 902. The CMP was prepared by Conestoga-Rovers & Associates, Inc. (CRA) and ENVIRON International Corporation (ENVIRON) on behalf of GM.

A RCRA Corrective Action 3008(h) Administrative Order on Consent was signed by the U.S. EPA and GM in September 1998. The Consent Order required GM to conduct RCRA corrective actions at seven Solid Waste Management Units (SWMUs). A total of 84 Areas of Interest (AOIs) (which included the seven SWMUs addressed by the Consent Order) had previously been identified by GM in the Review of Existing Conditions Report (CRA, 1995b) and Supplemental Review of Existing Conditions Report (CRA, 1995e). Two of the seven SWMUs (Former J-Lot and Former Coal Pile Storage Area) were addressed as Interim Measures (IMs) and the remaining five SWMUs were investigated under the RCRA Facility Investigation (RFI). The seven SWMUs identified in the Consent Order included the following:

	SWMU/AOI	*Description*	*Scope*
1)	#30/#79	Former J-Lot Fill Area	IM
2)	#32/#49	Former Coal Pile Storage Area	IM
3)	#3/#74	Container Storage Area	RFI
4)	#29/#66	Wastewater Treatment Plant	RFI
5)	#31/#54	Former Surface Impoundment	RFI
6)	#33/#45	Former South Retention Pond	RFI
7)	#34/#46	North Retention Pond	RFI

In addition to the seven SWMUs/AOIs identified in the Consent Order, the majority of the 84 AOIs were systematically investigated and/or remediated to support redevelopment at the Facility in the mid- to late-1990s (prior to the RCRA Corrective Action). The Review of Existing Conditions Report and the Supplemental Review of Existing Conditions Report concluded that no further action (NFA) was required at the remainder of the AOIs. Major investigations were conducted prior to the RFI in the following study areas:

- AOI #16 - Former Building 29 Tank Farm;
- SWMU #6/AOI #42- Building 53 Tank Area;
- AOI #44 - Building 43 Remediation;
- AOI #50 - DUCO Stores;
- AOI #52 - Building 35 Tank Farm;
- AOI #53 – Building 33 Free Product Area;
- AOI #69 - Container Storage Area;
- AOI #71 – Burn Pile Area;
- SWMU #2/AOI #75- Former East Tank Farm;
- AOI #82 - Former Paint Mix Room Retention Tank;
- AOI #83 - Dock 65; and
- AOI #84 - Former Tank Farm Area.

The locations of the SWMUs/AOIs are presented on Figure 1.2.

This CMP describes the Corrective Measures Alternatives evaluated for certain areas of the Facility and the rationale for the proposed Corrective Measures.

The U.S. EPA will select the final Corrective Measures for the Facility after a public notice and comment period. This CMP references more detailed information that can be found in the RFI Report (CRA, 2005c) and in other documents submitted to the U.S. EPA. A repository of documents has been established at the Pontiac Public Library located at 60 East Pike Street in Pontiac, Michigan.

1.2 CMP ORGANIZATION

This CMP is organized as follows:

- Section 2.0 provides a summary of the types of Corrective Measures considered in developing specific Corrective Measures Alternatives for specific SWMUs/AOIs;
- Section 3.0 provides a summary of the background information from previously submitted reports (CRA 1995b, 1995d, and 2005c);
- Section 4.0 provides an overview of the pre-RFI investigations and remedial actions;
- Section 5.0 provides an overview of the IMs conducted during the RFI;

- Section 6.0 provides an overview of the RFI, including a summary of the SWMUs/AOIs investigated during the RFI, and a summary of the stages of the RFI;
- Section 7.0 provides a summary of post-RFI activities completed following completion of the RFI;
- Section 8.0 provides an evaluation of the Corrective Measures Alternatives;
- Section 9.0 provides an evaluation of the proposed Corrective Measures; and
- Section 10.0 provides the references used to develop the CMP.

Figures and tables cited in the text of this report are found at the end of the text.

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2.0 PROPOSED CORRECTIVE MEASURES

Systematic decommissioning and remediation activities were implemented in the 1990s to support redevelopment of the Facility as the Centerpoint Business Campus. During the RCRA Corrective Action, additional areas were addressed as IMs or investigated/evaluated during the RFI. This CMP presents the proposed final Corrective Measures to complete the RCRA Corrective Action at this Facility.

The proposed final Corrective Measures at the specific SWMUs/AOIs are as follows:

- no further action (i.e., no need for active remediation, engineering controls, or institutional controls to restrict land or resource use;
  - SWMU #6/AOI #42 –Building 53 Tank Area;
  - AOI #44 – Building 43 Remediation; and
  - SWMU #33/AOI #45 – Former South Retention Pond.

- institutional controls to restrict land use to industrial/commercial uses and resource use restriction to prevent shallow groundwater in an unconfined aquifer from being used for drinking water;
  - AOI #16 – Former Building 29 Tank Farm;
  - SWMU #34/AOI #46 – North Retention Pond;
  - SWMU #32/AOI #49 – Former Coal Pile Storage Area;
  - SWMU #31/AOI #54 – Former Surface Impoundment;
  - SWMU #29/AOI #66 – Wastewater Treatment Plant;
  - AOI #69 – Container Storage Area (Wastewater Treatment Plant);
  - SWMU #3/AOI #74 – Container Storage Area (Pontiac Assembly Center);
  - SWMU #2/AOI #75 – Former East Tank Farm;
  - SWMU #30/AOI #79 – Former J-Lot Fill Area;
  - AOI #82 – Former Paint Mix Room Retention Tank;
  - AOI #83 – Dock 65; and
  - AOI #84 – Former Tank Farm Area.

- recovery of light non-aqueous phase liquid (LNAPL), long-term groundwater monitoring and institutional controls;
  - AOI #53 – Building 33 LNAPL

- closure under Michigan Act 451 Part 213 and institutional controls; and
  - AOI #50 – DUCO Stores
  - AOI #52 – Building 35 Tank Farm

- supplemental investigation, institutional controls and long-term groundwater monitoring.
  - AOI #71 – Burn Pile

The basis for these proposed final Corrective Measures is discussed in Section 8. The areas with proposed institutional controls (deed restrictions) are presented on Figure 2.1.

3.0 FACILITY BACKGROUND

3.1 FACILITY DESCRIPTION AND HISTORY

The Facility is located in Sections 3 and 4 of Township T2N, Range R10E, City of Pontiac, Oakland County, Michigan, as presented on Figure 1.1. The Facility encompasses approximately 400 acres of land and currently contains the Centerpoint Business Campus, including the Pontiac Assembly Center. The Facility formerly contained the Pontiac Central Manufacturing and Assembly Plant. The Facility is generally bordered by South Boulevard to the north, the Grand Trunk Western Railroad to the south, Opdyke Road to the east, and Martin Luther King Jr. Boulevard to the west. Land use to the north of the Facility is primarily industrial; to the east and south, residential; and to the west, a combination of residential, industrial and commercial.

In 1927, the Facility began producing medium and heavy duty trucks and buses at the former Pontiac Central Manufacturing and Assembly Plant, which was formerly located in the north central portion of the Facility. Major manufacturing activities associated with the production of these vehicles included machining, stamping, plating, smelting, fiberglass laminating, heat treating, painting, and sealing. Subsequent operations were expanded to include more than 60 manufacturing and office buildings, including the Pontiac East Assembly plant (now named the Pontiac Assembly Center).

In August 1990, manufacturing operations at the former Pontiac Central Manufacturing and Assembly Plant were discontinued. Between 1991 and 1995, the plant was decommissioned, all buildings (approximately 3 million square feet) were demolished except for the slab and structural steel on approximately 1 million square feet. The area was redeveloped as the Centerpoint Business Campus, which is a large-scale industrial and commercial business development. The Historic Facility Plan and Current Facility Plan are presented on Figure 3.1 and Figure 3.2, respectively.

Presently, the Facility includes a Truck Engineering Center, located at the west end of the Facility; the Pontiac Assembly Center on the eastern portion of the Facility; the GM Truck Product Center, which occupies approximately one-third of the former Pontiac Central Manufacturing and Assembly Plant's footprint, a wastewater treatment plant (WWTP) and two stormwater retention ponds.

3.2 CLIMATE

Meteorological data was obtained from the National Climatic Data Center (NCDC) for the Pontiac State Hospital weather station in the City of Pontiac, Oakland County, Michigan for the period 1961 through 1990, (NCDC, 2005). Precipitation data indicate the mean annual precipitation to be 30.6 inches.

Pontiac is located in an area of temperate climate. Temperature data indicate the mean 24-hour average daily temperature to be 48.4°F. The 24-hour average temperature for January and July are 22.3°F and 72.3°F, respectively.

The meteorological data from NCDC are presented in Table 3.1.

3.3 SURFACE WATER HYDROLOGY

There are no natural surface water bodies at the Facility, but there are two engineered stormwater retention basins (North Retention Pond (SWMU #34/AOI #46) and Current South Retention Pond). In addition, there was a Former South Retention Pond (SWMU #33/AOI #45) located on the southern portion of the Facility, but this area was redeveloped in 1995, and the new South Retention Pond was constructed approximately 2,000 feet northwest of the Former South Retention Pond.

There are several natural surface water bodies and intermittent drains surrounding the Facility. In June 2004, the Michigan Department of Environmental Quality (MDEQ) evaluated the stormwater drains located in the vicinity of the Facility (Amy Drain, Hamlin Drain, Levison Drain, and Murphy Creek (Rufe Collier/Bartlett Drain) to determine if these drains are surface waters of the state (MDEQ, 2004). MDEQ did not consider any of these drains to be surface waters of the state at the point they discharge from the Facility. Additional information regarding the locations where MDEQ considers each of these drains to become surface waters of the state is presented in Appendix A.

In the RFI, GM concluded that the Groundwater Surface Water Interface Criteria (GSIC) are not relevant at the Facility due to the absence of natural surface water bodies at the Facility. To support this conclusion, supplemental investigations at the Container Storage Area (SWMU #3/AOI #74) and the Former Surface Impoundment (SWMU #31/AOI #54) were performed. These evaluations were submitted to U.S. EPA in April 2003 and August 2005 in reports titled Groundwater Surface Water Interface (GSI) Pathway Elimination Determination Report (CRA, 2003) and Supplemental

Groundwater Surface Water Interface (GSI) Pathway Elimination Determination Report (CRA, 2005d). Additional evaluation to support this demonstration is ongoing.

3.4 REGIONAL GEOLOGY AND HYDROGEOLOGY

The following information on the regional geology of the Facility is from published regional information, as well as subsurface investigations performed on or in the vicinity of the Facility.

3.4.1 OVERBURDEN

Topography and overburden in the vicinity of the Facility are the result of glacial and post-glacial deposition and erosional processes. Continental glaciers advanced into this area of Michigan at least twice, once in each of the last two glacial stages of the Illinoian and Wisconsinan glaciers of the Pleistocene Epoch. During the Wisconsinan stage, ice sheets of the Huron-Erie glacial lobe advanced from the southeast across the area of the Facility. During the advance and retreat of this ice sheet, a series of end moraines (Fort Wayne, Defiance, and Birmingham) and a thick sequence of ground moraine (glacial till) comprised of clay, silt, and rock fragments were deposited in this area. As the ice sheet retreated to the southeast, large volumes of meltwater formed glacial Lake Maumee between the Fort Wayne Moraine and the retreating glacier. The ice again advanced, forming the Defiance Moraine, and subsequently retreated, forming glacial Lake Arkona. As the ice advanced yet again from the east, the Birmingham Moraine was formed.

The Facility is located in an area of terminal, or end moraine. In the area surrounding the Facility, the end moraine material may vary in thickness from slightly less than 100 feet to as much as 350 feet. The end moraine material is generally medium textured till with a dominant silt and clay matrix.

3.4.2 BEDROCK

The Coldwater Shale, of Early Mississippian age, is the first bedrock formation encountered below the Facility at an elevation of approximately 625 to 650 feet above mean sea level (AMSL) (at an approximate depth of 250 to 350 feet below ground surface (bgs)). This shale is dark brown to black, bituminous, fissile, and finely laminated. The Coldwater Shale may be as much as 1,300 feet thick in the vicinity of the Facility.

Located below the Coldwater Shale are sedimentary formations of the Berea Sandstone-Bedford Shale unit.

3.4.3 REGIONAL HYDROGEOLOGY

Groundwater resources in the Clinton River and Rouge River watersheds exist in both the glacial drift and the bedrock of the area. In the region surrounding the Facility, groundwater is encountered in four general water-bearing units:

- unconfined water table zone;
- glacial till aquifer(s);
- lower sand and gravel aquifer; and
- bedrock aquifer(s).

Further information on these units is available in the RFI Report (CRA, 2005d).

3.5 FACILITY GEOLOGY AND HYDROGEOLOGY

3.5.1 GEOLOGY

The description of the geologic units discussed in the following sections are based upon numerous geotechnical and environmental investigations completed at the Facility.

3.5.1.1 SURFICIAL FILL UNIT

The surficial materials encountered throughout the Facility are comprised of a variable mix of sand, gravel, clay, asphalt, concrete, and other engineering fill. The fill unit ranges in depth from approximately 5 to 15 feet bgs. The fill zones encountered at the Facility are a result of the various phases of construction that have been completed across the Facility since the mid-1920s. Underlying the surficial fill are the extensive glacial clay/till and interbedded sand and gravel units.

3.5.1.2 CLAY/TILL AND INTERBEDDED SANDS UNIT

A glacial clay/till deposit occurs immediately below the surficial fill materials at the Facility. Based on water well logs of wells at or near the Facility, as presented in the Review of Existing Conditions Report (CRA, 1995b), the clay/till is continuous across the area. The clay/till is comprised of clay, silt, sand, and gravel, and generally displays low to very low hydraulic conductivity.

In 1994, prior to the RCRA Corrective Action, CRA performed an Extent of Contamination evaluation, including geotechnical investigations of the clay till at the J-Lot (CRA, 1994d). The location of the J-Lot is presented on Figure 1.2. The hydraulic conductivity of the clay till at the J-Lot ranged between 1.6×10^{-8} cm/s and 4.1×10^{-7} cm/s. Given the range outlined above, the glacial till at the Facility acts as an aquitard, thereby restricting vertical movement from the shallow perched zone (when present) to the top of the interbedded sand and gravel aquifer encountered approximately 120 feet bgs.

The two predominant interbedded sand and gravel layers within the clay/till vary in thickness and depth. The first sand layer is about seven feet thick and was encountered at a depth of approximately 120 feet bgs. The second sand layer was medium to fine grained and was encountered more extensively within and to the south of the Facility at approximately 150 feet bgs. The second sand layer ranged from 10 to 75 feet thick.

The glacial till unit generally extends to a depth of about 230 feet bgs where a lower sand and gravel unit is encountered.

3.5.1.3 LOWER SAND AND GRAVEL UNIT

Consistent with the regional glacial deposition, the lower sand and gravel unit is encountered at the Facility underlying the clay/till and interbedded sand layers. The lower sand and gravel is identified in both Facility well logs and nearby residential well logs. The unit is at an elevation of approximately 740 feet AMSL, a depth of about 200 to 220 feet bgs, and may be as thick as 20 to 80 feet.

3.5.1.4 COLDWATER SHALE

The Coldwater Shale is the first bedrock formation encountered below the Facility. The shale is dark brown to black, bituminous, fissile, and finely laminated. Water well records of test wells drilled along the Grand Trunk Western Railroad, south of the

Facility, show the shale with associated sandstone and over consolidated clays encountered at a depth of approximately 290 feet bgs.

3.5.2 HYDROGEOLOGY

The individual hydrogeologic units identified at the Facility are discussed in the following sections.

3.5.2.1 UNCONFINED WATER TABLE ZONE

Shallow unconfined perched groundwater has been encountered in several areas of the Facility, generally at depths of approximately 10 to 20 feet bgs. It should be noted, however, that glacial clay till has been encountered in the near surface throughout the Facility. As such, significant groundwater only exists as discontinuous and intermittent perched groundwater. This groundwater is perched above the clay till in layers of engineered fill material or sand (or sand and gravel) seams of limited extent. As the clay till layer is approximately 100 feet thick between the perched groundwater and the interbedded confined sand aquifer, the perched groundwater is not considered to be hydraulically connected with the lower water bearing zones. GM believes that the unconfined water table is not an "aquifer" pursuant to Michigan Act 451, Part 201 and does not exist everywhere at the Facility.

3.5.2.2 CLAY/TILL AQUITARD AND INTERBEDDED SAND AQUIFER

In 1981, Camp Dresser and McKee (CDM) performed a hydrogeologic assessment of the Facility. The results were presented in a report entitled Mathematical Simulation of Groundwater Flow Conditions under GM's Truck and Coach Division, Pontiac, Michigan (CDM, 1981). A copy of this report was presented in the Review of Existing Conditions Report (CRA, 1995b).

The CDM report identified three sand and sand/gravel aquifers beneath the Facility. These aquifers occur at depths of 120, 150, and 210 feet bgs, and are approximately 7, 25, and 50 feet thick, respectively.

3.5.2.3 LOWER SAND AND GRAVEL AQUIFER

The lower sand and gravel aquifer has been encountered underlying the clay/till aquitard at approximately 210 to 220 feet bgs, consistent with the regional description of local outwash channels. This aquifer was used to support industrial wells at the Facility and is used by residential wells south of the Facility.

The lower sand and gravel aquifer is confined by the clay/till aquitard sequence above. This aquifer may also be confined by the Coldwater Shale below.

3.5.2.4 COLDWATER SHALE

The Coldwater Shale is not considered a usable aquifer beneath the Facility. Because it is overlain by the productive lower sand and gravel aquifer, the Coldwater Shale may be considered an aquitard with its relatively low hydraulic conductivity material. Available water well records for wells drilled along the Grand Trunk Western Railroad south of the Facility show the shale encountered at a depth of approximately 290 feet bgs (no elevation control was available).

3.6 WATER SUPPLY AND GROUNDWATER USE

Shallow perched groundwater at the Facility, to the extent it is present, is not used for any purpose. At many locations, the perched water is absent altogether. Historically, the 120, 150, and 210 feet bgs aquifers were used as a water supply for the Facility. All portions of the Facility are currently serviced by municipal water.

3.7 ECOLOGY

The ecological assessment of the Facility, prepared by Exponent is presented and evaluated in the Habitat Characterization and Ecological Pathways Assessment Report, presented in Appendix B. The evaluation presented in the ecological assessment consists of a habitat characterization and a screening-level ecological risk assessment for the Facility.

The ecological assessment included a review of historical information and a Facility visit, which Exponent conducted on September 13, 2005. Based on this review, it was determined that the Facility provides very limited habitat for wildlife due to the present

status of Facility development. Terrestrial and aquatic habitats (detention basins) were determined to be of insufficient size and too isolated to support populations of ecological receptors.

From the ecological assessment, it was concluded that further evaluation of risks to ecological receptors was not required. Additional information regarding the ecological assessment is presented in Appendix B.

4.0 PRE-RFI INVESTIGATIONS AND REMEDIAL ACTIONS

Environmental investigations and remedial activities conducted prior to the RFI are summarized in the Review of Existing Conditions Report (CRA, 1995b) and Supplemental Review of Existing Conditions Report (CRA, 1995e).

The majority of the environmental investigative activities, and all of the remedial activities, were conducted under a Facility-wide Health and Safety Plan (CRA, 1994e) and a Project-wide Quality Assurance Project Plan (CRA, 1994f). These documents were utilized to support remediation activities associated with Facility redevelopment to ensure that all work was completed to a standard of engineering and technical practice equivalent to that for RFIs.

The following sections summarize the major investigations and remedial activities performed prior to implementation of the RFI:

- AOI #16 - Former Building 29 Tank Farm;
- SWMU #6/AOI #42 - Building 53 Tank Area;
- AOI #44 - Building 43 Remediation;
- AOI #50 - DUCO Stores;
- AOI #52 - Building 35 Tank Farm;
- AOI #53 – Building 33 Free Product Area;
- AOI #69 - Container Storage Area;
- AOI #71 – Burn Pile;
- SWMU #2/AOI #75 - Former East Tank Farm;
- AOI #82 - Former Paint Mix Room Retention Tank;
- AOI #83 - Dock 65; and
- AOI #84 - Former Tank Farm Area.

4.1 AOI #16 - FORMER BUILDING 29 TANK FARM

AOI #16 is the former Building 29 Tank Farm. The location of this AOI is presented on Figure 1.2. The former Building 29 Tank Farm consisted of nine 12,000-gallon steel underground storage tanks (USTs) installed in 1946. The USTs were located near the south exterior wall of Building 29 and contained engine oil, transmission fluids, axle fluids, and power steering fluids. The UST farm was taken out of service during the

summer of 1991 and the USTs were excavated and removed in October 1991 in support of the Centerpoint Business Campus redevelopment. Benzene, toluene, ethylbenzene, and xylene (BTEX) and polynuclear aromatics (PNA) constituents were identified in confirmatory soil samples collected from soils surrounding the former tank farm following the UST removals (MDEQ Release Number C-2149-91). The soil contamination was assumed to be due to routine filling operations, as the USTs appeared undamaged.

Approximately 3,015 cubic yards (cy) of soil were removed from the Building 29 tank farm during multiple remedial excavations, thermally treated via low temperature thermal desorption, and then used as backfill for the tank excavation, or stockpiled along the side of the access road to Building 29.

CRA further investigated the former UST farm in January 1994. Six additional boreholes were advanced and samples were collected. Since there were no detections of compounds in the verification samples at concentrations above the Michigan Act 307 Type B (residential) Direct Contact Criteria (DCC), this area was considered remediated. The results of the investigations were presented in the Building 29 Underground Storage Tank Area – Final Report (CRA, 1995a). This report was approved by the Michigan Department of Natural Resources (MDNR) in a letter dated March 17, 1995 and the Building 29 MDEQ Release Number was subsequently closed.

4.2 SWMU #6/AOI #42 - BUILDING 53 TANK AREA

SWMU #6/AOI #42 is the former Building 53 Tank Area. The location of this unit is presented on Figure 1.2. In August 1991, a 1,000-gallon waste oil steel UST was removed from the Building 53 area. The tank was originally installed in 1972 for the temporary storage of waste oil.

The UST, which was removed on August 30, 1991, was found to be intact with no apparent leaks. Following the excavation and removal of the UST, site assessment samples were collected. In October 1991, BTEX and PNA constituents were identified at concentrations exceeding then current Michigan Act 307 Type B (residential) criteria (MDEQ Release Number C-2188-91).

Additional excavation of the Building 53 UST Area was completed in November 1991. The total volume of soil excavated for remediation was approximately 190 cy. The excavated soils were characterized and disposed of at an off-Facility commercial landfill.

A supplemental subsurface investigation of the UST area near Building 53 was conducted by CRA in January 1994 to address comments provided by the MDNR regarding elevated lead and chromium concentrations. Four boreholes were advanced to further define lead and chromium concentrations in Facility soils, including background conditions.

The results of the investigations were presented in The Building 53 Underground Storage Tank Study Area – Final Report (CRA, 1994a). This report was approved by the MDNR in a letter dated April 27, 1994 and the Building 53 MDEQ Release Number was subsequently closed.

4.3 AOI #44 - BUILDING 43 REMEDIATION

AOI #44 is the Building 43 remediation. The location of this AOI is presented on Figure 1.2. In June 1993, WW Engineering and Science (WWES) and GM conducted a test excavation of this area to visually assess the extent of potentially affected material in the vicinity of Building 43. The fill material located adjacent to Building 43 was identified to be comprised of ash and miscellaneous debris associated with a historic fire.

In August 1994, CRA conducted an additional subsurface soil investigation to substantiate the visual information using soil analytical data. Analytical results from soil samples collected from the boreholes indicated concentrations exceeding then current Michigan Act 307 Type B criteria.

A total of approximately 20,600 tons of affected soil was characterized and properly disposed at a commercial landfill. Verification of the remediation of impacted material was accomplished through the collection of approximately 40 soil samples from the floor and sidewalls of the excavation. The analytical results of the verification samples collected from the excavation were below applicable criteria, with the exception of two samples that were found to exceed then current Michigan Act 307 Type B DCC for lead. Approximately 50 cy of additional soil was removed in the area of these two verification samples to remove affected soil remaining in the excavation.

4.4 AOI #50 - DUCO STORES

AOI #50 consists of the DUCO Stores UST Area and the DUCO Stores Fuel Line Study Area. The location of this AOI is presented on Figure 1.2. This AOI is comprised of two

areas that were evaluated separately. These areas are discussed in the following titled sections.

4.4.1 AOI #50 - DUCO STORES UST AREA

The DUCO Stores UST area consisted of eight steel USTs installed in 1927. The USTs contained gasoline, Railway end lube, glycol, axle oil, and diesel fuel.

On February 2, 1990, gasoline was identified to be infiltrating into a sanitary sewer line located to the west of the former DUCO Stores UST area (MDEQ Release Number C-0235-90). In May 1990, gasoline was discovered infiltrating into a storm sewer, which was located near the DUCO Stores fuel lines (MDEQ Release Number C-0776-90). Following both instances, the sewer was plugged and the sewer contents removed, as necessary, by vacuum tanker truck.

In June 1990, GM retained Northeast Research Institute, Inc. (NERI) to perform a soil gas survey of the area, which consisted of 53 sample locations from 18 inches bgs. The results of the survey were presented in the report entitled Final Report on the Findings of the Petrex Soil Gas Survey Conducted for the General Motors Truck and Bus Group at the DUCO Stores Tank Farm Site in Pontiac, Michigan (NERI, 1990). This report identified compounds typically found in gasoline in the soil vapors. A plume of oil constituents was also identified as being present in the DUCO Stores UST area.

In August 1991, all eight USTs in this area were excavated and removed. Following collection of 36 confirmatory samples from the UST cavity by Maecorp, diesel fuel was observed seeping into the excavation (MDEQ Release Number C-1831-91). Approximately 100 gallons of diesel fuel were recovered before seepage ceased. Benzene, benzo(a)anthracene, and chrysene were identified above the then current Michigan Act 307 Type B DCC.

Approximately 3,000 cy of soil was excavated and thermally treated via low temperature thermal desorption. Further excavation to the east and west was not possible due to the location of existing structures, including buildings, concrete sewers, and a concrete storage pad. However, additional remedial excavation of the base was conducted. Verification samples were collected and submitted for BTEX and PNA analyses. Residual concentrations were identified to marginally exceed their respective then current Michigan Act 307 Type B soil cleanup criteria. Further remedial excavation of the base was conducted. Analytical results for the verification samples collected from

the floor of the excavation indicated no residual BTEX or PNAs at concentrations exceeding the then current Michigan Act 307 Type B DCC.

In January 1994, CRA was retained to further define the nature and extent of any potential residual soil contamination in the area. CRA installed six boreholes (four west of and two east of the former excavation). In addition CRA deepened the northern end of the excavation by approximately 2' resulting in the removal of an additional 175 cy of soil. Twelve soil samples were collected from the boreholes (8'-10'bgs and 18'-20'bgs) and three soil samples were collected from the northern floor of the excavation; these soil samples were submitted for BTEX and PNA analyses. Results of the investigation were summarized in the DUCO Stores Study Area – Final Report (CRA, 1994c). The DUCO Stores Report concluded that minor residual concentrations of BTEX and PNAs remained in soils at inaccessible locations.

During expansion activities of Building 34/52 in October 1997, GM contractors encountered diesel fuel odors and stained soils adjacent to the eastern side of a 12-inch diameter storm sewer line south of Building 34 at a depth of approximately seven feet bgs. Construction activities ceased in this area until the source of the staining and odors could be determined.

During the period from October 13, 1997 to October 24, 1997, CRA excavated, segregated, stockpiled and analyzed approximately 2,800 cy of clean fill and approximately 8,400 cy of potentially affected soil. CRA collected a total of 49 soil samples from the excavation limits. Samples were analyzed for BTEX and PNAs. BTEX and PNAs were not detected above then current applicable Michigan Act 451, Part 201 Industrial Direct Contact or Soil Inhalation Cleanup Criteria for soil in any of the samples collected from within the excavation limits. Results of the remedial work were summarized in the Building 34 Excavation Summary Report (CRA, 1998a).

This area is currently open on the MDEQ Leaking UST (LUST) list. It is expected that ongoing natural attenuation would have further degraded the low levels of residual BTEX and PNAs.

4.4.2 AOI #50 - DUCO STORES FUEL LINE STUDY AREA

The DUCO Stores Fuel Line Study Area consisted of an underground distribution network for gasoline and fuel oil that was installed in 1927, which originated from a pumping station in the former Building 21. As previously mentioned, gasoline was

discovered infiltrating into a storm sewer, which was located near the DUCO Stores fuel lines (MDEQ Release Number C-0776-90) in May 1990.

In 1992, WWES installed 12 soil borings and three monitoring wells in Building 11, in the north end of Building 12, and within Building 27. The locations of these buildings are presented on Figure 3.1. BTEX constituents were identified at levels exceeding the then current Michigan Act 307 Type B soil cleanup levels.

In order to further define the extent of the sand lens where evidence of gasoline vapors was detected, seven boreholes and three test pits were installed by CRA in the vicinity of the fuel line in January 1994. Samples were collected from each borehole for chemical analysis for BTEX and lead. The results of the analysis did not identify any further areas of residual BTEX constituents in soil at levels of concern. The perched water was identified as being minor in extent and/or seasonally dependent. The DUCO Stores – Fuel Line Study Area – Final Report concluded that no additional investigation or remediation was required or warranted within this area (CRA, 1994b). This area is currently open on the MDEQ LUST list. It is expected that ongoing natural attenuation would have further degraded any remaining BTEX constituents.

4.5 AOI #52 - BUILDING 35 TANK FARM

AOI #52 is the Building 35 Tank Farm. The location of this AOI is presented on Figure 1.2. In 1946, a dynamometer tank farm was installed west of Building 35. The tank farm consisted of six 2,000-gallon USTs (Dyno Tanks 1 through 6). The tanks initially contained diesel fuel, regular/premium fuel, special fuels, and mineral spirits. The dynamometer tank farm supplied fuel through overhead fuel supply lines located inside Building 35 and the tunnel connecting Building 35 and Building 33 to an indoor vehicle fueling station located inside Building 33 at Isle M, Bay 8. In 1961, the indoor fuel supply lines connecting Building 35 to Building 33 were removed; however, the USTs remained in service and new lines connected Building 35 to an outdoor fuelling station south of Building 33.

In 1971, a new 10,000-gallon diesel fuel UST was installed south of the dynamometer tank farm and was connected to the most southerly of the tanks in the Dyno tank farm. In 1984, this tank was removed and replaced by two 12,000-gallon USTs (Dyno Tanks 7 and 8). The newly installed USTs contained diesel fuel and special leaded gasoline, and were not connected to the dynamometer tank farm.

In June 1991, a backhoe accidentally punctured the 12,000-gallon gasoline UST, which resulted in an estimated loss of 20 gallons. During recovery activities, historic diesel contamination north of the two 12,000-gallon USTs was identified (MDEQ Release Number C-1245-91). This contamination was suspected to be from the historic 10,000-gallon diesel UST, which had been in the same UST cavity.

On October 12, 1992, GM reported a suspected release (MDEQ Release Number C-1771-92) following structural integrity testing of the tanks. The release was confirmed (MDEQ Release Number C-1832-92) on October 21, 1992 following receipt of the results from a second tank test. On November 5, 1992, another release was reported from the same tank system based on additional structural integrity testing (MDEQ Release Number C-1972-92).

In September 1994, Dyno Tanks 1 through 6 were removed by Progressive Environmental Consulting & Engineering, Inc. (Progressive) along with 450 cy of impacted soil. Follow-up sampling from the six soil borings that were installed around the tanks indicated that further excavation was required.

In October 1994, Progressive performed further excavation (1,244 cy) and collected additional verification samples until the results of verification samples were below Michigan Act 307 Type B criteria. A Closure Report for the 1992 releases described above was submitted to MDNR.

In July 2005, Dyno Tanks 7 and 8 were removed from the ground. A sheen was identified on the groundwater in the UST cavity. The suspected release was reported to the MDEQ. Subsequent analytical results confirmed the release (MDEQ Release Number C-0202-05) and an Initial Assessment Report was submitted to the MDEQ and U.S. EPA in October 2005 (CRA, 2005b).

No constituents were identified above Michigan Act 451, Part 201 generic residential criteria in soil. Concentrations of a few petroleum hydrocarbon constituents were identified above the GSIC and Drinking Water Criteria (DWC) in groundwater.

This area will be further evaluated under Michigan Act 451 Part 213 for USTs. A supplemental investigation is pending to define the groundwater impacts and assess the potential impact to utility trench/storm sewer backfill. In addition, the outstanding open MDEQ release numbers (C-1245-91, C-1771-92/C-1832-92) will be evaluated with the MDEQ.

4.6 AOI #53 – BUILDING 33 FREE PRODUCT AREA

AOI #53 is the Building 33 Free Product Area. The LNAPL is underneath Building 33 at a depth of approximately 15 to 20 feet bgs. This LNAPL was the result of a historical gasoline release. The source of the gasoline leak is believed to be an underground fuel line that was discovered to be leaking in 1968/1969. The fuel line supplied a fuel island south of Building 33 that has since been abandoned and removed. In 1969, the fuel line was abandoned and removed and the underground supply lines were abandoned and capped at both ends.

In 1970, a new outdoor fueling station was installed between Building 33 and Building 34. The fueling station consisted of three 10,000-gallon USTs. These USTs were subsequently replaced in the early 1990s with two 12,000-gallon USTs. During the removal of the historic tanks, contamination was identified (MDEQ Release Number (C-1468-92). Approximately 13,000 tons of soil excavated from this area was treated by low temperature thermal desorption. Remaining concentrations of BTEX and naphthalene, the only detected constituents, were at or below Michigan Act 307 Type B levels. This release was subsequently closed by the MDNR. The results of this investigation were presented in a letter report entitled GM Truck Platforms – Engineering-Building 34 (GM, 1993).

In 1989, E.C. Jordon attempted to recover the LNAPL in this area using traditional pump and treat. In 1990, the gasoline collection system was terminated, as GM determined that it was ineffective because only 120 gallons of LNAPL had been recovered.

To further define the extent of gasoline present in soils under Building 33, CRA conducted a subsurface investigation of the area in 1994, which included the installation of 19 boreholes to a maximum depth of 20 ft bgs. Soil samples were screened using a photoionization detector (PID) and submitted for BTEX and lead chemical analysis. A monitoring well (MW33-1-94) was installed within one of the interior building boreholes to permit sampling of the free product and measurement of LNAPL thickness. No groundwater samples were collected. Gasoline free product was encountered at depths of approximately 15 to 19 ft bgs within sand and/or silt lenses.

The results of the 1994 investigative activities identified that benzene was detected in soil at concentrations that exceed the Michigan Act 451, Part 201 industrial and commercial Infinite Source Volatile Soil Inhalation Criteria (VSIC) at sample location BH33-1-94 at a depth of 15.5-16 ft bgs. In addition, BTEX was detected at concentrations exceeding the Michigan Act 451, Part 201 industrial and commercial Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC) at location BH33-1-94 at a depth of

15.5-16 ft bgs. Benzene was also detected at sample location BH33-1-94 at a depth of 16-18 ft bgs at a concentration exceeding SVIIC. At soil boring location BH33-1-94, at a depth of 15.5-16 ft bgs, exceedances of the Michigan Act 451, Part 201 industrial and commercial DCC and Groundwater Contact Protection Criteria (GCPC) for toluene, ethylbenzene, and xylenes were also identified.

At the completion of the 1994 investigation, CRA completed a remedial alternatives evaluation which was presented in the Subsurface Investigation/Remedial Alternatives Evaluation Report, Building 33-Free Product Gasoline Plume (CRA, 1995c). The evaluation included the following alternatives: No Further Action; Institutional Controls/Monitoring; Free Product Extraction; In Situ Vapor Extraction; Horizontal Drilling for Product Recovery and/or In Situ Vapor Extraction; and Excavation.

Post-RFI investigation activities and results for this AOI are discussed in Section 7.1.

4.7 AOI #69 - CONTAINER STORAGE AREA

AOI #69 is the former Container Storage Area located at the WWTP. The location of this AOI is presented on Figure 1.2. The container storage area consisted of a 12,543-square foot, 8-inch thick epoxy-coated concrete waste management pad that was constructed in 1980. The waste management pad was divided into two operating halves. The western half was a covered hazardous waste drum storage area and the eastern half operated as an uncovered non-hazardous waste bulking area.

Closure activities included decontamination, soil sampling, and remedial excavation of approximately 35 cy of soil north of the bulking pad retaining wall. These activities satisfied the requirements of the waste management pad closure as specified in 40 Code of Federal Regulations 265.111. Closure activities are summarized in the General Motors Corporation Truck & Bus Group Pontiac Central Manufacturing Facility & Assembly Waste Management Facility Closure Report (McNamee Industrial Services, Inc., 1991). MDNR approval of the closure was obtained in a letter dated June 27, 1991.

4.8 AOI #71 – BURN PILE

AOI #71 is the Burn Pile. The location of this AOI is presented on Figure 1.2. The Burn Pile was reportedly formed from the placement of debris from Building 43 after it burned down. The historic evaluation of the Burn Pile consisted of a Phase I investigation, a Phase I excavation, a Phase II investigation, and a Phase II remedial

excavation. This remedial work was completed to support the installation of Centerpoint Parkway through the eastern half of the Burn Pile. The western edge of the excavation was approximately 5 feet west of the right-of-way clearance for the proposed Centerpoint Parkway road that was later constructed over the eastern portion of the original extent of the Burn Pile. Excavation activities did not continue beyond what was necessary to support the Centerpoint Parkway construction. The western half of the Burn Pile is being further evaluated as discussed in Section 8.0.

The Phase I investigation was conducted in March 1994 by Cook & Associates, Inc. (Cook). Cook advanced 76 soil borings into the native clay/till underlying the Burn Pile. Soil samples were collected at 5-foot intervals and were analyzed for total lead concentrations. Several composite samples were also collected and analyzed for total lead and toxicity characteristic leaching procedure lead concentrations.

The Phase I remedial excavation was conducted in July 1994 by Barton Malow. The eastern portion of the Burn Pile was excavated for the construction of Centerpoint Parkway. The material was segregated into "potentially clean" and "potentially affected" soil stockpiles. Approximately 35,500 cy of material was excavated, segregated, and stockpiled during the Phase I remedial excavation. Approximately 32,000 cy was stockpiled as "potentially clean" soil and 3,500 cy was stockpiled as "potentially affected" soil. The analytical results for the soil samples collected from the "potentially clean" soil indicated that the soil was non-hazardous and the concentrations of all compounds analyzed were below the then current Michigan Act 307 Type C (industrial) DCC. This clean soil was used to construct berms and other landscaping features. The analytical results for the soil samples collected from the "potentially affected" soil indicated the soil was non-hazardous and suitable for disposal at a Michigan Type II commercial landfill.

A Phase II investigation was conducted by CRA in August 1994. The investigation was conducted to characterize the nature and extent of affected or potentially affected material remaining in the vicinity of the Burn Pile after the Phase I remedial excavation. The investigation consisted of advancing 12 soil borings and installing four monitoring wells. The affected soil identified during the Phase II investigation was further characterized as non-hazardous and suitable for disposal at a Michigan Type II commercial landfill.

The Phase II remedial excavation was conducted in October 1994. Approximately 6,500 cy of potentially affected soil was stockpiled including material from the Phase I excavation. This material was excavated, loaded, and transported to Waste Management's Eagle Valley Recycling and Disposal Facility in Orion, Michigan. During the excavation of affected soil, an old clay sewer line was encountered. The line and

associated bedding were filled with water. Approximately 30,000 gallons of water was pumped into frac tanks, sampled, and treated at the Facility's WWTP. Verification samples were collected from the excavation of the affected soil area identified during the Phase II investigation. The soil analytical data from the verification sampling were presented in the Summary Report - Burn Pile (CRA, 1995d).

The Burn Pile area is currently landscaped with grass, trees, and brush, and is zoned for industrial purposes. Post-RFI investigation activities and results for this AOI are discussed in Section 7.2.

4.9 SWMU #2/AOI #75 - FORMER EAST TANK FARM

AOI #75/SWMU #2 is the Former East Tank Farm. The location of this unit is presented on Figure 1.2. The Former East Tank Farm area was identified as a former hazardous waste storage area of approximately 4,500 square feet housing two former vertical 10,000-gallon ignitable waste collection tanks.

The former waste storage area initially received drummed waste such as chlorinated solvents (F001), waste paints (F003, F005, and D001), and waste solvents (F003, F005, and D001). These drummed wastes were subsequently removed and the area was used as secondary containment for the two 10,000-gallon hazardous waste storage tanks. These waste storage tanks were used for the storage of waste paint and waste solvent (F003 and F005).

Closure activities were completed between October 4, 1989 and October 6, 1989. Excavation and disposal of 780 cy of contaminated soils was performed between February 1990 and March 1990.

Closure activities are presented in the Closure Report for the Pontiac East Assembly Hazardous Waste Storage Area (C-E Environmental, Inc., 1990). The MDNR approved the closure in a letter dated October 30, 1990.

4.10 AOI #82 - FORMER PAINT MIX ROOM RETENTION TANK

AOI #82 is the Former Paint Mix Room Retention Tank. The location of this AOI is presented on Figure 1.2. The former underground paint mix room retention tank was utilized as a secondary containment tank to collect water from the paint mix room's fire suppression deluge system.

Removal activities of the former paint mix room retention tank by ABB Environmental Services, Inc. commenced on December 6, 1989 with the removal of a concrete pad (approximately 115 tons), which had overlaid the former paint mix room retention tank.

During the excavation of the tank area, solvent odors were identified, and soil sampling from the excavation and surrounding area was performed. Analysis of the soils identified detectable levels of ethyl benzene, toluene, xylene and methyl ethyl ketone, primarily in the upper 2 to 4 feet, which was suspected to be from overfilling the tank. At the time, ABB concluded that the closure of this tank would be regulated under Michigan Act 307 as it was a spill retention vessel.

Approximately 465 tons of soils were excavated and disposed off-site. The soil excavation activities commenced on October 3, 1990 and were completed in five phases ending on June 13, 1991.

The remediation activities are summarized in the Remediation Activities Report – Paint Mix Room Retention Tank Site (ABB Environmental Services, Inc. (ABB), 1991). The Report concluded that the cleanup of the retention tank area met then current Michigan Act 307 Type B cleanup criteria.

4.11 AOI #83 - DOCK 65

AOI #83, Dock 65, is located adjacent to the Pontiac Assembly Center. The location of this AOI is presented on Figure 1.2. In July 1994, odors of paint solvent were detected in the excavated soils while in the process of installing concrete footers for a new process line. A soil and groundwater investigation was undertaken by ABB that documented elevated levels of volatile organic compounds (VOCs) in the area.

Following delineation of the extent of contamination, approximately 600 cy of impacted soils were removed during the first round of excavation. Some additional remedial excavation was conducted following the first round of verification sampling. Based on the additional verification sampling completed, the area was remediated to the then current Michigan Act 307 Type B criteria, and no additional activities were warranted. Results of the final remediation are presented in the Site Remediation and Closure Report (ABB, 1995b), which was submitted to the MDNR for review. The MDNR approved the remediation in a letter dated November 22, 1995.

4.12 AOI #84 - FORMER TANK FARM AREA

AOI #84 is the Former Tank Farm Area located at Pontiac Assembly Center. The location of this AOI is presented on Figure 1.2. The former tank farm area consisted of ten USTs of varying sizes ranging from 10,000 to 24,000 gallons each. These tanks were utilized for the storage of various automotive fluids including axle lubricant, power steering fluid, engine oil, glycol, manual and automatic transmission fluid, diesel fuel, and gasoline.

On October 11, 1991, a confirmed release was reported during UST excavation and removal activities (MDEQ Release Number C-2741-91). The tank farm area had previously been listed on the Michigan Act 307 LUST list in 1987.

Remediation of the former tank farm area commenced in October 1991 and was completed by November 1994. A total of 7,300 cy of soil was excavated and disposed at a commercial landfill. A closure report for the Former Tank Farm Area (ABB, 1995a) was prepared for submission to the MDNR. This report concluded that the former tank farm area had been remediated to then current Michigan Act 307 Type B criteria. Closure approval of the former tank farm area was received from the MDNR in a letter dated September 18, 1995.

5.0 COMPLETED INTERIM MEASURES

The IMs at the J-Lot (SWMU #30/AOI #79) and the Former Coal Pile Storage Area (SWMU #32/AOI #49) were completed concurrent with the RFI Work Plan (CRA, 1998b) development and implementation. The scope and results of the IM activities were submitted to the U.S. EPA in reports entitled RCRA Interim Measures Construction Certification Report, Former J-Lot Fill Area (CRA, 1998c) and RCRA Interim Measure Investigation and Design Report - Former Coal Pile Storage Area (CRA, 1999), respectively. The IMs at the J-Lot and the Former Coal Pile Storage Area were both approved by U.S. EPA in correspondence dated June 11, 1998 and June 15, 2000, respectively. Additional information regarding these IMs is presented below.

5.1 SWMU #32/AOI #49 - FORMER COAL PILE STORAGE AREA

SWMU #32/AOI #49 is the former Coal Pile Storage Area. The location of this unit is presented on Figure 1.2. The former Coal Pile Storage Area was historically used to manage power house coal unloaded from railroad cars. The Coal Pile Storage Area was identified as a suspected source of polychlorinated biphenyls (PCBs) (suspected to have resulted from a shipment of contaminated coal) identified in October 12, 1977 in stormwater runoff to a storm sewer that emptied into a tributary of the Clinton River.

Energy conversion at the Facility from coal to natural gas was completed on August 4, 1997. As a result, the Powerhouse, together with the former Coal Pile Storage Area, underwent decommissioning and demolition activities. Consistent with the April 29, 1988 meeting between U.S. EPA and GM, the former Coal Pile Storage Area was addressed as an IM to support ongoing redevelopment at the Facility. The results of the IM investigation were presented in the RCRA Interim Measure Investigation and Design Report - Former Coal Pile Storage Area (CRA, 1999) and the Addendum to RCRA Interim Measure Investigation and Design Report - Former Powerhouse Coal Pile Storage Area (CRA, 2000).

The IM investigation results showed that concentrations of all detected constituents were below then current Michigan Act 451, Part 201 cleanup criteria. U.S. EPA agreed that no further action is necessary for this area in correspondence dated June 15, 2000.

5.2 SWMU #30/AOI #79 - FORMER J-LOT FILL AREA

SWMU #30/AOI #79 is the J-Lot. The location of this AOI is presented on Figure 1.2. The J-Lot is an undeveloped 8-acre parcel, located to the northwest of the corner of South Boulevard and Opdyke Road. The J-Lot was identified as a SWMU/AOI based on a one-time burial of waste materials sometime between 1950 and 1955.

The nature and extent of potentially affected materials at the J-Lot was characterized through a series of investigations. Based on the results of these investigations, GM proposed to excavate, transport, and dispose of the impacted material from the J-Lot to an appropriate off-site landfill. This work was proposed in an IM work plan entitled Removal Action Design Report (CRA, 1997), which was approved by U.S. EPA in May 1997.

Excavation activities were initiated on July 28, 1997 and were completed on September 9, 1997. A total of 5,271 cy of clean overburden soil was excavated and temporarily stockpiled. A total of 21,564 cy of impacted fill was excavated, staged, and subsequently transported off-site for disposal.

The RCRA Interim Measures Construction Certification Report, Former J-Lot Fill Area (CRA, 1998c) indicated that all final soil verification samples were below then current Michigan Act 451, Part 201 generic industrial DCC. The IM for the J-Lot was approved by U.S. EPA in correspondence dated June 11, 1998.

6.0 RFI ACTIVITIES

The RFI investigation and supplemental RFI activities were conducted between November 1998 and August 2000. The RFI Report was submitted in red-lined format to U.S. EPA on November 30, 2000. It included information from both phases of the RFI investigation. The November 30, 2000 RFI Report was approved by U.S. EPA in a letter dated June 27, 2005. A "clean" version of the U.S. EPA-approved RFI Report (i.e., without red-line format) was submitted to U.S. EPA on October 21, 2005 (CRA 2005c).

A summary of the SWMUs/AOIs investigated as part of the RFI is presented in the following sections. Additional information regarding each unit is presented in the RFI Report (CRA, 2005d).

6.1 SWMU #33/AOI #45- FORMER SOUTH RETENTION POND

SWMU #33/AOI #45 is the former South Retention Pond. The former location of this unit is presented on Figure 1.2. The Former South Retention Pond collected stormwater runoff from the south end of the Pontiac Assembly Center and the WWTP area. As part of the Centerpoint Business Campus redevelopment program, the South Retention Pond was backfilled and redeveloped for commercial use.

In December 1998, CRA supervised the installation of seven investigative boreholes in the vicinity of the Former South Retention Pond as part of the RFI. Twelve soil samples collected from the area were submitted for laboratory analysis. Nine of the twelve soil samples submitted to the laboratory were analyzed for Target Compound List (TCL) VOCs, TCL Semi-Volatile Organic Compounds (SVOCs), TCL PCBs, Target Analyte List (TAL) metals, and cyanide. The remaining three soil samples, including a duplicate sample, were analyzed for the Appendix IX constituents (VOCs, SVOCs, PCBs, metals, cyanide, and sulfide). Analytical results for the soil samples identified no VOCs, two SVOCs (2-methylnaphthalene and phenanthrene), no PCBs, and 23 metals at concentrations at or above the laboratory method detection limit.

As discussed in Section 5.1.4 of the approved RFI Report, no detected concentrations were higher than the applicable MDEQ generic industrial screening criteria (2000). Therefore, it was concluded that no remedial action was required.

As presented in Section 8.4, all historical analytical data were compared to current Michigan Act 451, Part 201 criteria to support the final Corrective Measures decision for this SWMU/AOI.

6.2 SWMU #34 /AOI #46- NORTH RETENTION POND

SWMU #34/AOI #46 is the North Retention Pond. The location of this unit is presented on Figure 1.2. The North Retention Pond collects stormwater runoff from the northern parking lots of the Pontiac Assembly Center. As part of the redevelopment program, the North Retention Pond was regraded, deepened, and landscaped to accommodate additional stormwater runoff from the newly constructed Pontiac Centerpoint Campus-East parking lots and Campus Drive.

In December 1998, CRA supervised the installation of four investigative boreholes and the collection of two sediment samples within and adjacent to the North Retention Pond as part of the RFI. Five soil samples and two sediment samples collected from the area were submitted for laboratory analysis. Six of the seven soil samples submitted to the laboratory were analyzed for TCL VOCs, TCL SVOCs, TCL PCBs, TAL metals, and cyanide. The seventh sample was analyzed for the Appendix IX constituents (VOCs, SVOCs, PCBs, metals, cyanide, and sulfide). Analytical results for the soil samples identified no VOCs, 20 SVOCs, no PCBs, and 23 metals at concentrations at or above the laboratory method detection limit.

As discussed in Section 5.1.5 of the approved RFI Report, no detected concentrations were higher than the applicable MDEQ generic industrial screening criteria (2000). Therefore, it was concluded that no remedial action was required.

As presented in Section 8.5, all historical analytical data were compared to current Michigan Act 451, Part 201 criteria to support the final Corrective Measures decision for this SWMU/AOI.

6.3 SWMU #31/AOI #54 -FORMER SURFACE IMPOUNDMENT

SWMU #31/AOI #54 is the Former Surface Impoundment. The location of this unit is presented on Figure 1.2. The Former Surface Impoundment was used to temporarily store wastewater during a period of WWTP repair. Since 1995, redevelopment activities in the vicinity of the Former Surface Impoundment have included the construction of the South Access Road and grading and landscaping during development of the Centerpoint Business Campus.

In December 1998, CRA supervised the installation of six investigative boreholes within and adjacent to the Former Surface Impoundment as part of the RFI. Seven soil samples collected from the area were submitted for laboratory analysis. Six of the seven soil samples submitted to the laboratory were analyzed for TAL metals. The seventh sample was analyzed for the Appendix IX constituents (VOCs, SVOCs, PCBs, metals, cyanide, and sulfide). Additionally, one of the six samples submitted for metals analysis was also submitted for a TCL VOC analysis due to elevated PID readings. Analytical results for the soil samples identified one VOC, 11 SVOCs, one PCB, 23 metals and total cyanide at concentrations at or above the laboratory method detection limit.

One monitoring well was installed at this area as part of the second phase of the RFI investigation in August 2000. The groundwater sample collected from this monitoring well identified 3 VOCs, no SVOCs, no PCBs, 12 total metals, and 9 dissolved metals at concentrations at or above the laboratory method detection limit.

As discussed in Section 5.1.3 of the approved RFI Report, detected concentrations of arsenic and lead in soil were higher than the applicable MDEQ generic industrial screening criteria (2000). However, a site-specific risk evaluation determined that these concentrations of arsenic and lead, when considered in conjunction with the other concentrations of arsenic and lead at the area, do not pose a significant risk (CRA 2005d). No detected concentrations in groundwater were higher than the applicable industrial screening criteria.

As presented in Section 8.10, all historical analytical data were compared to current Michigan Act 451, Part 201 criteria to support the final Corrective Measures decision for this SWMU/AOI.

6.4 SWMU #29/AOI #66- WASTEWATER TREATMENT PLANT

AOI #66/ SWMU #29 is the WWTP. The location of this unit is presented on Figure 1.2. The WWTP Area currently consists of 20 open top, vertical, aboveground storage tanks located outside Building 56. The wastewater treatment tanks include tanks for the treatment of acid and general wastes, clarifiers, an equalization tank, a cleaner waste tank, and an oil skimmer tank.

In December 1998, CRA supervised the installation of eight investigative boreholes in the vicinity of the WWTP as part of the RFI. Nine soil samples collected from the area were submitted for laboratory analysis. Eight of the nine soil samples submitted to the laboratory were analyzed for TCL VOCs, TCL SVOCs, TCL PCBs, TAL metals, and

cyanide. The ninth sample was analyzed for the Appendix IX constituents (VOCs, SVOCs, PCBs, metals, cyanide, and sulfide). Analytical results for the soil samples identified five VOCs, 17 SVOCs, two PCBs, 23 metals, and sulfide at concentrations at or above the laboratory method detection limit.

As discussed in Section 5.1.2 of the approved RFI Report, no detected concentrations were higher than the applicable MDEQ generic industrial screening criteria (2000). Therefore, it was concluded that no remedial action was required.

As presented in Section 8.11, all historical analytical data were compared to current Michigan Act 451, Part 201 criteria to support the final Corrective Measures decision for this SWMU/AOI.

6.5 SWMU #3/AOI #74- CONTAINER STORAGE AREA

SWMU #3/AOI #74 is the Container Storage Area at the Pontiac Assembly Center. The location of this unit is presented on Figure 1.2. The Container Storage Area consists of a concrete containment pad measuring approximately 50 feet wide by 100 feet long. The container storage area is used for the temporary accumulation (less than 90 days) of 55-gallon drums containing waste solvents and sludges, as well as non-hazardous materials, from ongoing operations at the Pontiac Assembly Center.

In December 1998, CRA supervised the installation of six investigative boreholes in the vicinity of SWMU #3 as part of the RFI. No visual staining was observed during the sampling activities. Ten soil samples collected from the area were submitted for laboratory analysis. Nine of the ten soil samples submitted to the laboratory were analyzed for TCL VOCs, TCL SVOCs, TCL PCBs, TAL metals, and total cyanide. The tenth sample was analyzed for the Appendix IX constituents (VOCs, SVOCs, PCBs, metals, cyanide, and sulfide).

Analytical results for the soil samples collected from this area identified no VOCs, 20 SVOCs, one PCB, 23 metals, and total cyanide at concentrations at or above the laboratory method detection limit.

One monitoring well was installed at the area in August 2000 as part of the second phase of the RFI investigation. The groundwater samples collected from this monitoring well identified no VOCs, no SVOCs, no PCBs, 14 total metals, and 13 dissolved metals at concentrations at or above the laboratory method detection limit.

As discussed in Section 5.1.1 of the approved RFI Report, no detected concentrations were higher than the applicable MDEQ generic industrial screening criteria (2000). Therefore, it was concluded that no remedial action was required.

As presented in Section 8.14, all historical analytical data were compared to current Michigan Act 451, Part 201 criteria to support the final Corrective Measures decision for this SWMU/AOI.

6.6 SUMMARY OF RESULTS AND RISK SCREENING

As discussed in the approved RFI Report (CRA 2005c), data from the RFI field investigations were evaluated using then current Michigan Act 451, Part 201 generic industrial and commercial II, III, and IV DCC as screening levels to identify potentially significant risks associated with chemical constituents detected in soil and groundwater.

The result of the screening indicated that all analytes detected from SWMU #3/AOI #74, SWMU#29/AOI #66, SWMU #33/AOI #45, and SWMU #34/AOI #46 were below the Part 201 DCC. Detected concentrations of arsenic and lead were reported in multiple samples at the Former Surface Impoundment (AOI #54) in excess of DCC. However, a site-specific risk evaluation determined that these concentrations of arsenic and lead, when considered in conjunction with the concentrations of arsenic and lead in the samples that had been collected for investigation of the Former Surface Impoundment, do not pose a significant risk. These calculations were presented in Appendix F of the approved RFI Report (CRA 2005c).

7.0 POST-RFI ACTIVITIES

7.1 AOI #53 - BUILDING 33 FREE PRODUCT STUDY AREA

CRA conducted an environmental subsurface investigation between June 2004 and November 2004 to delineate LNAPL, soil, vapor, and groundwater impacts associated with a historical gasoline release from a former UST system at Building 33. During the course of the investigation, a second heavier (non-gasoline) LNAPL was identified in an area just east of the gasoline LNAPL beneath Building 33. Consequently, the scope of the investigation was expanded to also delineate the LNAPL, soil, and groundwater impacts associated with the second LNAPL. The investigations were conducted in accordance with the Building 33 IM Work Plan (CRA, 2004b) and the Building 33 Additional Investigation Work Plan Memorandum (CRA, 2004a). The gasoline LNAPL is referred to as LNAPL Area 1. The second heavier LNAPL is referred to as LNAPL Area 2.

A total of 32 boreholes, 17 temporary wells, and 11 permanent monitoring wells were installed from June 2004 through November 2004. All soil samples from boreholes were field screened to assist with the delineation of horizontal and vertical impacts. Soil and groundwater samples were collected from the boreholes/monitoring wells and select samples (based on field screening and evaluation) were submitted for laboratory analysis of target compounds. LNAPL samples were also collected from LNAPL Area 1 and LNAPL Area 2 and submitted for fingerprinting characterization and laboratory analysis of target compounds. The results of this investigation were reported to the U.S. EPA in the Building 33 Interim Measures Investigation Summary Report (CRA, 2005a).

The horizontal extent of LNAPL in both areas has been delineated. The LNAPL in LNAPL Area 1 consists of a slightly weathered gasoline with a mixture of some diesel or No. 2 fuel oil. The LNAPL in LNAPL Area 2 consists of a heavier petroleum hydrocarbon with properties characteristic of a hydraulic oil or lube oil. Monitoring well head space readings during investigation activities indicated that gasoline vapors in LNAPL Area 1 are greater than the lower explosive limit (LEL) for gasoline in several monitoring wells. Well head space readings in LNAPL Area 2 did not indicate readings above the LEL.

Additional field activities are required to further delineate the vertical extent of petroleum hydrocarbon impacts in the immediate vicinity of three wells in LNAPL Area 1, where elevated PID readings were encountered in the clay at the bottom of the boreholes (approximately 30 feet bgs). It is unknown how thick the clay layer is in this

area and additional vertical evaluation may create a pathway for further vertical migration.

Between December 2004 and February 2005, GM conducted a remedial pilot study to evaluate the effectiveness of a high vacuum multi-phase extraction (MPE) system to remediate LNAPL beneath Building 33. The pilot study was conducted in accordance with the Interim Measures Work Plan, Remedial Pilot Study, Building 33, LNAPL Area 1 submitted to the U.S. EPA in November 2004 (CRA, 2004b).

LNAPL was extracted from eight existing monitoring wells contained within LNAPL Area 1 between December 7, 2004 and February 15, 2005. Approximately 3,097 gallons of LNAPL equivalent were recovered from all three phases (vapor-phase, dissolved-phase, and free-phase) during the pilot study. The phase-specific hydrocarbon recovery fractions were as follows:

- 53% of the total mass of recovered LNAPL was recovered in the free phase (free product);
- 47% of the total mass of recovered LNAPL was recovered in the vapor phase; and
- 0.001% of the total mass of recovered LNAPL was recovered in the dissolved phase.

The results of the remedial pilot study indicate that a full-scale MPE system would be an effective remedial technology for the LNAPL in LNAPL Area 1. Previous attempts to use a traditional pump and treat method were ineffective in this area.

7.2 AOI #71 - BURN PILE

CRA conducted environmental investigations at the Burn Pile from August 13, 2004 to July 25, 2005. The purpose of these investigations was to further define the extent of contamination present in the vicinity of the Burn Pile through the collection of subsurface soil and groundwater samples. The investigation was conducted in accordance with the Burn Pile Interim Measures Work Plan (CRA, 2004c).

The investigation consisted of the advancement of 12 soil borings, installation of five permanent monitoring wells and seven temporary monitoring wells, collection of 17 subsurface soil samples and 18 groundwater samples, excavation of ten test pits, survey of all soil boring, monitoring well, and test pit locations, and performance of three groundwater elevation measurement events.

In addition, a small amount of LNAPL was encountered in monitoring well MW-1 during groundwater monitoring. Consequently, a LNAPL recovery program was initiated. In August 2004 approximately 325 milliliters (11 ounces) of LNAPL were recovered from monitoring well MW-1. The recovered LNAPL was submitted for chemical analysis. LNAPL presence checks were subsequently conducted at monitoring well MW-1 in August 2004, September 2004, October 2004, November 2004, and July 2005. Trace amounts of LNAPL were identified in September, October and November 2004; however, the amounts present were insufficient to recover.

Based on the results of the soil and groundwater investigation, a further investigation was conducted in March 2006 per the Burn Pile Phase 3 Investigation Report and Phase 4 Work Plan (CRA, 2006) to determine the extent of contamination and to determine the appropriate Corrective Measures.. The initial results of the investigation indicate that the LNAPL has been delineated and that no other major sources of significant contamination exist at this AOI.

A notice of off-site migration has been filed with the MDEQ. Property owners to the east and south of the Burn Pile (City of Pontiac and Canadian National Railway) have also been notified of existing contamination.

There are two community drinking water supply wells south of the Burn Pile (South Bloomfield Highlands Community Supply Wells #1 and #2). These wells are installed at a depth of approximately 220 feet bgs. Analytical data retrieved from the MDEQ for these wells from December 2000 to April 2005, indicate that none of the constituents that have been identified at the Burn Pile have concentrations that exceed Michigan Act 451, Part 201 generic residential DWC.

8.0 SUMMARY OF CORRECTIVE MEASURES ALTERNATIVES

The analytical data for each SWMU/AOI were compared to current Michigan Act 451, Part 201 residential and industrial criteria (December 2004) for the purpose of supporting decisions regarding the need for institutional controls on future land use as part of the final Corrective Measures for each area.

Subsequent to the submittal of the draft CMP to the U.S. EPA (October 24, 2005), the MDEQ updated the Michigan Act 451 Part 201 generic groundwater cleanup criterion for arsenic on October 26, 2005 and became effective on October 31, 2005. These revisions, among other things, revised the generic DWC for arsenic that was used for data screening from 0.05 mg/L to 0.010 mg/L. No arsenic concentration in groundwater at the Facility had exceeded the December 2004 Part 201 generic DWC, but 16 groundwater samples from 10 monitoring wells had arsenic concentrations that exceed the 2005 Part 201 generic DWC. The locations of these groundwater samples are presented in Appendix E. These new results do not have any substantive effect on the CMP because groundwater at the Site is not currently used as a drinking water supply, and these areas are proposed to have a resource use restriction prohibiting the shallow groundwater from being used for drinking water.

Although a comparison of analytical data to current criteria for a number of the SWMUs/AOIs does not warrant any further action, GM has proposed that all areas where it has active operations plus the J-Lot will have a commercial/industrial land use restriction and a restriction preventing shallow groundwater from being used as a drinking water source.

8.1 AOI #16 - FORMER BUILDING 29 TANK FARM

The LUST is listed as closed on the MDEQ LUST list. No exceedances of current criteria were identified. Therefore, no further action is required at this AOI. However, because this AOI is within GM's active operations, institutional controls, including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used as a drinking water source, are proposed as a Corrective Measure.

8.2 SWMU #6/AOI #42 - BUILDING 33 TANK AREA

The LUST is listed as closed on the MDEQ LUST list. No exceedances of current criteria were identified. NFA is the proposed Corrective Measure for this area.

8.3 AOI #44 - BUILDING 43 REMEDIATION

There are arsenic and lead exceedances of Michigan Act 451, Part 201 generic residential and industrial DCC in the post-excavation samples collected at Building 43 at a depth of 30 feet bgs at two discrete sample locations. As discussed in the Building 43 Excavation Report (CRA, 1996), contaminated soil in this area was excavated to depths up to 30 feet bgs. The excavation was subsequently backfilled with clean soil. Therefore, no pathway exists for surface soil, and the depths where the exceedances were found were at depths greater than what would be expected for construction worker exposure. The proposed Corrective Measure for this area is NFA.

8.4 SWMU #33/AOI #45- FORMER SOUTH RETENTION POND

Arsenic exceeds the current Michigan Act 451, Part 201 generic residential DCC at this area, but not the industrial DCC. The maximum concentration of arsenic is 8.5 mg/kg at a depth of 18-20 feet bgs. However, according to the Michigan Background Soil Survey 2005 prepared by the MDEQ, the average arsenic concentration in clay, which is the soil type found at 18 to 20 ft bgs at this area, is 9 mg/kg in this area of Michigan (MDEQ, 2005). This means the arsenic concentrations at this AOI are all within default natural background levels. Therefore, NFA is the proposed Corrective Measure for this area.

8.5 SWMU #34/AOI #46- NORTH RETENTION POND

Benzo(a)pyrene, detected in one of the seven samples, marginally exceeded the Michigan Act 451, Part 201 generic residential and industrial soil DCC (12 mg/kg compared to 10 mg/kg). This area is intermittently covered with surface water and contains a vegetative cover. The area is presently fenced. Therefore, no further action is required at this SWMU/AOI. However, because this SWMU/AOI is within GM's active operations, institutional controls, including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used as a drinking water source, is the proposed Corrective Measure.

8.6 SWMU #32/ AOI #49 - FORMER COAL PILE STORAGE AREA

As discussed in Section 7.1, an IM was completed and approved by U.S. EPA. No exceedances of criteria were identified and, therefore, no further action is required at this AOI. However, because this SWMU/AOI is within GM's active operations, institutional controls, including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used as a drinking water source, are proposed as a Corrective Measure.

8.7 AOI #50 - DUCO STORES

Residential and industrial exceedances of Michigan Act 451, Part 201 SVIIC, VSIC, GCPC, and DCC were identified in soil. Residential and industrial exceedances of Michigan Act 451, Part 201 DWC were also identified in groundwater. The proposed Corrective Measure for this area is closure in accordance with Michigan Act 451, Part 213 requirements and institutional controls, including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used as a drinking water source, as it is within GM's active operations.

8.8 AOI #52 - BUILDING 35 TANK FARM

Open MDEQ Release Numbers, including the July 2005 Release Number, are present at this area. A supplemental groundwater investigation in this area is pending. The proposed Corrective Measure for this area is closure in accordance with Michigan Act 451, Part 213 requirements (subject to supplemental groundwater investigation) and institutional controls, including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used as a drinking water source, as it is within GM's active operations.

8.9 AOI #53 – BUILDING 33 LNAPL

As discussed in Section 7.1, two LNAPL areas have been identified beneath Building 33. Building 33 was demolished in December 2005.

Risk-based soil and groundwater cleanup criteria for the smear zone soil and perched groundwater in LNAPL Area 1 were calculated based on consideration of vapor intrusion into a hypothetical industrial/commercial building, and potential exposure of construction workers during occasional excavations that extend into the smear zone and perched groundwater. The calculations are presented in Appendix C. The calculated cancer and noncancer risk-based cleanup criteria were also evaluated to determine whether the subsurface vapor concentrations in equilibrium with these soil and groundwater concentrations could pose a potential explosion hazard. As presented in Appendix C, the estimated subsurface equilibrium vapor concentrations for several of the constituents in smear zone soil are close to their LEL. This indicates that explosion hazard rather than health risk is the more significant consideration for the remediation of LNAPL Area 1. Subsurface conditions at LNAPL Area 1 are such that Corrective Measures for mitigating explosion hazard would also be expected to mitigate the potential for significant indoor health risks.

A risk-based evaluation of LNAPL Area 2 was conducted to determine whether the existing conditions in this area pose a significant risk. Potential exposures were evaluated for the same exposure scenarios evaluated for LNAPL Area 1 and using similar exposure assumptions. The calculations for this evaluation are also included in Appendix C. Based on the evaluation results for LNAPL Area 2, the existing conditions do not pose a significant risk.

8.9.1 SUMMARY OF ALTERNATIVES

As discussed in Section 4.6, CRA evaluated six Corrective Measures in 1994. Based on this previous evaluation and a recent pilot study performed at this area, the following Alternatives were evaluated for LNAPL Area 1 and LNAPL Area 2.

Alternative 1: Passive Recovery – Passive LNAPL recovery would be completed using absorbents, bailing, or pumping methods. The mass removal would continue to the extent practical. Long-term periodic monitoring would be implemented to ensure that residual LNAPL and soil vapors do not pose a safety hazard (i.e., health based risk or explosion hazards from LNAPL Area 1) for future use of this area. If such hazards remain at LNAPL Area 1 following the removal of LNAPL to the extent practical, institutional controls would be included to ensure that if a building were to be constructed in this area, proper engineering controls would be provided to mitigate these hazards. The recovered product would be characterized and transported off-Facility for fuel blending or disposal, as appropriate.

Passive recovery would be expected to recover small quantities of LNAPL over a relatively long time period. Alternative 1 would be the lowest cost option.

Alternative 2: MPE – LNAPL recovery would be implemented using MPE with pneumatic airlift and pneumatic fracturing. Vertical extraction wells would be installed to establish an extraction network that fully covers the areal extent of the plume. This option would aggressively recover LNAPL to the extent practical and stimulate aerobic biodegradation of the residual free product through the injection of air during the pneumatic fracturing. Long-term periodic monitoring would be implemented to ensure that residual LNAPL and soil vapors do not pose a hazard (i.e., health based risk or explosion hazards from LNAPL Area 1) for future use of this area. If such hazards remain following the removal of LNAPL to the extent practical, institutional controls would be included to ensure that if a building were to be constructed in this area, proper engineering controls would be provided to mitigate these hazards.

MPE would be expected to recover much larger quantities of LNAPL over a much shorter time period than Alternative 1. The cost of Alternative 2 would fall between those of Alternatives 1 and 3 (see below).

Alternative 3: Soil Excavation/Removal of LNAPL – Soil and LNAPL in this area would be excavated, characterized, and transported off Facility for proper disposal such that explosion hazards are reduced to acceptable levels.

Alternative 3 would be the most immediate Corrective Measure when compared with Alternatives 1 and 2. However, removal of LNAPL via excavation is not practical or completely effective and would represent the most expensive alternative.

Proposed Alternatives: The proposed alternatives are Alternative 1: Passive Recovery for LNAPL Area 2 and Alternative 2: MPE for LNAPL Area 1, and institutional controls, including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used as a drinking water source, as it is within GM's active operations, as discussed in Section 9.0.

8.10 SWMU #31/AOI #54-FORMER SURFACE IMPOUNDMENT

There are exceedances of Michigan Act 451, Part 201 generic residential and industrial soil DCC and Particulate Soil Inhalation Criteria (PSIC) in soil and exceedances of Michigan Act 451, Part 201 generic residential and industrial DWC in groundwater. The preliminary risk assessment completed for arsenic and lead identified that the

concentrations were acceptable (CRA 2005c). Chromium (total) exceeds the Michigan Act 451, Part 201 residential DCC and the residential and industrial PSIC. Chromium concentrations were compared to Cr (VI) criteria since the chromium was not speciated during the RFI. The area is currently covered with topsoil and grass, and the future land use is expected to remain the same (industrial). The proposed corrective measure for this area is institutional controls including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used for drinking water.

8.11 SWMU #29/AOI #66- WASTEWATER TREATMENT PLANT

There are exceedances of Michigan Act 451, Part 201 residential and industrial PSIC for chromium total (using Cr (VI) criteria) and Michigan Act 451, Part 201 residential DCC for thallium. The proposed Corrective Measure for this SWMU/AOI is institutional controls, including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used for drinking water.

8.12 AOI #69 - CONTAINER STORAGE AREA

No exceedances of current Michigan Act 451, Part 201 criteria were identified. Therefore no further action is required at this AOI. However, this AOI is within an area where GM has active operations therefore institutional controls, including a land use restriction to commercial/industrial use and a resource use restriction preventing shallow groundwater in an unconfined aquifer being used for drinking water is the proposed Corrective Measure.

8.13 AOI #71 – BURN PILE

Based on investigations of this area in 2004 and 2005, there are current exceedances of Michigan Act 451, Part 201 generic residential and industrial PSIC, VSIC, DCC, and SVIIC in the soil. In addition, there are exceedances of Michigan Act 451, Part 201 generic residential and industrial DWC and Groundwater Contact Criteria (GCC). Supplemental field investigations were conducted in March 2006 to define the extent of contamination and determine appropriate Corrective Measures Alternatives. The initial results of the supplemental investigations indicate that the LNAPL has been delineated and that no other major sources of contamination exist at this AOI. Potential Corrective Measures Alternative for this area include one or more of the following:

- institutional controls with long-term monitoring and passive recovery of LNAPL from well MW-1;
- hydraulic containment;
- engineered soil cover; and/or
- excavation and off–site disposal.

8.13.1 SUMMARY OF ALTERNATIVES

Alternative 1: Institutional Controls with Long-Term Monitoring and Passive Recovery of LNAPL from MW-1

Institutional controls would be imposed, including a land use restriction for commercial/industrial use and a restriction preventing shallow groundwater from being used as a drinking water source. This approach would be consistent with the fact that AOI #71 is within GM's area of active industrial operations at the Facility. In addition, long-term periodic monitoring would be implemented to ensure the remaining constituents do not pose a hazard for future use of this area and that contaminated groundwater is stabilized. Passive recovery of LNAPL, for the duration that recovery is practical, would be completed using absorbents, bailing, or pumping methods. Passive recovery would be expected to recover small quantities of LNAPL over a longer time period when recovery is practical. Alternative 1 would be the lowest cost alternative.

Alternative 2: Hydraulic Containment

A slurry wall, groundwater collection trench, or extraction wells (possibly in combination) would be installed to prevent impacted shallow groundwater from migrating off the Facility. The containment system would be installed on the eastern and southern boundaries of the Burn Pile. The collected groundwater would subsequently be treated. Long-term groundwater monitoring of downgradient monitoring wells would be performed. Alternative 2 would be more costly than Alternatives 1 and 3 but less than Alternative 4.

Alternative 3: Engineered Soil Cover

An engineered soil cover would be installed over all or a portion of the area to minimize precipitation infiltration and to prevent direct contact with any impacted soils. The cost of Alternative 3 would be less than Alternatives 2 and 4 but more than Alternative 1 and would limit the amount of impacted perched groundwater accumulating in the shallow zone.

Alternative 4: Excavation and Off-Site Disposal

Soil and LNAPL in this area would be completely excavated, characterized, and transported off site for disposal. This Alternative would be the most immediate and would likely remove all contamination, but would be impractical and the most expensive alternative.

Proposed Alternative:

The proposed alternative for this area is institutional controls (Alternative 1), including a land use restriction for commercial/industrial use and a restriction preventing groundwater from being used as a drinking water source. Long-term monitoring of the groundwater would be conducted to ensure the remaining constituents do not pose a hazard for future use of the Facility and to ensure that contaminated groundwater is stabilized. Passive removal of LNAPL from MW-1 would be conducted for the duration that recovery is practical. This alternative would provide sufficient protection of human health and the environment based on an evaluation of the historical data summarized in the Burn Pile Phase 3 Investigation Report and Phase 4 Work Plan (CRA, 2006), and a preliminary review of the March 2006 investigation. In the event that the final evaluation of the results of the March 2006 investigation would indicate the presence of any potentially significant risk beyond that identified based on the prior data, Alternatives 2, 3, or 4 will be proposed unless other more appropriate corrective measures become necessary.

8.14 SWMU #3/AOI #74 - CONTAINER STORAGE AREA

There are Michigan Act 451, Part 201 generic residential exceedances for DCC in soil and exceedances of DWC in groundwater. There are no exceedances of generic industrial DCC. The area is adjacent to the Pontiac Assembly Center and is currently used and zoned for industrial purposes. To evaluate the need for institutional controls to restrict future land use due to the presence of concentrations in soil that exceed the Part 201 generic residential DCC, additional risk calculations were performed to assess the significance of potential residential exposures to constituents in soil at this AOI. As presented in Appendix D, these risk calculations show that high-end estimates of residential cumulative cancer and noncancer risks that account for site-related metals concentrations (i.e., do not include MDEQ generic default background soil concentrations) do not exceed 10^{-4} and 1, respectively, which are within the U.S. EPA limits for triggering the need for corrective measures (USEPA 1991). Therefore, no further action is required at this AOI. However, because this SWMU/AOI is within an area where GM has active operations, institutional controls, including a land use restriction to commercial/industrial use and a restriction preventing shallow

groundwater from being used for drinking water, are proposed as a Corrective Measure for this area.

8.15 SWMU #2/AOI #75 - FORMER EAST TANK FARM

No exceedances of current Michigan Act 451, Part 201 criteria were identified. Therefore, no further action is required. However, because this SWMU/AOI is within an area where GM has active operations, institutional controls, including a land use restriction to commercial/industrial use and a restriction preventing shallow groundwater from being used for drinking water, are proposed as Corrective Measure for this area.

8.16 SWMU #30/AOI #79 - FORMER J-LOT FILL AREA

There are exceedances of Michigan Act 451, Part 201 generic residential and industrial DCC and PSIC in soil and DWC in groundwater. The area is currently covered with topsoil and grass. The proposed Corrective Measure for this area is institutional controls, including a land use restriction to commercial/industrial use and a restriction preventing shallow groundwater from being used for drinking water.

8.17 AOI #82 - FORMER PAINT MIX ROOM RETENTION TANK

No exceedances of current Michigan Act 451, Part 201 criteria were identified. Therefore, no further action is required. However, because this SWMU/AOI is within an area where GM has active operations, institutional controls, including a land use restriction to commercial/industrial use and a restriction preventing shallow groundwater from being used for drinking water, are proposed as a Corrective Measure for this area.

8.18 AOI #83 - DOCK 65

No exceedances of current Michigan Act 451, Part 201 criteria were identified. Therefore, no further action is required. However, because this SWMU/AOI is within an area where GM has active operations, institutional controls, including a land use restriction to commercial/industrial use and a restriction preventing shallow groundwater from being used for drinking water, are proposed as a Corrective Measure for this area.

8.19 AOI #84 - FORMER TANK FARM AREA

No exceedances of current Michigan Act 451, Part 201 criteria were identified. Therefore, no further action is required. However, because this SWMU/AOI is within an area where GM has active operations, institutional controls, including a land use restriction to commercial/industrial use and a restriction preventing shallow groundwater from being used for drinking water, are proposed as a Corrective Measure for this area.

9.0 EVALUATION OF PROPOSED CORRECTIVE MEASURES

The proposed final Corrective Measures at the Facility that are discussed in Section 8 are summarized below. The term "NFA" in the following list means "no further action", which means no active remediation, engineering controls, or institutional controls are warranted.

AOI #16 – Former Building 29 Tank Farm	Institutional Controls - deed restriction
SWMU #6/AOI #42 - Building 53 Tank Area	NFA
AOI #44 – Building 43 Remediation	NFA
SWMU #33/AOI #45 – Former South Retention Pond	NFA
SWMU #34/AOI #46 – North Retention Pond	Institutional Controls - deed restriction
SWMU #32/AOI #49 – Former Coal Pile Storage Area	Institutional Controls - deed restriction
AOI #50 – Duco Stores	Closure under Michigan Act 451 Part 213 and Institutional Controls - deed restriction
AOI #52 – Building 35 Tank Farm	Supplemental Investigation Pending/ Closure under Michigan Act 451 Part 213 and Institutional Controls - deed restriction
AOI #53 –Building 33 LNAPL	MPE for LNAPL Area 1, Passive Recovery for LNAPL Area 2, Long-Term Monitoring, and Institutional Controls – deed restriction
SWMU #31/AOI #54 – Former Surface Impoundment	Institutional Controls - deed restriction
SWMU #29/AOI #66 –Wastewater Treatment Plant	Institutional Controls - deed restriction
AOI #69 – Container Storage Area	Institutional Controls - deed restriction
AOI #71 – Burn Pile	Institutional Controls - deed restriction, long-term groundwater monitoring and passive recovery from MW-1 (Final investigation results are pending)
SWMU #3/AOI #74 – Container Storage Area	Institutional Controls - deed restriction
SWMU #2/AOI #75 –Former East Tank Farm	Institutional Controls - deed restriction
SWMU #30/AOI #79 – Former J-Lot Fill Area	Institutional Controls - deed restriction
AOI #82 – Paint Mix Room Retention Tank	Institutional Controls - deed restriction
AOI #83 – Dock 65	Institutional Controls - deed restriction
AOI #84 –Former Tank Farm Area	Institutional Controls - deed restriction

9.1 GENERAL REMEDY STANDARDS

1. Overall Protection – Through the proposed final Corrective Measures, overall protection will be achieved through institutional controls for select areas and remedial activities such as passive recovery and MPE proposed for AOI #53. Where appropriate, long-term monitoring is proposed to ensure subsurface conditions are consistent with the current understanding of Facility conditions and to monitor potential health and safety hazards.
2. Attainment of media cleanup standards – The proposed Corrective Measures are generally based on the use of Michigan Act 451, Part 201 generic cleanup criteria as media cleanup standards. For select AOIs, media cleanup standards are based on risk calculations performed consistent with U.S. EPA methodology.
3. Controlling the source – Free-phase LNAPL will be removed to the extent practical where risk to human health is present.
4. Compliance with applicable standards for waste management – A Waste Management Plan will be prepared for the Facility. All waste disposal for the chosen alternatives will be managed in accordance with applicable standards.

9.2 REMEDY DECISION FACTORS

1. Long-term reliability and effectiveness – The proposed CMs for each area are reliable, long-term, and effective methods to address these areas based on standard engineering practices.
2. Reduction of toxicity, mobility, or volume of wastes – LNAPL will be removed to the extent practical.
3. Short-term effectiveness – The proposed CMs will be effective in the short term in achieving protection of human health and the environment. Long-term monitoring will be implemented at Building 33 and the Burn Pile, if required, to ensure the proposed Corrective Measures is effective in the long term.
4. Implementation – The proposed Corrective Measures for each area can be readily implemented with no impact to the surrounding community.
5. Costs – The cost of the proposed Corrective Measures for each area is within an acceptable range.

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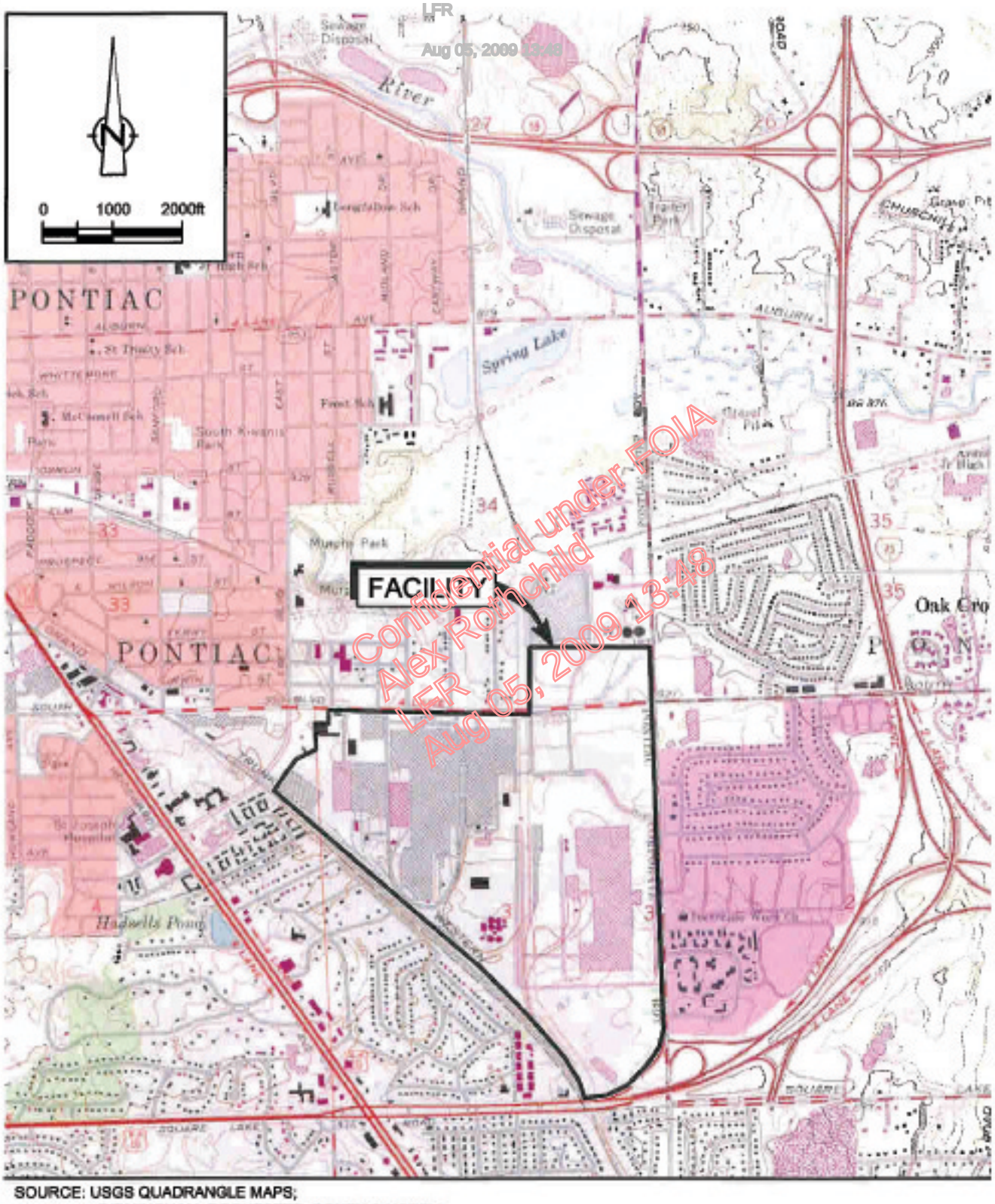


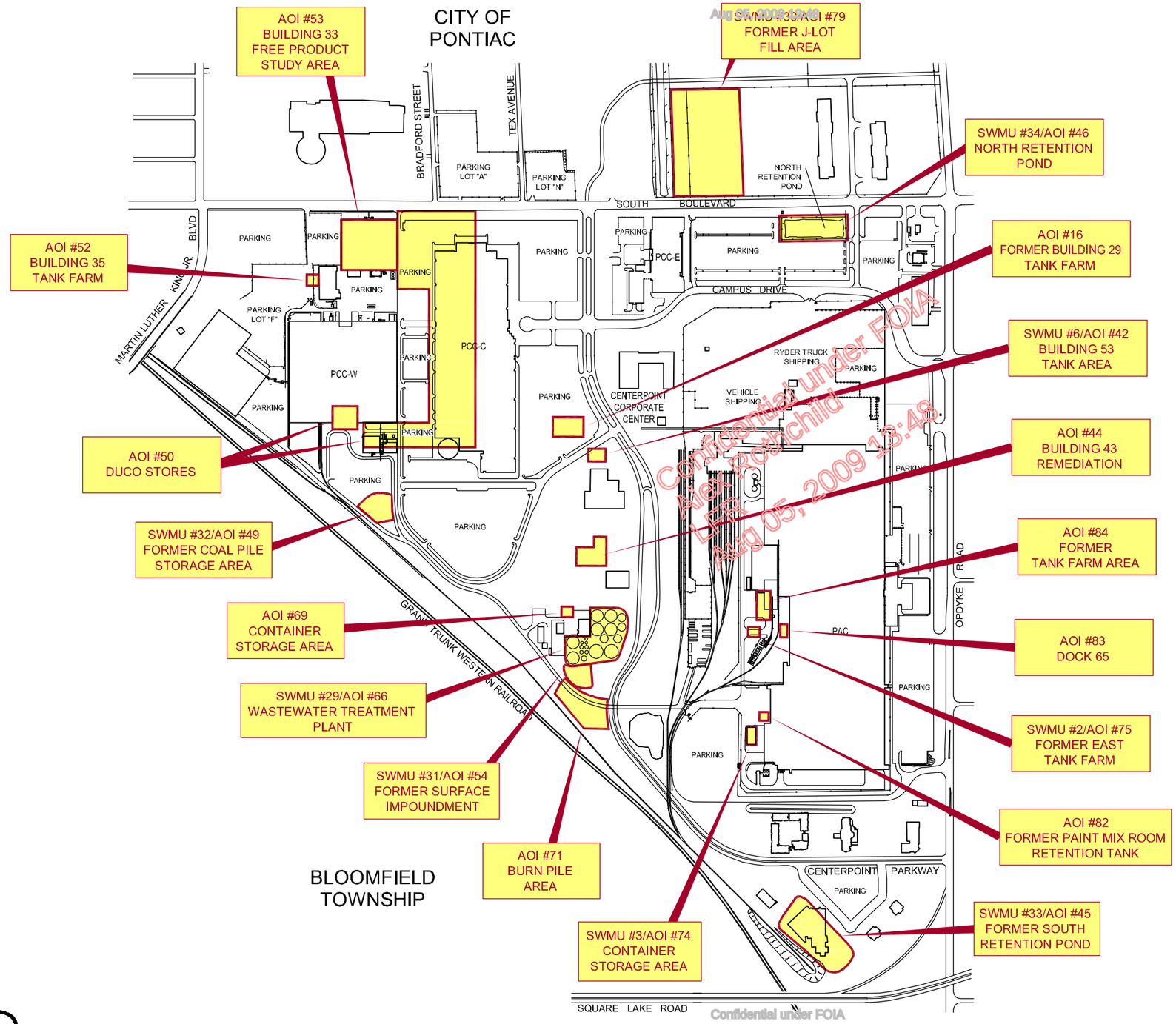
SOURCE: USGS QUADRANGLE MAPS;
BIRMINGHAM, ROCHESTER, PONTIAC NORTH,
AND PONTIAC SOUTH, MICHIGAN

figure 1.1

FACILITY LOCATION
CORRECTIVE MEASURES PROPOSAL
GM CENTERPOINT BUSINESS CAMPUS

Pontiac, Michigan

07097-03(046)GN-WA001 OCT 24/2005



LEGEND

SWMU #3/AOI #74 CONTAINER STORAGE AREA — SOLID WASTE MANAGEMENT UNIT (SWMU) / AREA OF INTEREST (AOI) LOCATION

figure 1.2

SWMU / AOI LOCATIONS
CORRECTIVE MEASURES PROPOSAL
GM CENTERPOINT BUSINESS CAMPUS
Pontiac, Michigan

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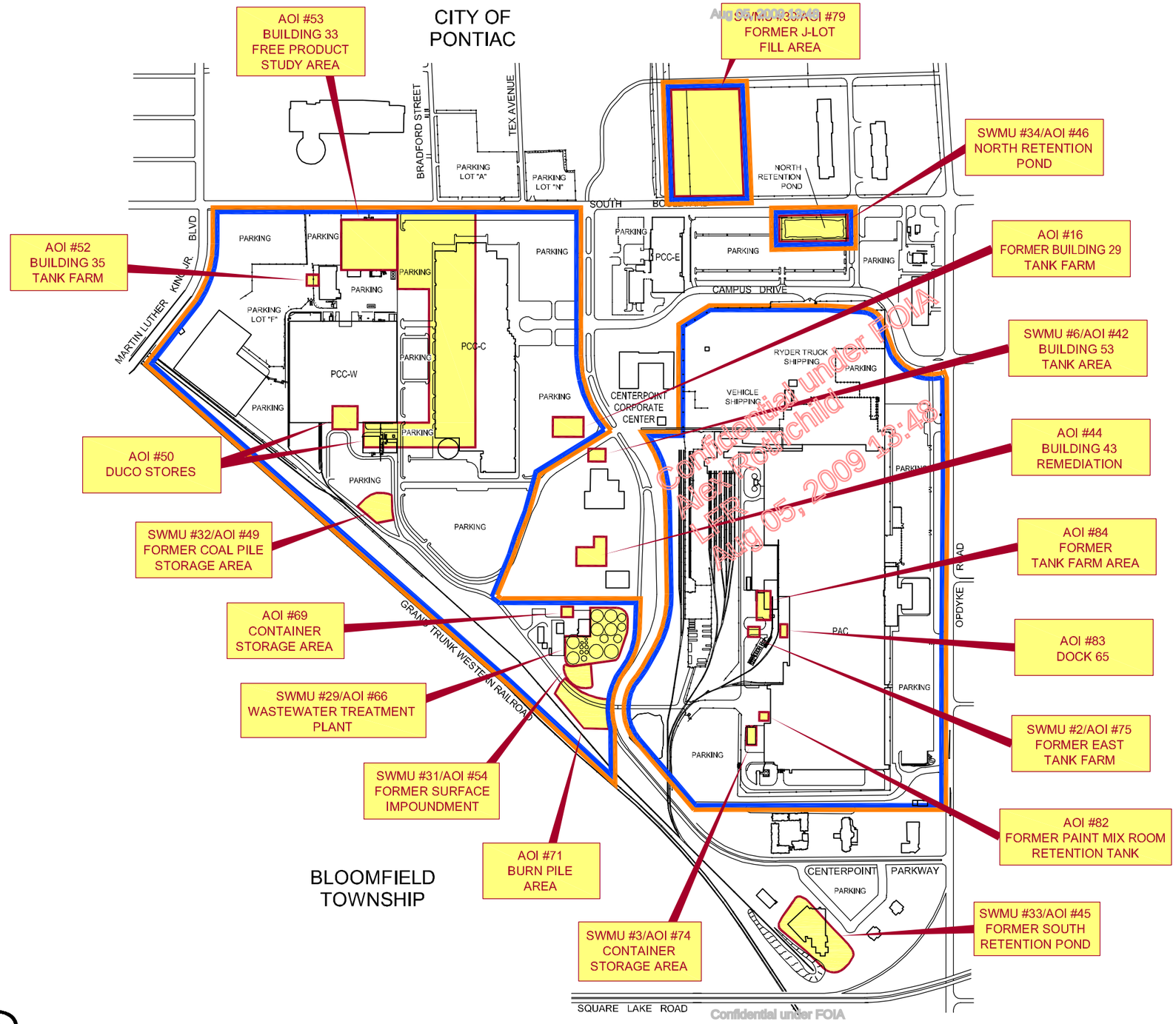
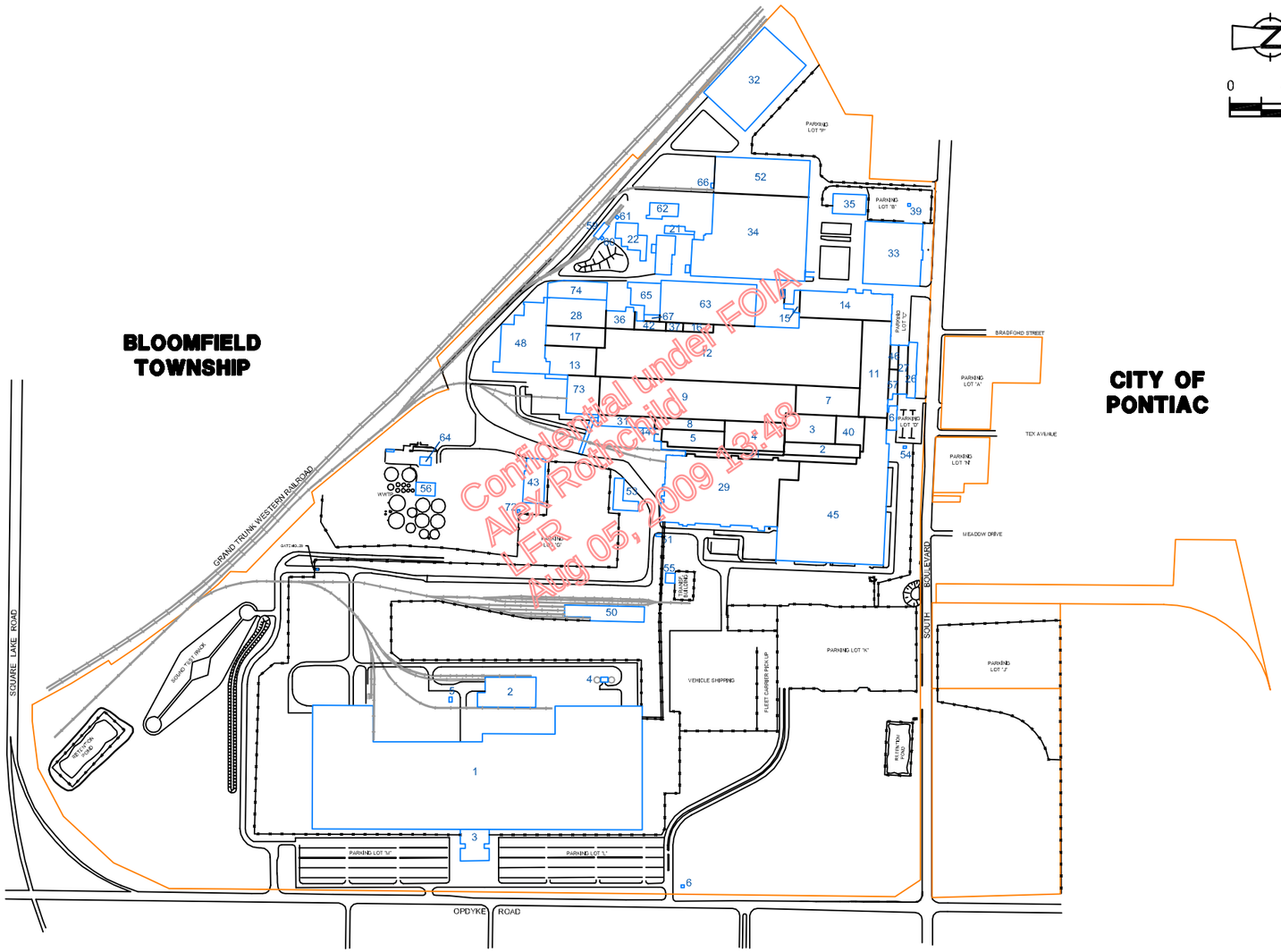


figure 2.1

PROPOSED DEED RESTRICTIONS
CORRECTIVE MEASURES PROPOSAL
GM CENTERPOINT BUSINESS CAMPUS
Pontiac, Michigan

07097-03(046)GN-WA005 MAR 07/2006



LEGEND

PROPERTY BOUNDARIES

43 BUILDING NUMBER

figure 3.1

HISTORIC FACILITY PLAN
CORRECTIVE MEASURES PROPOSAL
GM CENTERPOINT BUSINESS CAMPUS
Pontiac, Michigan

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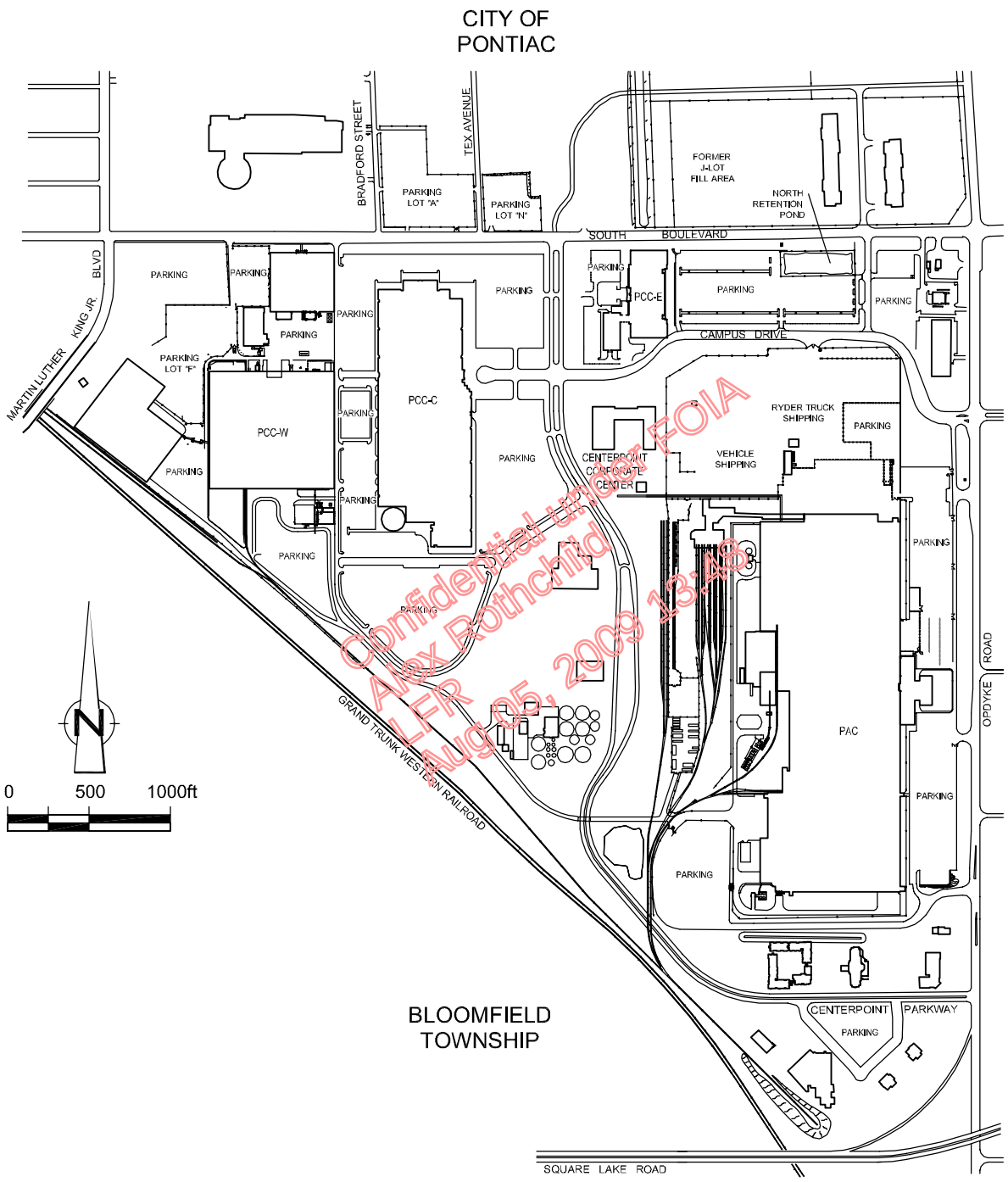

figure 3.2

CURRENT FACILITY PLAN
CORRECTIVE MEASURES PROPOSAL
GM CENTERPOINT BUSINESS CAMPUS
Pontiac, Michigan

TABLE 3.1

PONTIAC STATE HOSPITAL WEATHER STATION METEOROLOGICAL DATA
CORRECTIVE MEASURES PROPOSAL
CENTERPOINT BUSINESS CAMPUS
PONTIAC, MICHIGAN

	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Year*
Average Temperature (ºF)	22.3	24.6	34.9	46.9	58.6	67.8	72.3	70.3	63.5	51.4	39.7	27.5	48.4
Average Maximum Temperature (°F)	29.7	32.9	44.4	58.3	70.3	79.5	83.7	81.3	74.1	61.3	47.5	34.2	58.1
Average Minimum Temperature (°F)	14.9	16.3	25.5	35.8	46.9	55.9	60.8	59.4	52.5	41.5	32.2	20.8	38.5
Average Rainfall (inches)	1.4	1.5	2.3	2.8	2.7	3.6	2.8	3.3	2.9	2.4	2.6	2.3	30.6

Source: National Climatic Data Center, 1961-1990, obtained electronically from www.worldclimate.com on October 12, 2005

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APPENDIX A

MDEQ CORRESPONDENCE REGARDING SURFACE WATERS OF THE STATE

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

June 9, 2004

TO: Ronald Stone
Hazardous Waste and Radiological Protection Section
Waste and Hazardous Materials Division

FROM: Kevin Goodwin
Surface Water Quality Assessment Section
Water Division

SUBJECT: Surface Waters of the State Determination
GM – Centerpoint Business Campus (Pontiac East)

Following your February 17, 2004, request, we have reviewed the above facility and drains, including an on-site visit conducted April 15, 2004, to determine where surface waters of the state exist. Waters of the state, according to Rule R323.1044 of the Part 4. Water Quality Standards, "means all of the following, but does not include drainage ways and ponds used solely for wastewater conveyance, treatment, or control:

(i) The Great Lakes and their connecting waters
(ii) All inland lakes
(iii) Rivers
(iv) Streams
(v) Impoundments
(vi) Open drains
(vii) Other surface bodies of water within the confines of the state"

Based on this definition and our onsite review, we have determined the following points at which Amy, Hamlin, and Levinson drains, and Murphy Creek become surface waters of the state based on current conditions.

Amy Drain

Based on topographic maps, Amy Drain historically drained the northeast portion of the Centerpoint Campus property. The North Retention Pond (outfall 001) apparently drains into an underground culvert that follows the probable historic route of Amy Drain. Based on the site visit, Amy Drain is completely contained in an underground culvert until it opens to a subdivision retention pond just north of I-75, where it continues to flow south along Eastways Road. It is our determination that surface waters of the state for Amy Drain begins at the point just north of I-75 where it opens from the underground culvert south of Squirrel Valley Road (see Table 1 for location information and Figure 1, marker A).

Hamlin Drain

Hamlin Drain is made up, in part, of water exiting from the South Retention Pond and flows southeasterly across Opdyke Road to Kensington Road. Hamlin Drain is completely contained in an underground culvert until it opens to a free-flowing stream adjacent to school property along Kensington Road. It is our determination that Surface Waters of the State for Hamlin

Drain begins east of Kensington Road, adjacent to the school property where it opens from the underground culvert (see Table 1 for location information and Figure 1, marker B).

Murphy Creek

Murphy Creek is considered Surface Waters of the State at the point where Outfall 4 and the northwest detention pond discharge. The actual discharge location to Murphy Creek is enclosed in a large culvert, but Murphy Creek should be protected throughout this reach based on observations made during the site visit (see Table 1 for location information and Figure 1, marker C).

Levinson Drain

Levinson Drain is entirely enclosed in a culvert until its discharge to the Clinton River at the terminus of Auburn Court. The Clinton River is protected as Surface Waters of the State where Levinson Drain discharges to it. Levinson Drain is not considered Surface Waters of the State (see Table 1 for location information and Figure 1, marker D).

Table 1. Location information for Surface Water of the State determination points.

Location Description	Latitude	Longitude
A: Amy Drain south of Squirrel Valley Rd., north of I-75	42.6130888	-83.2271407
B: Hamlin Drain at Kensington Rd., adjacent to school	42.5971243	-83.2455139
C: Discharge of Outfall 4/Northwest detention pond to Murphy Creek	42.6244721	-83.265153
D: Levinson Drain at discharge point to Clinton River	42.6314459	-83.2282404

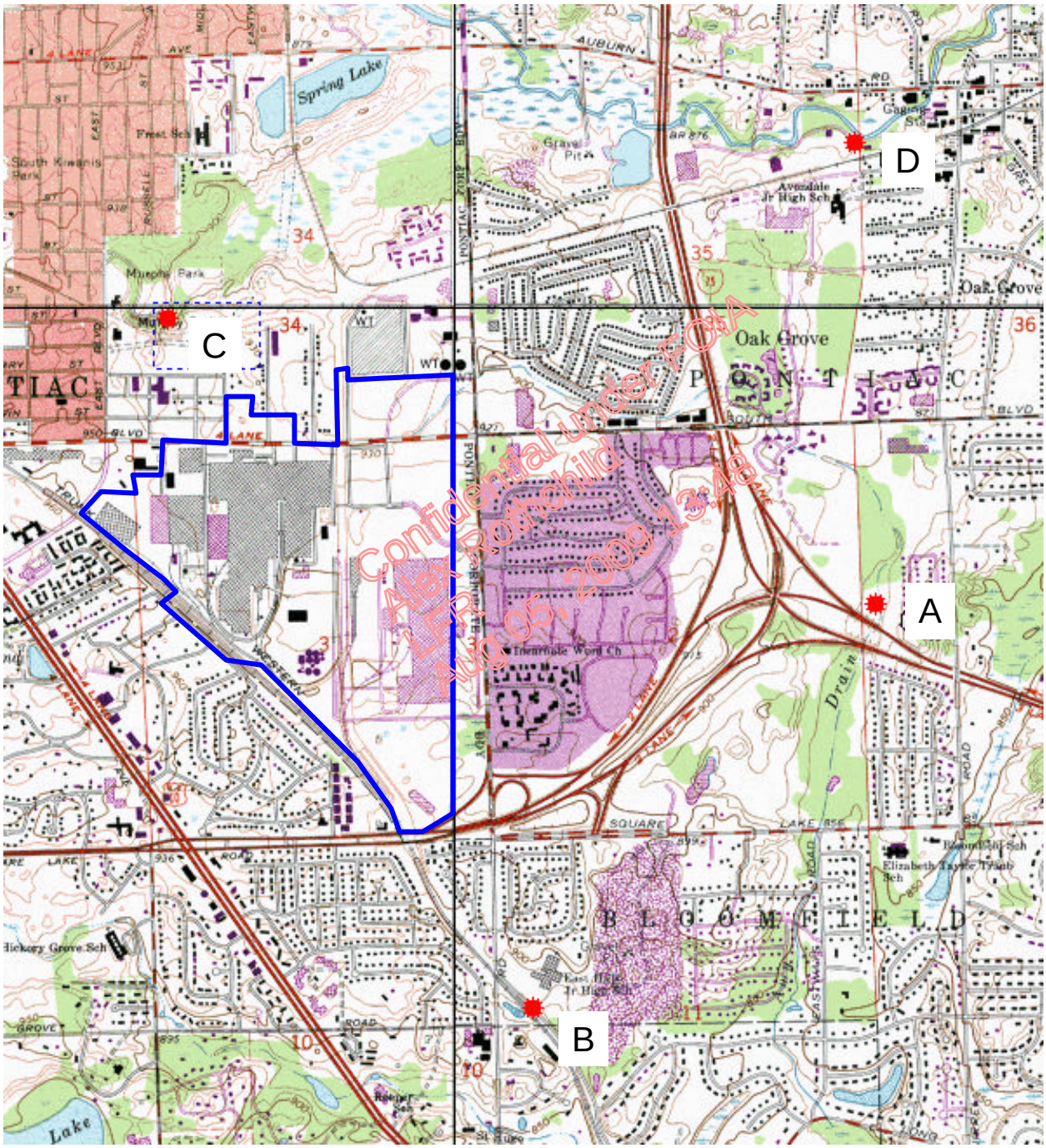
If you have additional questions regarding this determination, please feel free to contact me.

kg:rm

Attachment

cc: Amy Merricle, Hazardous Waste and Radiological Protection Section, WHMD
Sylvia Heaton/ Brenda Sayles/ Facility File, SWQAS, WD

Figure 1. Surface Waters of the State determination points. A = Amy Drain, B = Hamlin Drain, C = Murphy Creek (at outfall 4 discharge), and D = Clinton River (at Levinson Drain discharge).



APPENDIX B

HABITAT CHARACTERIZATION AND ECOLOGICAL PATHWAYS ASSESSMENT

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Alex Rothchild

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Aug 05, 2009 13:48

Habitat Characterization and Ecological Pathways Assessment for the Centerpoint Business Campus, Pontiac, Michigan

Introduction and Objective

This technical memorandum presents the results of a habitat characterization and ecological pathways assessment for the General Motors (GM) Centerpoint Business Campus (Centerpoint), in Pontiac, Michigan (Figure 1), which is also called the Pontiac Centerpoint Campus. GM is performing a Resource Conservation and Recovery Act (RCRA) Corrective Action at Centerpoint. Exponent is addressing ecological risk issues for Centerpoint as a component of the RCRA Corrective Action.

The first step in the ecological risk assessment process involves conducting a review of available Facility-specific data and a Facility visit, to become familiar with the nature and extent of contamination, to characterize ecological receptors at the Facility, and to identify potential pathways of exposure. The purpose of this technical memorandum is to summarize results of the data review and Facility visit to identify ecological habitats, if any, requiring further evaluation.

GM and its consultants have been working collaboratively with the United States Environmental Protection Agency (U.S. EPA) to develop a set of tools that can be applied to ecological risk assessments (ERAs) being performed at GM facilities that are undergoing RCRA Corrective Action to enhance the efficiency of the ERA process by focusing subsequent steps of the risk evaluation process on the most important pathways and receptors (Figure 2). The evaluations presented herein are intended to support a screening-level ERA as described by U.S. EPA guidance (U.S. EPA 1997, 2001). The initial elements of a screening level ERA are characterization of the environmental setting and contaminants, and identification of complete exposure pathways (U.S. EPA 1997). This document addresses these issues for CBC.

The objective of a screening-level ERA is to provide a defensible conclusion as to whether negligible ecological risk exists or whether certain contaminants and exposure pathways can be eliminated from further consideration in the ERA process (U.S. EPA 1997). The pathways assessment is a critical step in this process because it can be used to refine future steps of the ERA by eliminating areas of a Facility where exposure pathways are incomplete. The U.S. EPA (1997) guidance states that a screening-level ERA may conclude:

- Ecological risks are negligible and there is therefore no need for corrective action on the basis of ecological risk;
- Data are inadequate to make a decision at this point, and the ERA process will continue; or

- Data indicate a potential for adverse ecological effects, and a more thorough assessment is warranted.

If a screening assessment supports the first decision (i.e., negligible risk), the ERA process ends at that point with appropriate documentation to support the decision. This pathways assessment is intended to provide the documentation needed to support the conclusions of a screening-level ERA for Centerpoint.

The process used in this pathways assessment included a Facility visit to characterize habitats and identify potential exposure pathways for ecological receptors, and completion of a habitat assessment decision matrix to screen habitat characteristics for those areas at and adjacent to the Facility 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 ERA process, if any, and to determine the areas where ecological impacts are negligible because complete exposure pathways do not exist. Areas of the Facility where there is a likelihood of release and a reasonable potential for complete exposure pathways would be carried forward for additional ecological risk analysis. Areas of the Facility where there is minimal potential for complete exposure pathways require no further assessment in the ERA process.

General Facility Setting

The Centerpoint Campus is located in the City of Pontiac, Oakland County, Michigan and encompasses approximately 350 acres of land (Figure 1). Centerpoint is generally bordered by South Boulevard to the north, Opdyke Road to the east, Square Lake Road and the Grand Trunk Western Railroad to the south and southeast, and Martin Luther King Jr. Boulevard to the west. Table 1 lists dominant land uses in the immediate vicinity of the Facility. A detailed description of the Facility, including its operational history and historical waste management practices is presented in the Review of Existing Conditions (CRA, 1995a) and Supplemental Review of Existing Conditions (CRA, 1995b). The Facility has been subjected to significant redevelopment activities starting in 1991 when the manufacturing portion of the Facility ceased operations.

Demographics and Ecological Setting

Land within 1 mile of Centerpoint is predominantly developed for residential or commercial uses. There are some wooded patches scattered throughout the surrounding landscape, but these disconnected fragments do not provide significant tracts of contiguous wildlife habitat. However, the City of Pontiac's Murphy Park (located northwest of the Facility) encompasses an area of approximately 35 acres, most of which is wooded. Murphy Park is adjacent to an undeveloped area of several hundred acres that contains wetlands with wooded margins and terminates at Spring Lake approximately 0.75 miles north of the Facility. These areas provide the most extensive habitat close to Centerpoint.

No natural surface water bodies are present on the Facility. The closest natural water body to the Facility is Murphy Creek, which originates as a storm drain discharge from the 72 inch storm sewer located just north of South Boulevard at Murphy Park. Murphy Drain receives storm water from roof drains and paved areas of the west and central portions of the facility. Murphy Creek also likely receives storm water flows from Martin Luther King, Jr. Boulevard and South Boulevard, local secondary streets, and surrounding residential and commercial areas.

There are two engineered ponds located at the Facility (the North Retention Pond and South Retention Pond) and there are two additional detention basins located northeast and northwest of the Facility. The Northwest Detention Basin north of the northwest portion of the Facility (Figure 3) serves to dampen peak storm water flows into Murphy Creek. Storm water from the northeast portion of the Facility flows via storm drains into the North Retention Pond (Figure 3) and thence into Amy Drain, which is a buried municipal storm drain. Storm water from the southern portion of the Facility is collected in the South Retention Pond and thence flows into Hamlin Drain, which is also a buried municipal storm drain. The two nearest lentic (pond/lake) surface water bodies are Spring Lake, located about 0.75 miles north of Centerpoint, and Hadsells Pond, located about 0.4 miles southwest of Centerpoint. Neither of these water bodies receives storm water from the Facility.

In preparing this habitat characterization, a database search request was submitted to the Michigan Department of Natural Resources (MDNR) to determine whether federal and state endangered, threatened, and rare species, high-quality natural communities, or significant natural areas occur within a 5-mile radius of the Facility. For this location, it was found that no rare or unique natural features would be impacted. The correspondence from MDNR pertaining to this information request is provided in Attachment A.

Preliminary Identification of Areas of Interest for ERA

In September 1998, GM and U.S. EPA entered into a RCRA Corrective Action Administrative Order on Consent. The consent order required GM to evaluate seven solid waste management units (SWMUs) of the 84 Areas of Interest (AOIs) previously identified at the Facility (CRA, 1995b). .

Exponent ecologists reviewed information presented in these reports and the most recently available high-resolution aerial photos from 2002 to identify AOIs that were most likely to provide ecological habitat. This identification process relied on the habitat assessment matrix that has been developed for application at GM RCRA Corrective Action sites. The generic matrix, designed for application at any GM RCRA facility in U.S. EPA Region 5, is shown in Table 2. Application of the matrix at this early stage is intended to screen out AOIs that clearly do not provide ecological habitat, such as areas within buildings or on paved and graveled areas, and to retain for further evaluation those areas that are both a) likely to provide habitat to potential receptors and b) likely to have been the area of a past release of a hazardous

constituent or an area to which a complete exposure pathway exists. This preliminary review suggested that AOI #71, the Burn Pile Area, is the only AOI that is likely to provide ecological habitat. All other AOIs are in paved areas of the Facility, inside buildings, or no longer exist.

The Burn Pile Area occupies an area of approximately 1.4 acres that is roughly triangular in shape and is located south of the wastewater treatment plant and north of the Grand Trunk Western Railroad in the south-central portion of the Facility (Figure 3). The area consists of earth fill containing some wood and metal demolition debris, paint chips, brick, and metal scraps (CRA, 1995b).

GM has conducted several phases of investigation at the Burn Pile. The initial phases were completed to support the construction of Centerpoint Parkway through the eastern half of the Burn Pile. Subsequently, approximately 6,500 cubic yards (cy) of material in the eastern portion of the Burn Pile were excavated and disposed of off site.

From August 2004 to July 2005, GM conducted additional environmental investigations at the remaining portions of the Burn Pile. The purpose of these investigations was to further define the extent of contamination. Based on the results of the soil and groundwater investigation, further investigation is necessary to determine the extent of contamination and to develop appropriate Corrective Measures Alternatives. Further investigation of this area is ongoing.

Facility Visit

An Exponent ecological risk assessor visited the Facility on September 13, 2005. The purpose of the visit was to identify and evaluate potential ecological habitat at and in the vicinity of Centerpoint.

The area encompassed by the Facility is dominated by buildings and other man-made impervious surfaces that are part of industrial or commercial facilities or are under development for commercial uses. The Facility visit focused only on those areas that might provide some resources for potential ecological receptors; for example, habitat for foraging, breeding/nesting, or resting. The following areas were assessed during the Facility visit (please refer to Attachment B for photographs):

- Northeast Detention Basin
- North Retention Pond
- Landscaped median
- South Retention Pond
- Burn Pile Area

- Northwest Detention Basin
- Drainage swales.

The Northeast Detention Basin, located near the Facility was constructed between 1997 and 2000, and together with the North Retention Pond serves to dampen storm water flows from the Facility to Amy Drain. The Northeast Detention Basin is a shallow excavated depression of approximately 0.2 acres in size. The basin retains water for a sufficient hydroperiod to support small patches of hydrophyllic plants such as cattail reeds and sedges (e.g., *Typha* spp. and *Carex* spp.). Approximately two-thirds of the Northeast Detention Basin consists of intensively maintained landscaping (e.g., mown lawns and perennial and annual border plantings).

The North Retention Pond was initially constructed prior to 1987 and was expanded and regarded during redevelopment in the 1990's. It serves to store runoff from parking lots and roof drains from eastern and north-central portions of the Facility prior to release into Amy Drain. This basin is an excavated depression approximately 350 ft long by 50 ft wide and 10-15 ft deep, and is located within a fenced area of about 1.5 acres in size. There was little apparent standing water in the basin at the time of the Facility visit and the bottom of the basin was colonized by common reed grass (*Phragmites australis*) with smaller patches of cattails. The margins of the basin are maintained and appear to be mown, although the grass was 1-2 ft tall during the time of the Facility visit and some weedy forbs were beginning to colonize the area.

A landscaped median is present in the east-central portion of the Facility along Opdyke Road. The northern portion of this landscaped area consists of an approximately 2-acre lawn containing a small copse of several hardwood trees and bordered to the north by a line of smaller evergreen trees. This portion of the landscaped area also contains a long, narrow (approximately 400 ft by 25 ft) strip of lawn interspersed with 15- to 20-ft-tall hardwood tree species. There are two other similarly landscaped strips between Opdyke road and the parking lot of the assembly plant, which are each about 25 ft wide. The middle strip extends over a distance of approximately 1,450 ft and the southern strip is approximately 880 ft long. All of these landscaped areas are intensively landscaped and consist of short, mown lawns with mature trees and perennial plantings.

The South Retention Pond was constructed in 1995 and is located in the southwestern portion of the facility north of the Grand Trunk Western Railroad and southeast of the wastewater treatment plant. This basin serves the southern portion of the Facility and discharges to Hamlin Drain. The basin is roughly teardrop-shaped and is approximately 270 ft long by 100 ft wide at the north end, tapering to 20-30 ft in the south. The basin is located within a similarly shaped fenced area approximately 430 ft long by 260 ft wide at the north end. The basin had a fair amount of standing water with no apparent stands of hydrophyllic vegetation. The approximate distance between the water level and top of bank at the time of the Facility visit was 15-20 ft. The depth of the water in the basin was not determined. The banks and margins of the basin appear to be maintained. Grasses and weedy forbs dominate the vegetation in this area and this growth was approximately 2 ft tall. Several small saplings (probably eastern cottonwood [*Populus deltoides*]) have colonized the banks of the basin.

The Burn Pile Area is located between the Grand Trunk Western Railroad and the wastewater treatment plant west of Centerpoint Parkway. It is a mounded, mostly landscaped area approximately 15-20 ft high and covering approximately 1.4acres. The southern margin and southeast half of the Burn Pile Area are vegetated in brushy forbs with several willow (*Salix* spp.) and cottonwood saplings. The remainder of the area is mown grass less than 6 inches tall.

The Northwest Detention Basin is located at the northern edge of the northwest portion of the Facility adjacent to the City of Pontiac Murphy Park. The basin was constructed between summer 2000 and 2002, and is approximately 400 ft long by 25-35 ft wide and 10-15 ft deep. It is located inside a fenced area approximately 680 ft long by 165 ft wide. There was no apparent standing water in the basin at the time of the Facility visit and the bottom of the basin is colonized primarily by tree saplings (willow and cottonwood) and forbs. The margins of the basin are maintained and appear to be mown, although the grass was 1-2 ft tall during the time of the Facility visit.

There are two drainage swales located north of the Facility. These swales do not receive Facility stormwater. The swales are oriented north-south with one immediately north of South Boulevard and the second immediately north of Centerpoint Parkway. It is not known when these features were constructed. The northern drainage swale is a flat-bottomed drain approximately 650 ft long, 50 ft wide, and 10-15 ft deep with steep banks, some of which are armored with riprap. The swale is surrounded by an 8- to 10-ft-tall chainlink fence. No standing water was observed in the northern swale, but there were isolated patches of common reed grass and reed canary grass (*Phalaris arundinaceae*). The banks and borders of the northern swale are vegetated with turf grasses and weedy forbs. There were also some green ash (*Fraxinus pennsylvanica*), cottonwood, boxelder (*Acer negundo*), and willow saplings present. The south swale is a flat-bottomed drainageway approximately 630 ft long, 50 ft wide, and 10-15 ft deep. The south swale is vegetated with a fairly mature stand of hardwoods (primarily cottonwood and willow) growing along the banks as well as in the bottom of the depression. No obligate hydrophyllic plants were observed and the bottom of the swale was dry.

Habitat Matrix Refinement

Based on the Facility-specific habitat information described above, the generic habitat matrix for use at GM RCRA facilities in U.S. EPA Region 5 (Table 2) can be refined to reflect the ecological habitats present on or adjacent to Centerpoint. Table 3 presents the refined matrix based on the Facility visit and habitat characterization. The only water bodies present on the Centerpoint Campus are the North and South Retention Ponds. The northwest basin and the drainage swales are the only features with an outlet to a non-industrial water body (Murphy Creek and the wetland complex associated with Spring Lake, respectively). To the extent they may be present, aquatic plants, aquatic macroinvertebrates, and fish are not considered assessment endpoints in these man-made features because the retention ponds are integral components of the facilities at Centerpoint and they support only transitory ecological

communities. Piscivorous birds are not considered assessment endpoints because the basins do not support fish communities (with the possible exception of the South Retention Pond) and there has been no documented release that would have resulted in exposure of a fish community (and thus there is no complete pathway to piscivorous birds). Piscivorous and omnivorous mammals are not considered assessment endpoints for these same reasons.

The only non-industrial water body associated with Centerpoint is Murphy Creek (and its associated wetlands), which receives storm water flows from the Facility. There have been two confirmed releases to storm sewers that drain to Murphy Creek: approximately 1,500 gallons of process wastewater was released on August 8, 2002; and approximately 10,500 gallons of process wastewater was released on September 2, 2002. The releases resulted from failures at the process wastewater lift station, and in both instances, the wastewater was composed of 98 percent water and a 2 percent mixture of hydraulic oil and soap. In both instances, waste managers vacuumed the wastewater out of the affected storm sewers and delivered it to the wastewater treatment plant. Booms and absorbent materials were deployed at the Murphy Creek outfall. No further action was needed. These discrete releases are not expected to have resulted in long-term exposures to ecological receptors and are not considered an exposure pathway for this assessment.

With the exception of the Burn Pile Area, all terrestrial portions of the Facility either consist of buildings or paved areas, or are intensively maintained, landscaped areas. These areas are not considered ecological habitat for the purposes of an ERA. The Burn Pile Area supports a small patch of mown grass and a strip of volunteer saplings and small trees that could provide some habitat for small mammals and birds. To the extent the Burn Pile Area provides ecological habitat, there is not a complete exposure pathway to ecological receptors in this area because the burn pile has been covered with clean fill.

Conclusions

Based on observations made during the Facility visit and application of the habitat assessment matrix, the Centerpoint Campus provides only very limited habitat for wildlife. The only terrestrial habitat at the Facility consists of intensively maintained or landscaped areas and the area in the immediate vicinity of the burn pile. The landscaped areas are small in size and surrounded by developed industrial properties or public roads and they consist of mown grass (lawn), ornamental plantings, and small hardwood trees. The Burn Pile Area is small and surrounded by developed property, roads, and a railroad, and it also consists of mown grass with some saplings and young trees. These areas may be used for foraging or nesting by some bird species and small mammals that are common to urban areas; however, they are not of sufficient size and are too isolated to support populations of ecological receptors. For these reasons, these areas are not considered ecological habitat and do not warrant any further assessment. There are no naturally occurring water bodies on the Facility. The storm water retention ponds support varying levels of aquatic and wetland plant communities, but the basins are integral components of operating facilities and are subject to periodic maintenance, including removal or modification of features that may support the development of ecological habitat. In general, the

following conditions must be met for a surface water body to be considered habitat in the context of an ERA at a RCRA corrective action site, and for that area to be carried forward for further evaluation:

- There is a likelihood of a hazardous constituent release as documented or inferred from information from previous studies;
- The water body must be of sufficient size and hydroperiod for there to be a likelihood of reasonable use by potential ecological receptors;
- The water body is sufficiently accessible for there to be a likelihood of reasonable use by potential ecological receptors; and
- The water body will continue to support habitat into the foreseeable future.

All of the stormwater basins at Centerpoint and the surrounding area fail one or more of the above criteria. With the exception of a minor discharge of diesel oil to the North Retention Pond in 2003, there are no documented releases to any of the basins. All of the basins are small in size and support only small patches of hydrophyllic vegetation. The only basin that appears to retain water for a long enough period to support development of an aquatic community is the South Retention Pond. The majority of the retention ponds are surrounded by tall chain-link fencing, rendering them inaccessible to some wildlife species. The retention ponds are subjected to maintenance (e.g., water drawdown, sediment removal, and culvert cleaning) that can result in the removal of habitat features or prevention of their development. The storm water basins and swale areas are either not considered ecological habitat or there are no complete pathways of exposure to receptors that may use these areas; therefore, no further assessment of these areas is warranted.

Given the developed nature of the Facility and its surroundings and the absence of complete exposure pathways, no further evaluation of risks to ecological receptors at Centerpoint is warranted. Because ecological habitats and pathways are absent from the Facility, no conceptual site model was developed.

References

CRA. 1995a. Review of existing conditions report GM Truck Group Pontiac East Assembly/Former Pontiac Central Manufacturing and Assembly Plants—A "Brownfield" redevelopment project, Pontiac, Michigan. Prepared for General Motors, Inc.

CRA. 1995b. Supplemental review of existing conditions report: GM Truck Group Pontiac East Assembly/Former Pontiac Central Manufacturing and Assembly Plants—A "Brownfield" redevelopment project, Pontiac, Michigan. Prepared for General Motors, Inc.

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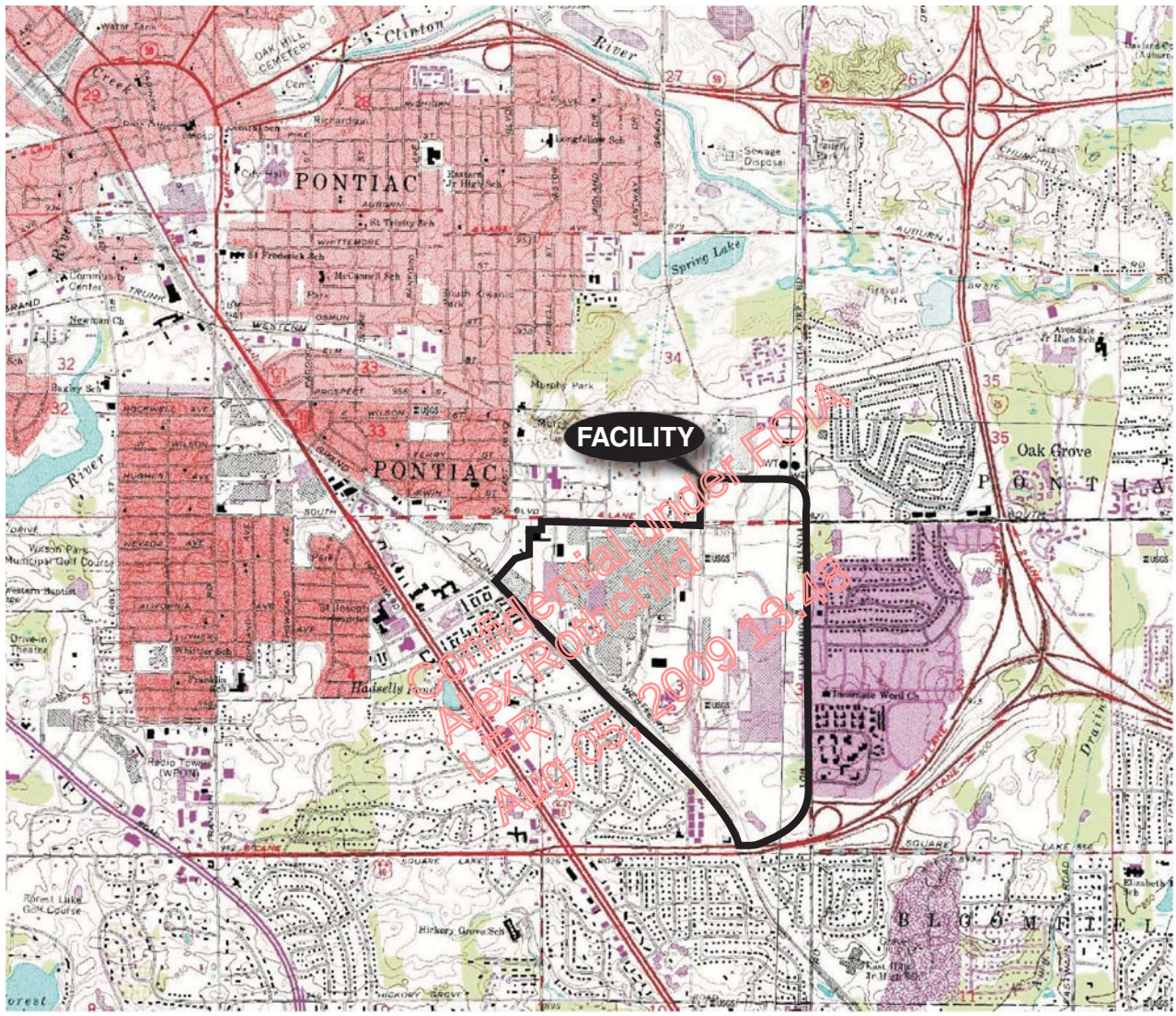
U.S. EPA. 2001. Eco update: The role of screening-level risk assessments and refining contaminants of concern in baseline ecological risk assessments. EPA 540/F-01/014. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.



Source: U.S. Geological Survey (1983)

Figure 1. Facility location

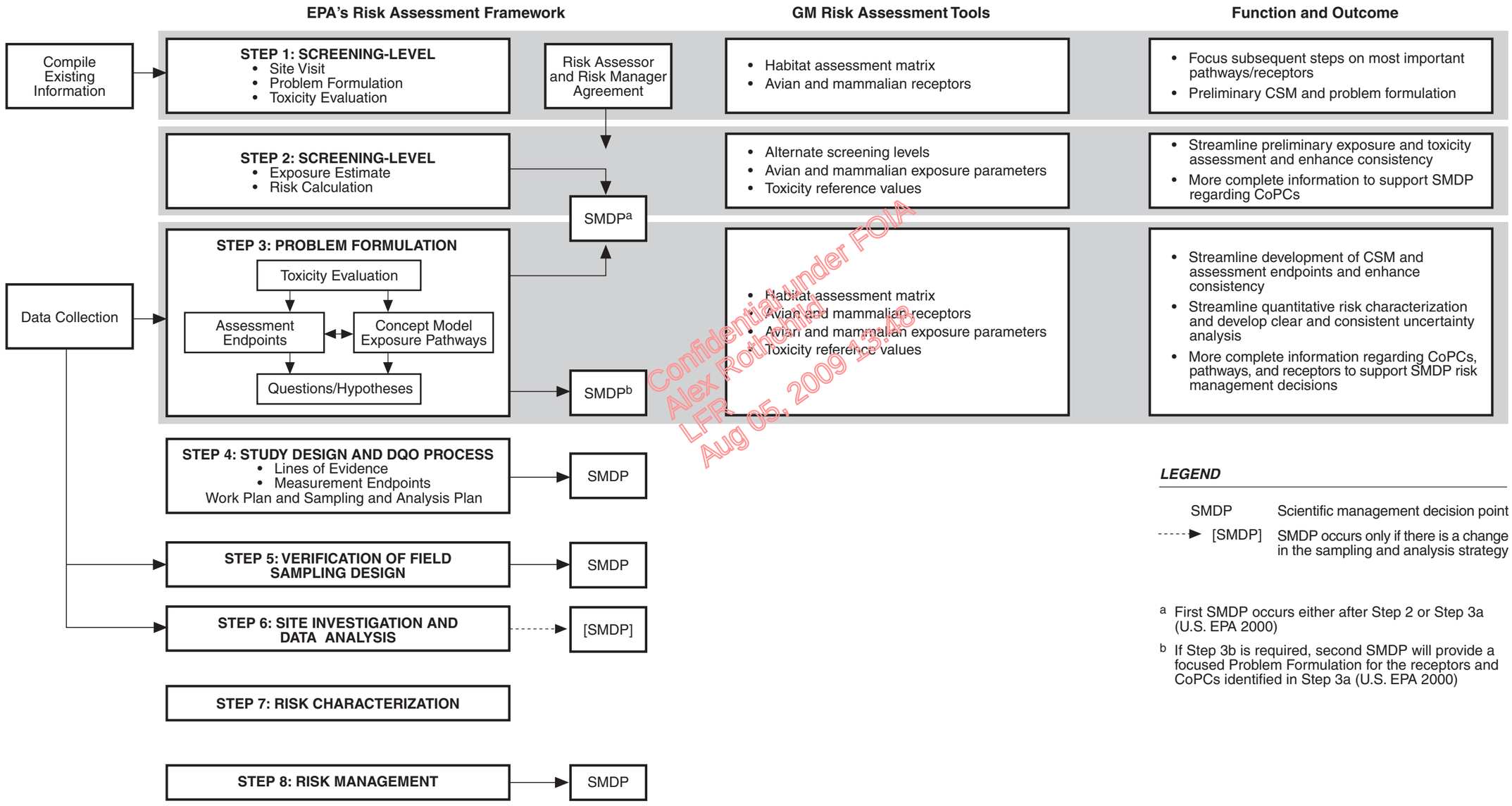
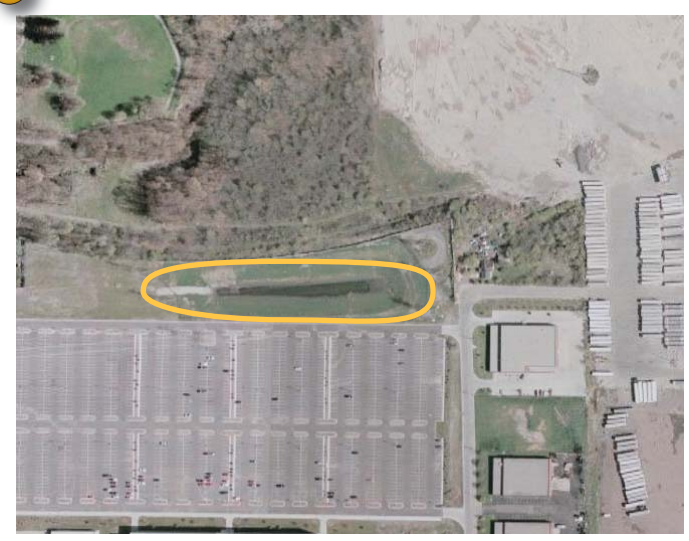


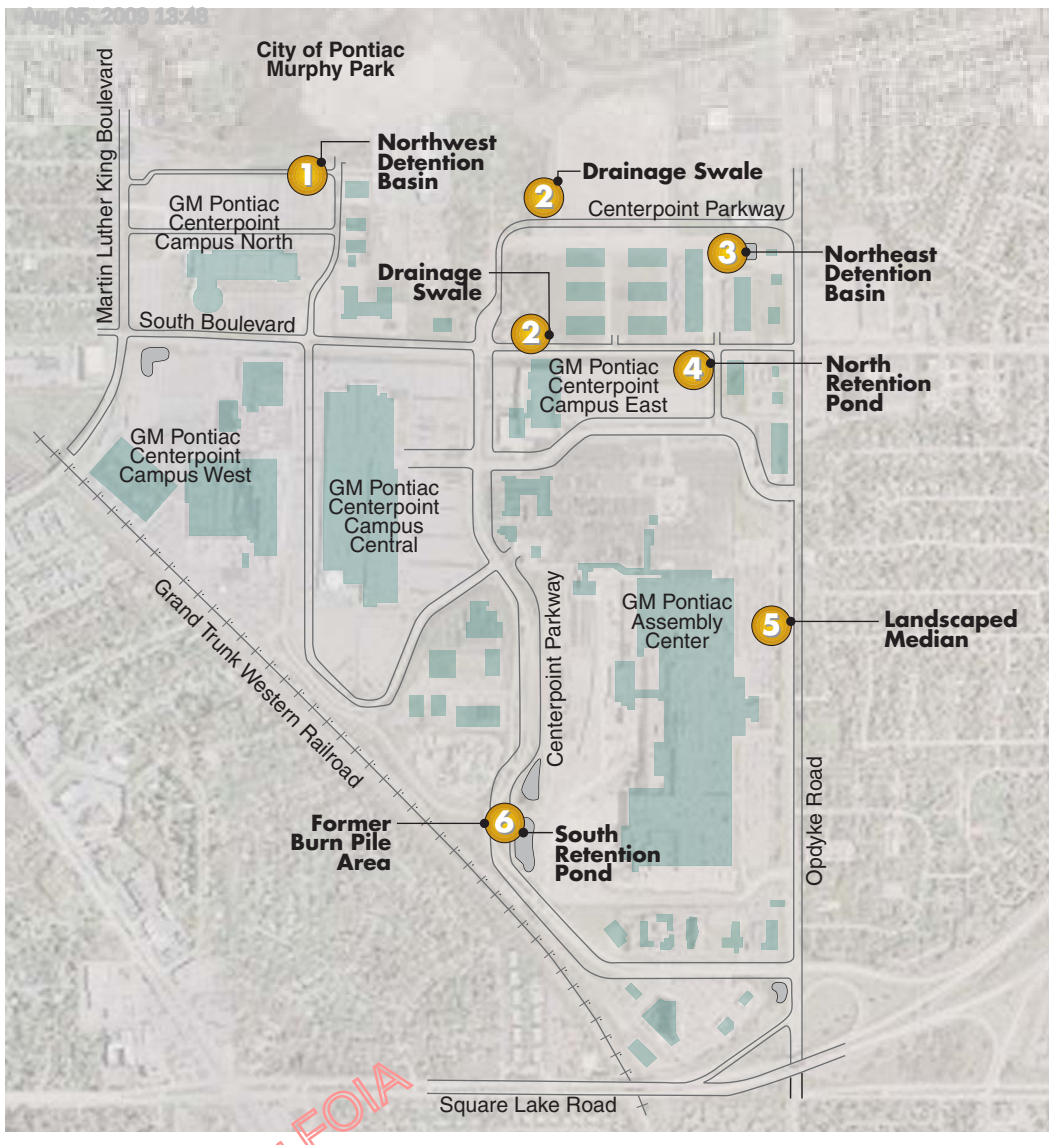
Figure 2. Application of GM ecological risk assessment tools in the EPA eight-step ecological risk assessment process

BE02943.001 0101 10/12/05 WA

1 Northwest Detention Basin

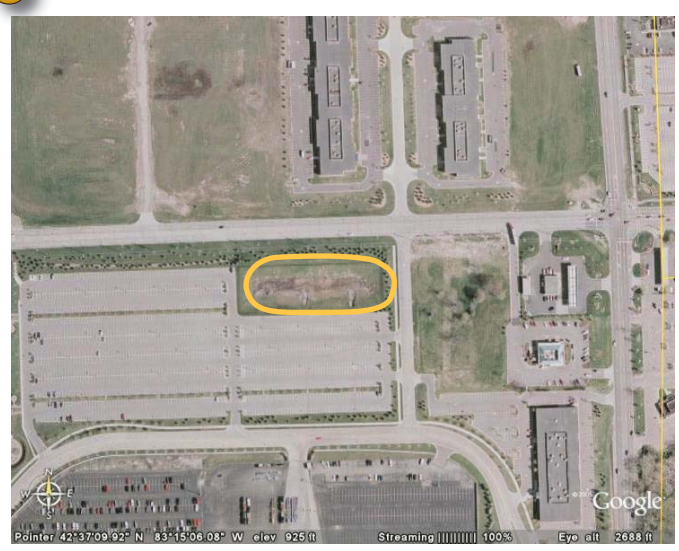


2 Drainage Swale

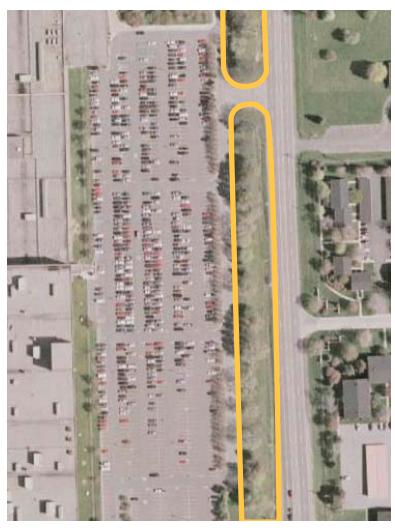


3 Northeast Detention Basin

4 North Retention Pond



5 Landscaped Median



Source: Google

6 Former Burn Pile Area and South Retention Pond

Figure 3. Key features for ecological habitat characterization

Table 1. Land uses at and surrounding the Pontiac Centerpoint Campus

Location	Jurisdiction	Land Use
PCC	City of Pontiac	Industrial/Commercial
North	City of Pontiac	Industrial/Commercial
East	Bloomfield Township	Residential
South	Bloomfield Township	Residential
West	City of Pontiac/Bloomfield Township	Industrial/Commercial

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Table 2. Matrix for habitat assessment at GM RCRA corrective action sites

Habitat	ERA Assessment Endpoint/Receptor Category								
	Aquatic Plants	Aquatic Macro-invertebrates	Fish	Piscivorous Birds and/or Mammals	Terrestrial Plants	Soil Fauna	Omnivorous Mammals	Herbivorous Mammals	Carnivorous or Insectivorous Birds and/or Mammals
Industrial Waterbodies									
Storm water pond, process water basin, or drainage ditch									
No outlet to non-industrial waterbody	x	x	x	√ [a]			√ [a]		
Hydrologic connection to non-industrial water body	x	x	√ [b]	√ [a]			√ [a]		
Non-industrial Waterbodies									
Pond/lake	x	√	√	√			√		
Marsh/wetland	x	√	√	√			√		
Creek/stream/river	x	√	√	√			√		
Terrestrial Habitats									
Developed areas (buildings, etc.)					NE	NE	NE	NE	NE
Paved or graveled areas					NE	NE	NE	NE	NE
Landscaped and intensively maintained areas					NE	NE	NE	NE	NE
Infrequently maintained areas or natural fields					x	x	√	√	√
Woodlots and forests					x	x	√	√	√

Note: x - not an assessment endpoint for this habitat, but may be sampled for evaluation of risk to higher trophic-level receptors
√ - assessment endpoint for this habitat
NE - not evaluated, as feature not considered to be ecological habitat
- not applicable

[a] Will be an assessment endpoint if water body is of sufficient size and hydroperiod and with appropriate prey species for proposed receptors.

[b] Will be an assessment endpoint if there is movement or colonization of fish from connected natural water body.

Table 3. Refined matrix for habitat assessment at Centerpoint Business Campus, Pontiac, Michigan

Habitat	ERA Assessment Endpoint/Receptor Category: Aquatic Plants	Aquatic Macro-invertebrates	Fish	Piscivorous Birds and/or Mammals	Terrestrial Plants	Soil Fauna	Omnivorous Mammals	Herbivorous Mammals	Carnivorous or Insectivorous Birds and/or Mammals
Industrial Water Bodies									
Stormwater Detention Basins									
No outlet to non-industrial water body (NE basin; North Pond; and South Pond)	x	x	x	x(a)			x(a)		
Hydrologic connection to non-industrial water body (NW basin and drainage swales)	x	x	x	x(a)			x(a)		
Non-industrial Water Bodies									
Pond/lake	NP	NP	NP	NP			NP		
Marsh/wetland	NP	NP	NP	NP			NP		
Murphy Creek	x	√(b)	√(b)	√(b)			√(b)		
Terrestrial Habitats									
Developed areas (buildings, etc.)					NE	NE	NE	NE	NE
Paved or graveled areas					NE	NE	NE	NE	NE
Landscaped median and other intensively maintained areas					NE	NE	NE	NE	NE
Infrequently maintained areas or natural fields					x	x	√(c)	√(c)	√(c)
Woodlots and forests					NP	NP	NP	NP	NP

Note: x - not an assessment endpoint for this habitat, but may be sampled for evaluation of risk to higher trophic-level receptors
√ - assessment endpoint for this habitat, if complete pathways are determined to occur
NE - not evaluated, as feature not considered to be ecological habitat
NP - not present, feature does not occur on Site or in adjacent area
- not applicable

(a) NE basins A and B do not retain water for sufficient periods to support fish populations
South basin may support fish populations, but there have been no releases to this area and therefore there is not a complete pathway.
(b) There have been no releases to this area and therefore there is not a complete pathway
(c) The area is capped with clean soil and therefore there is not a complete pathway

Attachment A

MDNR Correspondence

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STATE OF MICHIGAN

JENNIFER M. GRANHOLM
GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LANSING

REBECCA A. HUMPHRIES
DIRECTOR

November 8, 2005

Mr. Ian Ippolito
Exponent
4 Computer Drive West, Suite 201
Albany, NY 12204

Dear Mr. Ippolito:

SUBJECT: RCRA Facility Investigation – Pontiac Centerpoint Campus

The location of the proposed project was checked against known localities for rare species and unique natural features, which are recorded in a statewide database. This continuously updated database is a comprehensive source of existing data on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. Records in the database indicate that a qualified observer has documented the presence of special natural features at a site. The absence of records in the database for a particular site may mean that the site has not been surveyed. Records are not always up-to-date, and may require verification. In some cases, the only way to obtain a definitive statement on the status of natural features is to have a competent biologist perform a complete field survey.

Under Act 451 of 1994, the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection, "a person shall not take, possess, transport, ... fish, plants, and wildlife indigenous to the state and determined to be endangered or threatened," unless first receiving an Endangered Species Permit from the Department of Natural Resources, Wildlife Division. *Responsibility to protect endangered and threatened species is not limited to the list below. Other species may be present that have not been recorded in the database.*

The presence of threatened or endangered species does not preclude activities or development, but may require alterations in the project plan. Special concern species are not protected under endangered species legislation, but recommendations regarding their protection may be provided. Protection of special concern species will help prevent them from declining to the point of being listed as threatened or endangered in the future.

The following is a summary of the results for the project in Oakland County, Sections 3, 4, T2N R10E, Section 34, T3N R10E:

> The project should have no impact on rare or unique natural features at the location specified above if it proceeds according to the plans provided. Please contact me for an evaluation if the project plans are changed.

Thank you in advance for your coordination in addressing the protection of Michigan's natural resource heritage. Responses and correspondence can be sent to: Michigan Department of Natural Resources, Wildlife Division – Natural Heritage Program, PO Box 30180, Lansing, MI 48909. If you have further questions, please call me at 517-373-1263.

Sincerely,

Lori G. Sargent
Endangered Species Specialist
Wildlife Division

STEVENS T. MASON BUILDING • P.O. BOX 30028 • LANSING, MICHIGAN 48909-7528
www.michigan.gov/dnr • (517) 373-2329

Attachment B

Site Photographs

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Habitat Characterization and Ecological Pathway Assessment for the Centerpoint Business Campus, Pontiac, Michigan

September 2005

Photograph 1.
Northwest detention basin looking north

Photograph 2.
South end of north drainage swale looking northwest

Photograph 3.
North end of south drainage swale along margin looking south

Photograph 4.
North end of south drainage swale--bottom of the swale showing accumulated sediment.

Photograph 5.
Northeast detention basin looking northeast

Photograph 6.
North retention pond looking northeast

Photograph 7.
South retention pond

Photograph 8.
Top of the burn pile area looking northwest

Habitat Characterization and Ecological Pathway Assessment for the Centerpoint Business Campus, Pontiac, Michigan

September 2005

Photograph 9.
Burn pile as viewed from road looking south

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APPENDIX C

SUPPORTING RISK-BASED CALCULATIONS FOR LNAPL, SMEAR ZONE SOIL, AND PERCHED GROUNDWATER AT BUILDING 33

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CONTENTS

Attachments

C1 INTRODUCTION

This appendix to the Corrective Measures Proposal (CMP) Report for the General Motors Corporation (GM) Centerpoint Business Center (Facility) in Pontiac, Michigan provides information and calculations of human health risk-based cleanup criteria for the smear zone soil and perched groundwater at LNAPL Area #1 in Building 33 (Sections C2 and C3) and forward risk calculations for exposure to LNAPL Area #2 in Building 33 (Sections C4 and C5). The information in this appendix is organized in sections that correspond to the exposure scenarios for the following potentially exposed populations:

- Routine Workers
- Construction Workers

The references cited in this appendix are included in Section C6. Detailed calculation sheets are provided in attachments to this appendix.

C2 ROUTINE WORKERS RISK-BASED CRITERIA

The risk-based cleanup criteria are calculated to evaluate potential exposure of on-facility workers via vapor intrusion from the smear zone soil and perched groundwater. The computation of risk-based criteria associated with exposure via vapor intrusion is discussed in Section C2.2.

Vapor Intrusion from Smear Zone Soil and Groundwater

The risk-based criteria (RBC) for possible future routine workers to constituents in smear zone soil and perched groundwater at LNAPL Area #1 in Building 33 via assumed vapor intrusion are derived using a vapor intrusion modeling approach recommended by USEPA (2000) for screening-level analysis. The model parameters related to soil properties are based on facility-specific soil conditions and those related to building characteristics are based on facility-specific assumptions and conservative regulatory default assumptions for a hypothetical commercial/industrial building.

Indoor air concentrations are estimated using the following relationships described by Johnson and Ettinger (1991):

$$C_{building} = \alpha\, C_{source}$$

where $C_{building}$ is the indoor air concentration which is assumed to be equal to the allowable risk-based indoor air concentration, C_{source} is the source vapor concentrations, and α is an attenuation coefficient that is given by the following equation:

$$\alpha = \frac{\left[\frac{D_T^{\,eff} A_B}{Q_{building} L_T}\right] \exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right)}{\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) + \left[\frac{D_T^{\,eff} A_B}{Q_{building} L_T}\right] + \left[\frac{D_T^{\,eff} A_B}{Q_{soil} L_T}\right]\left[\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) - 1\right]}$$

Derivation of this equation and definition of the equation parameters can be found in Johnson and Ettinger's 1991 journal article, and therefore is not repeated here.

The source vapor concentration C_{source} for a constituent in soil is calculated from the constituent's concentration in soil C_{soil} based on three-phase equilibrium, as follows:

$$C_{source} = C_{soil}\left(\frac{K_d}{H} + \frac{\theta_w}{\rho_b H} + \frac{\theta_a}{\rho_b}\right)^{-1}$$

where K_d is the equilibrium-partition coefficient (estimated as the product of the organic carbon partition coefficient K_{oc} and the soil organic carbon fraction f_{oc}), H is the Henry's law constant, θ_w is the water-filled soil porosity, ρ_b is the soil bulk density, and θ_a is the air-filled soil porosity.

The source vapor concentration for a constituent in groundwater is calculated from the constituent's concentration in groundwater C_{gw} using Henry's law, as follows:

$$C_{source} = H \cdot C_{gw}$$

For the calculation of RBCs, the soil and groundwater concentrations used for the C_{soil} and C_{gw} terms in the above equations are the allowable concentrations of each constituent in soil, perched groundwater, or LNAPL at LNAPL Area #1 in Building 33 calculated using a target cancer risk (TR) and target hazard quotient (THQ) of 10^{-5} and 1, respectively.

After the RBCs for soil and groundwater were calculated, they were used to check the source vapor concentrations (C_{source}) for each medium to determine if the RBCs would result in subsurface vapor concentrations that would approach or exceed the lower explosive limit (LEL). As shown in Attachment C.3, the estimated source vapor concentrations for the RBCs are between 10% and 150% of the LELs. This comparison indicates that the potential for explosion hazard is more significant than the potential for significant health risks from vapor intrusion for the conditions evaluated in this case. This same comparison was performed for the construction worker cleanup criteria discussed in Section C3. The results of this comparison are also summarized in Attachment C.3.

The effective diffusion coefficient term D_T^{eff} in the equation for the attenuation coefficient α is calculated based on a "sandy clay loam" soil type, which is generally representative of the soil in the vadose zone at the Facility. The soil-water profile in the vadose zone is estimated using the van Genuchten soil-water retention curve, and water retention parameters appropriate for sandy clay loam (USEPA 2003). These parameters and the resulting soil-water profile in the vadose zone are shown in Attachment C.2.

The distance between perched groundwater and smear zone soil and a building foundation L_T is estimated to be approximately 3.4 m based on the depth to water table at the Facility (approximately 4.4 m) and an assumed LNAPL/smear zone thickness (approximately 1 m). The surface area of a future commercial/industrial building is assumed equal to the area of LNAPL Area #1 at Building 33. The remaining parameters in the equation for α, which relate to the characteristics of a hypothetical commercial/industrial building, are based on conservative default values that the Michigan Department of Environmental Quality (2002) used in deriving the Michigan Act 451, Part 201 generic vapor intrusion criteria for commercial/industrial sites. These values are shown in Attachment C.2; their bases are discussed in MDEQ guidance (1998).

C3 CONSTRUCTION WORKER RISK BASED CRITERIA

Potential exposures of construction workers to smear zone soil during excavations at LNAPL Area #1 are evaluated by calculating RBCs using exposure assumptions specific to construction workers. RBCs are calculated for small scale construction workers who may contact smear zone soil or perched groundwater during occasional construction/maintenance activities. Computation of these risk estimates is discussed in Section C3.1.

C3.1 Contact with Smear Zone Soil

Construction workers could be exposed to smear zone soil via incidental ingestion, dermal contact, and inhalation of vapors and particulates during excavations at LNAPL Area #1 in Building 33. The RBCs for these exposure routes are calculated as discussed below and presented in Attachment C.3.

In this case, the risk-based criteria for the ingestion and dermal routes of exposure are calculated as follows:

$$RBC = \frac{TR}{LADD^* \cdot SF}$$

$$RBC = \frac{THQ \cdot RfD}{ADD^*}$$

The *TR* and *THQ* are 10^{-5} and 1, respectively. The *LADD** and *ADD** are doses that are normalized to an unit concentration and are calculated using the exposure factors for soil contact presented in Attachment C.3.

The risk-based criteria for the inhalation route are calculated as follows:

$$RBC = \frac{TR \cdot AT}{URF \cdot ET \cdot EF \cdot ED}\left(J \cdot C/Q\right)^{-1}$$

$$RBC = \frac{THQ \cdot RfC \cdot AT}{ET \cdot EF \cdot ED}\left(J \cdot C/Q\right)^{-1}$$

where the product *J·C/Q* is an air concentration that is normalized to unit concentration in soil. The *J* term is the normalized average vapor or particulate flux, and the *C/Q* term is a normalized air concentration.

The normalized average vapor flux J_v of a chemical from unsaturated soil is conservatively estimated using an unsteady-state model derived by Jury et al. (1983) that USEPA has adapted for screening-level analysis (USEPA 1996). This model conservatively assumes that volatile chemicals are present in the soil to an infinite depth. The equation for J_v is given by:

$$J_v = 2\, C_{s,0}\, \rho_b \sqrt{\frac{D_E}{\pi\, T}}$$

$$D_E = \frac{D_G\, H + D_L}{\rho_b\, K_d + \theta_w + \theta_a\, H}$$

$$D_G = D_{air} \cdot \frac{\theta_a^{10/3}}{n^2}$$

$$D_L = D_{water} \cdot \frac{\theta_w^{10/3}}{n^2}$$

Derivation of this equation and definition of the equation parameters can be found in the Jury et al. 1983 journal article and in USEPA guidance (1996), and therefore, is not repeated here. The values for chemical-specific parameters and default soil parameters recommended in the 1996 USEPA guidance are used in calculating J_v.

The *C/Q* term is a normalized air concentration estimated using for construction workers, estimated using SCREEN3 (USEPA 1995a) for a 15-foot by 15-foot excavation pit. The SCREEN3 area-source algorithm is used with worst-case meteorological conditions selected by the model to estimate a maximum 1-hour air concentration at ground level. The maximum 1-hour air concentration is converted to a maximum 24-hour air concentration using a conservative factor of 0.4, because workers are conservatively assumed to have inhalation exposure over the entire work day while working around the excavation area. This air concentration is expected to be higher than actual air concentrations to which workers would be exposed during excavation activities.

Emission of respirable soil particulates (PM_{10}) during excavation activities at the Facility is expected to comply with the National Ambient Air Quality Standard for PM_{10}. Therefore, the 24-hour average PM_{10} standard of 150 ug/m^3 is used as an upper-bound for the *J·C/Q* term for construction workers.

The risk-based criteria for each route of exposure are then combined to give cancer and noncancer criteria that are based on the combination of all three routes, as follows:

$$RBC = \left(\sum_i RBC_i^{-1} \right)^{-1}$$

C3.2 Contact with Groundwater

Construction workers could be exposed to groundwater via incidental ingestion, dermal contact, and inhalation of vapors during excavations that extend to the water table at LNAPL Area #1 in Building 33. The RBCs for these exposure routes are calculated as discussed below and presented in Attachment C.3.

In this case, the risk-based criteria for the ingestion and dermal routes of exposure are calculated as discussed in Section C3.1, except *LADD** and *ADD** are calculated using the exposure factors for groundwater contact presented in Attachment C.3. The risk-based criteria for the inhalation route are also calculated as discussed in Section C3.1, except the normalized flux *J* is calculated as discussed below.

The normalized vapor flux *J* of a chemical from exposed groundwater in an excavation pit is estimated using an overall mass transfer coefficient that is recommended by USEPA (1995b):

$$K_L = \left(\frac{1}{k_l} + \frac{1}{H\, k_g} \right)^{-1} \left(\frac{m}{10^2\, cm} \right) \left(\frac{10^3\, L}{m^3} \right)$$

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

$$k_l = \left(\frac{MW_o}{MW} \right)^{0.5} \left(\frac{T}{298°K} \right) k_{l,o}$$

$$k_g = \left(\frac{MW_w}{MW} \right)^{0.335} \left(\frac{T}{298°K} \right)^{1.005} k_{g,w}$$

where MW, MW_o, and MW_w are the molecular weights of the chemical, oxygen, and water, T is the water's absolute temperature, $k_{l,o}$ is the liquid-phase mass transfer coefficient for oxygen (0.002 cm/s), and $k_{g,w}$ is the gas-phase mass transfer coefficient for water vapor (0.833 cm/s).

C4 ROUTINE WORKER RISK CALCULATIONS

Vapor Intrusion from LNAPL

Routine workers could be exposed to LNAPL vapors from LNAPL Area #2 at Building 33 that could migrate into indoor air. The cancer risk and HQ estimates for this potential exposure is calculated using the typical risk equations presented below, and the exposure factors for routine workers presented in Attachment C.2.

$$Risk = LADD \cdot SF$$

$$HQ = \frac{ADD}{RfD}$$

where *LADD* is the lifetime average daily dose, *SF* is the cancer slope factor, *ADD* is the average daily dose, and *RfD* is the reference dose.

The indoor air concentrations are estimated as discussed in Section C2, with one exception. The building area for Area #2 in Building 33 is assumed to be the MDEQ default commercial/industrial building (MDEQ 2002).

The source vapor concentration C_{source} for a constituent in NAPL is calculated from the constituent's concentration in NAPL C_{napl} using Raoult's law, as follows:

$$C_{source} = \frac{C_{napl} MW_{napl} VP}{R\,T}$$

where MW_{napl} is molecular weight of the NAPL, *VP* is the vapor pressure of the constituent, *R* is the gas constant, and *T* is absolute temperature in the subsurface. Cumulative cancer risk and HI computations for this scenario are shown in Attachment C.4.

C5 CONSTRUCTION WORKER RISK CALCULATIONS

Contact with LNAPL and Smear Zone Soil

Construction workers who excavate down to the water table at LNAPL Area #2 in Building 33 could be exposed to LNAPL and smear zone soil. Their most potentially significant exposure

to LNAPL would be via dermal contact and inhalation of vapors. Potential routes of exposure to smear zone soil could include incidental ingestion, dermal contact, and inhalation of vapors. The cancer risk and HQ estimates for these potential exposures are calculated using the typical risk equations presented in Section C4, and the exposure factors for LNAPL and smear zone soil contact presented in Attachment C.3.

The concentrations of LNAPL constituents used in the computations are the concentrations reported for the LNAPL sample collected from temporary monitoring well TW33-16-04 in Area #2 at Building 33. Smear zone soil samples are difficult to collect; therefore, the concentrations of LNAPL constituents in the smear zone are conservatively estimated in the risk assessment by assuming that the smear zone soil is completely saturated with LNAPL.

The concentration of a LNAPL constituent in the smear zone soil is estimated as follows:

$$C_{soil} = C_{napl} \cdot \rho_{napl} \cdot \frac{n}{\rho_{soil}}$$

where C_{napl} is the concentration of a constituent in LNAPL, ρ_{napl} is the density of the LNAPL (which is assumed to be 0.9 kg/L), n is the total porosity of the sandy clay loam soil (0.39, USEPA 2003), and ρ_{soil} is the dry bulk density of the sandy clay loam soil (1.63 kg/L, USEPA 2003). The assumption of 100% LNAPL saturation is highly conservative since typical LNAPL residual saturation does not exceed 20% to 50%, depending on the type of LNAPL and soil. The LNAPL concentrations and the estimated smear zone soil concentrations for Area #2 at Building 33 are shown in Attachment C.5.

The vapor concentration of LNAPL constituents in the air as a result of emission from LNAPL that is exposed in an open excavation pit is estimated using the "oil film surface emission model" (USEPA 1987), which is given by:

$$C_{air} = C_{NAPL} \cdot K\, e^{-Kt/L} \cdot (C/Q)$$

where K is the chemical's overall mass transfer coefficient given by the following equation, L is thickness of the LNAPL film, and C/Q is a normalized air concentration:

$$K = k_g \cdot K_{eq}$$

In this expression for K, k_g is the gas-phase mass transfer coefficient and K_{eq} is the equilibrium coefficient between a chemical's concentrations in air and in the LNAPL. These coefficients are defined as follows:

$$k_g = 0.00482\, u^{0.78} Sc_g^{-0.67} d_e^{-0.11}$$

$$K_{eq} = \frac{p\ \rho_{air}\ MW_{napl}}{p_O\ \rho_{napl}\ MW_{air}}$$

where u is wind speed (m/s), Sc_g is the chemical's gas-phase Schmidt number, d_e is effective diameter of the LNAPL film surface (m), p is the chemical's vapor pressure, p_o is total pressure, ρ_{air} and ρ_{napl} are densities of air and LNAPL, and MW_{air} and MW_{napl} are molecular weights of air and LNAPL.

As shown in the above equation for C_{air}, the model can account for depletion of constituents in the exposed LNAPL over time as they volatilize. However, this risk assessment conservatively assumes that the constituent in the exposed LNAPL layer do not deplete. This assumption is conservatively used to account for the possibility that exposed LNAPL in the pit could be refreshed by "fresh" LNAPL that drains into the pit, such as when workers attempt to "dewater" the pit.

The *C/Q* term used in the computations for this scenario is the same as that discussed in Section C3.1 for small scale construction workers. Cumulative cancer risk and HI computations for this scenario are shown in Attachment C.5.

C6 REFERENCES

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ATTACHMENT C.1:
Chemical Properties and Toxicity Information

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Aug 05, 2009 13:48

Attachment C.1: Toxicity Values
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	Cancer Class			SF_{oral} (mg/kg/d)$^{-1}$			SF_{derm} (mg/kg/d)$^{-1}$			IURF (mg/m^3)$^{-1}$			RfD_{oral} (mg/kg/d)				RfD_{derm} (mg/kg/d)				RfC (mg/m^3)			
			Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Notes	Value	UF	Ref	Notes	Value	UF	Ref	Notes	Value	UF	Ref	Notes
VOC	Acetone	67-64-1	ID	1											9.0E-01	1000	1		9.0E-01	1000	125	104	3.2E+00	1000	1	4, 44
VOC	Benzene	71-43-2	A	1		5.5E-02	1	68	5.5E-02	125	104	7.8E-03	1	60	4.0E-03	300	1		4.0E-03	300	125	104	3.0E-02	300	1	
VOC	2-Butanone	78-93-3	ID	1											6.0E-01	1000	1		6.0E-01	1000	125	104	5.0E+00	300	1	
VOC	Carbon Disulfide	75-15-0													1.0E-01	100	1		1.0E-01	100	125	104	7.0E-01	30	1	
VOC	Chloroethane	75-00-3				2.9E-03	3		2.9E-03	125	104				4.0E-01		3		4.0E-01		125	104	1.0E+01	300	1	
VOC	Cumene	98-82-8	D	1											1.0E-01	1000	1		1.0E-01	1000	125	104	4.0E-01	1000	1	
VOC	Cyclohexane	110-82-7	ID	1																			6.0E+00	300	1	
VOC	Dichlorodifluoromethane	75-71-8													2.0E-01	100	1		2.0E-01	100	125	104	2.0E-01	10000	2	
VOC	1,1-Dichloroethane	75-34-3	C	1											2.0E-01		3		2.0E-01		125	104	5.0E-01	1000	2	3
VOC	1,2-Dichloroethane	107-06-2	B2	1		9.1E-02	1		9.1E-02	125	104	2.6E-02	1		2.0E-02		3		2.0E-02		125	104	5.0E-03	3000	102	92
VOC	1,1-Dichloroethene	75-35-4	C	1											5.0E-02	100	1		5.0E-02	100	125	104	2.0E-01	30	1	
VOC	cis-1,2-Dichloroethene	156-59-2	D	1											1.0E-02	3000	126		1.0E-02	3000	125	104	3.5E-02	3000	126	4, 44
VOC	trans-1,2-Dichloroethene	156-60-5													2.0E-02	1000	1		2.0E-02	1000	125	104	6.0E-02		3	44
VOC	Ethyl Benzene	100-41-4	D	1											1.0E-01	1000	1		1.0E-01	1000	125	104	1.0E+00	300	1	
VOC	2-Hexanone	591-78-6													4.0E-02	10000	40		4.0E-02	10000	125	104	5.0E-03	10000	108	
VOC	Methyl Acetate	79-20-9													1.0E+00	1000	2		1.0E+00	1000	125	104	3.5E+00	1000	2	4, 44
VOC	4-Methyl-2-pentanone	108-10-1	ID	1													1	90			125	104	3.0E+00	300	1	
VOC	Methylcyclohexane	108-87-2																					3.0E+00	100	2	
VOC	Methylene Chloride	75-09-2	B2	1		7.5E-03	1		7.5E-03	125	104	4.7E-04	1		6.0E-02	100	1		6.0E-02	100	125	104	3.0E+00	100	2	
VOC	Styrene	100-42-5													2.0E-01	1000	1	6	2.0E-01	1000	125	104	1.0E+00	30	1	
VOC	Tetrachloroethene	127-18-4	C-B2	77		5.2E-02	77		5.2E-02	125	104	3.7E-03	77		1.0E-02	1000	1		1.0E-02	1000	125	104	4.0E-01	300	109	94
VOC	Toluene	108-88-3	D	1											2.0E-01	1000	1		2.0E-01	1000	125	104	4.0E-01	300	1	
VOC	Trichloroethene	79-01-6	C-B2	49	18	1.1E-02	49		1.1E-02	125	104	1.7E-03	49		6.0E-03	3000	46	6, 97	6.0E-03	3000	125	104	4.0E-02		75	86
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1													3.0E+01	10	1		3.0E+01	10	125	104	3.0E+01	100	2	
VOC	1,2,4-Trimethylbenzene	95-63-6													5.0E-02	3000	3		5.0E-02	3000	125	104	6.0E-03	3000	3	44
VOC	1,3,5-Trimethylbenzene	108-67-8													5.0E-02	3000	3		5.0E-02	3000	125	104	6.0E-03	3000	3	44
VOC	Vinyl Chloride	75-01-4	A	1		1.4E+00	1	78	1.4E+00	125	104	8.8E-02	1	79	3.0E-03	30	1		3.0E-03	30	125	104	1.0E-01	30	1	
VOC	Xylenes (total)	1330-20-7	ID	1											2.0E-01	1000	1		2.0E-01	1000	125	104	1.0E-01	300	1	
SVOC	Benzaldehyde	100-52-7													1.0E-01	1000	1		1.0E-01	1000	125	104	3.5E-01	1000	1	4, 44
SVOC	Biphenyl	92-52-4	D	1											5.0E-02	1000	1		5.0E-02	1000	125	104	1.8E-01	1000	1	4, 44
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	B2	1		1.4E-02	1		1.4E-02	125	104	4.0E-03	1	4, 45	2.0E-02	1000	1		2.0E-02	1000	125	104	7.0E-02	1000	1	4, 44
SVOC	Caprolactam	105-60-2													5.0E-01	100	1		5.0E-01	100	125	104	1.8E+00	100	1	4, 44
SVOC	Dibenzofuran	132-64-9	D	1											2.0E-03		3		2.0E-03		125	104	7.0E-03		3	4, 44
SVOC	2,4-Dimethylphenol	105-67-9													2.0E-02	3000	1		2.0E-02	3000	125	104	7.0E-02	3000	1	4, 44
SVOC	Di-n-octylphthalate	117-84-0													4.0E-02	1000	126		4.0E-02	1000	125	104			126	90
SVOC	Fluorene	86-73-7	D	1											4.0E-02	3000	1		4.0E-02	3000	125	104	1.4E-01	3000	1	4, 44
SVOC	2-Methylnaphthalene	91-57-6	ID	1											4.0E-03	1000	1		4.0E-03	1000	125	104	3.0E-03	3000	1	61
SVOC	Methylphenol (total)	1319-77-3													5.0E-02		1	99	5.0E-02		125	104	1.8E-01		1	99, 4, 44
SVOC	Naphthalene	91-20-3	C	1											2.0E-02	3000	1		2.0E-02	3000	125	104	3.0E-03	3000	1	
SVOC	Phenanthrene	85-01-8	D	1											3.0E-02	3000	1	20	3.0E-02	3000	125	104	1.1E-01	3000	1	20, 4, 44
SVOC	Phenol	108-95-2	ID	1											3.0E-01	300	1		3.0E-01	300	125	104			1	90,98
P/PCB	PCBs (total)	1336-36-3	B2	1		2.0E+00	1	30,32	2.0E+00	125	104	5.7E-01	1	30,32, 45	2.0E-05	300	1	72	2.0E-05	300	125	104				
INORG	Antimony	7440-36-0													4.0E-04	1000	1		6.0E-05	1000	125	104	1.4E-03	1000	1	4, 44
INORG	Arsenic	7440-38-2	A	1		1.5E+00	1		1.5E+00	125	104	4.3E+00	1		3.0E-04	3	1		3.0E-04	3	125	104				
INORG	Barium	7440-39-3	D	1											7.0E-02	3	1		4.9E-03	3	125	104			1	90
INORG	Beryllium	7440-41-7	B1	1								2.4E+00	1		2.0E-03	300	1		1.4E-05	300	125	104	2.0E-05	10	1	
INORG	Cadmium	7440-43-9	B1	1								1.8E+00	1		1.0E-03	10	1	95	2.5E-05	10	125	104	2.0E-04		3	44
INORG	Chromium (total)	7440-47-3										1.2E+01	1	8	3.0E-03	900	1	8	7.5E-05	900	125	104	1.0E-04	300	1	59, 8
INORG	Cobalt	7440-48-4	B1	126								2.8E+00	126		2.0E-02	10	126		2.0E-02	10	125	104	2.0E-05	100	126	
INORG	Copper	7440-50-8	D	1											4.0E-02	2	50	49	4.0E-02	2	125	104	1.4E-01	2	50	49, 4, 44
INORG	Lead	7439-92-1	B2	1																						
INORG	Manganese	7439-96-5	D	1											1.4E-01	1	1		8.4E-03	1	125	104	5.0E-05	1000	1	
INORG	Mercury	7439-97-6	D	1											3.0E-04	1000	1	51	2.1E-05	1000	125	104	3.0E-04	30	1	
INORG	Nickel	7440-02-0	A	1								2.4E-01	1		2.0E-02	300	1		8.0E-04	300	125	104				
INORG	Selenium	7782-49-2	D	1											5.0E-03	3	1		4.0E-03	3	125	104	1.8E-02	3	1	4, 44
INORG	Silver	7440-22-4	D	1											5.0E-03	3	1		2.0E-04	3	125	104	1.0E-05	1000	83	
INORG	Thallium	7440-28-0													7.0E-05	3000	52	49	7.0E-05	3000	125	104	2.5E-04	3000	52	49, 4, 44
INORG	Vanadium	7440-62-2													1.0E-03		3		2.6E-05		125	104	3.5E-03		3	4, 44
INORG	Zinc	7440-66-6	D	1											3.0E-01	3	1		3.0E-01	3	125	104	1.1E+00	3	1	4, 44

Attachment C.1: Toxicity Values
GMC Pontiac Centerpoint Building 33, Pontiac, MI

References:

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126	Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV) Database

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Alex Rothchild
LFR
Aug 05, 2009 13:48

Attachment C.1: Toxicity Values
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Notes:	
3	HEAST Alternate Method.
4	ENVIRON obtained value by route-to-route extrapolation.
6	Under review, according to IRIS.
8	ENVIRON used Chromium VI [CASRN 18540-29-9] value from IRIS (reference 1) as a surrogate.
18	Not verifiable, according to IRIS.
20	ENVIRON used Pyrene [CASRN 129-00-0] value from IRIS (reference 1) as a surrogate.
30	Upper-bound slope factor.
32	High risk & persistence tier for: food chain exposure; sediment/soil ingestion; dust/aerosol inhalation; dermal exposure, if an absorption factor is applied; presence of dioxin-like, tumor-promoting/persistent congeners; and all early life exposures.
44	ENVIRON derived inhalation RfC from inhalation RfD value presented in the indicated reference, using standard USEPA methodology presented in HEAST.
45	ENVIRON derived inhalation URF from Inhalation Slope Factor value presented in the indicated reference, using standard USEPA methodology presented in HEAST.
49	ENVIRON derived oral RfD from adverse health effect level value presented in the indicated reference.
51	ENVIRON used Mercuric Chloride [CASRN 7487-94-7] value from the indicated reference as a surrogate.
59	This RfD is for particulates. The RfD for chromic acid mists and dissolved Chromium VI aerosols is 0.000008 mg/m3.
61	ENVIRON used Naphthalene [CASRN 91-20-3] value from indicated reference as a surrogate.
68	IRIS provides a range of 1.5E-2 to 5.5E-2 (mg/kg/d)-1 as the oral Slope Factor for Benzene.
72	ENVIRON used Aroclor 1254 [CASRN 11097-69-1] value from the indicated reference as a surrogate for PCBs [CASRN 1336-36-3].
78	IRIS recommends an oral Slope Factor for Vinyl Chloride of 7.2E-1 (mg/kg/d)-1 to account for continuous lifetime exposure during adulthood; a twofold increase to 1.4 (mg/kg/d)-1 is recommended to account for continuous exposure from birth.
79	IRIS recommends an inhalation URF for Vinyl Chloride of 4.4E-6 (ug/m3)-1 to account for continuous lifetime exposure during adulthood; a twofold increase to 8.8E-6 (ug/m3)-1 is recommended to account for continuous exposure from birth.
86	This is a DRAFT toxicity value, which is currently undergoing EPA SAB review.
90	Inadequate data exist to derive a toxicity value, according to the indicated reference.
92	NCEA directed ENVIRON to use outdated value.
94	Two provisional RfC values are presented in the indicated reference (4E-1 and 6E-1 mg/m3). Personal communication with NCEA indicated that either RfC is acceptable and the RfC should be chosen on a case-by-case basis.
95	This RfD is for dietary exposure. The RfD for drinking water exposure is 0.0005 mg/kg/day.
97	ENVIRON used withdrawn source.
98	Route-to-route extrapolation is not appropriate, according to the indicated reference.
99	ENVIRON used 3-Methylphenol [CASRN 108-39-4] values from the indicated reference as a surrogate.
104	Dermal toxicity value is extrapolated from oral toxicity value in accordance with the referenced EPA guidance.

Attachment C.1: Physical and Chemical Properties
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	MW (g/mole)			K_{ow} (unitless)			log K_{ow} (unitless)			K_{oc} (L/kg)			K_d (L/kg)			H (unitless)			s (mg/L)			VP (mm Hg)			D_{air} (cm^2/s)			D_{water} (cm^2/s)			K_p (cm/hr)			ABS_d (unitless)			FA (unitless)		
			Value	Ref	Note	Value	Ref	Note	Value	Ref	Note	Value	Ref	Notes	Value	Ref	Notes	Value	Ref	Note	Value	Ref	Note	Value	Ref	Note	Value	Ref	Note	Value	Ref	Note	Value	Ref	Notes	Value	Ref	Note	Value	Ref	Notes
VOC	Acetone	67-64-1	5.8E+01	50		5.8E-01	44		-2.4E-01	44		5.8E-01	44	82				1.6E-03	44		1.0E+06	44		2.3E+02	50	92	1.2E-01	44		1.1E-05	44		5.2E-04	44	115		62		1.0E+00	62	114
VOC	Benzene	71-43-2	7.8E+01	50		1.3E+02	44		2.1E+00	44		5.8E+01	44	111				2.3E-01	44		1.8E+03	44		9.5E+01	50	92	8.8E-02	44		9.8E-06	44		1.5E-02	44	115		62		1.0E+00	62	
VOC	2-Butanone	78-93-3	7.2E+01	50		1.9E+00	69		2.8E-01	69		2.0E+00	69	111				2.3E-03	50	92	2.8E+05	69		9.5E+01	50	92	8.1E-02	69		9.8E-06	69		9.6E-04	69	115		62		1.0E+00	62	
VOC	Carbon Disulfide	75-15-0	7.6E+01	50		1.0E+02	44		2.0E+00	44		4.6E+01	44	111				1.2E+00	44		1.2E+03	44		3.6E+02	50	92	1.0E-01	44		1.0E-05	44		1.2E-02	44	115		62		1.0E+00	62	
VOC	Chloroethane	75-00-3	6.5E+01	50		2.7E+01	69		1.4E+00	69		1.6E+01	69	111				3.6E-01	50	92	5.7E+03	50	92	1.0E+03	50	92	2.7E-01	69		1.2E-05	69		6.1E-03	69	115		62		1.0E+00	62	
VOC	Cumene	98-82-8	1.2E+02	50		3.1E+03	69		3.5E+00	69		7.1E+02	69	111				4.7E+01	50	92	6.1E+01	50	92	4.5E+00	50	92	6.5E-02	69		7.1E-06	69		6.8E-02	69	115		62		1.0E+00	62	114
VOC	Cyclohexane	110-82-7	8.4E+01	50		2.8E+03	39		3.4E+00	39		6.3E+02	39	111				8.0E+00	50	92	5.5E+01	50	92	9.7E+01	50	92	8.4E-02	69		9.1E-06	69		1.0E-01	39	115		62		1.0E+00	62	114
VOC	Dichlorodifluoromethane	75-71-8	1.2E+02	50		1.4E+02	1		2.2E+00	1		6.2E+01	1	111				1.4E+01	50	92	2.8E+02	50	92	4.8E+03	50	92	8.0E-02	40		8.0E-06	40		8.9E-03	1	115		62		1.0E+00	62	
VOC	1,1-Dichloroethane	75-34-3	9.9E+01	50		6.2E+01	44		1.8E+00	44		3.1E+01	44	111				2.3E-01	44		5.1E+03	44		2.3E+02	50	92	7.4E-02	44		1.1E-05	44		6.7E-03	44	115		62		1.0E+00	62	
VOC	1,2-Dichloroethane	107-06-2	9.9E+01	50		3.0E+01	44		1.5E+00	44		1.7E+01	44	111				4.0E-02	44		8.5E+03	44		7.9E+01	50	92	1.0E-01	44		9.9E-06	44		4.1E-03	44	115		62		1.0E+00	62	
VOC	1,1-Dichloroethene	75-35-4	9.7E+01	50		1.3E+02	44		2.1E+00	44		5.8E+01	44	111				1.1E+00	44		2.3E+03	44		6.0E+02	50	92	9.0E-02	44		1.0E-05	44		1.2E-02	44	115		62		1.0E+00	62	
VOC	cis-1,2-Dichloroethene	156-59-2	9.7E+01	50		7.2E+01	44		1.9E+00	44		3.6E+01	44	111				1.7E-01	44		3.5E+03	44		2.0E+02	50	92	7.4E-02	44		1.1E-05	44		7.7E-03	44	115		62		1.0E+00	62	114
VOC	trans-1,2-Dichloroethene	156-60-5	9.7E+01	50		1.2E+02	44		2.1E+00	44		5.2E+01	44	111				3.9E-01	44		6.3E+03	44		3.3E+02	50	92	7.1E-02	44		1.2E-05	44		1.1E-02	44	115		62		1.0E+00	62	114
VOC	Ethyl Benzene	100-41-4	1.1E+02	50		1.4E+03	44		3.1E+00	44		3.7E+02	44	111				3.2E-01	44		1.7E+02	44		9.6E+00	50	92	7.5E-02	44		7.8E-06	44		4.8E-02	44	115		62		1.0E+00	62	
VOC	2-Hexanone	591-78-6	1.0E+02	50		2.4E+01	39		1.4E+00	39		1.5E+01	39	111				7.2E-02	1		1.8E+04	39		1.2E+01	50	92							3.5E-03	39	115		62		1.0E+00	62	114
VOC	Methyl Acetate	79-20-9	7.4E+01	55		1.5E+00	39		1.8E-01	39		1.7E+00	39	111				3.7E-03	69		2.4E+05	39		2.2E+02	39		9.6E-02	69		1.1E-05	69		8.0E-04	39	115		62		1.0E+00	62	114
VOC	4-Methyl-2-pentanone	108-10-1	1.0E+02	50		1.5E+01	62		1.2E+00	62		1.0E+01	62	111				5.6E-03	50	92	1.9E+04	39		2.0E+01	50	92	7.5E-02	40		7.8E-06	40		2.7E-03	62	115		62		1.0E+00	62	
VOC	Methylcyclohexane	108-87-2	9.8E+01	55		9.2E+02	69		3.0E+00	69		2.7E+02	69	111				1.8E+01	69		1.4E+01	69		4.3E+01	69		7.4E-02	69		8.5E-06	69		4.0E-02	69	115		62		1.0E+00	62	114
VOC	Methylene Chloride	75-09-2	8.5E+01	50		1.8E+01	44		1.3E+00	44		1.2E+01	44	111				9.0E-02	44		1.3E+04	44		4.3E+02	50	92	1.0E-01	44		1.2E-05	44		3.5E-03	44	115		62		1.0E+00	62	
VOC	Styrene	100-42-5	1.0E+02	50		8.7E+02	44		2.9E+00	44		7.8E+02	44	82				1.1E-01	44		3.1E+02	44		6.1E+00	50	92	7.1E-02	44		8.0E-06	44		3.6E-02	44	115		62		1.0E+00	62	
VOC	Tetrachloroethene	127-18-4	1.7E+02	50		4.7E+02	44		2.7E+00	44		1.6E+02	44	111				7.5E-01	44		2.0E+02	44		1.9E+01	50	92	7.2E-02	44		8.2E-06	44		1.1E-02	44	115		62		1.0E+00	62	
VOC	Toluene	108-88-3	9.2E+01	50		5.6E+02	44		2.8E+00	44		1.8E+02	44	111				2.7E-01	44		5.3E+02	44		2.8E+01	50	92	8.7E-02	44		8.6E-06	44		3.2E-02	44	115		62		1.0E+00	62	
VOC	Trichloroethene	79-01-6	1.3E+02	50		5.1E+02	44		2.7E+00	44		1.7E+02	44	111				4.2E-01	44		1.1E+03	44		7.3E+01	50	92	7.9E-02	44		9.1E-06	44		1.8E-02	44	115		62		1.0E+00	62	
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1.9E+02	50		1.4E+03	40		3.1E+00	40		3.7E+02	40	111				2.0E+01	50	92	1.7E+02	50	92	3.3E+02	50	92	7.8E-02	40		8.2E-06	40		1.7E-02	40	115		62		1.0E+00	62	114
VOC	1,2,4-Trimethylbenzene	95-63-6	1.2E+02	55		4.3E+03	1		3.6E+00	1		9.0E+02	1	111				2.3E-01			5.7E+01	1		1.0E+00	1		6.1E-02	69		7.9E-06	69		8.4E-02	1	115		62		1.0E+00	62	
VOC	1,3,5-Trimethylbenzene	108-67-8	1.2E+02	39		2.6E+03	1		3.4E+00	1		6.1E+02	1	111				2.4E-01	69		2.0E+01	1	55	1.0E+00	1		6.0E-02	69		8.7E-06	69		6.1E-02	1	115		62		1.0E+00	62	
VOC	Vinyl Chloride	75-01-4	6.3E+01	50		3.2E+01	44		1.5E+00	44		1.8E+01	44	111				1.1E+00	44		2.8E+03	44		3.0E+03	50	92	1.1E-01	44		1.2E-05	44	113	6.9E-03	44	115		62		1.0E+00	62	
VOC	Xylenes (total)	1330-20-7	1.1E+02	50		1.5E+03	44		3.2E+00	44		3.9E+02	44	111				2.8E-01	44		1.7E+02	44		8.0E+00	50	92	7.8E-02	44		8.7E-06	44		5.0E-02	44	115		62		1.0E+00	62	114
SVOC	Benzaldehyde	100-52-7	1.1E+02	39		3.0E+01	39		1.5E+00	39		2.9E+01	39	82				9.7E-04	69		3.0E+03	39		9.0E-01	69		7.2E-02	69		9.1E-06	69		3.8E-03	39	115	1.0E-01	62		1.0E+00	62	114
SVOC	Biphenyl	92-52-4	1.5E+02	50		1.2E+04	39		4.1E+00	39		1.0E+04	39	82				1.2E-02	50	92	6.0E+00	50	93	9.6E-03	50	92	4.0E-02	69		8.2E-06	69		1.1E-01	39	115	1.0E-01	62		1.0E+00	62	114
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	3.9E+02	50		2.0E+07	44		7.3E+00	44		1.5E+07	44	82				1.2E-06	44		3.4E-01	44		6.5E-06	50	94	3.5E-02	44		3.7E-06	44		6.8E-01	44	115	1.0E-01	62		4.0E-01	62	117
SVOC	Caprolactam	105-60-2	1.1E+02	39		6.5E-01	39		-1.9E-01	39		6.5E-01	39	82				2.1E-07	69		7.7E+05	68		1.6E-03	39		6.9E-02	69		9.0E-06	69		2.8E-04	39	115	1.0E-01	62		1.0E+00	62	114
SVOC	Dibenzofuran	132-64-9	1.7E+02	50		2.5E+04	69		4.4E+00	69		2.1E+04	69	82				5.1E-04	50	92	1.0E+01	50	93	1.8E-04	50	92	2.4E-02	69		6.0E-06	69		1.4E-01	69	115	1.0E-01	62		1.0E+00	62	114
SVOC	2,4-Dimethylphenol	105-67-9	1.2E+02	50		2.3E+02	44		2.4E+00	44		2.1E+02	44					8.2E-05	44		7.9E+03	44		9.8E-02	50	92	5.8E-02	44		8.7E-06	44		1.2E-02	44	115	1.0E-01	62		1.0E+00	62	
SVOC	2-Methylnaphthalene	91-57-6	1.4E+02	50		7.2E+03	1		3.9E+00	1		6.2E+03	1	82				2.1E-02	50	92	2.5E+01	50	92	5.5E-02	50	92	9.9E-02	52		7.8E-06	52		8.9E-02	1	115	1.0E-01	62		1.0E+00	62	114
SVOC	Methylphenol (total)	1319-77-3																																							
SVOC	Naphthalene	91-20-3	1.3E+02	50		2.3E+03	44		3.4E+00	44		2.0E+03	44	82				2.0E-02	44		3.1E+01	44		8.5E-02	50	92	5.9E-02	44		7.5E-06	44		5.0E-02	44	115	1.3E-01	62		1.0E+00	62	
SVOC	Phenanthrene	85-01-8	1.8E+02	50		2.9E+04	69		4.5E+00	69		2.4E+04	69	82				9.5E-04	50	92	1.2E+00	50	92	1.1E-04	50	92	3.8E-02	69		7.5E-06	69		1.4E-01	69	115	1.3E-01	62		1.0E+00	62	
SVOC	Phenol	108-95-2	9.4E+01	50		3.0E+01	44		1.5E+00	44		2.9E+01	44					1.6E-05	44		8.3E+04	44		2.8E-01	50	92	8.2E-02	44		9.1E-06	44		4.5E-03	44	115	1.0E-01	62		1.0E+00	62	
P/PCB	PCBs (total)	1336-36-3	3.3E+02	64	116	3.2E+06	64	116	6.5E+00	64	116	2.5E+06	64	116, 82				8.2E-02	64	116	1.2E-02	64	116	7.7E-05	64	116	8.0E-02	40		1.0E-05	40		4.5E-01	64	116, 115	1.4E-01	62		7.0E-01	62	117, 110
INORG	Antimony	7440-36-0	1.2E+02	50			1	48		1	48				4.5E+01	44	43					1	61					40	48		40	48	1.0E-03	62			62			62	
INORG	Arsenic	7440-38-2	7.5E+01	50			1	48		1	48				2.9E+01	44	43					1	61					40	48		40	48	1.0E-03	62		3.0E-02	62			62	
INORG	Barium	7440-39-3	1.4E+02	50			1	48		1	48				4.1E+01	44	43					1	60					40	48		40	48	1.0E-03	62			62			62	
INORG	Beryllium	7440-41-7	9.0E+00	50			1	48		1	48				7.9E+02	44	43					1	61					40	48		40	48	1.0E-03	62			62			62	
INORG	Cadmium	7440-43-9	1.1E+02	50			1	48		1	48				7.5E+01	44	43					1	61		40	48		40	48		40	48	1.0E-03	62		1.0E-03	62			62	
INORG	Chromium (total)	7440-47-3	5.2E+01	50			1	48		1	48				1.9E+01	44	43, 45					1	61					40	48		40	48	2.0E-03	62	45		62			62	
INORG	Cobalt	7440-48-4	5.9E+01	50			1	48		1	48				4.5E+01	35						1	61										4.0E-04	62			62			62	
INORG	Copper	7440-50-8	6.4E+01	50			1	48		1	48				3.5E+01	35						1	61					40	48		40	48	1.0E-03	62			62			62	
INORG	Lead	7439-92-1	2.1E+02	50			1	48		1	48				9.0E+02	35						1	61					40	48		40	48	1.0E-04	62			62			62	
INORG	Manganese	7439-96-5	5.5E+01	50											6.5E+01	35																1.0E-03	62			62			62	
INORG	Mercury	7439-97-6	2.0E+02	67			1	48		1	48				1.0E+03	67		2.9E-01	67		5.6E-02	1		2.0E-03	50	92	3.1E-02	44		6.3E-06	44		1.0E-03	62			62			62	
INORG	Nickel	7440-02-0	5.9E+01	50			1	48		1	48				6.5E+01	44	43					1	61					40	48		40	48	2.0E-04	62			62			62	
INORG	Selenium	7782-49-2	7.9E+01	50			1	48		1	48				5.0E+00	44	43					40	48		40	48		40	48		40	48	1.0E-03	62			62			62	
INORG	Silver	7440-22-4	1.1E+02	50			1	48		1	48				8.3E+00	44	43					1	61					40	48		40	48	6.0E-04	62			62			62	
INORG	Thallium	7440-28-0	2.0E+02	50			1	48		1	48				7.1E+01	44	43					1	61					40	48		40	48	1.0E-03	62			62			62	
INORG	Vanadium	7440-62-2	5.1E+01	50			1	48		1	48				1.0E+03	44	43					1	61		40	48		40	48		40	48	1.0E-03	62			62			62	
INORG	Zinc	7440-66-6	6.5E+01	50			1	48		1	48				6.2E+01	44	43					1	61					40	48		40	48	6.0E-04	62			62			62	

Attachment C.1: Physical and Chemical Properties GMC Pontiac Centerpoint Building 33, Pontiac, MI	
References:	
1	USEPA. 1992. Handbook of RCRA Ground-Water Monitoring Constituents. Chemical and Physical Properties (40 CFR Part 264, Appendix IX). EPA-530-R-92-022. September.
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39	CHEMFATE data base. Syracuse Research Corporation.
40	Research Triangle Institute, Center for Environmental Analysis. 1995. Supplemental Technical Support Document for Hazardous Waste Identification Rule: Risk Assessment for Human and Ecological Receptors--Volume 1, TABLE A-1. November 1995.
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55	W.G. Mallard and P.J. Linstrom, Eds., NIST Chemistry WebBook, NIST Standard Reference Database Number 69, March, 2003, National Institute of Standards and Technology, Gaithersburg MD, 20899
62	USEPA. 2001. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim - Review Draft-For Public Comment. September.
64	Agency for Toxic Substances and Disease Registry (ATSDR). November 2000. Toxicological Profile for Polychlorindated Biphenyls (PCBs).
67	USEPA. 1997. Mercury Study Report to Congress. EPA's Office of Air Quality Planning and Standards and Office of Research and Development. December.
68	PHYSPROP data base. Syracuse Research Corporation.
69	USEPA. 2004. WATER9. Version 2.0.0. Office of Air Quality Planning and Standards. July.

Attachment C.1: Physical and Chemical Properties GMC Pontiac Centerpoint Building 33, Pontiac, MI	
Notes:	
43	pH associated with value is 6.8.
45	ENVIRON used the value for Chromium VI [CASRN 18540-29-9] presented in indicated reference as a surrogate.
48	Not Available or Not Applicable
55	Reference temperature is unspecified.
60	Hydrolyzes
61	Insoluble
82	ENVIRON used Equation (70) from Reference 44 to calculate Koc value using Log Kow value from indicated reference.
92	Indicated source cites CHEMFATE.
93	Indicated source cites FATE.
94	Indicated source cites LIVECHEM.
110	ENVIRON used the value for 4-Chlorobiphenyl [CASRN 2051-62-9] from the indicated reference as a surrogate.
111	ENVIRON used Equation (71) from Reference 44 to calculate Koc value using Log Kow value from indicated reference.
113	Personal communication with RCRA, Superfund & EPCRA Hotline on 9/15/2000; indicated reference presents the value which is off by an order of magnitude (1.23E-06 cm2/s). The database has the correct value of 1.23E-05 cm2/s.
114	ENVIRON calculated FA from Exhibit A-4 from the cited reference.
115	ENVIRON calculated Kp value using equation 3.8 (p.3-8) in reference 62 with log Kow from the indicated reference and the MW presented in table.
116	ENVIRON used the value for Aroclor-1254 [CASRN 11097-69-1] from the indicated reference as a surrogate.
117	ENVIRON derived the FA based on Exhibit A-4 in the indicated reference.

ATTACHMENT C.2:
Calculations for Vapor Intrusion from Smear Zone Soil and Perched Groundwater at LNAPL Area#1

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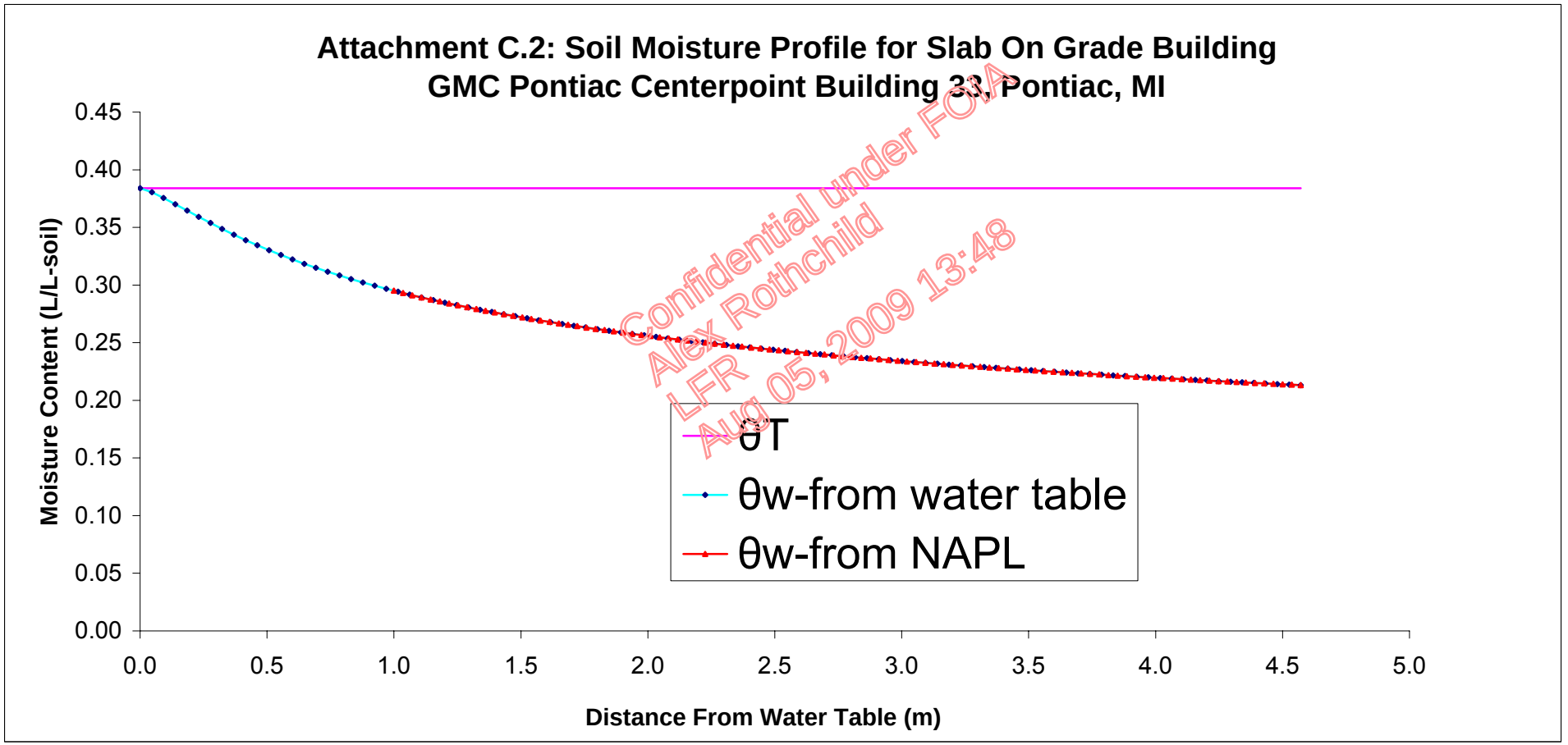

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Attachment C.2: Calculation of Effective Diffusion Coefficients from Groundwater for an Industrial Slab On Grade Building
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	D_{air} (m^2/d)	D_{water} (m^2/d)	H (unitless)	D_{eff}^T (m^2/d)
VOC	Benzene	71-43-2	7.60E-01	8.47E-05	1.14E-01	5.95E-03
VOC	Ethyl Benzene	100-41-4	6.48E-01	6.74E-05	1.62E-01	5.05E-03
VOC	Toluene	108-88-3	7.52E-01	7.43E-05	1.36E-01	5.86E-03
VOC	1,2,4-Trimethylbenzene	95-63-6	5.24E-01	6.84E-05	1.15E-01	4.11E-03
VOC	1,3,5-Trimethylbenzene	108-67-8	5.20E-01	7.49E-05	1.20E-01	4.09E-03
VOC	Xylenes (total)	1330-20-7	6.74E-01	7.56E-05	1.38E-01	5.26E-03
SVOC	2-Methylnaphthalene	91-57-6	8.52E-01	6.70E-05	1.06E-02	7.34E-03
SVOC	Naphthalene	91-20-3	5.10E-01	6.48E-05	9.90E-03	4.70E-03
Notes:						
Only chemicals detected in NAPL Area 1 are shown.						

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Attachment C.2: Vapor Intrusion into an Industrial Slab On Grade Building from Groundwater
GMC Pontiac Centerpoint Building 33, Pontiac, MI

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	Benzene	71-43-2	7.60E-01	8.47E-05	1.14E-01	1.39E-02	5.95E-03	2.71E-07	3.09E-05
VOC	Ethyl Benzene	100-41-4	6.48E-01	6.74E-05	1.62E-01	1.18E-02	5.05E-03	2.71E-07	4.37E-05
VOC	Toluene	108-88-3	7.52E-01	7.43E-05	1.36E-01	1.37E-02	5.86E-03	2.71E-07	3.69E-05
VOC	1,2,4-Trimethylbenzene	95-63-6	5.24E-01	6.84E-05	1.15E-01	9.56E-03	4.11E-03	2.69E-07	3.10E-05
VOC	1,3,5-Trimethylbenzene	108-67-8	5.20E-01	7.49E-05	1.20E-01	9.50E-03	4.09E-03	2.69E-07	3.24E-05
VOC	Xylenes (total)	1330-20-7	6.74E-01	7.56E-05	1.38E-01	1.23E-02	5.26E-03	2.71E-07	3.74E-05
SVOC	2-Methylnaphthalene	91-57-6	8.52E-01	6.70E-05	1.06E-02	1.58E-02	7.34E-03	2.72E-07	2.88E-06
SVOC	Naphthalene	91-20-3	5.10E-01	6.48E-05	9.90E-03	9.55E-03	4.70E-03	2.70E-07	2.67E-06
Notes:	**Crack Soil and Building Characteristics**								
	SCS Soil texture class	Sandy Clay Loam							
	Bulk density	kg/L	ρ_b	1.63					
	Total porosity	L/L-soil	θ	0.384					
	Water-filled porosity	L/L-soil	θ_w	0.215					
	Air-filled porosity	L/L-soil	θ_a	0.169					
	Residual saturation	L/L-soil	θ_r	0.063					
	Hydraulic conductivity	cm/s	K	1.1E-04					
	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	1.5E-09					
	Effective total saturation	unitless	S_{te}	0.473					
	van Genuchten N	unitless	N	1.330					
	van Genuchten M	unitless	M	0.248					
	Relative air permeability	unitless	k_{rg}	0.708					
	Permeability to vapor	cm^2	k_v	1.0E-09					
	Distance from building foundation to source	m	L_T	3.42					
	Bldg foundation thickness	m	L_{crack}	0.15					
	Bldg foundation length	m		60.48					
	Bldg foundation width	m		60.48					
	Bldg occupied height	m		2.44					
	Bldg occupied volume	m^3		8925.66					
	Occupied depth below ground	m							
	Bldg area for vapor intrusion	m^2	A_B	3658.1					
	Ratio of A_{crack} to A_B			3E-05					
	Area of cracks	m^2	A_{crack}	1.21E-01					
	Air exchange rate	$hour^{-1}$	ac/h	2.0					
	Building ventilation rate	m^3/d	Q_{bldg}	4.28E+05					
	Pressure difference between outdoors-indoors	kg/m-s^2	ΔP	1.0					
	Air viscosity	kg/m-s	μ	1.8E-05					
	Crack length (bldg perimeter)	m	X_{crack}	241.9275					
	Crack depth below ground	m	Z_{crack}	0.15					
	Crack radius	m	r_{crack}	5E-04					
	Soil gas flow rate into bldg	m^3/d	Q_{soil}	1.18E-01					

Attachment C.2: Vapor Intrusion into an Industrial Slab On Grade Building from Smear Zone Soil
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	D_{air} (m^2/d)	D_{water} (m^2/d)	H (unitless)	L_{crack} (m^2/d)	D_{eff}^T (m^2/d)	α_∞ (unitless)	K_{oc} (L/kg)	K_d (L/kg)	$C_{s,\ vap}$ (kg-soil/m^3)	C_{bldg} (kg-soil/m^3)
VOC	Benzene	71-43-2	7.60E-01	8.47E-05	1.14E-01	1.39E-02	5.95E-03	2.71E-07	5.82E+01	3.49E-01	2.31E+02	6.28E-05
VOC	Ethyl Benzene	100-41-4	6.48E-01	6.74E-05	1.62E-01	1.18E-02	5.05E-03	2.71E-07	3.67E+02	2.20E+00	6.87E+01	1.86E-05
VOC	Toluene	108-88-3	7.52E-01	7.43E-05	1.36E-01	1.37E-02	5.86E-03	2.71E-07	1.80E+02	1.08E+00	1.11E+02	3.01E-05
VOC	1,2,4-Trimethylbenzene	95-63-6	5.24E-01	6.84E-05	1.15E-01	9.56E-03	4.11E-03	2.69E-07	8.97E+02	5.38E+00	2.08E+01	5.61E-06
VOC	1,3,5-Trimethylbenzene	108-67-8	5.20E-01	7.49E-05	1.20E-01	9.50E-03	4.09E-03	2.69E-07	6.12E+02	3.67E+00	3.15E+01	8.48E-06
VOC	Xylenes (total)	1330-20-7	6.74E-01	7.56E-05	1.38E-01	1.23E-02	5.26E-03	2.71E-07	3.86E+02	2.31E+00	5.61E+01	1.52E-05
SVOC	2-Methylnaphthalene	91-57-6	8.52E-01	6.70E-05	1.06E-02	1.58E-02	7.34E-03	2.72E-07	6.23E+03	3.74E+01	2.82E-01	7.68E-08
SVOC	Naphthalene	91-20-3	5.10E-01	6.48E-05	9.90E-03	9.55E-03	4.70E-03	2.70E-07	2.01E+03	1.21E+01	8.12E-01	2.19E-07

Notes:	Soil and Building Characteristics			Crack	Vadose							
	SCS Soil texture class			Sandy Clay Loam	Sandy Clay Loam							
	Bulk density	kg/L	ρ_b	1.63	1.63							
	Total porosity	L/L-soil	θ	0.384	0.384							
	Water-filled porosity	L/L-soil	θ_w	0.215	0.215							
	Air-filled porosity	L/L-soil	θ_a	0.169	0.169							
	Organic carbon fraction	unitless	f_{oc}		0.006							
	Residual saturation	L/L-soil	θ_r	0.0630								
	Hydraulic conductivity	cm/s	K	1.1E-04								
	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	1.5E-09								
	Effective total saturation	unitless	S_{te}	4.7E-01								
	van Genuchten N	unitless	N	1.330								
	van Genuchten M	unitless	M	0.248								
	Relative air permeability	unitless	k_{rg}	0.708								
	Permeability to vapor	cm^2	k_v	1.04E-09								
	Distance from building foundation to source	m	L_T	3.42								
	Bldg foundation thickness	m	L_{crack}	0.15								
	Bldg foundation length	m		60.48								
	Bldg foundation width	m		50.48								
	Bldg occupied height	m		2.44								
	Bldg occupied volume	m^3		8925.05								
	Occupied depth below ground	m										
	Bldg area for vapor intrusion	m^2	A_B	3658.1								
	Ratio of A_{crack} to A_B			3E-05								
	Area of cracks	m^2	A_{crack}	1.21E-01								
	Air exchange rate	$hour^{-1}$	ac/h	2.0								
	Building ventilation rate	m^3/d	Q_{bldg}	4.28E+05								
	Pressure difference between outdoors-indoors	kg/m-s^2	ΔP	1.0								
	Air viscosity	kg/m-s	μ	1.8E-05								
	Crack length (bldg perimeter)	m	X_{crack}	241.9275								
	Crack depth below ground	m	Z_{crack}	0.15								
	Crack radius	m	r_{crack}	5E-04								
	Soil gas flow rate into bldg	m^3/d	Q_{soil}	1.18E-01								
	Averaging period	s	T	7.88E+08								

Attachment C.2: Risk Based Cancer Criteria for Routine Worker Exposure to Smear Zone Soil via Vapor Intrusion
GMC Pontiac Centerpoint Building 33, Pontiac, MI

					Vapor Inhalation		
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**C_{soil}** (mg/kg)	**C_{air}** (mg/m^3)	**URF** (m^3/mg)	**RBC** (mg/kg)
VOC	Benzene	71-43-2	A	1.00E+00	6.28E-05	7.8E-03	8.3E+01
VOC	Ethyl Benzene	100-41-4	D	1.00E+00	1.86E-05		
VOC	Toluene	108-88-3	D	1.00E+00	3.01E-05		
VOC	1,2,4-Trimethylbenzene	95-63-6		1.00E+00	5.61E-06		
VOC	1,3,5-Trimethylbenzene	108-67-8		1.00E+00	8.48E-06		
VOC	Xylenes (total)	1330-20-7	D	1.00E+00	1.52E-05		
SVOC	2-Methylnaphthalene	91-57-6	D	1.00E+00	7.68E-08		
SVOC	Naphthalene	91-20-3	C	1.00E+00	2.19E-07		
Notes:							
Criteria are based on a target cancer risk level of 1E-05							
Only chemicals detected in NAPL Area 1 are shown.							

Attachment C.2: Risk Based NonCancer Criteria for Routine Worker Exposure to Smear Zone Soil via Vapor Intrusion
GMC Pontiac Centerpoint Building 33, Pontiac, MI

					Vapor Inhalation		
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**C_{soil}** (mg/kg)	**C_{air}** (mg/m^3)	**RfC** (mg/m^3)	**RBC** (mg/kg)
VOC	Benzene	71-43-2	A	1.00E+00	6.28E-05	3.0E-02	7.0E+02
VOC	Ethyl Benzene	100-41-4	D	1.00E+00	1.86E-05	1.0E+00	7.9E+04
VOC	Toluene	108-88-3	D	1.00E+00	3.01E-05	4.0E-01	1.9E+04
VOC	1,2,4-Trimethylbenzene	95-63-6		1.00E+00	5.61E-06	6.0E-03	1.5E+03
VOC	1,3,5-Trimethylbenzene	108-67-8		1.00E+00	8.48E-06	6.0E-03	1.0E+03
VOC	Xylenes (total)	1330-20-7	ID	1.00E+00	1.52E-05	1.0E-01	9.6E+03
SVOC	2-Methylnaphthalene	91-57-6	ID	1.00E+00	7.68E-08	3.0E-03	5.7E+04
SVOC	Naphthalene	91-20-3	C	1.00E+00	2.19E-07	3.0E-03	2.0E+04
Notes:							
Criteria are based on a target hazard quotient of 1.							
Only chemicals detected in NAPL Area 1 are shown.							

Attachment C.2: Risk Based Cancer Criteria for Routine Worker Exposure to Groundwater via Vapor Intrusion
GMC Pontiac Centerpoint Building 33, Pontiac, MI

					Vapor Inhalation		
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**C_{gw}** (mg/l)	**C_{air}** (mg/m^3)	**URF** (m^3/mg)	**RBC** (mg/l)
VOC	Benzene	71-43-2	A	1.00E+00	3.09E-05	7.8E-03	1.7E+02
VOC	Ethyl Benzene	100-41-4	D	1.00E+00	4.37E-05		
VOC	Toluene	108-88-3	D	1.00E+00	3.69E-05		
VOC	1,2,4-Trimethylbenzene	95-63-6		1.00E+00	3.10E-05		
VOC	1,3,5-Trimethylbenzene	108-67-8		1.00E+00	3.24E-05		
VOC	Xylenes (total)	1330-20-7	ID	1.00E+00	3.74E-05		
SVOC	2-Methylnaphthalene	91-57-6	ID	1.00E+00	2.88E-06		
SVOC	Naphthalene	91-20-3	C	1.00E+00	2.67E-06		
Notes:							
Criteria are based on a target cancer risk level of 1E-05							
Only chemicals detected in NAPL Area 1 are shown.							

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Attachment C.2: Risk Based NonCancer Criteria for Routine Worker Exposure to Groundwater via Vapor Intrusion
GMC Pontiac Centerpoint Building 33, Pontiac, MI

					Vapor Inhalation		
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**C_{gw}** (mg/l)	**C_{air}** (mg/m^3)	**RfC** (mg/m^3)	**RBC** (mg/l)
VOC	Benzene	71-43-2	A	1.00E+00	3.09E-05	3.0E-02	1.42E+03
VOC	Ethyl Benzene	100-41-4	D	1.00E+00	4.37E-05	1.0E+00	3.34E+04
VOC	Toluene	108-88-3	D	1.00E+00	3.69E-05	4.0E-01	1.58E+04
VOC	1,2,4-Trimethylbenzene	95-63-6		1.00E+00	3.10E-05	6.0E-03	2.80E+02
VOC	1,3,5-Trimethylbenzene	108-67-8		1.00E+00	3.24E-05	6.0E-03	2.68E+02
VOC	Xylenes (total)	1330-20-7	D	1.00E+00	3.74E-05	1.0E-01	3.91E+03
SVOC	2-Methylnaphthalene	91-57-6	D	1.00E+00	2.88E-06	3.0E-03	1.52E+03
SVOC	Naphthalene	91-20-3	C	1.00E+00	2.67E-06	3.0E-03	1.64E+03
Notes:							
Criteria are based on a target hazard quotient of 1.							
Only chemicals detected in NAPL Area 1 are shown.							

Attachment C.2: Risk Based Criteria for Routine Worker Inhalation of Vapor that Migrates into Indoor Air
GMC Pontiac Centerpoint Building 33, Pontiac, MI

			Vapor Intrusion				Vapor Intrusion		
Chem Group	**Chemical**	**CASRN**	**Smear Zone Soil VI RBC - Cancer** (mg/kg)	**Smear Zone Soil VI RBC - NonCancer** (mg/kg)	**Smear Zone Soil VI RBC - Combined** (mg/kg)		**GW VI RBC - Cancer** (mg/L)	**GW VI RBC - NonCancer** (mg/L)	**GW VI RBC - Combined** (mg/L)
VOC	Benzene	71-43-2	8.3E+01	7.0E+02	8.3E+01		1.7E+02	1.4E+03	1.7E+02
VOC	Ethyl Benzene	100-41-4		7.9E+04	7.9E+04			3.3E+04	3.3E+04
VOC	Toluene	108-88-3		1.9E+04	1.9E+04			1.6E+04	1.6E+04
VOC	1,2,4-Trimethylbenzene	95-63-6		1.5E+03	1.5E+03			2.8E+02	2.8E+02
VOC	1,3,5-Trimethylbenzene	108-67-8		1.0E+03	1.0E+03			2.7E+02	2.7E+02
VOC	Xylenes (total)	1330-20-7		9.6E+03	9.6E+03			3.9E+03	3.9E+03
SVOC	2-Methylnaphthalene	91-57-6		5.7E+04	5.7E+04			1.5E+03	1.5E+03
SVOC	Naphthalene	91-20-3		2.0E+04	2.0E+04			1.6E+03	1.6E+03
Notes:									
Criteria are based on a cancer risk level (CRL) of 1E-5 and a hazard quotient (HQ) of 1.									

ATTACHMENT C.3:

Calculations for Construction Workers Contact with Smear Zone Soil and Perched Groundwater in Excavations at LNAPL Area #1

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Attachment C.3: High-End Exposure Factors for Small Scale Construction Worker
GMC Pontiac Centerpoint Building 33, Pontiac, MI

			Small Scale Construction Worker	
Soil Ingestion				
Ingestion Rate	mg-soil/day	**IR**	200	c
Conversion Factor	kg/mg	**CF**	1E-06	
Fraction Contaminated	unitless	**FC**	1.0	
Exposure Frequency	days/year	**EF**	5	a
Expoure Duration	years	**ED**	10	c
Body Weight	kg	**BW**	70	a
Averaging Time, cancer	days	**AT_c**	25,550	a
Averaging Time, noncancer	days	**AT_{nc}**	3,650	a
Soil Dermal Contact				
Adherence Factor	mg-soil/cm^2	**AF**	0.2	c
Skin Surface Area	cm^2/day	**SA**	3,300	b
Conversion Factor	kg/mg	**CF**	1E-06	
Fraction Contaminated	unitless	**FC**	1.0	
Exposure Frequency	days/year	**EF**	5	a
Expoure Duration	years	**ED**	10	c
Body Weight	kg	**BW**	70	a
Averaging Time, cancer	days	**AT_c**	25,550	a
Averaging Time, noncancer	days	**AT_{nc}**	3,650	a
Vapor and Particulate Inhalation				
Exposure Frequency	days/year	**EF**	5	a
Expoure Duration	years	**ED**	10	c
Averaging Time, cancer	days	**AT_c**	25,550	a
Averaging Time, noncancer	days	**AT_{nc}**	3,650	a
Groundwater Ingestion				
Drinking Rate	L-water/hr	**DR**	0.005	c
Exposure Time	hr	**t**	2	c
Exposure Frequency	days/year	**EF**	5	c
Exposure Duration	years	**ED**	10	c
Body Weight	kg	**BW**	70	a
Averaging Time, cancer	days	**AT_c**	25,550	a
Averaging Time, noncancer	days	**AT_{nc}**	3,650	a
Groundwater Dermal Contact				
Event Time	hr	**t**	2	c
Skin Surface Area	cm^2	**SA**	3,300	b
Events per Day	1/d	**EV**	1	
Exposure Frequency	days/year	**EF**	5	c
Exposure Duration	years	**ED**	10	c
Body Weight	kg	**BW**	70	a
Averaging Time, cancer	days	**AT_c**	25,550	a
Averaging Time, noncancer	days	**AT_{nc}**	3,650	a
References:				
a. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A) Interim Final (EPA 1989)				
b. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual: Part E, Supplemental Guidance for Dermal Risk Assessment, Final (EPA 2004)				
c. Based on professional judgement and site-specific considerations as follows: 1) soil ingestion rate and soil adherence factor are the same as those discussed in the Supplemental RFI Report No. 1; 2) exposure frequency is an upper-bound assuming 5 work days per week for 50 weeks; and 3) exposure duration of 1 year is based on site-specific site preparation plans.				

Attachment C.3: Nonsteady State Dermal Absorption of Chemical from Water
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	MW (g/mole)	K_p (cm/hr)	FA (unitless)	K_p (cm/hr)	B (unitless)	τ (hr)	c	b	ts (hr)	DA (L/cm^2-event)
VOC	Benzene	71-43-2	7.8E+01	1.5E-02	1.0E+00	1.5E-02	5.0E-02	2.9E-01	3.7E-01	3.3E-01	6.9E-01	3.70E-05
VOC	Ethyl Benzene	100-41-4	1.1E+02	4.8E-02	1.0E+00	4.8E-02	1.9E-01	4.1E-01	4.7E-01	4.3E-01	9.9E-01	1.27E-04
VOC	Toluene	108-88-3	9.2E+01	3.2E-02	1.0E+00	3.2E-02	1.2E-01	3.5E-01	4.2E-01	3.8E-01	8.3E-01	8.08E-05
VOC	1,2,4-Trimethylbenzene	95-63-6	1.2E+02	8.4E-02	1.0E+00	8.4E-02	3.5E-01	5.0E-01	6.0E-01	5.7E-01	1.2E+00	2.34E-04
VOC	1,3,5-Trimethylbenzene	108-67-8	1.2E+02	6.1E-02	1.0E+00	6.1E-02	2.6E-01	5.0E-01	5.2E-01	4.8E-01	1.2E+00	1.72E-04
VOC	Xylenes (total)	1330-20-7	1.1E+02	5.0E-02	1.0E+00	5.0E-02	2.0E-01	4.1E-01	4.8E-01	4.4E-01	9.9E-01	1.32E-04
SVOC	2-Methylnaphthalene	91-57-6	1.4E+02	8.9E-02	1.0E+00	8.9E-02	4.1E-01	6.6E-01	6.5E-01	6.2E-01	1.6E+00	2.89E-04
SVOC	Naphthalene	91-20-3	1.3E+02	5.0E-02	1.0E+00	5.0E-02	2.2E-01	5.5E-01	4.9E-01	4.5E-01	1.3E+00	1.49E-04
Note:	Event Time	hours	**t**	2								
	K_p capped at 1 cm/hr (USEPA 1992)											

Attachment C.3: Vapor Flux (mg/m2-s per mg/kg) from Smear Zone Soil to Ambient Air
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	K_{oc} (L/kg)	K_d (L/kg)	H (unitless)	D_{air} (cm^2/s)	D_{water} (cm^2/s)	H_L (unitless)	D_G (cm^2/s)	D_L (cm^2/s)	D_E (cm^2/s)	J_G (kg/m^2-s)	MW (g/mole)	VP (mm Hg)	s (mg/L)	v* (mg/L)	C_{sat} (mg/kg)
VOC	Benzene	71-43-2	5.82E+01		1.14E-01	8.80E-02	9.80E-06	8.04E-01	1.59E-03	3.96E-07	2.26E-04	1.56E-05	7.81E+01	9.50E+01	1.75E+03	4.17E+02	8.63E+02
VOC	Ethyl Benzene	100-41-4	3.67E+02		1.62E-01	7.50E-02	7.80E-06	3.83E+00	1.36E-03	3.15E-07	5.73E-05	7.84E-06	1.06E+02	9.60E+00	1.69E+02	5.73E+01	3.98E+02
VOC	Toluene	108-88-3	1.80E+02		1.36E-01	8.70E-02	8.60E-06	2.00E+00	1.57E-03	3.47E-07	1.07E-04	1.07E-05	9.21E+01	2.84E+01	5.26E+02	1.47E+02	6.46E+02
VOC	1,2,4-Trimethylbenzene	95-63-6	8.97E+02		1.15E-01	6.06E-02	7.92E-06	9.01E+00	1.10E-03	3.20E-07	1.40E-05	3.88E-06	1.20E+02	1.00E+00	5.70E+01	6.76E+00	3.15E+02
VOC	1,3,5-Trimethylbenzene	108-67-8	6.12E+02		1.20E-01	6.02E-02	8.67E-06	6.22E+00	1.09E-03	3.50E-07	2.11E-05	4.76E-06	1.20E+02	1.00E+00	2.00E+01	6.76E+00	7.63E+01
VOC	Xylenes (total)	1330-20-7	3.86E+02		1.38E-01	7.80E-02	8.75E-06	4.01E+00	1.41E-03	3.53E-07	4.87E-05	7.22E-06	1.06E+02	7.99E+00	1.75E+02	4.77E+01	4.30E+02
SVOC	2-Methylnaphthalene	91-57-6	6.23E+03		1.06E-02	9.86E-02	7.75E-06	6.12E+01	1.78E-03	3.13E-07	3.14E-07	5.80E-07	1.42E+02	5.50E-02	2.46E+01	4.40E-01	9.23E+02
SVOC	Naphthalene	91-20-3	2.01E+03		9.90E-03	5.90E-02	7.50E-06	1.99E+01	1.07E-03	3.03E-07	5.47E-07	7.66E-07	1.28E+02	8.50E-02	3.10E+01	6.12E-01	3.78E+02
Notes:	Soil bulk density	kg/L	ρ_b	1.63	*EPA default/MDEQ 1998*												
	Soil particle density	kg/L	ρ_s	2.65	*EPA default/MDEQ 1998*												
	Soil porosity	L/L-soil	θ	0.384	*1-(pb/ps)*												
	Soil water content	L/L-soil	θ_w	0.215													
	Soil air-filled porosity	L/L-soil	θ_a	0.17	*porosity-water content*												
	Soil organic carbon fraction	unitless	f_{oc}	0.006													
	Averaging period	year	**ED**	10													
		s	**ED**	3.2E+08													
	Molar Gas Constant	mmHg/mole-	**R**	62.411													
	Temperature	^oC	**T**	12													
		^oK	**T**	285													

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Attachment C.3: Vapor Flux (mg/m2-s per mg/L) from Exposed Groundwater in Excavations to Ambient Air
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	H' (unitless)	MW (g/mol)	K_{Gi} (cm/s)	K_{li} (cm/s)	$1/K_L$ (cm/s)	K_L (cm/s)	J_L (L/m^2-s)
VOC	Benzene	71-43-2	1.1E-01	7.8E+01	4.87E-01	1.22E-03	8.35E+02	1.20E-03	1.20E-02
VOC	Ethyl Benzene	100-41-4	1.6E-01	1.1E+02	4.40E-01	1.05E-03	9.66E+02	1.03E-03	1.03E-02
VOC	Toluene	108-88-3	1.4E-01	9.2E+01	4.61E-01	1.13E-03	9.03E+02	1.11E-03	1.11E-02
VOC	1,2,4-Trimethylbenzene	95-63-6	1.2E-01	1.2E+02	4.22E-01	9.87E-04	1.03E+03	9.67E-04	9.67E-03
VOC	1,3,5-Trimethylbenzene	108-67-8	1.2E-01	1.2E+02	4.22E-01	9.87E-04	1.03E+03	9.68E-04	9.68E-03
VOC	Xylenes (total)	1330-20-7	1.4E-01	1.1E+02	4.40E-01	1.05E-03	9.69E+02	1.03E-03	1.03E-02
SVOC	2-Methylnaphthalene	91-57-6	1.1E-02	1.4E+02	3.99E-01	9.07E-04	1.34E+03	7.47E-04	7.47E-03
SVOC	Naphthalene	91-20-3	9.9E-03	1.3E+02	4.13E-01	9.56E-04	1.29E+03	7.75E-04	7.75E-03
Notes:	molecular weight of oxygen	g/mol	MW_{02}	32					
	molecular weight of water	g/mol	MW_{H20}	18					
	temperature	K	**T**	285					
	liquid-phase mass transfer coefficient for oxygen	cm/s	$k_{L,02}$	0.002					
	gas-phase mass transfer coefficient for water vapor at 25 °C	cm/s	$K_{G,H20}$	0.833					

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Attachment C.3: Concentrations in Ambient Air from Smear Zone Soil
GMC Pontiac Centerpoint Building 33, Pontiac, MI

					PM10 value used:		1.37E-08
			Vapor			PM_{10}	
	C/Q (kg/m^3 per kg/m^2-s)**:**		10.96			10.96	
Chem Chem	**Chemical**	**CASRN**	C_{soil} (mg/kg)	C_{source} (mg/kg)	C_{air} (mg/m^3)	C_{soil} (mg/kg)	C_{air} (mg/m^3)
VOC	Benzene	71-43-2	1.00E+00	1.00E+00	1.71E-04	1.00E+00	1.50E-07
VOC	Ethyl Benzene	100-41-4	1.00E+00	1.00E+00	8.59E-05	1.00E+00	1.50E-07
VOC	Toluene	108-88-3	1.00E+00	1.00E+00	1.17E-04	1.00E+00	1.50E-07
VOC	1,2,4-Trimethylbenzene	95-63-6	1.00E+00	1.00E+00	4.25E-05	1.00E+00	1.50E-07
VOC	1,3,5-Trimethylbenzene	108-67-8	1.00E+00	1.00E+00	5.22E-05	1.00E+00	1.50E-07
VOC	Xylenes (total)	1330-20-7	1.00E+00	1.00E+00	7.92E-05	1.00E+00	1.50E-07
SVOC	2-Methylnaphthalene	91-57-6	1.00E+00	1.00E+00	6.36E-06	1.00E+00	1.50E-07
SVOC	Naphthalene	91-20-3	1.00E+00	1.00E+00	8.40E-06	1.00E+00	1.50E-07

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Attachment C.3: Risk Based Cancer Criteria for Small Scale Construction Worker Exposures to Smear Zone Soil
GMC Pontiac Centerpoint Building 33, Pontiac, MI

				Smear Zone Soil Ingestion				Smear Zone Soil Dermal Contact				Smear Zone Soil Vapor Inhalation				Smear Zone Soil Particulate Inhalation				
Chem Group	**Chemical**	**CASRN**	**Carc Class**	C_{soil} (mg/kg)	**LADD** (mg/kg/d)	SF_{oral} (mg/kg/d)$^{-1}$	**RBC** (mg/kg)	AF_{derm}	**LADD** (mg/kg/d)	SF_{derm} (mg/kg/d)$^{-1}$	**RBC** (mg/kg)	C_{air} (mg/m^3)	**Dose** (mg/m^3)	**URF** (m^3/mg)	**RBC** (mg/kg)	C_{air} (mg/m^3)	**Dose** (mg/m^3)	**URF** (m^3/mg)	**RBC** (mg/kg)	**RBC Combined** (mg/kg)
VOC	Benzene	71-43-2	A	1.00E+00	5.59E-09	5.5E-02	3.3E+04			5.5E-02		1.71E-04	3.34E-07	7.8E-03	3.8E+03	1.50E-07	2.94E-10	7.8E-03	4.4E+06	3.4E+03
VOC	Ethyl Benzene	100-41-4	D	1.00E+00	5.59E-09							8.59E-05	1.68E-07			1.50E-07	2.94E-10			
VOC	Toluene	108-88-3	D	1.00E+00	5.59E-09							1.17E-04	2.30E-07			1.50E-07	2.94E-10			
VOC	1,2,4-Trimethylbenzene	95-63-6		1.00E+00	5.59E-09							4.25E-05	8.33E-08			1.50E-07	2.94E-10			
VOC	1,3,5-Trimethylbenzene	108-67-8		1.00E+00	5.59E-09							5.22E-05	1.02E-07			1.50E-07	2.94E-10			
VOC	Xylenes (total)	1330-20-7	ID	1.00E+00	5.59E-09							7.92E-05	1.55E-07			1.50E-07	2.94E-10			
SVOC	2-Methylnaphthalene	91-57-6	ID	1.00E+00	5.59E-09			1.00E-01	1.85E-09			6.36E-06	1.24E-08			1.50E-07	2.94E-10			
SVOC	Naphthalene	91-20-3	C	1.00E+00	5.59E-09			1.30E-01	2.40E-09			8.40E-06	1.64E-08			1.50E-07	2.94E-10			

Notes:

Criteria are based on a target cancer risk level of 1E-05.

Only chemicals detected in NAPL Area 1 are shown.

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Attachment C.3: Risk Based NonCancer Criteria for Small Scale Construction Worker Exposures to Smear Zone Soil
GMC Pontiac Centerpoint Building 33, Pontiac, MI

				Smear Zone Soil Ingestion				Smear Zone Soil Dermal Contact				Smear Zone Soil Vapor Inhalation				Smear Zone Soil Particulate Inhalation				
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**C_{soil}** (mg/kg)	**ADD** (mg/kg/d)	**RfD_{oral}** (mg/kg/d)	**RBC** (mg/kg)	**AF_{derm}**	**ADD** (mg/kg/d)	**RfD_{derm}** (mg/kg/d)	**RBC** (mg/kg)	**C_{air}** (mg/m^3)	**Dose** (mg/m^3)	**RfC** (mg/m^3)	**RBC** (mg/kg)	**C_{air}** (mg/m^3)	**Dose** (mg/m^3)	**RfC** (mg/m^3)	**RBC** (mg/kg)	**RBC Combined** (mg/kg)
VOC	Benzene	71-43-2	A	1.00E+00	3.91E-08	4.0E-03	1.02E+05			4.0E-03		1.71E-04	2.34E-06	3.0E-02	1.28E+04	1.50E-07	2.05E-09	3.0E-02	1.46E+07	1.14E+04
VOC	Ethyl Benzene	100-41-4	D	1.00E+00	3.91E-08	1.0E-01	2.56E+06			1.0E-01		8.59E-05	1.18E-06	1.0E+00	8.50E+05	1.50E-07	2.05E-09	1.0E+00	4.87E+08	6.37E+05
VOC	Toluene	108-88-3	D	1.00E+00	3.91E-08	2.0E-01	5.11E+06			2.0E-01		1.17E-04	1.61E-06	4.0E-01	2.49E+05	1.50E-07	2.05E-09	4.0E-01	1.95E+08	2.37E+05
VOC	1,2,4-Trimethylbenzene	95-63-6		1.00E+00	3.91E-08	5.0E-02	1.28E+06			5.0E-02		4.25E-05	5.83E-07	6.0E-03	1.02E+04	1.50E-07	2.05E-09	6.0E-03	2.90E+06	1.01E+04
VOC	1,3,5-Trimethylbenzene	108-67-8		1.00E+00	3.91E-08	5.0E-02	1.28E+06			5.0E-02		5.22E-05	7.14E-07	6.0E-03	8.33E+03	1.50E-07	2.05E-09	6.0E-03	2.90E+06	8.25E+03
VOC	Xylenes (total)	1330-20-7	ID	1.00E+00	3.91E-08	2.0E-01	5.11E+06			2.0E-01		7.92E-05	1.08E-06	1.0E-01	9.22E+04	1.50E-07	2.05E-09	1.0E-01	4.87E+07	9.04E+04
SVOC	2-Methylnaphthalene	91-57-6	ID	1.00E+00	3.91E-08	4.0E-03	1.02E+05	1.00E-01	1.29E-08	4.0E-03	3.10E+05	6.36E-06	8.71E-08	3.0E-03	3.44E+04	1.50E-07	2.05E-09	3.0E-03	1.46E+06	2.34E+04
SVOC	Naphthalene	91-20-3	C	1.00E+00	3.91E-08	2.0E-02	5.11E+05	1.30E-01	1.68E-08	2.0E-02	1.19E+06	8.40E-06	1.15E-07	3.0E-03	2.61E+04	1.50E-07	2.05E-09	3.0E-03	1.46E+06	2.39E+04

Notes:

Criteria are based on a target hazard quotient of 1.

Only chemicals detected in NAPL Area 1 are shown.

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Attachment C.3: Risk Based Cancer Criteria for Small Scale Construction Worker Exposures to Groundwater in Excavations
GMC Pontiac Centerpoint Building 33, Pontiac, MI

				Incidental Ingestion				Dermal Contact					Vapor Inhalation				
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**C_{gw}[1] (mg/L)**	**LADD (mg/kg/d)**	**SF_{oral} (mg/kg/d)$^{-1}$**	**RBC (mg/L)**	**C_{gw}[2] (mg/L)**	**DA (L/cm^2)**	**LADD (mg/kg/d)**	**SF_{derm} (mg/kg/d)$^{-1}$**	**RBC (mg/L)**	**C_{air} (mg/m^3)**	**Dose (mg/m^3)**	**URF (m^3/mg)**	**RBC (mg/L)**	**RBC Combined (mg/L)**
VOC	Benzene	71-43-2	A	1.0E+00	2.8E-07	5.5E-02	6.5E+02	1.0E+00	3.7E-05	6.8E-06	5.5E-02	2.7E+01	1.3E-01	2.6E-04	7.8E-03	5.0E+00	4E+00
VOC	Ethyl Benzene	100-41-4	D	1.0E+00	2.8E-07			1.0E+00	1.3E-04	2.3E-05			1.1E-01	2.2E-04			
VOC	Toluene	108-88-3	D	1.0E+00	2.8E-07			1.0E+00	8.1E-05	1.5E-05			1.2E-01	2.4E-04			
VOC	1,2,4-Trimethylbenzene	95-63-6		1.0E+00	2.8E-07			1.0E+00	2.3E-04	4.3E-05			1.1E-01	2.1E-04			
VOC	1,3,5-Trimethylbenzene	108-67-8		1.0E+00	2.8E-07			1.0E+00	1.7E-04	3.2E-05			1.1E-01	2.1E-04			
VOC	Xylenes (total)	1330-20-7	ID	1.0E+00	2.8E-07			1.0E+00	1.3E-04	2.4E-05			1.1E-01	2.2E-04			
SVOC	2-Methylnaphthalene	91-57-6	ID	1.0E+00	2.8E-07			1.0E+00	2.9E-04	5.3E-05			8.2E-02	1.6E-04			
SVOC	Naphthalene	91-20-3	C	1.0E+00	2.8E-07			1.0E+00	1.5E-04	2.7E-05			8.5E-02	1.7E-04			
Notes:																	
Criteria are based on a target cancer risk level of 1E-05.																	
Only chemicals detected in NAPL Area 1 are shown.																	

Attachment C.3: Risk Based NonCancer Criteria for Small Scale Construction Worker Exposure to Groundwater in Excavations
GMC Pontiac Centerpoint Building 33, Pontiac, MI

				Incidental Ingestion				Dermal Contact					Vapor Inhalation				
Chem Group	**Chemical**	**CASRN**	**Carc Class**	**C_{gw}[1] (mg/L)**	**ADD (mg/kg/d)**	**RfD_{oral} (mg/kg/d)**	**RBC (mg/L)**	**C_{gw}[2] (mg/L)**	**DA (L/cm^2)**	**ADD (mg/kg/d)**	**RfD_{derm} (mg/kg/d)**	**RBC (mg/L)**	**C_{air} (mg/m^3)**	**Dose (mg/m^3)**	**RfC (mg/m^3)**	**RBC (mg/L)**	**RBC Combined (mg/L)**
VOC	Benzene	71-43-2	A	1.0E+00	2.0E-06	4.0E-03	2.0E+03	1.0E+00	3.7E-05	4.8E-05	4.0E-03	8.4E+01	1.3E-01	1.8E-03	3.0E-02	1.7E+01	1.4E+01
VOC	Ethyl Benzene	100-41-4	D	1.0E+00	2.0E-06	1.0E-01	5.1E+04	1.0E+00	1.3E-04	1.6E-04	1.0E-01	6.1E+02	1.1E-01	1.6E-03	1.0E+00	6.4E+02	3.1E+02
VOC	Toluene	108-88-3	D	1.0E+00	2.0E-06	2.0E-01	1.0E+05	1.0E+00	8.1E-05	1.0E-04	2.0E-01	1.9E+03	1.2E-01	1.7E-03	4.0E-01	2.4E+02	2.1E+02
VOC	1,2,4-Trimethylbenzene	95-63-6		1.0E+00	2.0E-06	5.0E-02	2.6E+04	1.0E+00	2.3E-04	3.0E-04	5.0E-02	1.7E+02	1.1E-01	1.5E-03	6.0E-03	4.1E+00	4.0E+00
VOC	1,3,5-Trimethylbenzene	108-67-8		1.0E+00	2.0E-06	5.0E-02	2.6E+04	1.0E+00	1.7E-04	2.2E-04	5.0E-02	2.3E+02	1.1E-01	1.5E-03	6.0E-03	4.1E+00	4.0E+00
VOC	Xylenes (total)	1330-20-7	ID	1.0E+00	2.0E-06	2.0E-01	1.0E+05	1.0E+00	1.3E-04	1.7E-04	2.0E-01	1.2E+03	1.1E-01	1.5E-03	1.0E-01	6.5E+01	6.1E+01
SVOC	2-Methylnaphthalene	91-57-6	ID	1.0E+00	2.0E-06	4.0E-03	2.0E+03	1.0E+00	2.9E-04	3.7E-04	4.0E-03	1.1E+01	8.2E-02	1.1E-03	3.0E-03	2.7E+00	2.1E+00
SVOC	Naphthalene	91-20-3	C	1.0E+00	2.0E-06	2.0E-02	1.0E+04	1.0E+00	1.5E-04	1.9E-04	2.0E-02	1.0E+02	8.5E-02	1.2E-03	3.0E-03	2.6E+00	2.5E+00
Notes:																	
Criteria are based on a target hazard quotient of 1.																	
Only chemicals detected in NAPL Area 1 are shown.																	

Attachment C.3: Risk Based Criteria for Small Scale Construction Worker Exposures
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	Smear Zone Soil			Groundwater		
			RBC - Cancer (mg/kg)	RBC - NonCancer (mg/kg)	RBC - Combined (mg/kg)	RBC - Cancer (mg/L)	RBC - NonCancer (mg/L)	RBC - Combined (mg/L)
VOC	Benzene	71-43-2	3.43E+03	1.14E+04	3.43E+03	4.18E+00	1.38E+01	4.18E+00
VOC	Ethyl Benzene	100-41-4		6.37E+05	6.37E+05		3.11E+02	3.11E+02
VOC	Toluene	108-88-3		2.37E+05	2.37E+05		2.13E+02	2.13E+02
VOC	1,2,4-Trimethylbenzene	95-63-6		1.01E+04	1.01E+04		4.00E+00	4.00E+00
VOC	1,3,5-Trimethylbenzene	108-67-8		8.25E+03	8.25E+03		4.02E+00	4.02E+00
VOC	Xylenes (total)	1330-20-7		9.04E+04	9.04E+04		6.11E+01	6.11E+01
SVOC	2-Methylnaphthalene	91-57-6		2.34E+04	2.34E+04		2.14E+00	2.14E+00
SVOC	Naphthalene	91-20-3		2.39E+04	2.39E+04		2.52E+00	2.52E+00
Note:								
Criteria are based on a cancer risk level (CRL) of 1E-05 and a hazard quotient (HQ) of 1.								
Only chemicals detected in NAPL Area 1 are shown.								

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Attachment C.3: Cleanup Criteria Summary
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	Smear Zone Soil RBC - Combined (1E-5 and 1) (mg/kg)	Basis		LEL (%)	Ratio of Air Conc to LEL		GW RBC - Combined (1E-5 and 1) (mg/L)	Basis		Air Conc Resulting from RBC (%)	LEL (%)	Ratio of Air Conc to LEL
VOC	Benzene	71-43-2	8.3E+01	VI		1.2%	5.0E-01		4.2E+00	SSCW		0.01%	1.2%	1.2E-02
VOC	Ethyl Benzene	100-41-4	7.9E+04	VI		0.8%	1.6E+02		3.1E+02	SSCW		1.2%	0.8%	1.4E+00
VOC	Toluene	108-88-3	1.9E+04	VI		1.1%	5.2E+01		2.1E+02	SSCW		0.8%	1.1%	7.0E-01
VOC	1,2,4-Trimethylbenzene	95-63-6	1.5E+03	VI		0.9%	7.3E-01		4.0E+00	SSCW		0.01%	0.9%	1.0E-02
VOC	1,3,5-Trimethylbenzene	108-67-8	1.0E+03	VI		0.9%	7.3E-01		4.0E+00	SSCW		0.01%	0.9%	1.1E-02
VOC	Xylenes (total)	1330-20-7	9.6E+03	VI		0.9%	1.4E+01		6.1E+01	SSCW		0.2%	0.9%	2.2E-01
SVOC	2-Methylnaphthalene	91-57-6	2.3E+04	SSCW		0.9%	1.3E-01		2.1E+00	SSCW		0.0004%	0.9%	4.3E-04
SVOC	Naphthalene	91-20-3	2.0E+04	VI		0.9%	3.4E-01		2.5E+00	SSCW		0.0005%	0.9%	5.3E-04
Notes:														
Criteria are based on a cancer risk level (CRL) of 1E-5 and a hazard quotient (HQ) of 1.														
VI = Indoor Air Vapor Inhalation														
SSCW = Small Scale Construction Worker														

ATTACHMENT C.4:
Calculations for Vapor Intrusion from LNAPL Area #2

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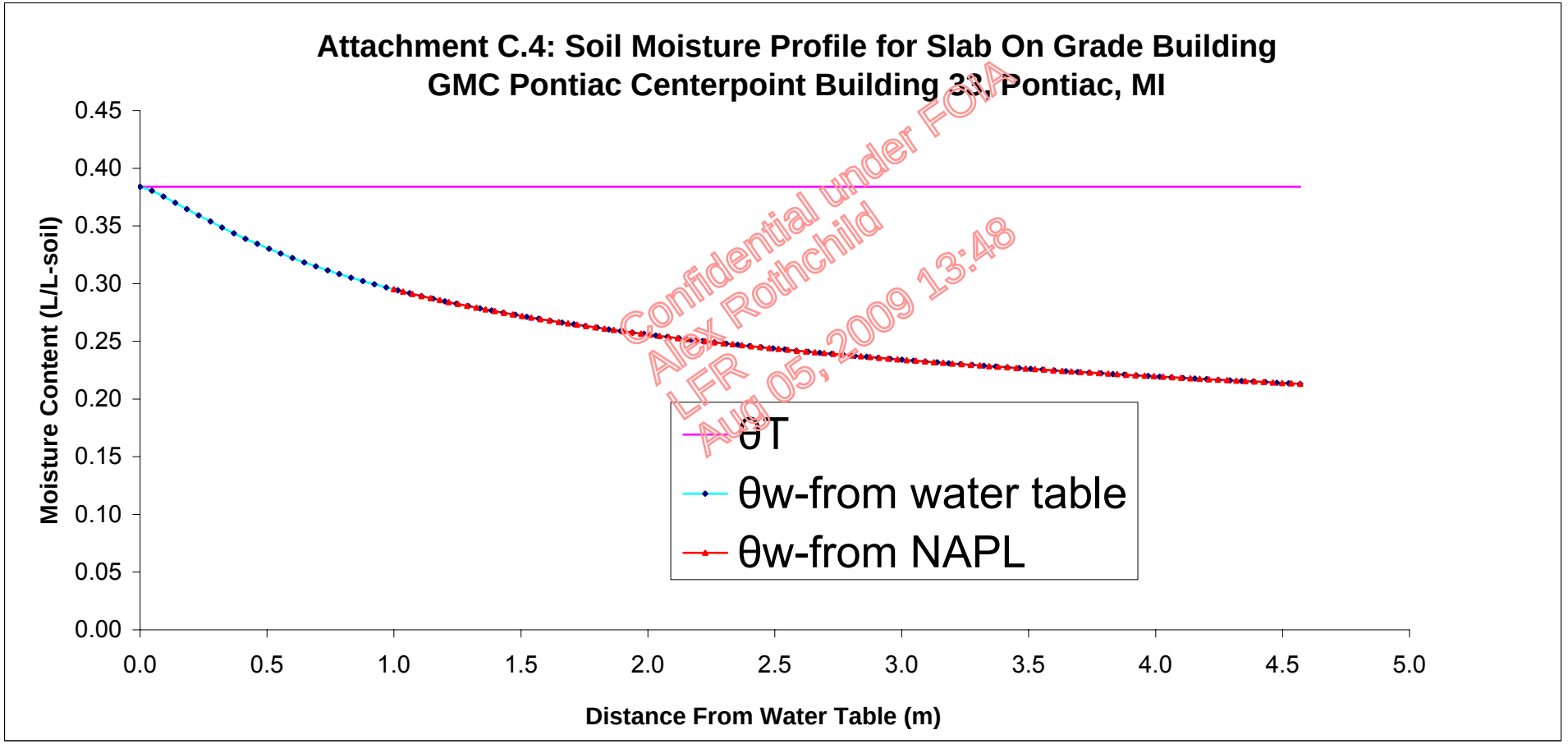

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Attachment C.4: Concentrations of Chemicals in LNAPL and Smear Zone Soil GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	Smear Zone Soil Conc (mg/kg)	LNAPL Conc (mg/kg)
VOC	Cumene	98-82-8	1.47E-01	7.10E-01
VOC	Ethyl Benzene	100-41-4	1.58E-01	7.60E-01
VOC	Methylcyclohexane	108-87-2	2.49E-02	1.20E-01
VOC	Tetrachloroethene	127-18-4	6.43E-02	3.10E-01
VOC	Toluene	108-88-3	7.88E-02	3.80E-01
VOC	Xylenes (total)	1330-20-7	6.43E-01	3.10E+00
P/PCB	PCBs (total)	1336-36-3	5.18E-02	2.50E-01
INORG	Antimony	7440-36-0	7.88E-02	3.80E-01
INORG	Barium	7440-39-3	9.12E-01	4.40E+00
INORG	Cadmium	7440-43-9	1.49E-02	7.20E-02
INORG	Cobalt	7440-48-4	2.07E-02	1.00E-01
INORG	Copper	7440-50-8	1.66E+00	8.00E+00
INORG	Lead	7439-92-1	1.29E+00	6.20E+00
INORG	Manganese	7439-96-5	9.33E-02	4.50E-01
INORG	Nickel	7440-02-0	3.11E-01	1.50E+00
INORG	Silver	7440-22-4	3.52E-02	1.70E-01
INORG	Vanadium	7440-62-2	3.52E-02	1.70E-01
INORG	Zinc	7440-66-6	4.56E-01	2.20E+00
	NAPL density	0.9	kg/L	
	Soil bulk density	1.63	kg/L	
	Soil total porosity	0.38		
	NAPL saturation	100%		
	NAPL Molecular Weight	300	g/g mol	
	Notes:			
	Only chemicals detected in NAPL Area 2 are shown.			

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Attachment C.4: Vapor Intrusion into an Industrial Slab On Grade Building from NAPL Area 2
GMC Pontiac Centerpoint Building 33, Pontiac, MI

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_∞ (unitless)
VOC	Cumene	98-82-8	5.62E-01	6.13E-05	2.37E+01	1.02E-02	4.32E-03	1.08E-06
VOC	Ethyl Benzene	100-41-4	6.48E-01	6.74E-05	1.62E-01	0.0118128	0.0050445	1.1E-06
VOC	Methylcyclohexane	108-87-2	6.35E-01	7.36E-05	8.78E+00	1.16E-02	4.89E-03	1.10E-06
VOC	Tetrachloroethene	127-18-4	6.22E-01	7.08E-05	3.77E-01	1.13E-02	4.81E-03	1.10E-06
VOC	Toluene	108-88-3	7.52E-01	7.43E-05	1.36E-01	0.0137054	0.0058598	1.114E-06
VOC	Xylenes (total)	1330-20-7	6.74E-01	7.56E-05	1.38E-01	0.0122846	0.0052589	1.104E-06
P/PCB	PCBs (total)	1336-36-3	6.91E-01	8.64E-05	4.09E-02	1.27E-02	5.59E-03	1.11E-06
INORG	Antimony	7440-36-0						
INORG	Barium	7440-39-3						
INORG	Cadmium	7440-43-9						
INORG	Cobalt	7440-48-4						
INORG	Copper	7440-50-8						
INORG	Lead	7439-92-1						
INORG	Manganese	7439-96-5						
INORG	Nickel	7440-02-0						
INORG	Silver	7440-22-4						
INORG	Vanadium	7440-62-2						
INORG	Zinc	7440-66-6						

Notes:	Soil and Building Characteristics			Crack	Vadose			
	SCS Soil texture class			Sandy Clay Loam	Sandy Clay Loam			
	Bulk density	kg/L	ρ_b	1.63	1.63			
	Total porosity	L/L-soil	θ	0.384	0.384			
	Water-filled porosity	L/L-soil	θ_w	0.215	0.215			
	Air-filled porosity	L/L-soil	θ_a	0.169	0.169			
	Organic carbon fraction	unitless	f_{oc}		0.006			
	Residual saturation	L/L-soil	θ_r	0.0630				
	Hydraulic conductivity	cm/s	K	1.5E-04				
	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	2.0E-09				
	Effective total saturation	unitless	S_{te}	4.7E-01				
	van Genuchten N	unitless	N	1.330				
	van Genuchten M	unitless	M	0.248				
	Relative air permeability	unitless	k_{rg}	0.708				
	Permeability to vapor	cm^2	k_v	1.44E-09				
	Distance from building foundation to source	m	L_T	3.42				
	Bldg foundation thickness	m	L_{crack}	0.15				
	Bldg foundation length	m		19.29				
	Bldg foundation width	m		19.29				
	Bldg occupied height	m		2.44				
	Bldg occupied volume	m^3		907.93				
	Occupied depth below ground	m						
	Bldg area for vapor intrusion	m^2	A_B	372.1				
	Ratio of A_{crack} to A_B			1E-04				
	Area of cracks	m^2	A_{crack}	3.86E-02				
	Air exchange rate	$hour^{-1}$	ac/h	2.0				
	Building ventilation rate	m^3/d	Q_{bldg}	4.36E+04				
	Pressure difference between outdoors-indoors	$kg/m-s^2$	ΔP	1.0				
	Air viscosity	kg/m-s	μ	1.8E-05				
	Crack length (bldg perimeter)	m	X_{crack}	77.16				
	Crack depth below ground	m	Z_{crack}	0.15				
	Crack radius	m	r_{crack}	5E-04				
	Soil gas flow rate into bldg	m^3/d	Q_{soil}	5.26E-02				
	Averaging period	s	T	7.88E+08				

Attachment C.4: Estimated Indoor Air Concentrations from Vapor Intrusion at NAPL Area 2
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	C_{LNAPL} (mg/kg)	VP (mm Hg)	$C_{vapor\text{-}equil}$ (mg/m^3)	α_∞	C_{bldg} ($kg\text{-}soil/m^3$)
VOC	Cumene	98-82-8	7.10E-01	4.50E+00	5.39E-02	1.08E-06	5.85E-08
VOC	Ethyl Benzene	100-41-4	7.60E-01	9.60E+00	1.23E-01	1.10E-06	1.36E-07
VOC	Methylcyclohexane	108-87-2	1.20E-01	4.30E+01	8.71E-02	1.10E-06	9.56E-08
VOC	Tetrachloroethene	127-18-4	3.10E-01	1.86E+01	9.71E-02	1.10E-06	1.06E-07
VOC	Toluene	108-88-3	3.80E-01	2.84E+01	1.82E-01	1.11E-06	2.03E-07
VOC	Xylenes (total)	1330-20-7	3.10E+00	7.99E+00	4.18E-01	1.10E-06	4.62E-07
P/PCB	PCBs (total)	1336-36-3	2.50E-01	7.71E-05	3.25E-07	1.11E-06	3.61E-13
INORG	Antimony	7440-36-0	3.80E-01				
INORG	Barium	7440-39-3	4.40E+00				
INORG	Cadmium	7440-43-9	7.20E-02				
INORG	Cobalt	7440-48-4	1.00E-01				
INORG	Copper	7440-50-8	8.00E+00				
INORG	Lead	7439-92-1	5.20E+00				
INORG	Manganese	7439-96-5	4.50E-01				
INORG	Nickel	7440-02-0	1.50E+00				
INORG	Silver	7440-22-4	1.70E-01				
INORG	Vanadium	7440-62-2	1.70E-01				
INORG	Zinc	7440-66-6	2.20E+00				
Notes:							
Only chemicals detected in NAPL Area 2 are shown.							
	Molecular Weight of NAPL	g/mole	**MW_{LNAPL}**	300			
	Temperature	K	**T**	285			
	Gas Constant	mmHg-m3/mole/K	**R**	0.062361			

Attachment C.4: Risk Based Cancer Criteria for Routine Worker Exposures to Vapors that Migrate into Indoor Air
GMC Pontiac Centerpoint Building 33, Pontiac, MI

					NAPL Vapor Inhalation			
Chem Group	**Chemical**	**CASRN**	**Carc Class**		**C_{air}[3] (mg/m^3)**	**Dose (mg/m^3)**	**URF (m^3/mg)**	**Risk**
VOC	Cumene	98-82-8	D		5.8E-08	1.4E-08		
VOC	Ethyl Benzene	100-41-4	D		1.4E-07	3.3E-08		
VOC	Methylcyclohexane	108-87-2			9.6E-08	2.3E-08		
VOC	Tetrachloroethene	127-18-4	C-B2		1.1E-07	2.6E-08	3.1E-03	8.0E-11
VOC	Toluene	108-88-3	D		2.0E-07	5.0E-08		
VOC	Xylenes (total)	1330-20-7	ID		4.6E-07	1.1E-07		
P/PCB	PCBs (total)	1336-36-3	B2		3.6E-13	8.8E-14	5.7E-01	5.0E-14
INORG	Antimony	7440-36-0						
INORG	Barium	7440-39-3	D					
INORG	Cadmium	7440-43-9	B1				1.8E+00	
INORG	Cobalt	7440-48-4	B1				2.8E+00	
INORG	Copper	7440-50-8	D					
INORG	Lead	7439-92-1	B2					
INORG	Manganese	7439-96-5	D					
INORG	Nickel	7440-02-0	A				2.4E-01	
INORG	Silver	7440-22-4	D					
INORG	Vanadium	7440-62-2						
INORG	Zinc	7440-66-6	D					
Note:								
Only chemicals detected in NAPL Area 2 are shown.								

Attachment C.4: Risk Based NonCancer Criteria for Routine Worker Exposures to Vapors that Migrate into Indoor Air
GMC Pontiac Centerpoint Building 33, Pontiac, MI

					NAPL Vapor Inhalation			
Chem Group	**Chemical**	**CASRN**	**Carc Class**		**C_{air} (mg/m^3)**	**Dose (mg/m^3)**	**RfC (mg/m^3)**	**HQ**
VOC	Cumene	98-82-8	D		5.85E-08	4.01E-08	4.0E-01	1.0E-07
VOC	Ethyl Benzene	100-41-4	D		1.36E-07	9.28E-08	1.0E+00	9.3E-08
VOC	Methylcyclohexane	108-87-2			9.56E-08	6.55E-08	3.0E+00	2.2E-08
VOC	Tetrachloroethene	127-18-4	C-B2		1.06E-07	7.29E-08	4.0E-01	1.8E-07
VOC	Toluene	108-88-3	D		2.03E-07	1.39E-07	4.0E-01	3.5E-07
VOC	Xylenes (total)	1330-20-7	ID		4.62E-07	3.16E-07	1.0E-01	3.2E-06
P/PCB	PCBs (total)	1336-36-3	B2		3.61E-13	2.47E-13		
INORG	Antimony	7440-36-0					1.4E-03	
INORG	Barium	7440-39-3	D					
INORG	Cadmium	7440-43-9	B1				2.0E-04	
INORG	Cobalt	7440-48-4	B1				2.0E-05	
INORG	Copper	7440-50-8	D				1.4E-01	
INORG	Lead	7439-92-1	B2					
INORG	Manganese	7439-96-5	D				5.0E-05	
INORG	Nickel	7440-02-0	A					
INORG	Silver	7440-22-4	D				1.0E-05	
INORG	Vanadium	7440-62-2					3.5E-03	
INORG	Zinc	7440-66-6	D				1.1E+00	
Note:								
Only chemicals detected in NAPL Area 2 are shown.								

ATTACHMENT C.5:
Calculations for Construction Workers Contact with LNAPL and Smear Zone Soil in Excavations at LNAPL Area #2

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Alex Rothchild

LFR

Aug 05, 2009 13:48

Attachment C.5: Nonsteady State Dermal Absorption of Chemical from NAPL Area 2
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	MW (g/mole)	K_{ow} (unitless)	K_p (cm/hr)	FA (unitless)	K_p (cm/hr)	B (unitless)	τ (hr)	c	b	ts (hr)	DA (L/cm^2-event)
VOC	Cumene	98-82-8	1.2E+02	3.1E+03	6.8E-02	1.0E+00	2.2E-05	9.2E-05	5.0E-01	3.3E-01	3.0E-01	1.2E+00	6.51E-08
VOC	Ethyl Benzene	100-41-4	1.1E+02	1.4E+03	4.8E-02	1.0E+00	3.5E-05	1.4E-04	4.1E-01	3.3E-01	3.0E-01	9.9E-01	9.75E-08
VOC	Methylcyclohexane	108-87-2	9.8E+01	9.2E+02	4.0E-02	1.0E+00	4.4E-05	1.7E-04	3.7E-01	3.3E-01	3.0E-01	9.0E-01	1.21E-07
VOC	Tetrachloroethene	127-18-4	1.7E+02	4.7E+02	1.1E-02	1.0E+00	2.3E-05	1.1E-04	8.9E-01	3.3E-01	3.0E-01	2.1E+00	8.53E-08
VOC	Toluene	108-88-3	9.2E+01	5.6E+02	3.2E-02	1.0E+00	5.6E-05	2.1E-04	3.5E-01	3.3E-01	3.0E-01	8.3E-01	1.51E-07
VOC	Xylenes (total)	1330-20-7	1.1E+02	1.5E+03	5.0E-02	1.0E+00	3.4E-05	1.3E-04	4.1E-01	3.3E-01	3.0E-01	9.9E-01	9.55E-08
P/PCB	PCBs (total)	1336-36-3	3.3E+02	3.2E+06	4.5E-01	7.0E-01	1.4E-07	9.9E-07	7.2E+00	3.3E-01	3.0E-01	1.7E+01	1.05E-09
INORG	Antimony	7440-36-0	1.2E+02		1.0E-03		1.0E-03		5.1E-01	3.3E-01	3.0E-01	1.2E+00	2.00E-06
INORG	Barium	7440-39-3	1.4E+02		1.0E-03		1.0E-03		6.2E-01	3.3E-01	3.0E-01	1.5E+00	2.00E-06
INORG	Cadmium	7440-43-9	1.1E+02		1.0E-03		1.0E-03		4.5E-01	3.3E-01	3.0E-01	1.1E+00	2.00E-06
INORG	Cobalt	7440-48-4	5.9E+01		4.0E-04		4.0E-04		2.2E-01	3.3E-01	3.0E-01	5.4E-01	8.00E-07
INORG	Copper	7440-50-8	6.4E+01		1.0E-03		1.0E-03		2.4E-01	3.3E-01	3.0E-01	5.7E-01	2.00E-06
INORG	Lead	7439-92-1	2.1E+02		1.0E-04		1.0E-04		1.5E+00	3.3E-01	3.0E-01	3.7E+00	2.00E-07
INORG	Manganese	7439-96-5	5.5E+01		1.0E-03		1.0E-03		2.1E-01	3.3E-01	3.0E-01	5.1E-01	2.00E-06
INORG	Nickel	7440-02-0	5.9E+01		2.0E-04		2.0E-04		2.2E-01	3.3E-01	3.0E-01	5.4E-01	4.00E-07
INORG	Silver	7440-22-4	1.1E+02		6.0E-04		6.0E-04		4.2E-01	3.3E-01	3.0E-01	1.0E+00	1.20E-06
INORG	Vanadium	7440-62-2	5.1E+01		1.0E-03		1.0E-03		2.0E-01	3.3E-01	3.0E-01	4.9E-01	2.00E-06
INORG	Zinc	7440-66-6	6.5E+01		6.0E-04		6.0E-04		2.4E-01	3.3E-01	3.0E-01	5.9E-01	1.20E-06
	Note:												
	Event Time	hours	**t**										
	K_p divided by the K_{ow} of organics in NAPL (USEPA 1992)												
	K_p capped at 1 cm/hr (USEPA 1992)												
	Only chemicals detected in NAPL Area 2 are shown.												

Attachment C.5: Vapor Flux (mg/m2-s per mg/kg) from Smear Zone Soil at NAPL Area 2 to Ambient Air
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	K_{oc} (L/kg)	K_d (L/kg)	H (unitless)	D_{air} (m^2/d)	D_{water} (m^2/d)	R_L (unitless)	D_{eff} (m^2/d)	D_{eff} (m^2/d)	D_{eff} (m^2/d)	J_G (kg/m^2-s)	MW (g/mole)	VP (mm Hg)	s (mg/L)	v* (mg/L)	C_{sat} (mg/kg)	C_{soil} (mg/kg)	J_{sat} (mg/m^2-s)	J_{unsat} (mg/m^2-s)	$J_{critical}$ (mg/m^2-s)	J (mg/m^2-s)
VOC	Cumene	98-82-8	7.05E+02		2.37E+01	5.62E-01	6.13E-05	1.11E+01	1.02E-02	2.46E-06	2.18E-02	5.20E-05	1.20E+02	4.50E+00	6.13E+01	3.04E+01	2.71E+02	1.47E-01		7.66E-06	1.41E-02	7.66E-06
VOC	Ethyl Benzene	100-41-4	3.67E+02		1.62E-01	6.48E-01	6.74E-05	3.83E+00	1.18E-02	2.71E-06	4.98E-04	7.86E-06	1.06E+02	9.60E+00	1.69E+02	5.73E+01	3.97E+02	1.58E-01		1.24E-06	3.12E-03	1.24E-06
VOC	Methylcyclohexane	108-87-2	2.66E+02		8.78E+00	6.35E-01	7.36E-05	4.31E+00	1.16E-02	2.96E-06	2.36E-02	5.41E-05	9.82E+01	4.30E+01	1.40E+01	2.37E+02	3.70E+01	2.49E-02		1.35E-06	2.00E-03	1.35E-06
VOC	Tetrachloroethene	127-18-4	1.56E+02		3.77E-01	6.22E-01	7.08E-05	1.80E+00	1.13E-02	2.85E-06	2.37E-03	1.72E-05	1.66E+02	1.86E+01	2.00E+02	1.73E+02	2.21E+02	6.43E-02		1.10E-06	3.80E-03	1.10E-06
VOC	Toluene	108-88-3	1.80E+02		1.36E-01	7.52E-01	7.43E-05	2.00E+00	1.37E-02	2.99E-06	9.32E-04	1.08E-05	9.21E+01	2.84E+01	5.26E+02	1.47E+02	6.46E+02	7.88E-02		8.47E-07	6.95E-03	8.47E-07
VOC	Xylenes (total)	1330-20-7	3.86E+02		1.38E-01	6.74E-01	7.56E-05	4.01E+00	1.23E-02	3.04E-06	4.23E-04	7.25E-06	1.06E+02	7.99E+00	1.75E+02	4.77E+01	4.30E+02	6.43E-01		4.66E-06	3.11E-03	4.66E-06
P/PCB	PCBs (total)	1336-36-3	2.45E+06		4.09E-02	6.91E-01	8.64E-05	2.40E+04	1.26E-02	3.47E-06	2.16E-08	5.18E-08	3.28E+02	7.71E-05	1.20E-02	1.42E-03	1.77E+02	5.18E-02		2.68E-09	9.14E-06	2.68E-09
INORG	Antimony	7440-36-0		4.50E+01									1.22E+02					7.88E-02				
INORG	Barium	7440-39-3		4.10E+01									1.37E+02					9.12E-01				
INORG	Cadmium	7440-43-9		7.50E+01									1.12E+02					1.49E-02				
INORG	Cobalt	7440-48-4		4.50E+01									5.89E+01					2.07E-02				
INORG	Copper	7440-50-8		3.50E+01									6.35E+01					1.66E+00				
INORG	Lead	7439-92-1		9.00E+02									2.07E+02					1.29E+00				
INORG	Manganese	7439-96-5		6.50E+01									5.49E+01					9.33E-02				
INORG	Nickel	7440-02-0		6.50E+01									5.87E+01					3.11E-01				
INORG	Silver	7440-22-4		8.30E+00									1.08E+02					3.52E-02				
INORG	Vanadium	7440-62-2		1.00E+03									5.09E+01					3.52E-02				
INORG	Zinc	7440-66-6		6.20E+01									6.54E+01					4.56E-01				
Notes:	Soil bulk density	kg/L	ρ_b	1.63	*EPA default/MDEQ 1998*																	
	Soil particle density	kg/L	ρ_s	2.65	*EPA default/MDEQ 1998*																	
	Soil porosity	L/L-soil	θ	0.38	*1-(pb/ps)*																	
	Soil water content	L/L-soil	θ_w	0.215																		
	Soil air-filled porosity	L/L-soil	θ_a	0.169	*porosity-water content*																	
	Soil organic carbon fraction	unitless	f_{oc}	0.006																		
	Averaging period	year	ED	10																		
		s	ED	3.2E+08																		
	Molar Gas Constant	mmHg/mole-	R	62.411																		
	Temperature	°C	T	12																		
		K	T	285																		

Attachment C.5: Estimated Ambient Air Concentration from Excavation Into Smear Zone Soil at NAPL Area 2
GMC Pontiac Centerpoint Building 33, Pontiac, MI

Chem Group	Chemical	CASRN	C_{NAPL} (mg/kg)	MW (g/mole)	VP (mm Hg)	D_{air} (cm^2/s)	K_{eq} (unitless)	Sc	k_G (m/s)	K (m/s)	J_L (mg/m^2-s)	$C_{air, worker}$ (mg/m^3)
VOC	Cumene	98-82-8	7.10E-01	1.20E+02	4.50E+00	6.50E-02	9.04E-05	2.15E+00	1.40E-03	1.27E-07	7.94E-05	8.70E-04
VOC	Ethyl Benzene	100-41-4	7.60E-01	1.06E+02	9.60E+00	7.50E-02	1.93E-04	1.86E+00	1.55E-03	2.98E-07	1.99E-04	2.19E-03
VOC	Methylcyclohexane	108-87-2	1.20E-01	9.82E+01	4.30E+01	7.35E-02	8.64E-04	1.90E+00	1.53E-03	1.32E-06	1.39E-04	1.53E-03
VOC	Tetrachloroethene	127-18-4	3.10E-01	1.66E+02	1.86E+01	7.20E-02	3.73E-04	1.94E+00	1.50E-03	5.61E-07	1.53E-04	1.68E-03
VOC	Toluene	108-88-3	3.80E-01	9.21E+01	2.84E+01	8.70E-02	5.71E-04	1.60E+00	1.71E-03	9.74E-07	3.26E-04	3.57E-03
VOC	Xylenes (total)	1330-20-7	3.10E+00	1.06E+02	7.99E+00	7.80E-02	1.60E-04	1.79E+00	1.59E-03	2.55E-07	6.95E-04	7.61E-03
P/PCB	PCBs (total)	1336-36-3	2.50E-01	3.28E+02	7.71E-05	8.00E-02	1.55E-09	1.74E+00	1.61E-03	2.50E-12	5.50E-10	6.03E-09
INORG	Antimony	7440-36-0	3.80E-01	1.22E+02								
INORG	Barium	7440-39-3	4.40E+00	1.37E+02								
INORG	Cadmium	7440-43-9	7.20E-02	1.12E+02								
INORG	Cobalt	7440-48-4	1.00E-01	5.89E+01								
INORG	Copper	7440-50-8	8.00E+00	6.35E+01								
INORG	Lead	7439-92-1	6.20E+00	2.07E+02								
INORG	Manganese	7439-96-5	4.50E-01	5.49E+01								
INORG	Nickel	7440-02-0	1.50E+00	5.87E+01								
INORG	Silver	7440-22-4	1.70E-01	1.08E+02								
INORG	Vanadium	7440-62-2	1.70E-01	5.09E+01								
INORG	Zinc	7440-66-6	2.20E+00	6.54E+01								
Notes:												
Physical Properties of Air												
	Pressure	1	atm	assumed								
	Molecular Weight	28.8	g/g mol	Perry and Chilton (1973)								
	Viscosity	1.80E-04	g/(cm.s)	Perry and Chilton (1973)								
	Density	0.00129	g/cm^3	Perry and Chilton (1973)								
Physical Properties of NAPL												
	Molecular Weight	300	g/g mol									
	Density	0.88	g/cm^3									
Physical Characteristics of Excavation Pit												
	Windspeed	0.5	m/s	assumed								
	Surface Area	2.1E+01	m^2									
	Effective Diameter of Area	5.2E+00	m	calculated								

Attachment C.5: Concentrations in Ambient Air from Smear Zone Soil at NAPL Area 2
GMC Pontiac Centerpoint Building 33, Pontiac, MI

			Vapor	
	C/Q (kg/m^3 per kg/m^2-s)**:**		10.96	
Chem Chem	**Chemical**	**CASRN**	**C_{soil}** (mg/kg)	**C_{air}** (mg/m^3)
VOC	Cumene	98-82-8	1.47E-01	8.39E-05
VOC	Ethyl Benzene	100-41-4	1.58E-01	1.36E-05
VOC	Methylcyclohexane	108-87-2	2.49E-02	1.48E-05
VOC	Tetrachloroethene	127-18-4	6.43E-02	1.21E-05
VOC	Toluene	108-88-3	7.88E-02	9.29E-06
VOC	Xylenes (total)	1330-20-7	6.43E-01	5.10E-05
P/PCB	PCBs (total)	1336-36-3	5.18E-02	2.94E-08
INORG	Antimony	7440-36-0	7.88E-02	
INORG	Barium	7440-39-3	9.12E-01	
INORG	Cadmium	7440-43-9	1.49E-02	
INORG	Cobalt	7440-48-4	2.07E-02	
INORG	Copper	7440-50-8	1.66E+00	
INORG	Lead	7439-92-1	1.29E+00	
INORG	Manganese	7439-96-5	9.33E-02	
INORG	Nickel	7440-02-0	3.11E-01	
INORG	Silver	7440-22-4	3.52E-02	
INORG	Vanadium	7440-62-2	3.52E-02	
INORG	Zinc	7440-66-6	4.56E-01	
Notes:				
Only chemicals detected in NAPL Area 2 are shown.				

Attachment C.5: Risk Based Cancer Criteria for Construction Worker Exposures to NAPL Area 2 and Smear Zone Soil in Excavations
GMC Pontiac Centerpoint Building 33, Pontiac, MI

				Smear Zone Soil Ingestion				Smear Zone Soil Dermal Contact				Smear Zone Soil Vapor Inhalation				NAPL Dermal Contact					NAPL Vapor Inhalation				
Chem Group	Chemical	CASRN	Carc Class	C_{soil}[1] (mg/kg)	LADD (mg/kg/d)	SF_{oral} (mg/kg/d)$^{-1}$	Risk	ABS_d	LADD (mg/kg/d)	SF_{oral} (mg/kg/d)$^{-1}$	Risk	C_{air} (mg/m^3)	Dose (mg/m^3)	URF (m^3/mg)	Risk	C_{NAPL}[2] (mg/L)	DA (L/cm^2)	LADD (mg/kg/d)	SF_{derm} (mg/kg/d)$^{-1}$	Risk	C_{air}[3] (mg/m^3)	Dose (mg/m^3)	URF (m^3/mg)	Risk	Risk Across Routes
VOC	Cumene	98-82-8	D	1.5E-01	8.2E-10							8.4E-05	1.6E-07			6.2E-01	6.5E-08	3.8E-09			8.7E-04	1.7E-06			
VOC	Ethyl Benzene	100-41-4	D	1.6E-01	8.8E-10							1.4E-05	2.7E-08			6.7E-01	9.8E-08	6.0E-09			2.2E-03	4.3E-06			
VOC	Methylcyclohexane	108-87-2		2.5E-02	1.4E-10							1.5E-05	2.9E-08			1.1E-01	1.2E-07	1.2E-09			1.5E-03	3.0E-06			
VOC	Tetrachloroethene	127-18-4	C-B2	6.4E-02	3.6E-10	5.2E-02	1.9E-11			5.2E-02		1.2E-05	2.4E-08	3.1E-03	7.2E-11	2.7E-01	8.5E-08	2.1E-09	5.2E-02	1.1E-10	1.7E-03	3.3E-06	3.1E-03	1.0E-08	1.0E-08
VOC	Toluene	108-88-3	D	7.9E-02	4.4E-10							9.3E-06	1.8E-08			3.3E-01	1.5E-07	4.7E-09			3.6E-03	7.0E-06			
VOC	Xylenes (total)	1330-20-7	ID	6.4E-01	3.6E-09							5.1E-05	1.0E-07			2.7E+00	9.6E-08	2.4E-08			7.6E-03	1.5E-05			
P/PCB	PCBs (total)	1336-36-3	B2	5.2E-02	2.9E-10	2.0E+00	5.8E-10	1.4E-01	1.3E-10	2.0E+00	2.7E-10	2.9E-08	5.8E-11	5.7E-01	3.3E-11	2.2E-01	1.0E-09	2.1E-11	2.0E+00	4.2E-11	6.0E-09	1.2E-11	5.7E-01	6.7E-12	9.3E-10
INORG	Antimony	7440-36-0		7.9E-02	4.4E-10											3.3E-01	2.0E-06	6.2E-08							
INORG	Barium	7440-39-3	D	9.1E-01	5.1E-09											3.9E+00	2.0E-06	7.1E-07							
INORG	Cadmium	7440-43-9	B1	1.5E-02	8.3E-11			1.0E-03	2.8E-13					1.8E+00		6.3E-02	2.0E-06	1.2E-08					1.8E+00		
INORG	Cobalt	7440-48-4	B1	2.1E-02	1.2E-10									2.8E+00		8.8E-02	8.0E-07	6.5E-09					2.8E+00		
INORG	Copper	7440-50-8	D	1.7E+00	9.3E-09											7.0E+00	2.0E-06	1.3E-06							
INORG	Lead	7439-92-1	B2	1.3E+00	7.2E-09											5.5E+00	2.0E-07	1.0E-07							
INORG	Manganese	7439-96-5	D	9.3E-02	5.2E-10											4.0E-01	2.0E-06	7.3E-08							
INORG	Nickel	7440-02-0	A	3.1E-01	1.7E-09									2.4E-01		1.3E+00	4.0E-07	4.9E-08					2.4E-01		
INORG	Silver	7440-22-4	D	3.5E-02	2.0E-10											1.5E-01	1.2E-06	1.7E-08							
INORG	Vanadium	7440-62-2		3.5E-02	2.0E-10											1.5E-01	2.0E-06	2.8E-08							
INORG	Zinc	7440-66-6	D	4.6E-01	2.6E-09											1.9E+00	1.2E-06	2.1E-07							

Notes:
1. Smear zone soil is conservatively assumed to be 100% saturated with NAPL.
2. Based on NAPL specific gravity of 0.88.
3. Estimated based on Raoult's law with conservatively assumed NAPL molecular weight of 300 g/mole.

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Attachment C.5: Risk Based NonCancer Criteria for Construction Worker Exposures to NAPL Area 2 and Smear Zone Soil in Excavations
GMC Pontiac Centerpoint Building 33, Pontiac, MI

				Smear Zone Soil Ingestion				Smear Zone Soil Dermal Contact				Smear Zone Soil Vapor Inhalation				NAPL Dermal Contact					NAPL Vapor Inhalation				
Chem Group	Chemical	CASRN	Carc Class	C_{soil}[1] (mg/kg)	ADD (mg/kg/d)	RfD_{oral} (mg/kg/d)	HQ	AF_{derm}	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	HQ	C_{air} (mg/m^3)	Dose (mg/m^3)	RfC (mg/m^3)	HQ	C_{NAPL}[2] (mg/L)	DA (L/cm^2)	ADD (mg/kg/d)	RfD_{derm} (mg/kg/d)	HQ	C_{air}[3] (mg/m^3)	Dose (mg/m^3)	RfC (mg/m^3)	HQ	HI
VOC	Cumene	98-82-8	D	1.47E-01	5.76E-09	1.0E-01	5.8E-08			1.0E-01		8.4E-05	1.1E-06	4.0E-01	2.9E-06	6.25E-01	6.51E-08	2.63E-08	1.0E-01	2.6E-07	8.70E-04	1.19E-05	4.0E-01	3.0E-05	3.3E-05
VOC	Ethyl Benzene	100-41-4	D	1.58E-01	6.17E-09	1.0E-01	6.2E-08			1.0E-01		1.4E-05	1.9E-07	1.0E+00	1.9E-07	6.69E-01	9.75E-08	4.21E-08	1.0E-01	4.2E-07	2.19E-03	2.99E-05	1.0E+00	3.0E-05	3.1E-05
VOC	Methylcyclohexane	108-87-2		2.49E-02	9.74E-10							1.5E-05	2.0E-07	3.0E+00	6.7E-08	1.06E-01	1.21E-07	8.22E-09			1.53E-03	2.09E-05	3.0E+00	7.0E-06	7.0E-06
VOC	Tetrachloroethene	127-18-4	C-B2	6.43E-02	2.52E-09	1.0E-02	2.5E-07			1.0E-02		1.2E-05	1.7E-07	4.0E-01	4.1E-07	2.73E-01	8.53E-08	1.50E-08	1.0E-02	1.5E-06	1.68E-03	2.30E-05	4.0E-01	5.7E-05	6.0E-05
VOC	Toluene	108-88-3	D	7.88E-02	3.08E-09	2.0E-01	1.5E-08			2.0E-01		9.3E-06	1.3E-07	4.0E-01	3.2E-07	3.34E-01	1.51E-07	3.26E-08	2.0E-01	1.6E-07	3.57E-03	4.89E-05	4.0E-01	1.2E-04	1.2E-04
VOC	Xylenes (total)	1330-20-7	ID	6.43E-01	2.52E-08	2.0E-01	1.3E-07			2.0E-01		5.1E-05	7.0E-07	1.0E-01	7.0E-06	2.73E+00	9.55E-08	1.68E-07	2.0E-01	8.4E-07	7.61E-03	1.04E-04	1.0E-01	1.0E-03	1.1E-03
P/PCB	PCBs (total)	1336-36-3	B2	5.18E-02	2.03E-09	2.0E-05	1.0E-04	1.4E-01	9.37E-10	2.0E-05	4.7E-05	2.9E-08	4.0E-10			2.20E-01	1.05E-09	1.49E-10	2.0E-05	7.4E-06	6.03E-09	8.26E-11			1.6E-04
INORG	Antimony	7440-36-0		7.88E-02	3.08E-09	4.0E-04	7.7E-06			6.0E-05				1.4E-03		3.34E-01	2.00E-06	4.32E-07	6.0E-05	7.2E-03			1.4E-03		7.2E-03
INORG	Barium	7440-39-3	D	9.12E-01	3.57E-08	7.0E-02	5.1E-07			4.9E-03						3.87E+00	2.00E-06	5.00E-06	4.9E-03	1.0E-03					1.0E-03
INORG	Cadmium	7440-43-9	B1	1.49E-02	5.84E-10	1.0E-03	5.8E-07	1.0E-03	1.93E-12	2.5E-05	7.7E-08			2.0E-04		6.34E-02	2.00E-06	8.18E-08	2.5E-05	3.3E-03			2.0E-04		3.3E-03
INORG	Cobalt	7440-48-4	B1	2.07E-02	8.11E-10	2.0E-02	4.1E-08			2.0E-02				2.0E-05		8.80E-02	8.00E-07	4.55E-08	2.0E-02	2.3E-06			2.0E-05		2.3E-06
INORG	Copper	7440-50-8	D	1.66E+00	6.49E-08	4.0E-02	1.6E-06			4.0E-02				1.4E-01		7.04E+00	2.00E-06	9.09E-06	4.0E-02	2.3E-04			1.4E-01		2.3E-04
INORG	Lead	7439-92-1	B2	1.29E+00	5.03E-08											5.46E+00	2.00E-07	7.05E-07							
INORG	Manganese	7439-96-5	D	9.33E-02	3.65E-09	1.4E-01	2.6E-08			8.4E-03				5.0E-05		3.96E-01	2.00E-06	5.11E-07	8.4E-03	6.1E-05			5.0E-05		6.1E-05
INORG	Nickel	7440-02-0	A	3.11E-01	1.22E-08	2.0E-02	6.1E-07			8.0E-04						1.32E+00	4.00E-07	3.41E-07	8.0E-04	4.3E-04					4.3E-04
INORG	Silver	7440-22-4	D	3.52E-02	1.38E-09	5.0E-03	2.8E-07			2.0E-04				1.0E-05		1.50E-01	1.20E-06	1.16E-07	2.0E-04	5.8E-04			1.0E-05		5.8E-04
INORG	Vanadium	7440-62-2		3.52E-02	1.38E-09	1.0E-03	1.4E-06			2.6E-05				3.5E-03		1.50E-01	2.00E-06	1.93E-07	2.6E-05	7.4E-03			3.5E-03		7.4E-03
INORG	Zinc	7440-66-6	D	4.56E-01	1.79E-08	3.0E-01	6.0E-08			3.0E-01				1.1E+00		1.94E+00	1.20E-06	1.50E-06	3.0E-01	5.0E-06			1.1E+00		5.1E-06

Notes:

1. Smear zone soil is conservatively assumed to be 100% saturated with NAPL.
2. Based on NAPL specific gravity of 0.88.
3. Estimated based on Raoult's law with conservatively assumed NAPL molecular weight of 300 g/mole.

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APPENDIX D

RISK CALCULATIONS FOR CONTAINER STORAGE AREA (SWMU #3 / AOI #74)

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Attachment D: Bounding Residential Risk Estimates for Soil at AOI 74
GMC Pontiac Centerpoint, Pontiac, MI

Chem Group	Chemical	CASRN	Carc Class	Analyzed	Detected	Max Conc (mg/kg)	MDEQ Generic Background (mg/kg)	Residential Carcinogenic Criteria (TR = 1E-6) (mg/kg)	Residential Noncarcinogenic Criteria (HQ = 1) (mg/kg)	Residential Risk	Residential HQ
SVOC	Acenaphthene	83-32-9		10	4	1.50E+00			3.7E+03		4.07E-04
SVOC	Anthracene	120-12-7	D	10	4	2.60E+00			2.2E+04		1.19E-04
SVOC	Benzo(a)anthracene	56-55-3	B2	10	5	3.20E+00		6.2E-01		5.15E-06	
SVOC	Benzo(a)pyrene	50-32-8	B2	10	5	2.60E+00		6.2E-02		4.18E-05	
SVOC	Benzo(b)fluoranthene	205-99-2	B2	10	5	3.30E+00		6.2E-01		5.31E-06	
SVOC	Benzo(g,h,i)perylene	191-24-2	D	10	5	1.20E+00			2.3E+03		5.18E-04
SVOC	Benzo(k)fluoranthene	207-08-9	B2	10	5	1.40E+00		6.2E+00		2.25E-07	
SVOC	bis(2-Ethylhexyl)phthalate	117-81-7	B2	10	1	1.00E-01		3.5E+01	1.2E+03	2.88E-09	8.18E-05
SVOC	Carbazole	86-74-8	B2	9	3	1.60E+00		2.4E+01		6.58E-08	
SVOC	Chrysene	218-01-9	B2	10	5	2.90E+00		6.2E+01		4.67E-08	
SVOC	Dibenz(a,h)anthracene	53-70-3	B2	10	5	4.00E-01		6.2E-02		6.44E-06	
SVOC	Dibenzofuran	132-64-9	D	10	3	1.20E+00			1.5E+02		8.26E-03
SVOC	Fluoranthene	206-44-0	D	10	5	9.70E+00			2.3E+03		4.23E-03
SVOC	Fluorene	86-73-7	D	10	4	1.80E+00			2.7E+03		6.55E-04
SVOC	Indeno(1,2,3-cd)pyrene	193-39-5	B2	10	4	1.40E+00		6.2E-01		2.25E-06	
SVOC	2-Methylnaphthalene	91-57-6	ID	10	1	3.00E-01			5.6E+01		5.37E-03
SVOC	Naphthalene	91-20-3	C	10	3	8.00E-01			5.6E+01		1.43E-02
SVOC	Phenanthrene	85-01-8	D	10	5	1.20E+01			2.3E+03		5.18E-03
SVOC	Phenol	108-95-2	ID	10	3	4.00E-01			1.8E+04		2.18E-05
SVOC	Pyrene	129-00-0	D	10	6	8.30E+00			2.3E+03		3.58E-03
PCB	PCBs (total)	1336-36-3	B2	10	2	4.60E-01		2.2E-01	1.1E+00	2.07E-06	4.09E-01
INORG	Aluminum	7429-90-5	D	9	9	9.04E+03	9.90E+03		7.6E+04		2.81E-02
INORG	Antimony	7440-36-0		10	8	1.80E-01			3.1E+01		5.75E-03
INORG	Arsenic	7440-38-2	A	10	10	8.10E+00	5.80E+00	3.9E-01	2.2E+01	5.90E-06	1.06E-01
INORG	Barium	7440-39-3	D	10	10	1.15E+02	7.50E+01		5.4E+03		7.44E-03
INORG	Beryllium	7440-41-7	B1	10	10	5.20E-01		1.1E+03	1.5E+02	4.94E-10	3.37E-03
INORG	Cadmium	7440-43-9	B1	10	10	1.60E-01	1.20E+00	1.4E+03	3.7E+01		
INORG	Calcium	7440-70-2		9	9	1.53E+05					
INORG	Chromium (total)	7440-47-3		10	10	3.60E+01		2.1E+02	2.2E+02	1.71E-07	1.61E-01
INORG	Cobalt	7440-48-4	B1	10	10	8.79E+00	6.80E+00	9.0E+02	1.4E+03	2.20E-09	1.44E-03
INORG	Copper	7440-50-8	D	10	10	1.59E+01	3.20E+01		3.1E+03		
INORG	Cyanide (total)	57-12-5	D	10	2	4.00E-01	3.90E-01		1.2E+03		8.18E-06
INORG	Iron	7439-89-6	D	9	9	1.60E+04	1.20E+04		2.3E+04		1.70E-01
INORG	Lead	7439-92-1	B2	10	10	1.62E+01	2.10E+01		4.0E+02		
INORG	Magnesium	7439-95-4		9	9	2.48E+04					
INORG	Manganese	7439-96-5	D	9	9	3.97E+02	4.40E+02		1.8E+03		
INORG	Mercury	7439-97-6	D	10	5	4.00E-02	1.30E-01		3.7E+00		
INORG	Nickel	7440-02-0	A	10	10	2.41E+01	2.00E+01		1.6E+03		2.62E-03
INORG	Potassium	7440-09-7		9	6	1.90E+03					
INORG	Selenium	7782-49-2	D	10	4	6.00E-01	4.10E-01		3.9E+02		4.86E-04
INORG	Silver	7440-22-4	D	10	9	7.00E-02	1.00E+00		3.9E+02		
INORG	Sodium	7440-23-5		9	9	2.44E+03					
INORG	Thallium	7440-28-0		10	10	4.20E-01			5.2E+00		8.14E-02
INORG	Vanadium	7440-62-2		10	10	2.30E+01			7.8E+01		2.94E-01
INORG	Zinc	7440-66-6	D	10	10	6.50E+01	4.70E+01		2.3E+04		7.67E-04
									Sum	**7E-05**	**1E+00**

Notes:

The Residential Criteria are the Region 9 PRGs (2004), which are used as a conservative tool to estimate residential cancer risk and HI.
The Screening Criteria for Pyrene were used as surrogates for Phenanthrene and Benzo(g,h,i)perylene.
The Screening Criteria for Naphthalene were used as surrogates for 2-Methylnaphthalene.
The Screening Criteria for Chromium VI was used as a surrogate for Chromium (total).
The concentrations for all PCB isomers were summed before comparing to Polychlorinated biphenyls (PCBs) for cancer effects and Aroclor 1254 for noncancer effects.
The Screening Criteria for Mercury was calculated by ENVIRON to account for the vapor inhalation pathway using: EPA Region 9 equations, RfC from IRIS, and chemical properties from EPA's Soil Screening Guidance.
Chem Group - Chemical Group

APPENDIX E

SUPPLEMENTAL EVALUATION OF ARSENIC GROUNDWATER DATA

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Alex Rothchild

LFR

Aug 05, 2009 13:48

December 19, 2005

To: Jeanne Piercey
Jean Caufield

From: Francis Ramacciotti
Stephen Song

RE: Supplemental Evaluation of Arsenic Groundwater Data
GMC: Pontiac Centerpoint Business Campus

This memorandum discusses a supplemental evaluation that supports the Corrective Measures Proposal (CMP) (CRA 2005) for the Pontiac Centerpoint Business Campus (the Site) dated October 24, 2005. This supplemental evaluation compares the arsenic groundwater data for the Site with an update to the Michigan Part 201 generic groundwater cleanup criterion for arsenic that was issued by the Michigan Department of Environmental Quality (MDEQ) on October 26, 2005 and became effective on October 31, 2005. As discussed below, the update affects some of the data screening results in the CMP, but it does not substantively affect the conclusions of the CMP.

The December 2004 version of the Michigan Part 201 generic cleanup criteria (MDEQ 2004) was used for data screening during the initial preparation of the CMP, because it was the version in effect at the time. Subsequently, MDEQ announced revisions to the Part 201 generic cleanup criteria that, among other things, revised the generic drinking water criterion for arsenic that was used for data screening from 0.05 mg/L to 0.010 mg/L. No arsenic concentration in groundwater at the Site had exceeded the 2004 Part 201 generic drinking water criterion, but 16 groundwater samples from 10 monitoring wells have arsenic concentrations that exceed the 2005 Part 201 generic drinking water criterion (see attached Table 1). These new results do not have any substantive effect on the CMP because groundwater at the Site is not currently used as a drinking water supply, and the proposed corrective measures for the Site include institutional controls to prohibit future use of groundwater as a drinking water supply.

References

Conestoga-Rovers & Associates (CRA). 2005. Corrective Measures Proposal, Centerpoint Business Campus, Pontiac, Michigan. October.

Michigan Department of Environmental Quality (MDEQ). 2004. Administrative Rules for Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as Amended. Generic Cleanup Criteria and Screening Levels. December.

Michigan Department of Environmental Quality (MDEQ). 2005. Administrative Rules for Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as Amended. Generic Cleanup Criteria and Screening Levels. October.

T A B L E

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Aug 05, 2009 13:48

Table 1: Arsenic Concentrations in Perched Groundwater Exceeding 2005 MDEQ Generic Drinking Water Criteria GMC Pontiac Centerpoint, Pontiac, Michigan

Area	Location ID	Sample Name	Sample Date	Meas Basis	Conc (mg/L)	Ratio of Conc to DW Criteria
AOI53	MW33-16-04	GW-7097-102204-JY-076	10/22/2004	T	1.9E-02	**1.9E+00**
AOI53	MW33-16-04	GW-7097-102204-JY-077	10/22/2004	T	2.0E-02	**2.0E+00**
AOI53	MW33-31-04	GW-7097-102204-JY-075	10/22/2004	T	4.5E-02	**4.5E+00**
AOI54	MW31-1AOI54	GW-7097-081700-TJ-003	8/17/2000	D	3.8E-02	**3.8E+00**
AOI54	MW31-1AOI54	GW-7097-081700-TJ-003	8/17/2000	T	3.3E-02	**3.3E+00**
AOI71	BH-BP-04-04	GW-7097-101504-BF-023	10/15/2004	T	2.1E-02	**2.1E+00**
AOI71	BH-BP-05-04	GW-7097-101404-BF-018	10/14/2004	T	4.7E-02	**4.7E+00**
AOI71	BH-BP-06-04	GW-7097-102004-BF-022	10/20/2004	T	1.4E-02	**1.4E+00**
AOI71	MW-3	GW-7097-102004-BF-026	10/20/2004	T	1.5E-02	**1.5E+00**
AOI71	MW-3	GW-7097-102004-BF-027	10/20/2004	T	1.6E-02	**1.6E+00**
AOI71	MW31-1AOI71	GW-7097-101404-BF-021	10/14/2004	T	5.0E-02	**5.0E+00**
AOI74	MW3-1	GW-7097-081700-TJ-001	8/17/2000	D	2.6E-02	**2.6E+00**
AOI74	MW3-1	GW-7097-081700-TJ-001	8/17/2000	T	2.4E-02	**2.4E+00**
AOI74	MW3-1	GW-7097-081700-TJ-002	8/17/2000	D	2.6E-02	**2.6E+00**
AOI74	MW3-1	GW-7097-081700-TJ-002	8/17/2000	T	2.6E-02	**2.6E+00**
AOI79	MW-J-3	BTH-003	12/7/1994	T	1.5E-02	**1.5E+00**
Notes:						
Meas Basis - Measured Basis; T = Total, D = Dissolved						
2005 MDEQ Part 201 Generic Drinking Water Criterion is 0.010 mg/L.						