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Date:
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ARCADIS Project No.:
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Subject:
AOI 09-B MPE System Shutdown Memo
RACER Buick City Site, Flint, Michigan

This AOI 09-B multiphase extraction (MPE) System (the System) Shutdown memo was prepared by ARCADIS on behalf of Revitalizing Auto Communities Environmental Response Trust (RACER) for the Buick City Site (Site) located in Flint, Michigan. As explained below further operation of this system is not warranted and will not provide any material environmental benefit because site conditions meet applicable cleanup criteria.

The AOI 09-B MPE System was installed to address offsite migration of dissolved phase concentrations of volatile organic compounds (VOCs) in groundwater and light non-aqueous phase liquid (LNAPL) impacts at AOI-09-B. As identified in the human health risk assessment (HHRA), which was presented in the RFI Phase II Report, the LNAPL impacts include potential exposure of routine workers in a non-OSHA commercial building to LNAPL via vapor intrusion and potential exposure of maintenance and redevelopment construction workers to LNAPL. Subsequent to the preparation of the RFI Phase II Report the remaining buildings on the Site were demolished; therefore, indoor inhalation is not presently an applicable pathway. The remaining applicable pathways include ambient air, soil and groundwater.

As further discussed below, the offsite groundwater impacts have been addressed by active removal with the MPE system and planned institutional controls will address the potential LNAPL impacts. Because applicable criteria have been met additional LNAPL recovery at AOI 09-B is no longer necessary.

1. AOI 09-B MPE System Objectives

As discussed above the original objectives of the AOI 09-B MPE System were to address offsite migration of dissolved phase concentrations of VOCs in groundwater and LNAPL direct contact and vapor intrusion to indoor air impacts at AOI-09-B. As noted above indoor air impacts are no longer applicable.

- The offsite migration of dissolved phase concentrations of VOCs in groundwater pertains to the detection of gasoline related constituents above residential and nonresidential drinking water (RDW and NDW) criteria at monitoring wells located along the property boundary (RFI-09-08 and RFI-09-55S) and at offsite monitoring well RFI-09-46 (**Figure 1**). Analytical data from annual groundwater samples collected in 2013 and 2014 from RFI-09-08, RFI-09-46, and RFI-09-55S show that there are no longer any exceedances of RDW or NDW criteria. Therefore, the risk to the offsite receptors has been addressed.
- The RFI Phase II HHRA indicated an unacceptable on-site risk for the potential exposure of routine workers in a non-OSHA commercial building to LNAPL via vapor intrusion and exposure of maintenance and redevelopment construction workers to LNAPL. There are currently no buildings at the Site; therefore, the indoor air pathway is not applicable. No exceedances of ambient are present and the potential future vapor intrusion and worker exposure concerns will be addressed by the Site-wide institutional controls planned for the Site.

2. Additional Considerations

This section presents additional information to consider when evaluating the shutdown of the AOI 09-B System.

2.1 Presence of LNAPL Observed in Existing Wells

Since the start of the System operation, LNAPL has been detected, as identified through gauging, in monitoring wells 31-7, 31-8, RFI-09-11, RFI-09-09, RFI-09-41, RFI-09-42, RFI-09-45, and RFI-09-47 (as shown on **Figure 1**). The monitoring wells at AOI 09-B were gauged regularly during system operation.

During the most recent round of levels, collected in October 2014, LNAPL was only detected in wells 31-7, RFI-09-41, and RFI-09-47 with no detections at the perimeter wells as shown on **Figure 1**. As represented by this data the area of LNAPL impacts is substantially reduced and well within the facility boundaries.

2.2 ASTM Standard E2531

The 2006 ASTM Standard E2531 Standard Guide for Development of Conceptual Site Models and Remediation Strategies for Light Nonaqueous-Phase Liquids (LNAPL) Released to the Subsurface provides in Table X5.1 under the heading LNAPL Site Objective – item 5, the three following criteria for determining when recovering LNAPL is no longer cost effective:

- When there is less than 0.1 percent additional recovery per day relative to cumulative recovery totals (asymptotic conditions)
- When pollution from energy use or system emissions or both is greater than the mass recovery
- When monetary costs exceed \$50/gal equivalent and no further meaningful change in flux or longevity

Per the ASTM standard these metrics are provided as examples only; therefore, all three metrics do not have to be met for LNAPL recovery to be considered “no longer effective” nor are these the only standards by which this can be measured. Moreover, these suggested metrics are not intended to substitute for applicable cleanup criteria but rather are intended as guidance when meeting specific criteria may be a challenge.

2.2.1 Asymptotic Conditions

Asymptotic conditions were recommended as a reasonable endpoint in the *AOI 09-B Remedial Endpoints Memo (Endpoint Memo)*. Per the Endpoint Memo asymptotic conditions are considered to be met when the daily total mass recovery (liquid and vapor) is less than 0.1 percent of the prior total mass recovery for two consecutive months. Please note that the focus of the ASTM guidance was on LNAPL removal in liquid form and applying this metric to a multi-phase system may be problematic – as was discovered in this case. Current Site conditions meet the applicable cleanup standard, demonstrating that compliance with the asymptotic condition combining liquid

and vapor removal was difficult to achieve. Because ASTM does not mandate compliance with the asymptotic condition we can appropriately rely on demonstrating compliance with applicable cleanup criteria.

As an example of the variability in meeting the asymptotic condition we note several conditions that impacted the results. During 2014 (April through September) 20 of the 28 recovery wells were operated. Eight of the recovery wells were not operated in 2014 due to low mass removal based on the 2013 data. The 20 recovery wells that were operated (shown on **Figure 1**) were selected to target the highest impacted areas within and around the LNAPL area. In 2014 the System achieved the 0.1 percent average daily mass recovery to total mass recovery ratio (ratio) in May. It was decided that weekly vapor samples would be collected in June and July to provide a definitive data set to determine the ratio. The average ratio was slightly above the targeted 0.1 percent in June with a ratio of 0.14 percent and fell below the target in July with a ratio of 0.06 percent (see **Table 1**).

Figures 2, 3, and 4 present graphs of the Monthly LNAPL Removal, Monthly Total Mass Removal, and Endpoint Comparison to evaluate asymptotic conditions.

2.2.2 Pollution for Energy Use Exceeds Mass Recovery

Operation of the System's Flame Oxidizer Model 1 requires natural gas to supplement the VOC mass loading during periods of lower mass removal which generates pollution emissions (NO_x, SO_x, & CO₂) from burning natural gas. In 2014, the total mass recovered by the treatment system was approximately 1,587 pounds between April and November 2014. Based on the usage rates at the Site the System generated approximately 379 pounds of pollutants during the same time frame. During the 2014 operational period the mass of pollutants generated was approximately 24 percent of the mass removed by the System (See **Table 2**).

As asymptotic conditions are approached the mass of pollution generated will continue to increase and the mass recovery of the System will continue to decrease until the pollutants generated is greater than the mass recovered. For instance in July 2014, when the end point ratio was 0.06 percent, the System recovered approximately 46 pounds of VOCs but generated approximately 70 pounds of natural gas combustion pollution.

2.2.3 Monetary Cost

In 2014 approximately \$245,000 has been spent on OMM of the System. A total of 1,587 pounds (253 gallons) of petroleum hydrocarbons was recovered in the vapor and liquid phases. The cost per gallon of removal was therefore calculated to be approximately \$968.

3. Conclusions

The AOI 09-B MPE System was installed to address offsite migration of dissolved phase concentrations of VOCs in groundwater and LNAPL direct contact and potential vapor intrusion to indoor air impacts at AOI-09-B. The offsite impacts have been addressed and planned institutional controls will address the potential LNAPL impacts onsite.

In addition, the following summarizes the ASTM Standard E2531 performance metrics for the AOI 09-B LNAPL Area.

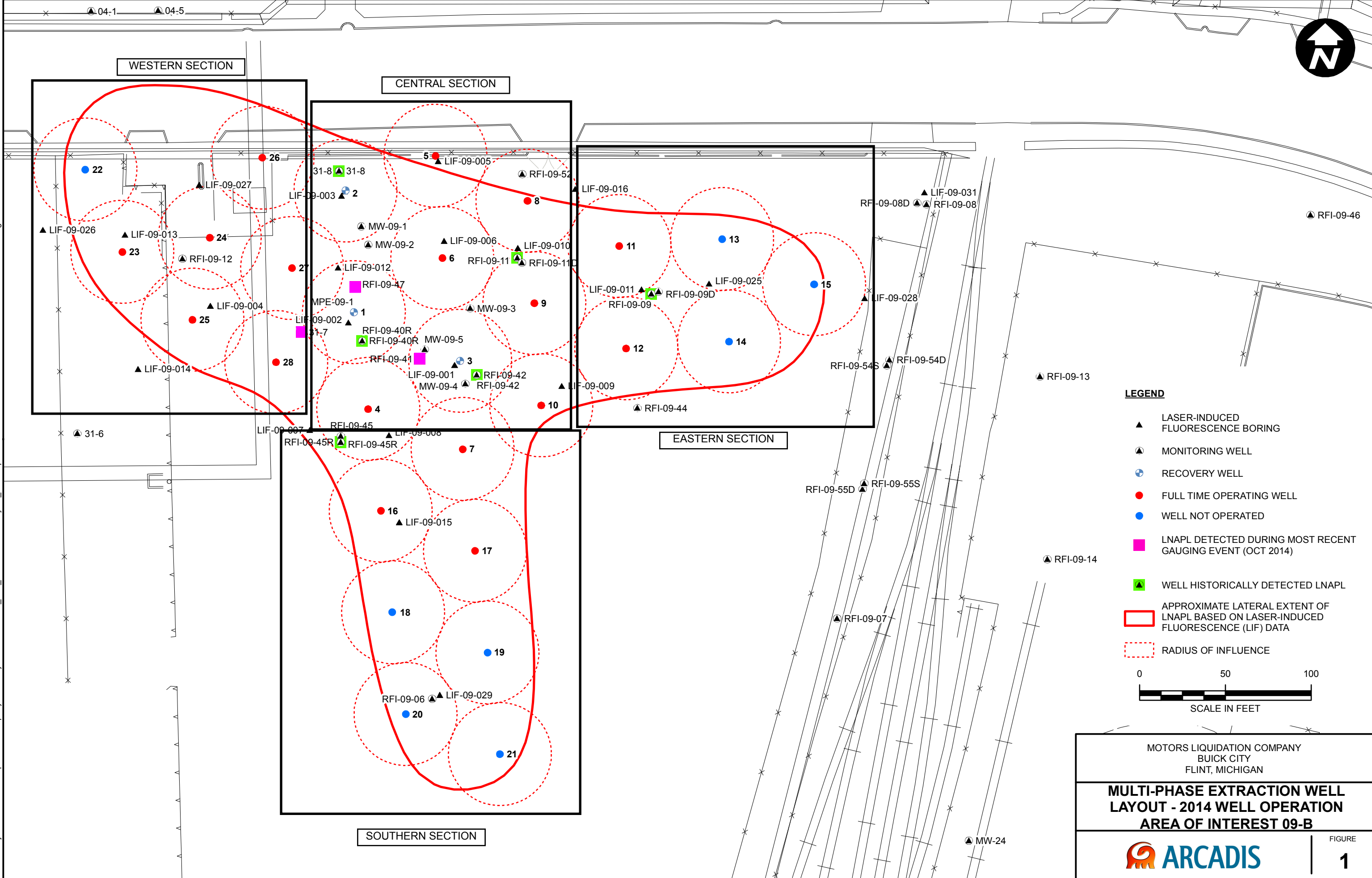
- The AOI 09-B MPE system is nearing asymptotic conditions for total mass recovery (liquid and vapor), but has not yet reached the goal of two consecutive months where the daily total mass recovery is less than 0.1% of the prior total mass recovery. The asymptotic condition was met one month (0.06%), was equal to the criteria one month (0.1%) and slightly above criteria (0.14%) one month in 2014, even though the monitoring well network was reduced to 20 recovery wells focused in the most impacted portion of the LNAPL area.
- The Pollution for Energy Use was approximately 24% of the total mass recovery in 2014. Therefore, there is currently more pollution being removed than generated.
- The cost per gallon for recovery during the 2014 operational period \$968, which significantly exceeds the ASTM guideline of \$50/gallon.

In summary, the system has reduced contaminant levels below the applicable cleanup criteria and no further operation is required to demonstrate compliance with applicable cleanup criteria.

Based on the results of this review and summary we intend to retrofit the system and relocate it to the Factory 36 area this summer. The reconfiguration of the system will depend on the results of the field pilot

tests and making necessary adjustments of the system components to establish the most effective means of remediating the contamination found at Factory 36.

CITY: Novi; DIV: ENV; DB: TRY; PIC: PM; TR: PROJECT NUMBER: COORDINATE SYSTEM: NAD 1983 StatePlane Michigan South FIPS 2113 Feet Intl
 D:\GIS\Project Files\MotorsLiquidationCompany\BuickCity\Documents\AOI_09B_Extracton Well Layout_2014 Operation.mxd PLOTTED: 2/20/2015 2:40:13 PM BY: TYarborough



LEGEND

- ▲ LASER-INDUCED FLUORESCENCE BORING
- ▲ MONITORING WELL
- ⊕ RECOVERY WELL
- FULL TIME OPERATING WELL
- WELL NOT OPERATED
- LNAPL DETECTED DURING MOST RECENT GAUGING EVENT (OCT 2014)
- ▲ WELL HISTORICALLY DETECTED LNAPL
- ▭ APPROXIMATE LATERAL EXTENT OF LNAPL BASED ON LASER-INDUCED FLUORESCENCE (LIF) DATA
- RADIUS OF INFLUENCE

0 50 100
SCALE IN FEET

MOTORS LIQUIDATION COMPANY
 BUICK CITY
 FLINT, MICHIGAN

**MULTI-PHASE EXTRACTION WELL
 LAYOUT - 2014 WELL OPERATION
 AREA OF INTEREST 09-B**

ARCADIS

FIGURE
1

Figure 2
AOI-09B MPE System - Monthly LNAPL Removal
RACER Buick City
Flint, Michigan

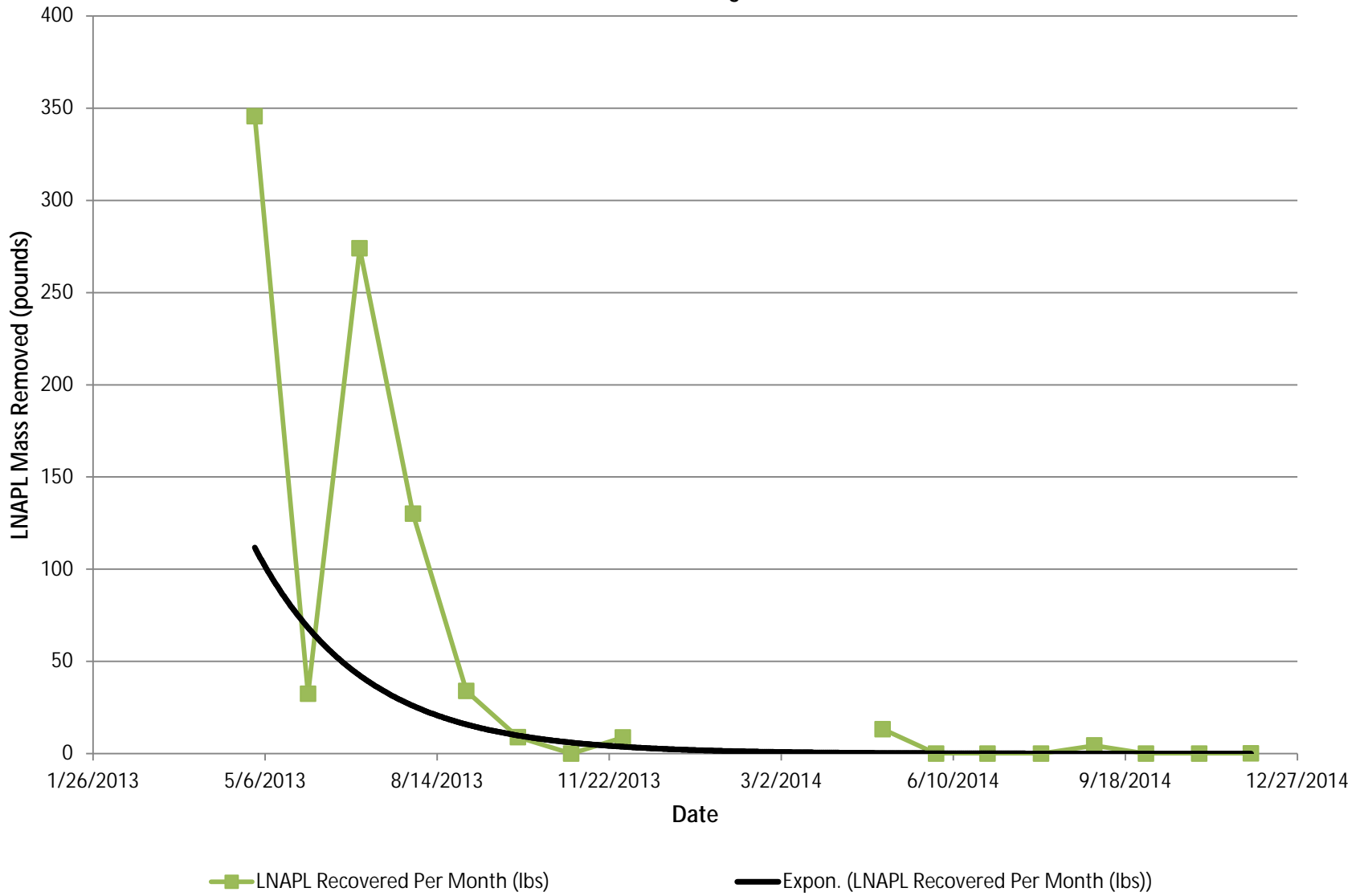
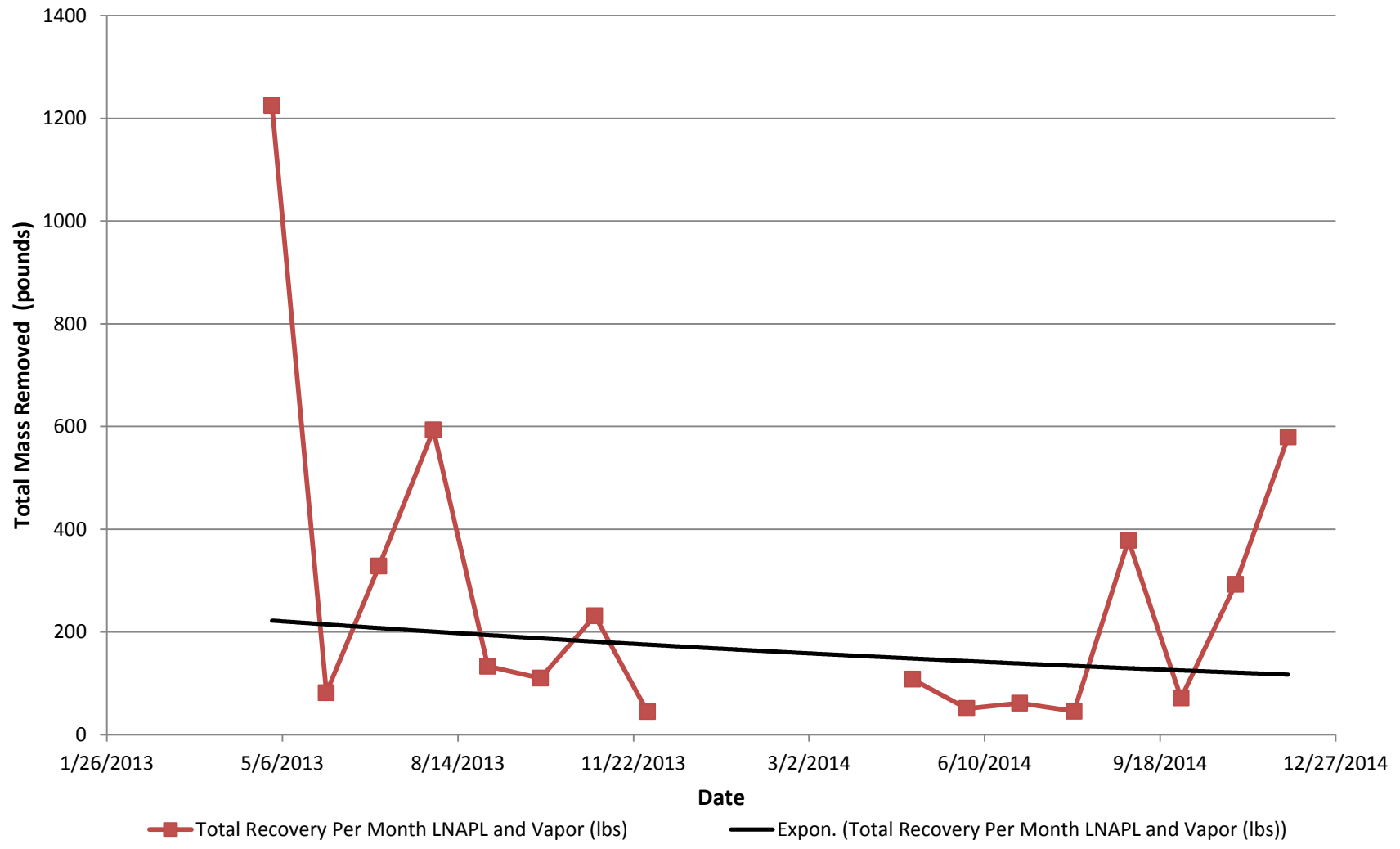
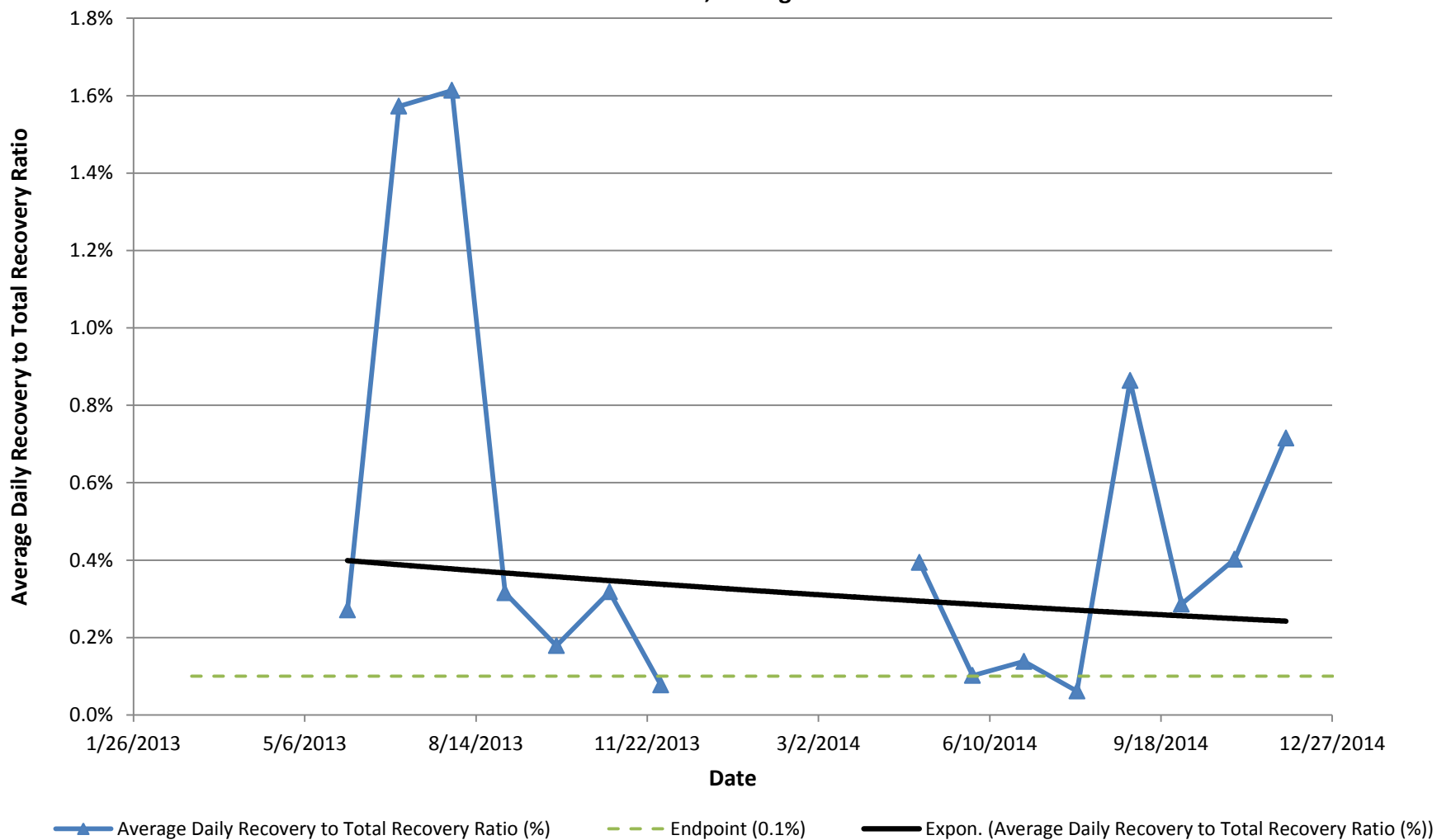


Figure 3
AOI-09B MPE System - Monthly Total Mass Removal
RACER Buick City
Flint, Michigan



Note: Vapor phase mass removal is determined by applying the instantaneous mass removal rate, based on SVE flow rate and weekly and/or monthly air sample concentrations, to the corresponding operating time

Figure 4
AOI-09B MPE System - Endpoint Comparison
RACER Buick City
Flint, Michigan



Note: Vapor phase mass removal is determined by applying the instantaneous mass removal rate, based on SVE flow rate and weekly and/or monthly air sample concentrations, to the corresponding operating time

Table 1. RACER Buick City Vapor Phase and LNAPL End Point Tracking
RACER Trust, Buick City Site, Flint, Michigan.

Year	Sample Date	Hours of System Operation Per weekly sample.	Hours of System Operation Per Month	Number of Operational Extraction Wells	Number of Extraction Wells Operating During Vapor Sample Collection	Volume of Water Discharged Per Month (gal)	Cumulative Annual Volume of Water Discharged (gal)	Cumulative Volume of Water Discharged 2013-2014 (gal)	SVE Vapor Phase Mass Recovered Per Weekly sample (lbs)	SVE Vapor Phase Mass Recovered Per Month (lbs)	Cumulative Annual SVE Vapor Phase Mass Recovered (lbs)	Cumulative SVE Vapor Phase Mass Recovered 2013-2014 (lbs)	LNAPL Recovered Per Month (lbs)	Cumulative Annual LNAPL Recovered (lbs)	Cumulative LNAPL Recovered 2013-2014 (lbs)	Total LNAPL and Vapor Mass Recovered Per weekly samples (lbs)	Total LNAPL and Vapor Mass Recovered Per Month (lbs)	Cumulative Annual LNAPL and Vapor Mass Recovered (lbs)	Cumulative LNAPL and Vapor Mass Recovered 2013-2014 (lbs)	Average Daily Mass Recovery to Total Mass Recovery Ratio (%)	Monthly Average Daily Mass Recovery to Total Mass Recovery Ratio (%)
2013	4/16/2013	--	125	28	28	54,686	54,686	54,686	--	879	879	879	346	346	346	--	1225	1225	1225	NA	NA
	5/10/2013	--	553	21	13	102,845	157,530	157,530	--	49	929	929	32	378	378	--	82	1307	1307	0.27%	0.27%
	6/11/2013	--	306	20	16	120,354	277,884	277,884	--	54	983	983	274	653	653	--	328	1635	1635	1.57%	1.57%
	7/17/2013	--	396	25	17	87,374	365,258	365,258	--	463	1446	1446	130	783	783	--	594	2229	2229	1.61%	1.61%
	8/14/2013	--	429	18	17	116,596	481,854	481,854	--	99	1545	1545	34	817	817	--	133	2362	2362	0.32%	0.32%
	9/24/2013	--	596	28	18	85,858	567,512	567,512	--	101	1646	1646	9	826	826	--	110	2472	2472	0.18%	0.18%
	10/9/2013	--	646	28	18	67,284	634,796	634,796	--	232	1878	1878	0	826	826	--	232	2704	2704	0.32%	0.32%
	11/20/2013	--	506	28	18	64,315	699,111	699,111	--	36	1914	1914	9	834	834	--	45	2748	2748	0.08%	0.08%
	4/25/2014	--	231	20	20	14,123	14,123	713,235	--	95	95	2009	13	13	848	--	108	108	2856	0.39%	0.39%
	5/14/2014	--	414	20	20	23,632	37,756	736,867	--	51	146	2060	0	13	848	--	51	159	2907	0.10%	0.10%
2014	6/13/2014	56		20	20				12							12				0.18%	
	6/23/2014	160		20	20				23							23				0.12%	
	6/27/2014	143		20	20				26							26				0.15%	
	6/30/2014	--	359	20	20	18,990	56,746	755,857	--	61	207	2121	0	13	848	--	61	220	2969	--	0.14%
	7/2/2014	24		20	20				12							12				0.42%	
	7/8/2014	120		20	20				2							2				0.01%	
	7/16/2014	149		20	20				14							14				0.07%	
	7/22/2014	140		20	20				15							15				0.08%	
	7/29/2014	157		20	20				3							3				0.02%	
	7/31/2014	--	589	20	20	20,607	77,353	776,464	--	46	253	2167	0	13	848	--	46	266	3014	--	0.06%
	8/4/2014	81		20	20				4							4				0.04%	
	8/15/2014	229		20	20				370							374				1.15%	
	8/31/2014	--	310	20	20	13,114	90,467	789,578	--	374	627	2541	4.4	17.6	852	--	378	644	3393	--	0.86%
	9/17/2014	--	172	20	20	6,309	96,776	795,888	--	71	698	2612	0	17.6	852	--	71	715	3464	--	0.29%
	10/15/2014	--	465	21	21	16,090	112,866	811,978	--	293	991	2905	0	17.6	852	--	293	1008	3757	--	0.40%
	11/6/2014	--	448	21	21	11,830	124,697	823,808	--	579	1570	3484	0	17.6	852	--	579	1587	4336	--	0.72%

Notes:

- % percent
- gal gallons
- NA Criterion or value is not available or, in the case of background and CAS numbers, not applicable.
- SVE Soil Vapor Extraction
- lbs pounds
- LNAPL Lighter-than-water, non-aqueous phase liquid

Table 2

RACER Buick City Vapor Phase and LNAPL End Point Tracking 2014
 RACER Trust, Buick City Site, Flint, Michigan.

Operational Period		Emissions								
		April 2014	May 2014	June 2014	July 2014	August 2014	September 2014	October 2014	November 2014	Annual Mass (2014)
Criteria Pollutants & GHG Fuel Use per Month (10⁶ SCF)		0.35200	0.24300	0.13430	0.38040	0.35330	0.11680	0.35630	0.11800	2.05410
Pollutant	Emission Factor ^a NG (10 ⁶ SCF)									
NO _x (lb)	100	35	24	13	38	35	12	36	12	205
CO (lb)	84	30	20	11	32	30	10	30	10	173
SO ₂ (lb)	0.6	0.21	0.15	0.08	0.23	0.21	0.07	0.21	0.07	1.23
Emissions Mass Generated from System Operations (lb)		65	45	25	70	65	22	66	22	379
Vapor Mass Removal from System Operations (lb)		108	51	61	46	378	71	293	579	1587
Difference in Mass Generated/Removed		43	6	36	-24	313	49	227	557	1208

Notes: SCF = Standard Cubic Feet

NG = Natural Gas

GHG = Green House Gas

lb = Pounds

^a = Obtained from USEPA's AP-42 Chapter 1, Section 4 (July 1998) for small, uncontrolled boilers.

^b = Negative number indicates more pollutants were generated than mass recovered