Memorandum

To:	Sue Kaelber-Matlock (MDEQ)	Ref. No.:	007878
	J.E.P.		
From:	John-eric Pardys/wg/156	Date:	April 8, 2016
cc:	Dave Favero (RACER)		
Re:	**2015 Summary of LNAPL Activities at Malleable Iron Industrial Land**		

1. Introduction

GHD Services Inc. (GHD), on behalf of the Revitalizing Auto Communities Environmental Response (RACER) Trust, has prepared the following memorandum to summarize the Light Non-Aqueous Phase Liquid (LNAPL) monitoring activities completed in the Quench Pit and Southwest Plant LNAPL Areas at the Malleable Iron Industrial Land, Saginaw, Michigan (Site) (Figure 1) for the 2015 calendar year.

The following tables, figures, and attachments are referenced throughout the remainder of this memorandum:

Figure 1	Site Plan
Figure 2	Southwest Plant LNAPL Area – LNAPL Monitoring Program
Figure 3	Quench Pit Area – LNAPL Monitoring Program
Table 1	Quarterly LNAPL Gauging
Table 2	LNAPL Transmissivity Testing Results for QPTW-10
Attachment A	November 2014 Presentation
Attachment B	Proposed Monitoring Plant for Southwest Plant LNAPL Area – September 8, 2014
Attachment C	Inspection Checklists
Attachment D	Standard Operating Procedures – Transmissivity Testing

2. Background

RACER has been working with the Michigan Department of Environmental Quality (MDEQ) to obtain closure for the Southwest Plant LNAPL Area and the Quench Pit Area. LNAPL was first identified in each area in the

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mid-1990's and various remedial activities have been completed since then to remove LNAPL and prevent migration of LNAPL. A complete summary of the history of each area is included in the November 7, 2014 LNAPL Status presentation that was given to the MDEQ and is included in Attachment A.

One of the recommendations made by the MDEQ to obtain closure for the Southwest Plant LNAPL Area was to complete additional monitoring to confirm the absence/presence of LNAPL in the source area and further downgradient at the stormwater and secondary ponds (storm sewers that pass through the Southwest Plant LNAPL Area provide a potential migration pathway for LNAPL to discharge to the stormwater and secondary ponds). A proposed monitoring plan was submitted to the MDEQ for review on May 27, 2014. The MDEQ provided comments on the proposed monitoring plan on August 21, 2014 and a revised monitoring plan was submitted back to the MDEQ on September 8, 2014 (Attachment B) which included quarterly monitoring of manholes in the Southwest Plant LNAPL Area, the stormwater pond, and the secondary pond to confirm LNAPL is not migrating. RACER has been implementing the proposed monitoring plan for the Southwest Plant LNAPL Area since Q2-2014.

As part of the November 7, 2014 LNAPL Status presentation, GHD (formerly Conestoga-Rovers & Associates, Inc.) recommended on-going LNAPL recovery at QPTW-10 (the only well in the Quench Pit Area with transmissivity levels greater than 0.5 square feet per day [ft^2/day]) until transmissivity levels are less than 0.5 ft^2/day (MDEQ de minimis recoverability criterion) and quarterly monitoring to confirm LNAPL is not migrating or accumulating at downgradient sewer bedding monitoring wells, nearby active sewers that discharge to the stormwater and secondary ponds, and nearby sewers that historically discharged to the City. RACER has been implementing the proposed monitoring plan for the Quench Pit Area since Q2-2014.

3. Summary of LNAPL Monitoring Activities

Quarterly monitoring/inspections were conducted in the Quench Pit Area and the Southwest Plant LNAPL Area on March 24, 2015, June 17, 2015, September 9, 2015, and December 4, 2015. The inspection checklists are provided in Attachment C.

Southwest Plant LNAPL Area

Figure 2 presents the manhole locations inspected/gauged quarterly for water/LNAPL in the Southwest Plant LNAPL Area. No measurable product was identified in the manholes; however, an oil absorbent boom was placed in manhole FV3.0 during the fourth quarter as a result of an oily scum layer in the manhole. In addition, no LNAPL was present during the inspections at the ground surface of the Southwest Plant LNAPL Area, in the stormwater pond, or in the secondary pond. Therefore, based on the inspections LNAPL in the Southwest Plant LNAPL Area LNAPL is mobile (as evidenced by the oily scum layer), unrecoverable, and stable/non-migrating (LNAPL area not expanding).

Quench Pit Area

Figure 3 presents the manhole and monitoring well locations inspected/gauged quarterly for water/LNAPL in the Quench Pit Area. Water/LNAPL gauging for the Quench Pit Area monitoring wells collected during the quarterly events is summarized in Table 1. LNAPL, if present, was recovered manually and containerized in an on-Site 330-gallon tote. Approximately 4 gallons were manually recovered from the monitoring wells. No measurable product was identified in the manholes, at downgradient sewer bedding monitoring wells, at the ground surface of the Quench Pit Area, in the stormwater pond, or in the secondary pond.

In addition to the quarterly inspections, GHD operated and maintained an on-demand LNAPL skimmer pump in QPTW-10. A new skimmer pump was installed on January 30, 2015, which operated consistently the rest of 2015. The pump in QPTW-10 recovered approximately 16 gallons of LNAPL in 2015. The LNAPL recovered is stored in an on-Site 330-gallon tote. On September 30, 2015, GHD conducted a transmissivity test on QPTW-10. The results of the transmissivity testing were 1.17 ft^2/day which is greater than 0.5 ft^2/day (MDEQ minimum recoverability criterion) as summarized in Table 2. A copy of GHD's standard operating procedures for transmissivity testing is included in Attachment D.

In June 2015 during a rainstorm event, the recovery well QPTW-10 was inundated with water and as a result the pump recovered both LNAPL and water, filling the 330-gallon tote. The oily water recovered was characterized and disposed of off-Site on September 3, 2015 along with other miscellaneous items. The LNAPL in the 330-gallon tote was not disposed of.

LNAPL continues to be present in the Quench Pit Area monitoring wells; however, there is no evidence of LNAPL migrating downgradient. GHD will continue to operate the on-demand LNAPL skimmer pump in QPTW-10 and will conduct another transmissivity test at QPTW-10 in 2016.

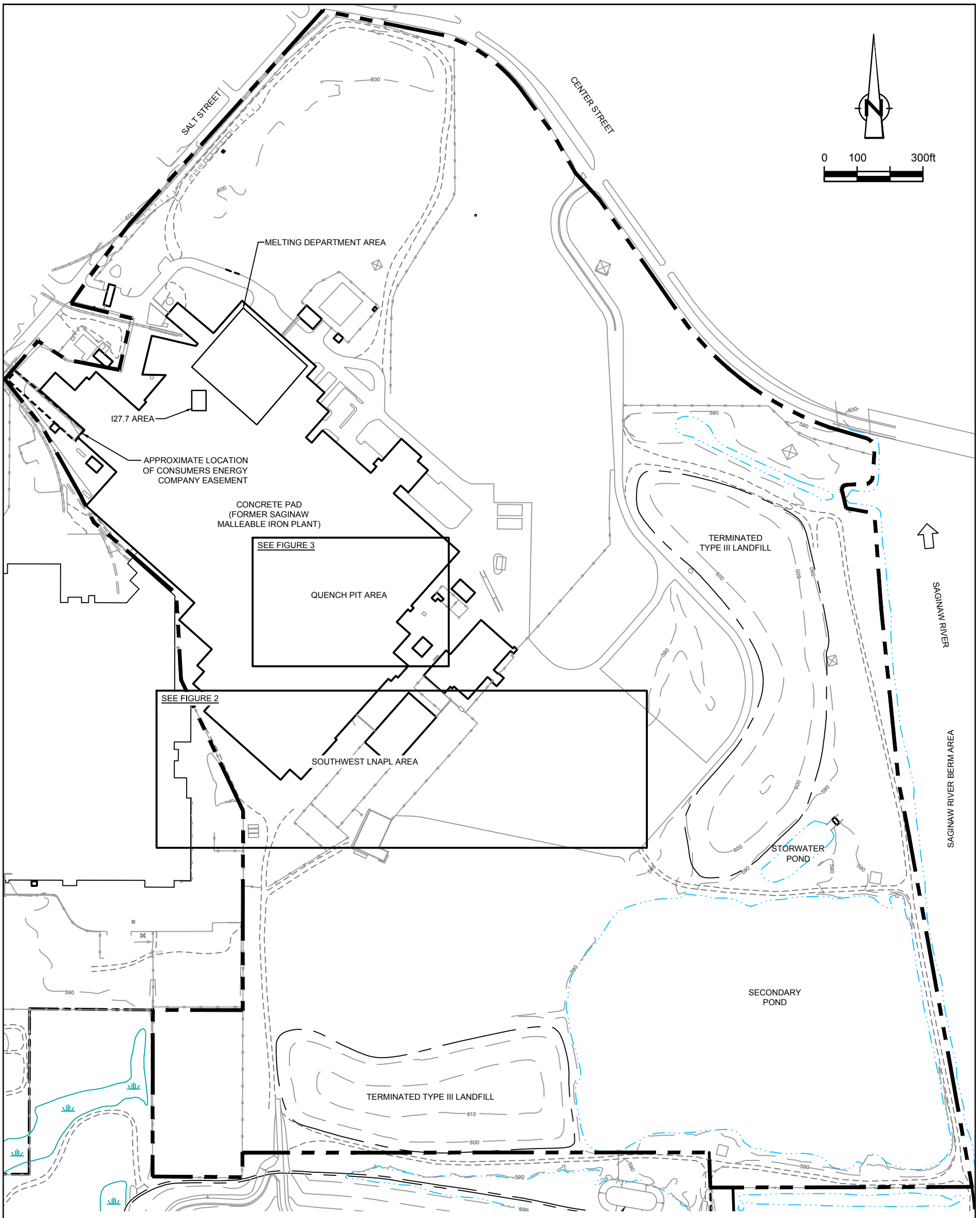

figure 1

SITE PLAN
RACER SAGINAW MALLEABLE IRON INDUSTRIAL LAND
Saginaw, Michigan

GHD

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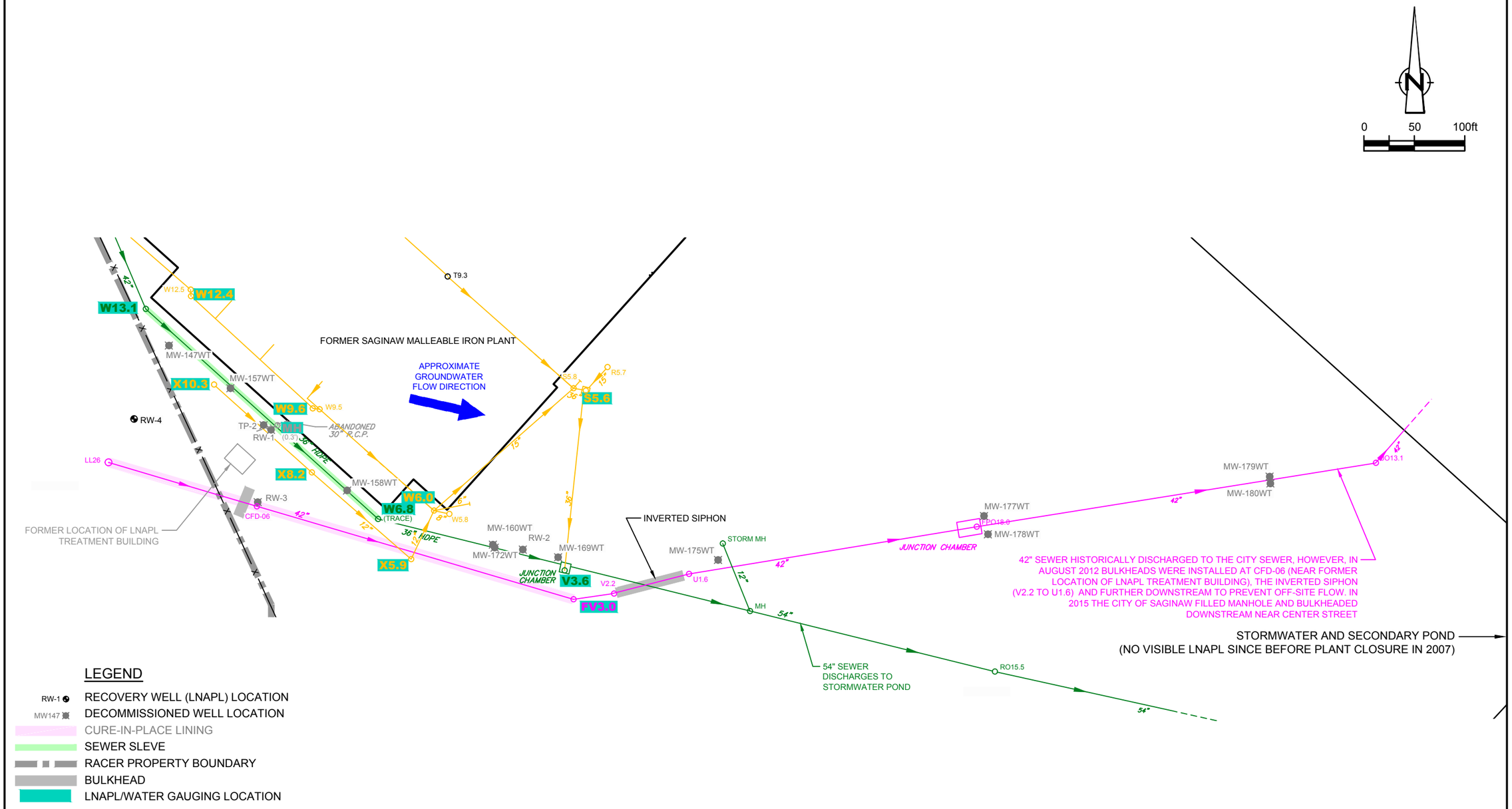

figure 2

SOUTHWEST PLANT LNAPL AREA - LNAPL MONITORING PROGRAM
RACER SAGINAW MALLEABLE IRON INDUSTRIAL LAND
Saginaw, Michigan

0 20 40 ft

QPTW-02
QPTW-06
QPTW-04
QPTW-12
QPTW-05
QPTW-08
QPTW-11
QPTW-09
QPTW-03
QPTW-03R
QPTW-10
QPTW-01
QPTW-07
QPTW-13

QP-1
QP-2
QP-3
1
2
3

L15.7 K14.1 FK13.6 L13.6 L12.8 FL12.7 L12.9 L12.6 L12.5 L12.3 L12.2 M13.0 J12.1 K12.2 K11.3 L11.8 H11.3 I8.9 I8.6 J8.9 I7.6 O13.7 P13.7 Q12.8 Q12.7 Q12.5 Q10.3 L10.8 K8.9 L8.8 L8.0 L8.9 L8.7 L8.2 M8.3 M8.2 M8.0 N9.1 N8.0 O8.8 O9.1

BULKHEAD
BULKHEAD 12"
D.S.
PERMANENTLY PLUGGED
ABANDONED
LNAPL RECOVERY BUILDING

APPROXIMATE GROUNDWATER FLOW DIRECTION

LEGEND

- QPTW-11 — MONITORING WELL
- 1 — FORMER QUENCH PIT
- QP-1 — RECOVERY POINT (APPROXIMATE LOCATION)
- QPTW-10 — AUTOMATED LNAPL SKIMMER PUMP LOCATION
- E — ELECTRICAL LINE (ABOVE GRADE)
- QPTW-03 — DECOMMISSIONED/ABANDONED WELL
- I8.8 — MANHOLE
- BRANCH SEWER TO SETTLING BASIN OR STORM POND - STORM AND PROCESS
- BRANCH SEWER FORMERLY DIRECTED TO CITY - SANITARY, STORM AND PROCESS (ALL SEWER LINES TO CITY BULKHEADED)
- ABANDONED SEWER LINE
- LNAPL/WATER GAUGING LOCATION

figure 3

QUENCH PIT AREA - LNAPL MONITORING PROGRAM
RACER SAGINAW MALLEABLE IRON INDUSTRIAL LAND
Saginaw, Michigan

GHD

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Table 1

Quarterly LNAPL/Water Gauging
RACER Saginaw Malleable Industrial Land
Saginaw, Michigan

Location		Date 24-Mar-15	17-Jun-15	9-Sep-15	4-Dec-15
QPTW-01	DTW (ft)	4.51	3.31	3.81	4.70
	DTP (ft)	3.14	1.25	1.11	3.48
	LNAPL Thickness (ft)	1.37	2.06	2.70	1.22
QPTW-02	DTW (ft)	3.20	*(1)	1.84	3.85
	DTP (ft)	NP	*(1)	NP	NP
	LNAPL Thickness (ft)	NP	*(1)	NP	NP
QPTW-03R	DTW (ft)	3.56	3.36	2.74	4.14
	DTP (ft)	3.55	2.72	2.46	NP
	LNAPL Thickness (ft)	0.01	0.64	0.28	NP
QPTW-04	DTW (ft)	4.66	3.51	4.09	5.56
	DTP (ft)	3.02	2.05	2.64	3.51
	LNAPL Thickness (ft)	1.64	1.46	1.45	2.05
QPTW-05	DTW (ft)	5.11	4.77	5.30	6.38
	DTP (ft)	3.70	2.59	2.49	4.10
	LNAPL Thickness (ft)	1.41	2.18	2.81	2.28
QPTW-07	DTW (ft)	*(2)	2.49	2.36	3.78
	DTP (ft)	*(2)	NP	NP	NP
	LNAPL Thickness (ft)	*(2)	NP	NP	NP
QPTW-08	DTW (ft)	4.14	3.08	3.10	NM
	DTP (ft)	NP	NP	NP	NM
	LNAPL Thickness (ft)	NP	NP	NP	NM
QPTW-09	DTW (ft)	4.49	3.75	3.96	NM
	DTP (ft)	NP	NP	NP	NM
	LNAPL Thickness (ft)	NP	NP	NP	NM
QPTW-10	DTW (ft)	*(3)	*(3)	2.99	NM
	DTP (ft)	*(3)	*(3)	2.85	NM
	LNAPL Thickness (ft)	*(3)	*(3)	0.14	NM
QPTW-11	DTW (ft)	4.01	2.92	3.08	NM
	DTP (ft)	NP	NP	NP	NM
	LNAPL Thickness (ft)	NP	NP	NP	NM
QPTW-12	DTW (ft)	3.31	2.33	2.59	3.84
	DTP (ft)	NP	NP	NP	NP
	LNAPL Thickness (ft)	NP	NP	NP	NP
QPTW-13	DTW (ft)	4.12	3.17	3.17	*(4)
	DTP (ft)	NP	NP	NP	4.55
	LNAPL Thickness (ft)	NP	NP	NP	NM
QP1	DTW (ft)	7.55	6.51	6.12	8.25
	DTP (ft)	NP	NP	NP	NP
	LNAPL Thickness (ft)	NP	NP	NP	NP
QP2	DTW (ft)	6.51	5.79	5.71	7.35
	DTP (ft)	6.30	5.53	5.36	6.88
	LNAPL Thickness (ft)	0.21	0.26	0.35	0.47
QP3	DTW (ft)	6.36	5.20	5.12	6.40
	DTP (ft)	6.34	5.18	5.09	6.39
	LNAPL Thickness (ft)	0.02	0.02	0.03	0.01

Notes:

*(1) underwater
*(2) ice
*(3) pump
*(4) LNAPL is thick and therefore was unable to obtain water level
NM - not measured
NP- not present

Table 2

LNAPL Transmissivity Testing Results for: QPTW-10
RACER Saginaw Malleable Industrial Land
Saginaw, Michigan

Day	Time	Elapsed Time (hours)	DTP (ft btor)	DTW (ft btor)	In-Well LNAPL Thickness (in)	Volume Removed (fl oz)	Volume Removed (gal)	LNAPL Recovery Rate - Q_n (gal/day)	25% of Recovery Rate (gal/day)	Recovery Rate Difference (gal/day)	LNAPL Drawdown - S_n (feet)	LNAPL Recovery Rate - Q_n (ft^3/day)
9/30/2015	8:25	0:00	3.81	4.39	6.96	12.00	0.09					
9/30/2015	8:30	0:05	3.86	4.01	1.80	3.00	0.02	6.8			0.05	0.90
9/30/2015	8:35	0:10	3.86	4.01	1.80	2.50	0.02	5.6	1.4		0.05	0.75
9/30/2015	8:40	0:15	3.86	3.97	1.32						0.05	
9/30/2015	8:45	0:20	3.85	3.98	1.56	2.75	0.02	3.1	0.8	0.6	0.04	0.41
9/30/2015	8:50	0:25	3.86	3.96	1.20						0.05	
9/30/2015	8:55	0:30	3.85	3.98	1.56	2.75	0.02	3.1	0.8	0.0	0.04	0.41
9/30/2015	9:00	0:35	3.86	3.96	1.20						0.05	
9/30/2015	9:05	0:40	3.85	3.97	1.44	2.50	0.02	2.8	0.7	0.1	0.04	0.38
9/30/2015	9:10	0:45	3.86	3.95	1.08						0.05	
9/30/2015	9:15	0:50	3.85	3.96	1.32						0.04	
9/30/2015	9:20	0:55	3.85	3.98	1.56	2.75	0.02	2.1	0.5	0.2	0.04	0.28
9/30/2015	9:25	1:00	3.86	3.96	1.20						0.05	
9/30/2015	9:30	1:05	3.85	3.96	1.32						0.04	
9/30/2015	9:35	1:10	3.85	3.98	1.56	2.75	0.02	2.1	0.5	0.0	0.04	0.28
9/30/2015	9:45	1:20	3.85	3.96	1.32						0.04	
9/30/2015	9:55	1:30	3.85	3.98	1.56	2.75	0.02	1.5	0.4	0.1	0.04	0.21
9/30/2015	10:05	1:40	3.85	3.96	1.32						0.04	
9/30/2015	10:15	1:50	3.84	3.98	1.68	2.75	0.02	1.5	0.4	0.0	0.03	0.21
9/30/2015	10:25	2:00	3.86	3.96	1.20						0.05	
9/30/2015	10:35	2:10	3.85	3.98	1.56	2.75	0.02	1.5	0.4	0.0	0.04	0.21
9/30/2015	10:50	2:25	3.85	3.96	1.32						0.04	
9/30/2015	11:05	2:40	3.85	3.98	1.56	2.75	0.02	1.0	0.3	0.1	0.04	0.14
9/30/2015	11:20	2:55	3.86	3.97	1.32						0.05	
9/30/2015	11:35	3:10	3.85	3.98	1.56	2.75	0.02	1.0	0.3	0.0	0.04	0.14
9/30/2015	11:55	3:30	3.86	3.97	1.32						0.05	
9/30/2015	12:15	3:50	3.85	3.99	1.68	2.75	0.02	0.8	0.2	0.1	0.04	0.10
9/30/2015	12:35	4:10	3.86	3.96	1.20						0.05	
9/30/2015	12:55	4:30	3.85	3.98	1.56	2.75	0.02	0.8	0.2	0.0	0.04	0.10
9/30/2015	13:25	5:00	3.86	3.96	1.20						0.05	
9/30/2015	13:55	5:30	3.85	3.98	1.56	2.75	0.02	0.5	0.1	0.1	0.04	0.07
9/30/2015	14:25	6:00	3.85	3.94	1.08						0.04	
9/30/2015	14:55	6:30	3.85	3.96	1.32						0.04	
9/30/2015	15:25	7:00	3.85	3.98	1.56						0.04	

Inputs	**0.04**	**0.07**
LNAPL Transmissivity - T_n (ft^2/day)		**1.17**

Attachment A
November 2014 Presentation

LNAPL STATUS

RACER Malleable Iron Industrial Land

Review with MDEQ
November 7, 2014

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OUTLINE

1. Malleable Iron Industrial Land (Site)
   - A. Background
   - B. Adjacent Land Uses
   - C. Site Geology
   - D. Site Hydrogeology
   - E. Remedial History
2. Southwest Plant LNAPL Area
   - A. Background
   - B. Previous Characterization
   - C. Previous Remedial Activities
   - D. LNAPL Conceptual Site Model
   - E. LNAPL Remedial Decision Tree
   - F. Conclusions/Recommendations

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OUTLINE

3. Quench Pit LNAPL Area
   - A. Background
   - B. Previous Characterization
   - C. Previous Remedial Activities
   - D. LNAPL Conceptual Site Model
   - E. LNAPL Remedial Decision Tree
   - F. Conclusions/Recommendations
4. Summary of Review
5. Discussion

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1. MALLEABLE IRON INDUSTRIAL LAND (SITE)

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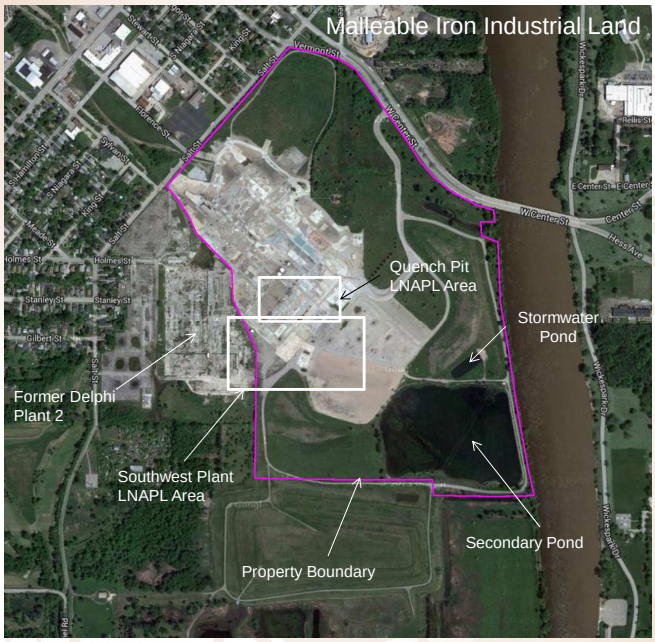

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1. Malleable Iron Industrial Land

A. Background

- Approximate size of Site: 150 acres
- Approximate size of former Saginaw Malleable Iron (SMI) Plant : 1 million square feet
- Approximate slab elevation: 593.5 feet AMSL
- Historical manufacturing operations involved casting and heat treating of iron
- Historically, used large volumes of quench and hydraulic oil
- Operated from 1907 to 2007
- Demolition was initiated in 2009 and was completed in December 2010

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1. Malleable Iron Industrial Land

B. Adjacent land uses

- To the north is a residential area
- To the south is the Greenpoint landfill (RACER property)
- To the west is the former Delphi Plant 2 which historically cut and ground parts. Delphi Plant 2 was closed in 2001
- To the east is the Saginaw River

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1. Malleable Iron Industrial Land

C. Site Geology

- Overburden at the Site is approximately 86 feet thick and is comprised generally of (in descending order): fill materials, glaciolacustrine silts and clays, a sand unit which becomes coarser with depth, glaciolacustrine silty clay, and glacial till
- The Site lies over bedrock units in the central part of the Michigan basin, the shallowest of which consists of Pennsylvanian age bedrock of the Grand River and Saginaw Formations

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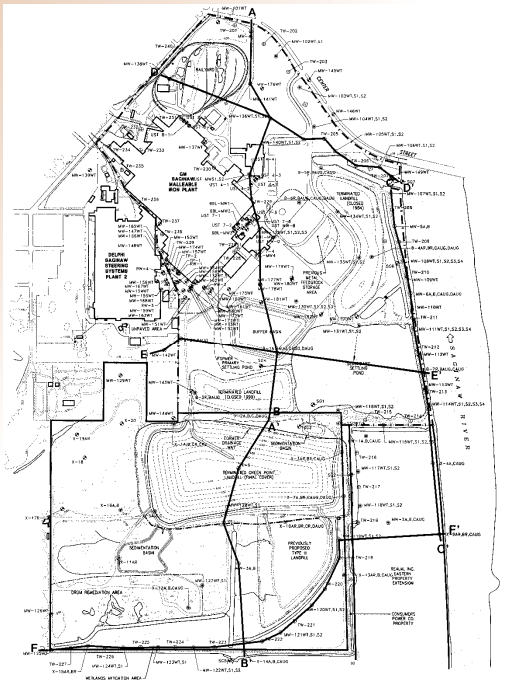


LEGEND

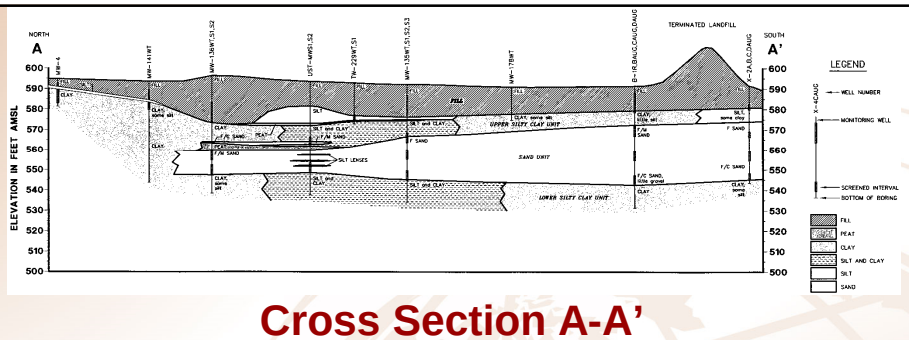
- GM SAGINAW MALLEABLE IRON PLANT PROPERTY LINE (APPROX.)
- REALM, INC. PROPERTY LINE (APPROX.)
- UNPAVED ROAD
- GROUND SURFACE ELEVATION CONTOUR (10 FT INTERVAL)
- FENCE LINE
- SWAMPY AREA
- MW-4 MONITORING WELL
- MW-102WT,S1 MONITORING WELL CLUSTER
- TW-203 TEMPORARY MONITORING WELL
- SGS STAFF GAUGE
- TP-2 PIEZOMETER
- RW-4 RECOVERY WELL
- Y-11AR ABANDONED MONITORING WELL
- A—A' CROSS SECTION LOCATION

NOTES:

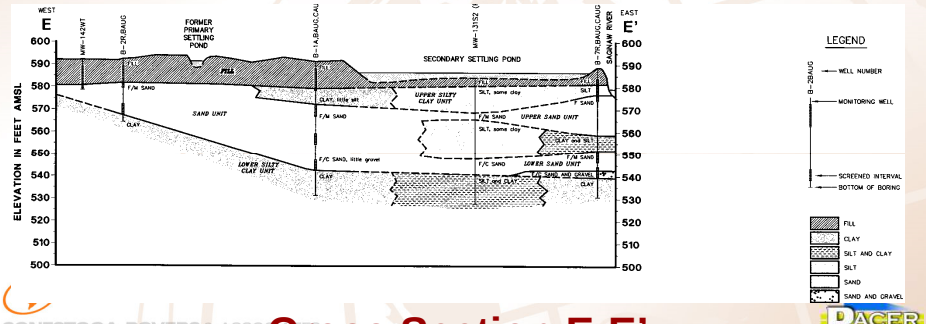
1. THIS PHOTOGRAMMETRIC BASE MAP FOR THE GM SAGINAW MALLEABLE IRON PLANT AND DELPHI SAGINAW STEERING SYSTEMS PLANT 2 PROPERTIES WAS PREPARED BY LOCKWOOD MAPPING, INC. OF ROCHESTER, NEW YORK. AERIAL PHOTOGRAPHY WAS CONDUCTED ON 11/11/94. ORIGINAL LOCKWOOD MAP WAS AT A SCALE OF 1"=100' AND WAS INTERPRETED FOR TWO-FOOT CONTOURS.
2. SAMPLING LOCATIONS SURVEYED BY ATWELL-HICKS, INC. UTICA, MICHIGAN, FILE NO. M1014SU2, FILE DATE 3/22/96, REVISED 8/8/96, OR SPICER GROUP.
3. VERTICAL DATUM REFERENCED TO NGVD OF 1929, HORIZONTAL DATUM REFERENCED TO MICHIGAN SPC-NAD 1983.
4. BASE MAP HAS BEEN MODIFIED TO INCORPORATE BUFFER BASIN, SEDIMENTATION BASINS, WETLANDS MITIGATION AREA, AND GREEN POINT LANDFILL (GPL) FINAL COVER FROM THE FINAL ENGINEERING DESIGN REPORT PREPARED BY BBL FOR THE GPL, DATED JANUARY 1998.
5. PROPERTY BOUNDARY FOR REALM, INC. DIGITIZED FROM SPICER GROUP DRAWING NO. A-21854-1, DATED 3/27/98.

Cross Section Locations

9



Cross Section A-A'



Cross Section E-E'

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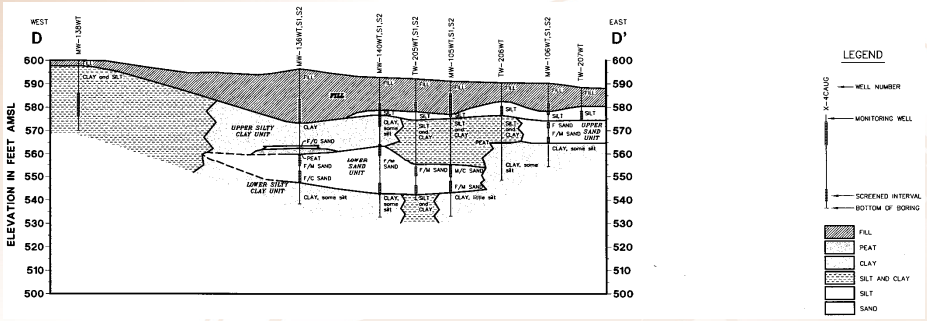

Cross Section D-D'

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1. Malleable Iron Industrial Land

D. Site Hydrogeology

- Shallow groundwater exists in an unconfined condition in the fill or silty clay units and the depth to groundwater varies from 2 to 10 feet bgs
- The fill/sand units, which pinch out toward the west, act as primary pathways for groundwater flow
- The underlying silty clay unit acts as a local flow boundary or lower confining unit
- The bedrock aquifer is confined by the continuous lower silty clay
- Groundwater flow is controlled on a regional scale by the Saginaw River, which acts as a discharge point for overburden groundwater

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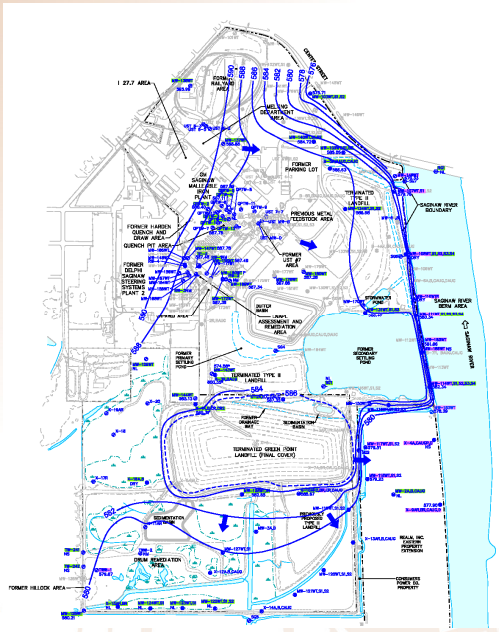

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2. BASE MAP HAS BEEN MODIFIED TO INCORPORATE RUPPER BASIN, SEDIMENTATION BASINS, WETLANDS MITIGATION AREA, AND GREEN POINT LANDFILL (GPL) FINAL COVER FROM THE FINAL ENGINEERING DESIGN REPORT PREPARED BY BEL FOR THE GPL, DATED JANUARY 1998.
3. VERTICAL DATUM REFERENCED TO NGVD OF 1929, HORIZONTAL DATUM REFERENCED TO MICHIGAN SPC-NAD 1983.
4. PROPERTY BOUNDARY FOR REALM, INC. DIGITIZED FROM SPICER GROUP DRAWING NO. A-21854-1, DATED 1/27/98.
5. BASE MAP INFORMATION SOUTH OF MAIN REALM, INC. PROPERTY LINE FROM AIR-LAND SURVEYS, INC. PHOTO DATE 11/93, MAPPING DATE 10/01.
6. CONTOURS HAVE BEEN INFERRED IN THE AREA OF THE LANDFILL BASED ON HISTORICAL DATA.
* ELEVATIONS AT MW-142WT AND B-3R WERE NOT USED FOR CONTOURING.
* MONITORING WELLS RW-1, RW-2 AND RW-3 NOT MEASURED BECAUSE THE VAULTS WERE FLOODED.

LEGEND:

- GM SAGINAW MALLEABLE IRON PLANT PROPERTY LINE (APPROX.)
- REALM, INC. PROPERTY LINE (APPROX.)
- UNPAVED ROAD
- GROUND SURFACE ELEVATION CONTOUR (10 FT INTERVAL)
- FENCE LINE
- SWAMPY AREA
- MONITORING WELL
- MONITORING WELL CLUSTER
- STAFF GAUGE
- PIEZOMETER
- RECOVERY WELL
- ABANDONED MONITORING WELL
- ABANDONED MONITORING WELL CLUSTER
- RIVER GAUGE
- WELL NOT FOUND
- GROUNDWATER ELEVATION (TEST AMSL)
- NOT SURVEYED
- NOT LOCATED
- NOT MEASURED
- PRODUCT MEASURED IN WELL
- MONITORING WELL DRY AT TIME OF GAUGING
- GROUNDWATER ELEVATION CONTOUR LINE (TEST AMSL), DASHED WHERE INFERRED
- GROUNDWATER FLOW DIRECTION

RAP (7/31/08) MONITORING PROGRAM; REVISED 12/08

- SAMPLING AND GROUNDWATER ELEVATION MEASUREMENT LOCATION
- LNAPL AND/OR GROUNDWATER ELEVATION MEASUREMENT LOCATION

Water Elevation Contour Map Sept. 23, 2013

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1. Malleable Iron Industrial Land

E. Remedial History

- The Remedial Investigation (RI) was completed between December 1994 and August 2000 in accordance with the MDEQ approved Work Plan and the additional phases of RI activities
- The RI report was submitted to the MDEQ on November 27, 2000 and approved on July 5, 2001

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1. Malleable Iron Industrial Land

E. Remedial History cont'd

- A Feasibility Study, including Human Health Evaluation Report (HHE) and Ecological Risk Assessment (ERA) Report, was completed and submitted in July of 2003 and approved by the MDEQ in a letter dated November 18, 2003
  - The HHE evaluated groundwater contact, industrial groundwater volatilization to indoor air inhalation, flammability and explosivity screening, water solubility screening, soil direct contact, and industrial drinking water protection exposure pathways in the Southwest Plant LNAPL and Quench Pit areas
  - LNAPL was being addressed through on-going LNAPL removal and monitoring, evaluation of remedial alternatives, other than deed restrictions, were not required at that time

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1. Malleable Iron Industrial Land

E. Remedial History cont'd

- Environmental Indicator (EI) CA 750 – Migration of contaminated groundwater under control was approved by US EPA on September 15, 2006
  - The EI CA 750 identified that monitoring should continue in the areas with LNAPL. At the time the document was prepared LNAPL was being recovered
- EI CA 725 – Current Human Exposures Under Control was approved by US EPA on September 27, 2007

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1. Malleable Iron Industrial Land

E. Remedial History cont'd

- A Remedial Action Plan (RAP) was initially submitted on July 30, 2008, was modified on December 31, 2008, and approved with conditions on February 27, 2009. A revised RAP was submitted on May 29, 2009
  - The approved RAP included the following specific activities associated with the Southwest Plant and Quench Pit LNAPL areas:
    - Continued operation and maintenance of LNAPL recovery systems
    - Areas subject to restrictive covenant that limits property to non residential, prohibits the installation of potable water supply wells, and places restrictions on intrusive activities. Worker duration restrictions also apply
    - Monitoring of LNAPL thickness and groundwater level elevations on an annual basis

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2. SOUTHWEST PLANT LNAPL AREA

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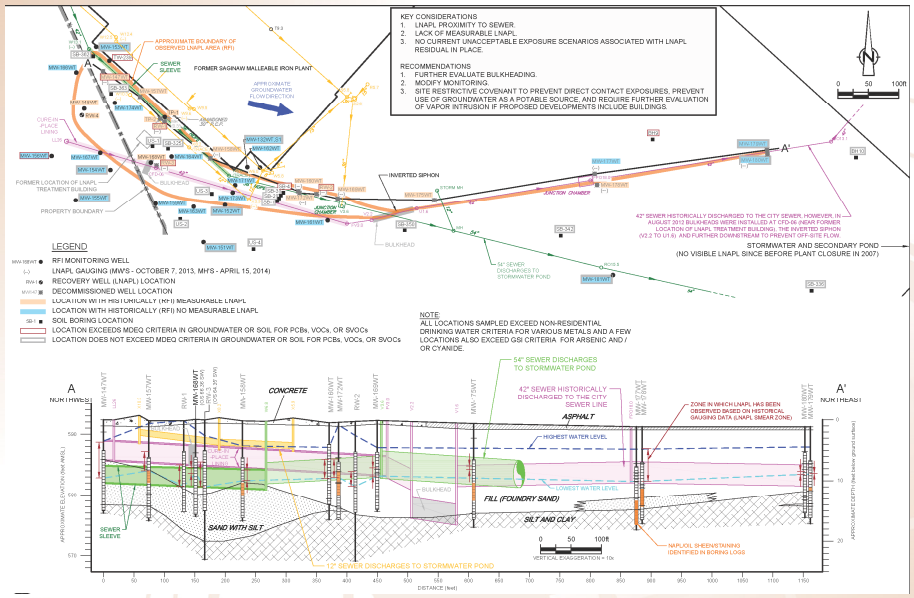

Southwest Plant LNAPL Area Plan and Profile

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2. Southwest Plant LNAPL Area

A. Background

- LNAPL was first observed in monitoring wells in the southwest corner of the Plant during the RI in March 1995
- Subsequent investigations were completed between June 1995 and August 1996 to determine the extent of LNAPL impacts and to provide additional data for design of a LNAPL and groundwater recovery and treatment system (completed in September 1997)
- An LNAPL fingerprint analyses was completed (January 2005)

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2. Southwest Plant LNAPL Area

A. Background, cont'd

- The storm sewer system intersects groundwater table
  - Since demolition, the groundwater surface has risen (rebounded) in the area of the former Plant
- Two large storm sewers pass through the LNAPL area. The bedding for the two sewers were investigated for potential preferential pathways
- The magenta colored sewer on the plan and profile figure historically discharged to the City sewer system further downstream at Outfall CFD-02 (several bulkheads have been installed)
- The green colored sewer on the plan and profile figure discharges to the stormwater pond which discharges into the secondary pond. The secondary pond has no outlet.

2. Southwest Plant LNAPL Area

A. Background, cont'd

- A letter to cease automated recovery of LNAPL in the Southwest Plant LNAPL area was submitted in August 2010
- MDEQ agreed passive recovery was appropriate in October 2010
- In November 2013, a draft memorandum was submitted to the MDEQ for review, summarizing the LNAPL evaluation activities completed in the Southwest Plant LNAPL Area and proposed activities moving forward
- As a follow-up a presentation was given on May 5, 2014

2. Southwest Plant LNAPL Area

A. Background, cont'd

- As a follow-up to the May 5, 2014 meeting, a Proposed Monitoring Plan was submitted to the MDEQ on May 27, 2014
- Comments on the Proposed Monitoring Plan were received on August 21, 2014.
- A redline of the plan was submitted to the MDEQ on September 8, 2014 (response pending)

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2. Southwest Plant LNAPL Area

B. Previous Characterization

- Investigation included:
  - 33 monitoring wells (including wells in sewer bedding)
  - 12 soil borings
  - 4 recovery wells
  - LNAPL, soil, and groundwater sampling
- Concentrations of PCBs detected during the RI were:
  - Non-detect to 9,600 ppm in LNAPL
  - Non-detect to 41 ppm in soil
  - No PCBs were reported in filtered groundwater samples
- LNAPL was characterized as an amber colored, light, viscous, multi-component mixture of petroleum based oils, containing PCBs

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2. Southwest Plant LNAPL Area

B. Previous Characterization, cont'd

- The sewers at the Site have been investigated extensively since 1996:
  - 326 manhole surveys were completed at the former SMI Plant and 84 were completed at Delphi Plant 2 (prior to Delphi separation from GM)
  - More than 3,000 ft of sewers at the Former SMI Plant were evaluated using a combination of video inspections, visual observations, and dye testing
  - This resulted in a comprehensive sewer map that was developed for the Site including the Southwest Plant LNAPL Area
- Potential on-site sources of LNAPL are the historical operations of the former SMI Plant

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2. Southwest Plant LNAPL Area

C. Previous Remedial Activities

- September 1995: Manual LNAPL recovery initiated from wells (bailing)
- April 1996: Repair of sewer that discharge to the stormwater pond
  - Various sections of the sewer (42" Ø concrete) that discharges to the stormwater pond, upstream of manhole W13.1 to manhole W6.8, were replaced to prevent LNAPL from entering the sewer
  - The two ends of a truncated 30" Ø sewer line which was previously abandoned was also located while completing the 42" Ø sewer repair
  - Approximately 4,300 gallons of LNAPL was removed from the 30" Ø abandoned sewer line and an additional 700 gallons of LNAPL was removed from the excavation
  - A recovery well (RW-1) was installed in the backfill of the 30" Ø abandoned sewer excavation to allow for ongoing LNAPL recovery

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2. Southwest Plant LNAPL Area

C. Previous Remedial Activities, cont'd

- June 1996: Additional sewer repairs
  - Approximately 600 ft of cure-in-place lining was installed in the 42" Ø sewer line that formerly discharged to the City between the former Plant 2 diversion chamber and the inverted siphon (manhole V2.2 and manhole U1.6)
  - Three additional recovery wells (RW-2, RW-3, and RW-4) were installed
- September 1997: Initiated operation of LNAPL and Groundwater Recovery and Treatment System:
  - Four recovery wells
  - An oil/water separator
  - A hydrogen peroxide system to control iron bacteria
  - Bag filters
  - GAC treatment

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2. Southwest Plant LNAPL Area

C. Previous Remedial Activities, cont'd

- July 1998: PCB impacted soil excavation
  - PCB impacted soil (up to 41 ppm) was excavated from a 40'x10' area to a depth of 1 ft, south of the Southwest Plant LNAPL Area
  - Confirmation samples confirmed that soils containing PCBs above industrial direct contact values were removed
- August 1998: Sewer Sleeve installation
  - Approximately 300 ft of 36" Ø HDPE pipe was installed between manhole W13.1 and W6.8 within the 42" Ø sewer line that discharges to the stormwater pond which discharges to the secondary pond
- Mid 1990's to 2000: More than 2,500 ft of sewers at the Site were cleaned by jetting and bucketing

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2. Southwest Plant LNAPL Area

C. Previous Remedial Activities, cont'd

- August 2000: Stormwater Pond Improvements
  - Oily material identified in the stormwater pond in 1998
  - PCBs were detected in the oily material and from sediment samples located adjacent to the active storm sewer discharge line that goes through the LNAPL impacted area, however Industrial Direct Contact values for soil were not exceeded
  - No PCBs were detected in surface water
  - As a result of the supplemental investigation sediments were stabilized using lime and fly ash and the Stormwater Pond was lined in August 2000

2. Southwest Plant LNAPL Area

C. Previous Remedial Activities, cont'd

- October 1998 to 2007: Stormwater Pond Inspections/Maintenance
  - Inspections of the stormwater pond were conducted weekly for the presence of LNAPL
  - Oil absorbent booms and containment booms were replaced, as necessary
  - LNAPL was occasionally skimmed off the stormwater pond
  - Weekly inspections and maintenance of the stormwater pond ceased in 2007 when the plant was closed. Periodic inspections of the stormwater pond have been conducted since the plant closed
  - LNAPL has not been observed in the stormwater pond since before 2007

2. Southwest Plant LNAPL Area

C. Previous Remedial Activities, cont'd

- 1997 to 2007: O&M of LNAPL and Groundwater Recovery and Treatment System
  - May 2001: the scavenger pump in RW-1 was switched to a skimmer pump, and RW-2, RW-3, and RW-4 continued to operate with scavenger pumps
  - October 2001: RW-4 was disconnected from the system and wells located on the Delphi Plant 2 property were excluded from gauging
  - 3,700 gallons of LNAPL recovered
  - December 2007: Operation of the system ceased when power was turned off, as a result of SMI closure
  - Periodic monitoring of LNAPL thicknesses and manual LNAPL removal (bailing) in area wells was completed during the operation of the system

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2. Southwest Plant LNAPL Area

C. Previous Remedial Activities, cont'd

- 2007 to Present: Post-LNAPL and Groundwater Recovery System Operation
  - 2007 to October 2013: Passive and/or manual recovery and monitoring has occurred periodically
  - July to August 2010: conducted a study to determine the effectiveness of passive recovery utilizing absorbent socks.
  - MDEQ approved use of passive recovery using absorbent socks instead of re-starting the system in October 2010
  - Measurable LNAPL (generally less than 0.1 ft present at four wells)
  - Late 2010: the water table rose above the top of a number of monitoring well screens due to groundwater rebound after plant demolition
  - April 2012: last measurable LNAPL reading

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2. Southwest Plant LNAPL Area

C. Previous Remedial Activities, cont'd

- 2007 to Present: Post-LNAPL and Groundwater Recovery System Operation, cont'd
  - October 2013: last LNAPL readings taken (no measureable LNAPL) prior to abandonment of the majority of monitoring wells in the area
  - 2007 to present: no LNAPL observed in the stormwater pond
- August 2011: Bulkheads installed in sewer that discharge to City
  - Flow directed to the City sewer from the 42" Ø sewer was bulkheaded at the inverted siphon (manhole V2.2 to manhole U1.6, at CFD-06, and further downstream where the 42" Ø sewer connects to the City 60" Ø sewer

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2. Southwest Plant LNAPL Area

C. Previous Remedial Activities, cont'd

- 2014: Quarterly Manhole inspections initiated in June
  - Nine manholes are inspected quarterly for the presence of LNAPL
  - During the first quarterly inspection in June, LNAPL was observed in three manholes (one on 30" abandoned sewer, X8.2, and W6.8). Absorbent booms were installed in each of the manholes.
  - Booms were removed in the second quarterly event in October with a saturation level of approximately 25% (< 2 gallons per boom). During the second quarterly event, there was no measurable product in the manholes inspected
- To date no LNAPL has been observed at the ground surface

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2. Southwest Plant LNAPL Area

D.1 LCSM - Release History

- Potential sources of LNAPL are the historical operational activities at the Former SMI Plant and adjacent property
  - Former SMI Plant closed in 2007
  - Former Delphi Plant 2 was closed in 2001

D.2 LCSM - Remedial History

- Recovery of LNAPL has been performed by various methods since 1995
  - Automated recovery system efficiency decreased significantly prior to water table submerging screens post-demolition (ratio of LNAPL recovered/water recovered decreased from high of 0.01 in 2000 to 0.0004 in 2006 and 2007)

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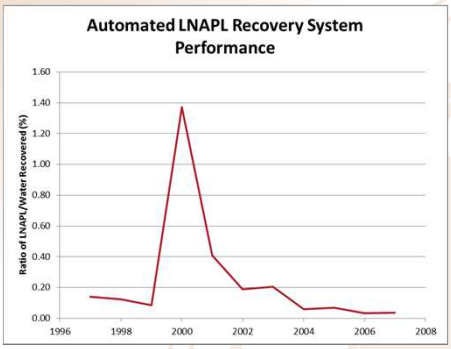
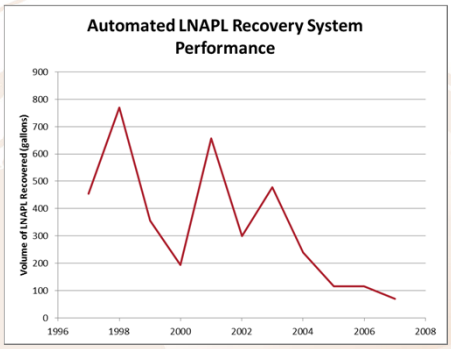
Annual LNAPL Recovery Performance





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2. Southwest Plant LNAPL Area

D.3 LCSM - Land Use

- Residual LNAPL within the confines of former heavy industrial site with future land use restricted to non-residential

D.4 LCSM - LNAPL Properties

- Amber colored, light, viscous, multi-component mixture of primarily petroleum based oils resembling motor oils
- LNAPL results from a waste characterization sample collected in June 2010 indicated the presence of PCBs at 17 ppm

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2. Southwest Plant LNAPL Area

D.5 LCSM - LNAPL Spatial Distribution

- Vertical impacts 4-14 ft bgs
- Extent of potentially mobile/recoverable LNAPL historically delineated by MWs
  - Limited measurable LNAPL detected mid-2010
  - Trace LNAPL thicknesses or no LNAPL detected prior to post-demo water table rise (submerging screens)
  - No measurable LNAPL in monitoring wells since April 2012 (including wells where screens are not submerged currently)
- Residual LNAPL impacts may extend from up-gradient property (from historical sources)

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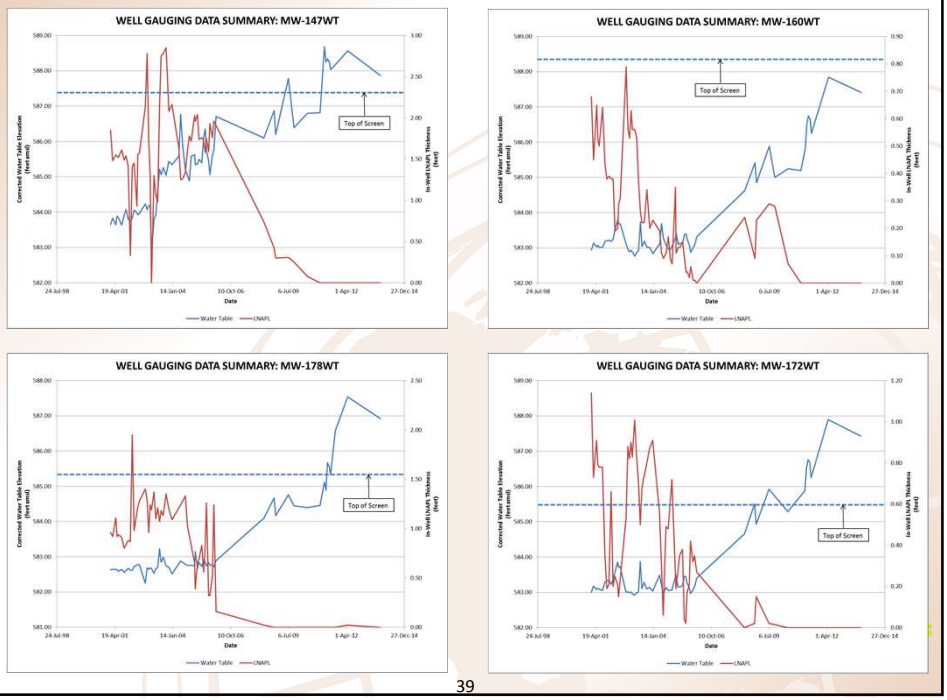

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2. Southwest Plant LNAPL Area

D.6 LCSM - LNAPL Mobility and Recoverability

- Only trace amounts of LNAPL observed recently and prior to water table submerging screens
  - de minimis mobility/recoverability condition
  - Post-demolition water table rise would have significantly smeared and further immobilized/submerged the limited mobile LNAPL observed prior
- Active recovery completed until 2007 when the SMI Plant was shut down
  - Recovery efficiency diminished prior to shut down and post-demolition water table rise
- MDEQ agreed passive recovery was appropriate in October 2010

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2. Southwest Plant LNAPL Area

D.7 LSCM - LNAPL Stability

- LNAPL stable based on:
  1. Time since possible release
  2. Historical LNAPL recovery performance
  3. Diminishing mobility/recoverability trend before post-demolition water table rise
  4. Significant post-demolition water table rise (further immobilization)
  5. De minimis mobility/recoverability of potential source zone(s)

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2. Southwest Plant LNAPL Area

D.8 LSCM - Potential Exposures

- The results for groundwater samples collected during the RI from the Southwest Plant LNAPL Area exceed current generic State of Michigan criteria for various metals, PCBs, SVOCs, and VOCs for GSI, Non-Residential Drinking Water, and Vapor Intrusion
- Groundwater and soil data from the RI was also evaluated in the HHE and concluded that there are no completed unacceptable exposure pathways following implementation of restrictive covenant

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2. Southwest Plant LNAPL Area

D.8 LCSM - Potential Exposures cont'd

- Exposures that exceed current State of Michigan Criteria will be addressed as identified below:
  - Drinking Water Pathway
    - This pathway is incomplete since the Site is serviced by municipal water supply
    - Use of groundwater as a potable source will be prohibited by Restrictive Covenant
  - Vapor Intrusion Pathway
    - This pathway is not currently complete as there are no buildings
    - Will include RRD template language for VI restriction for possible future redevelopment in Restrictive Covenant

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2. Southwest Plant LNAPL Area

D.8 LCSM - Potential Exposures cont'd

- GSI Pathway
  - Any remaining LNAPL is stable and is a significant distance from the Saginaw River (~1,000 ft)
  - Sewers routed through the LNAPL area discharge to the stormwater pond which empties into the Secondary Pond, however, no LNAPL has been observed in the stormwater pond since before 2007
  - Ongoing quarterly monitoring of nine manholes in the Southwest Plant LNAPL area including the three manholes with observed LNAPL. Including inspections of the stormwater pond and the Secondary Pond for the presence/absence of LNAPL. LNAPL, if present, will be recovered. Once there are four consecutive rounds of no measurable LNAPL at a given location, monitoring of that location will cease

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2. Southwest Plant LNAPL Area

D.8 LCSM - Potential Exposures cont'd

- Direct Contact
  - Not currently a relevant pathway as NAPL is located at least 4 ft bgs, however, there is a potential pathway in the future should the area be excavated for redevelopment or other purposes
  - A restrictive covenant will be placed on the Southwest Plant LNAPL Area that identifies that caution is required and proper precautions should be in place while excavating or conducting other work in the area, and that requires maintaining 2 ft of cover over the area following any work and to properly manage any impacted material encountered while performing the work

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2. Southwest Plant LNAPL Area

E. LNAPL Remedial Decision Tree

- Risk-based LNAPL management decision-making process developed in conjunction with MDEQ
  - Implemented at RACER sites across Michigan
  - Strategies based on realistic assessment of risk and potential benefit of engineered remedies
  - The process can be implemented at any point in the life of a project to determine an appropriate risk-based LNAPL management strategy (e.g., determine whether to start, stop or continue LNAPL recovery if already implemented)
- Consistent with MDEQ Petroleum NAPL Policy

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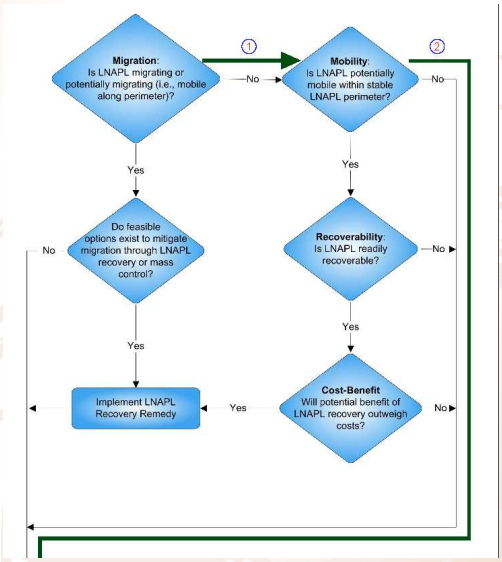
LNAPL Saturation Concerns (mobility and migration issues)
- Potential for LNAPL to spread and create new or increased risk (migration toward surface water, property boundary, underground utilities)
- Aesthetic/Nuisance issues



1. AGE, LNAPL WELL OBSERVATIONS SINCE 2000 INDICATE LNAPL IS STABLE.
2. NO MEASURABLE LNAPL IN WELLS, SHEEN OBSERVED (DE MINIMIS MOBILITY CONDITION, INSUFFICIENT LNAPL PRESENT TO EVALUATE TRANSMISSIVITY)

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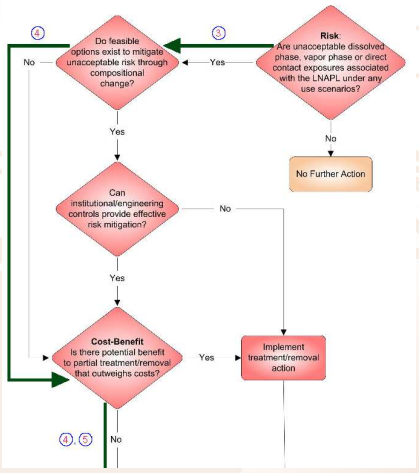
LNAPL Compositional Concerns (potential exposure/risk issues):
- Explosive hazards (vapor accumulation in confined spaces/ utilities, open excavations)
- Dissolved-phase concentrations (migration toward surface water bodies or groundwater supply wells)
- Vapor-phase concentrations (vapor intrusion/Long-term exposure risk)
- Direct contact or ingestion



3. NO CURRENT RISK DUE TO LNAPL PRESENCE DIRECT CONTACT REMAINS A POTENTIAL FUTURE CONCERN IN THE EVENT OF SUBSURFACE EXCAVATION.
4. COMPOSITIONAL CHANGE WILL NOT MITIGATE POTENTIAL EXPOSURE TO LNAPL IN THE EVENT OF EXCAVATION.
5. RESTRICTIVE COVENANT WILL PROVIDE EFFECTIVE MITIGATION AND WILL BE THE MOST SUSTAINABLE APPROACH.

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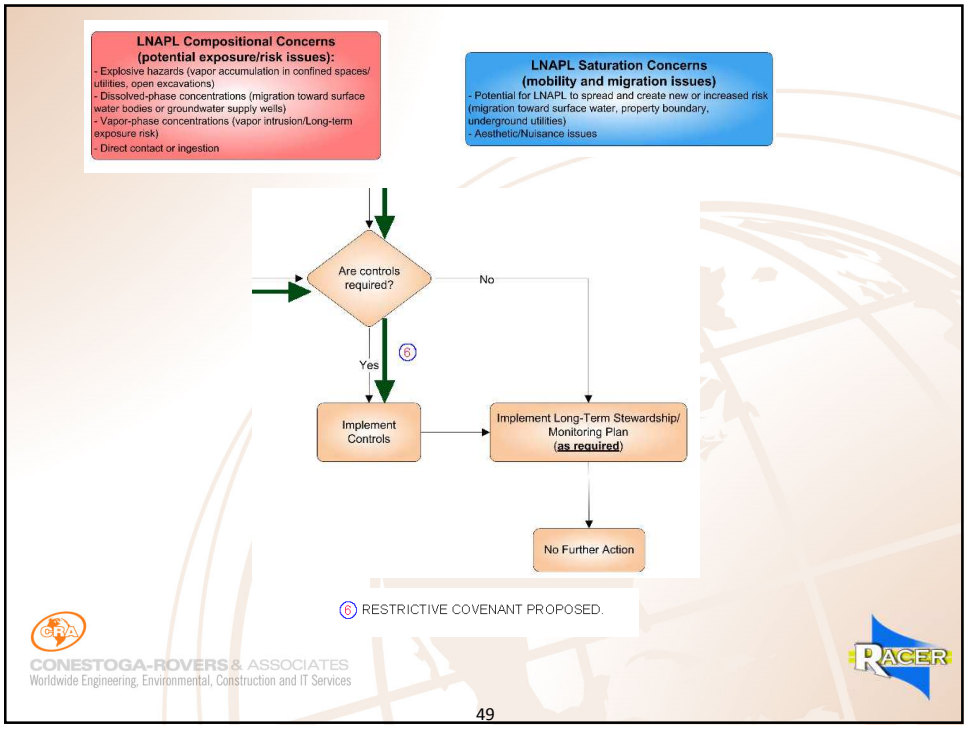

2. Southwest Plant LNAPL Area

F. Conclusions

- LNAPL is a viscous, non-volatile motor oil range fuel type
- LNAPL is effectively immobile, unrecoverable and stable/non-migrating
- LNAPL has the potential to migrate in the sewers, however, due to the current state of the water table (significantly above the sewers), it is unlikely LNAPL will migrate to the stormwater pond. In addition, LNAPL has not been observed in the stormwater pond since before 2007
- No current unacceptable exposure pathways
- Proposed Site restrictive covenant will prevent any potential future unacceptable exposure pathways

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2. Southwest Plant LNAPL Area

G. Recommendations

- Proposed Monitoring
  - Discontinue monitoring of remaining wells for LNAPL with water levels above the screen and abandon
  - Collect quarterly depth to LNAPL/water in nine manholes in the Southwest Plant LNAPL area (including the three manholes with LNAPL observed in June 2014)
  - Inspect the stormwater pond and the Secondary Pond for the presence/absence of LNAPL. LNAPL, if present, will be recovered.
  - **Endpoint:** Once there are four consecutive rounds of no measurable LNAPL at a given location, monitoring of that location will cease.
  - **Reporting:** Annual data summary reports

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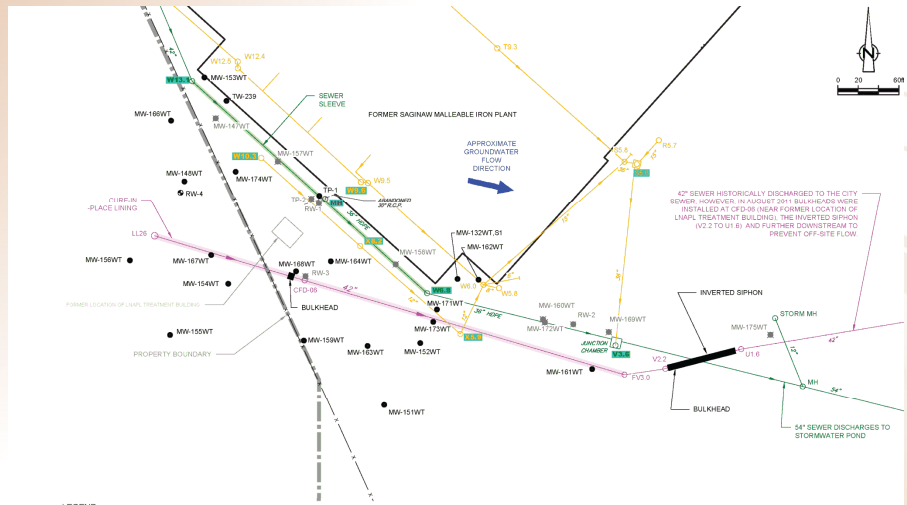

figure 2
PROPOSED MONITORING PLAN
SOUTHWEST PLANT LNAPL AREA
MALLEABLE IRON INDUSTRIAL LAND
Saginaw, Michigan

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2. Southwest Plant LNAPL Area

G. Recommendations cont'd

- Implement restrictive covenant
  - Prevent direct contact exposures
  - Prevent use of groundwater as a potable source
  - Require further evaluation of vapor intrusion pathway should future development include buildings in vicinity
- **Contingency:** In the event measurable LNAPL continues to be observed in the manholes a proposed investigation will be submitted to MDEQ within sixty days of the annual report

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3. QUENCH PIT AREA

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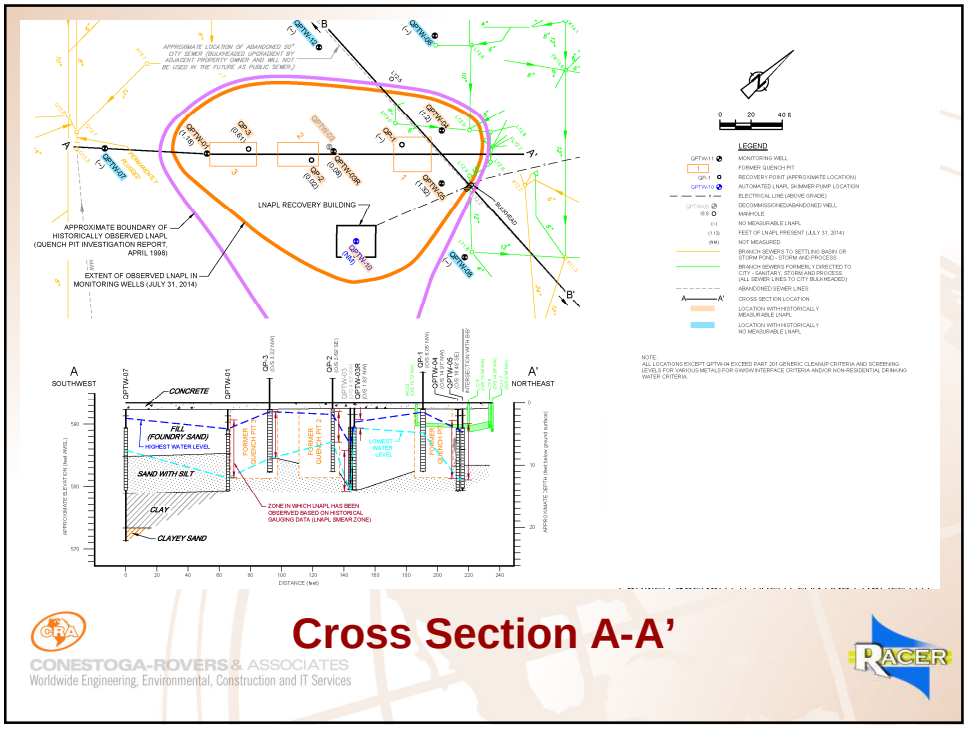

Cross Section A-A'

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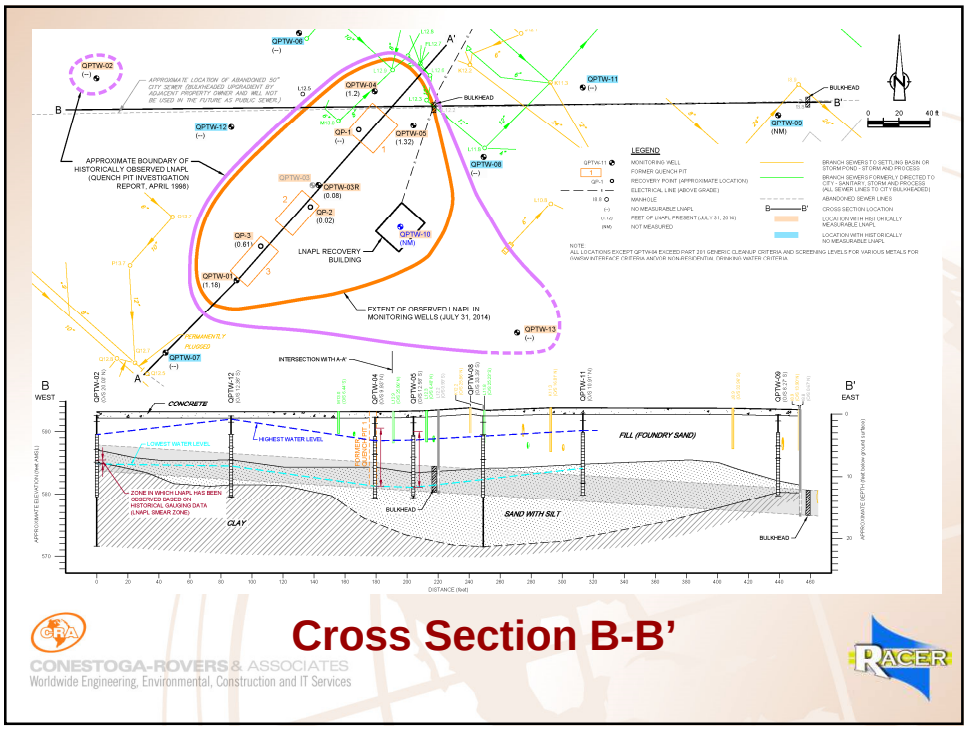

Cross Section B-B'

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3. Quench Pit Area

A. Background

- The Quench Pit Area is located in the former Annealing Department (heat treatment) in the south-central portion of the former SMI Plant
- The area contained three quench pits, installed in the late 1960's which each held 25,000 gallons of quench oils used in the heat treatment process
- In 1997, the quench pits were emptied, cleaned and leaks repaired.
- In January 1998 smaller stainless steel shells were built inside the quench pits to act as primary containment while the original stainless steel structures acted as secondary containment

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3. Quench Pit Area

B. Previous Characterization

- The Plant periodically analyzed the quench oils for PCBs and detections were noted in 1977 and 1979. Since 1979, PCBs were not detected in the quench oils used at the Plant
- Quench Pit Investigation (March 1997) included:
  - 13 monitoring wells (including wells in sewer bedding)
  - groundwater and LNAPL sampling
- Concentrations of PCBs detected in the Quench Pit Area during the Investigation were:
  - Non-detect to 19 ppm in LNAPL
  - No PCBs were reported in groundwater samples

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3. Quench Pit Area

B. Previous Characterization, cont'd

- Samples of LNAPL were collected from the Quench Pit monitoring wells in March 2007
- Concentrations of PCBs detected in the samples ranged from 2.7ppm to 6.0 ppm
- During demolition, a composite LNAPL sample was collected from Quench Pit #2 and #3 in June 2010 for waste characterization and reported PCBs as non-detect
- LNAPL was characterized as being non-volatile and viscous, having similar properties to hydraulic oil

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3. Quench Pit Area

C. Previous Remedial Activities

- 1997: During a Site-wide sewer investigation LNAPL was identified in a 50-inch abandoned sewer line immediately adjacent to former Quench Pit #1
  - 4,000 gallons of LNAPL were removed
  - Two bulkheads were installed on the 50-inch abandoned sewer downgradient of the quench pits
  - A third bulkhead was previously installed upgradient from the Quench Pit Area by the adjacent facility
- 1997 to 2002: approximately 6,500 gallons of LNAPL was manually recovered (bailed)

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3. Quench Pit Area

C. Previous Remedial Activities, cont'd

- February 2002: automated LNAPL recovery system (skimmer pump) was installed in QPTW-03
- 2002 to 2007: O&M of LNAPL recovery system
  - ~2,400 gallons of LNAPL recovered from QPTW-03
  - Periodic monitoring of LNAPL thicknesses and manual LNAPL removal (bailing) in area wells was completed during the operation of the system
- December 2007: Operation of the LNAPL recovery system ceased as a result of closure activities
- December 2007 to present: Ongoing periodic monitoring and manual recovery of LNAPL from wells
- June 2010: QPTW-03 was decommissioned due to damages sustained during plant demolition

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3. Quench Pit Area

C. Previous Remedial Activities, cont'd

- 2007 to 2010: Demolition of the SMI Plant
  - Quench pits were emptied of product when the plant was shut down in 2007
  - Bulkheads were installed (green) to eliminate all discharges from the Site to the City (pink)
  - Summer 2010: Demolition of quench pits
    - Stainless steel shells were removed and the remaining concrete structure sidewalls and floors were punched through to ensure the pits do not act as a "bathtub"
    - 55,000 gallons of LNAPL were removed from the quench pit excavations and disposed of in accordance with applicable laws
    - Three LNAPL recovery wells were installed, one in each quench pit excavation and were added to the monitoring program

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3. Quench Pit Area

C. Previous Remedial Activities, cont'd

- October 2011: LNAPL building from the Southwest Plant LNAPL Area was moved to the former Quench Pit Area and the LNAPL skimmer pump was installed in QPTW-10 (well reporting the greatest thickness of LNAPL)
- January 2012: Skimmer pump in QPTW-10 was commissioned
  - To date 60 gallons of LNAPL has been recovered
- October 2013: replacement well was installed within 3-feet of the abandoned QPTW-03, to confirm presence/absence of LNAPL

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3. Quench Pit Area

C. Previous Remedial Activities, cont'd

- QPTW-03R was added to the monitoring program. The most recent reading (October 2014) reported no measurable LNAPL. Since the installation of QPTW-03R, the greatest thickness of LNAPL measured was 0.37 feet in April 2014
- To date no LNAPL has been observed at the ground surface

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3. Quench Pit Area

D.1 LCSM - Release History

- Source of LNAPL is the three former quench pits
  - Former SMI Plant closed in 2007 and significant LNAPL (55,000 gallons) removed during the summer of 2010

D.2 LCSM - Remedial History

- Recovery of LNAPL has been performed by various methods since 1997
  - 55,000 gallons of oil were removed from the quench pit excavations during their decommissioning
  - Various efforts involving manual bailing and skimming pumps have recovered an additional 60 gallons (since 2012)

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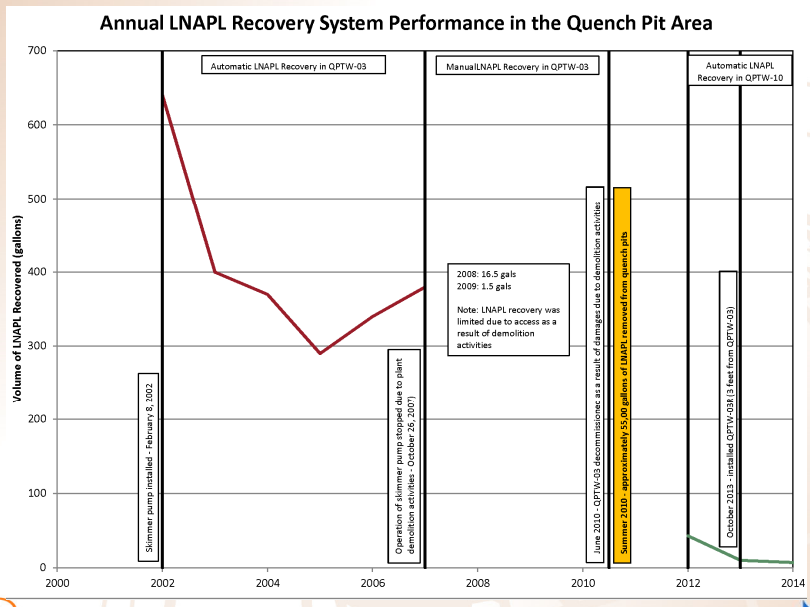

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3. Quench Pit Area

D.3 LCSM - Land Use

- Residual LNAPL within the confines of former heavy industrial site with future land use restricted to non-residential

D.4 LCSM - LNAPL Properties

- Viscous, non-volatile hydraulic oil range fuel type
- LNAPL results have indicated the presence of PCBs, however, most recent sampling in 2010 reported ND

D.5 LCSM - LNAPL Spatial Distribution

- Vertical impacts 1.5-13.5 ft bgs
- Extent of potentially mobile/recoverable LNAPL delineated by MWs (approximately 200 ft by 200 ft in size)

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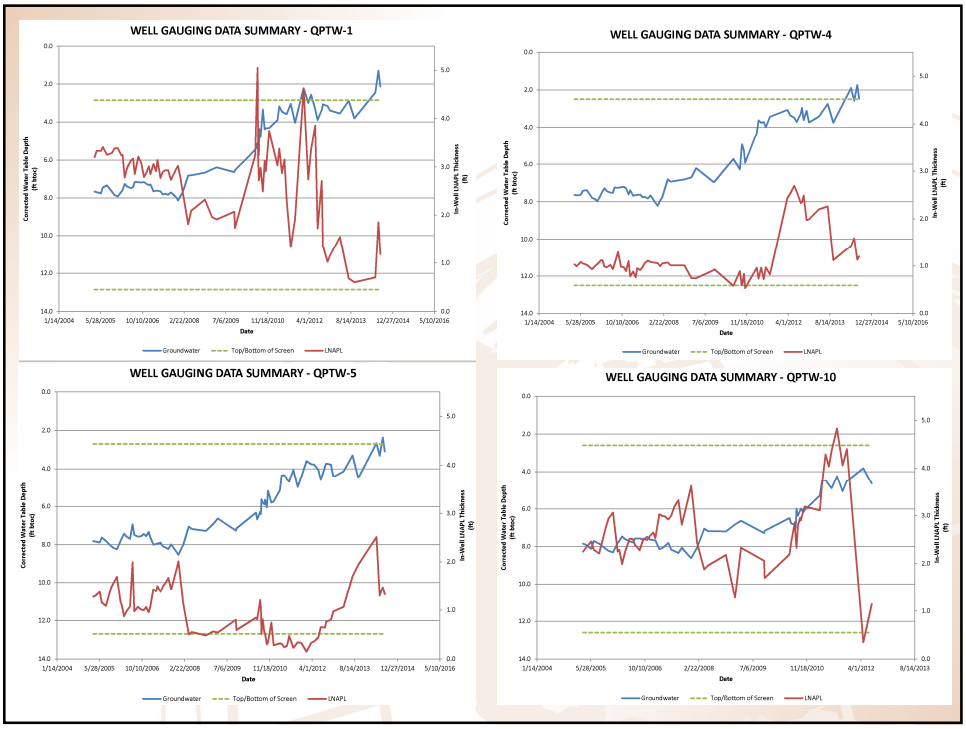

3. Quench Pit Area

D.6 LCSM - LNAPL Mobility and Recoverability

- Fraction of LNAPL that remains potentially mobile is likely negligible given:
  - The age of the LNAPL (>4 years since source of LNAPL removed – demolition of quench pits)
  - Historical recovery efforts that were continued until performance was observed to diminish to very low levels
  - Post-demolition water table rise would have significantly smeared and further immobilized/submerged the limited mobile LNAPL observed prior
- LNAPL transmissivity results are all within MDEQ de minimis range, with the possible exception of QPTW-10
- Therefore, LNAPL is predominantly present at residual saturation (i.e., effectively immobile, unrecoverable)

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3. Quench Pit Area

D.7 LSCM - LNAPL Stability

- LNAPL stable based on:
  1. The footprint of where LNAPL is observed in wells has decreased over time
  2. Time since possible release
  3. Well gauging, remedial history, and LNAPL transmissivity estimates confirm that the potential mobility of the LNAPL is very low
  4. Diminishing mobility/recoverability following demolition of quench pits
  5. Post-demolition water table rise (further immobilization)

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3. Quench Pit Area

D.8 LSCM - Potential Exposures

- The results of available groundwater samples collected in the Quench Pit Area exceed current generic State of Michigan criteria for various metals for GSI and Non-Residential Drinking Water
- Groundwater and soil data from the RI was also evaluated in the HHE and concluded that there are no completed unacceptable exposure pathways following implementation of restrictive covenant

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3. Quench Pit Area

D.8 LCSM - Potential Exposures cont'd

- Exposures that exceed current State of Michigan Criteria will be addressed as identified below:
  - Drinking Water Pathway
    - This pathway is incomplete since the Site is serviced by municipal water supply
    - Use of groundwater as a potable source will be prohibited by the Restrictive Covenant

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3. Quench Pit Area

D.8 LCSM - Potential Exposures cont'd

- GSI Pathway
  - Any remaining LNAPL is stable and is a significant distance from the Saginaw River (~1,500 ft)
  - Some sewers in the vicinity of the LNAPL area discharge to the former stormwater pond which empties into the Secondary Pond, however, no LNAPL has been observed in the stormwater pond since before 2007
  - Quarterly monitoring of select manholes is recommended to confirm presence/absence of LNAPL. LNAPL, if present, will be recovered. Once there are four consecutive rounds of no measurable LNAPL at a given location, monitoring at that location will cease

3. Quench Pit Area

D.8 LCSM - Potential Exposures cont'd

- Direct Contact
  - Not currently a relevant pathway as NAPL is located below a concrete slab, however, there is a potential pathway in the future should the area be excavated for redevelopment or other purposes
  - A restrictive covenant will be placed on the Quench Area that identifies that caution is required and proper precautions should be in place while excavating or conducting other work in the area, and that requires maintaining a minimum 6" concrete cover over the area following any work and to properly manage any impacted material encountered while performing the work

3. Quench Pit Area

E. LNAPL Remedial Decision Tree

- Risk-based LNAPL management decision-making process developed in conjunction with MDEQ
  - Implemented at RACER sites across Michigan
  - Strategies based on realistic assessment of risk and potential benefit of engineered remedies
  - The process can be implemented at any point in the life of a project to determine an appropriate risk-based LNAPL management strategy (e.g., determine whether to start, stop or continue LNAPL recovery if already implemented)
- Consistent with MDEQ Petroleum NAPL Policy

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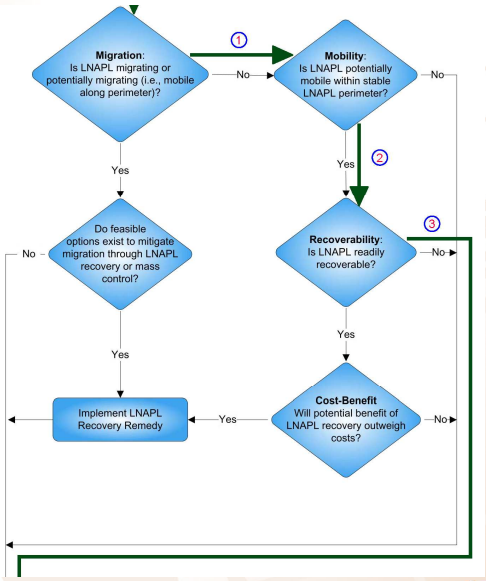
LNAPL Saturation Concerns (mobility and migration issues)
- Potential for LNAPL to spread and create new or increased risk (migration toward surface water, property boundary, underground utilities)
- Aesthetic/Nuisance issues



1. AGE, LNAPL WELL OBSERVATIONS INDICATE LNAPL IS STABLE.
2. LNAPL IN WELLS INDICATES POTENTIALLY MOBILE LNAPL WITHIN STABLE PERIMETER.
3. LNAPL TRANSMISSIVITY IN THE DE MINIMIS RANGE.

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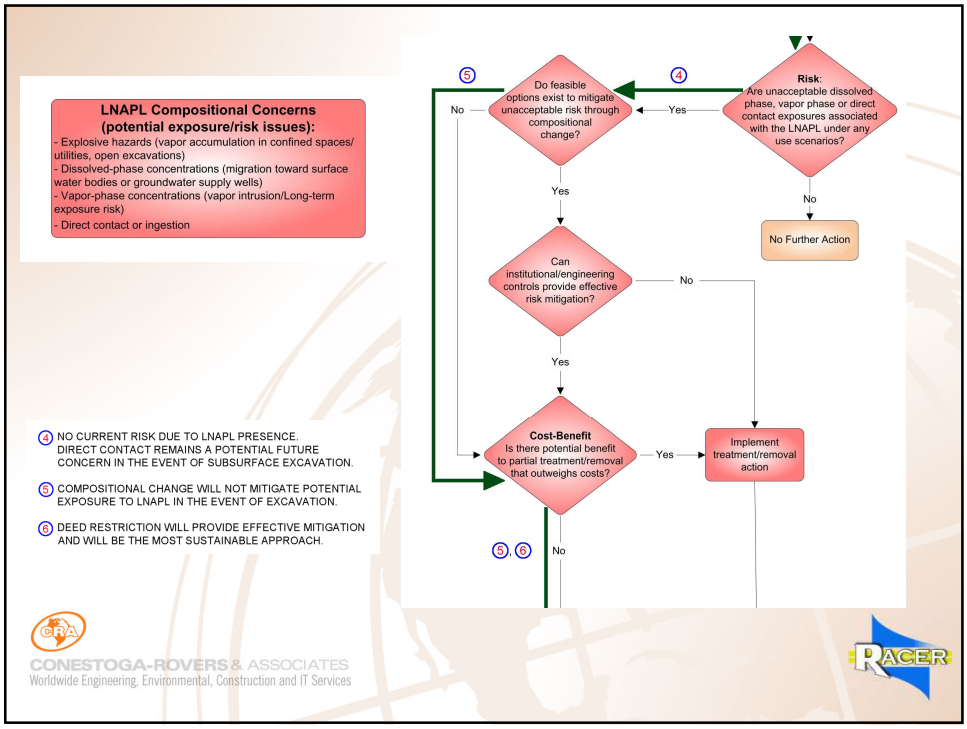
LNAPL Compositional Concerns
(potential exposure/risk issues):
- Explosive hazards (vapor accumulation in confined spaces/ utilities, open excavations)
- Dissolved-phase concentrations (migration toward surface water bodies or groundwater supply wells)
- Vapor-phase concentrations (vapor intrusion/Long-term exposure risk)
- Direct contact or ingestion
Risk:
Are unacceptable dissolved phase, vapor phase or direct contact exposures associated with the LNAPL under any use scenarios?
4
Yes
No
No Further Action
Do feasible options exist to mitigate unacceptable risk through compositional change?
5
No
Yes
Can institutional/engineering controls provide effective risk mitigation?
No
Yes
Cost-Benefit
Is there potential benefit to partial treatment/removal that outweighs costs?
Yes
Implement treatment/removal action
5, 6
No
4 NO CURRENT RISK DUE TO LNAPL PRESENCE. DIRECT CONTACT REMAINS A POTENTIAL FUTURE CONCERN IN THE EVENT OF SUBSURFACE EXCAVATION.
5 COMPOSITIONAL CHANGE WILL NOT MITIGATE POTENTIAL EXPOSURE TO LNAPL IN THE EVENT OF EXCAVATION.
6 DEED RESTRICTION WILL PROVIDE EFFECTIVE MITIGATION AND WILL BE THE MOST SUSTAINABLE APPROACH.
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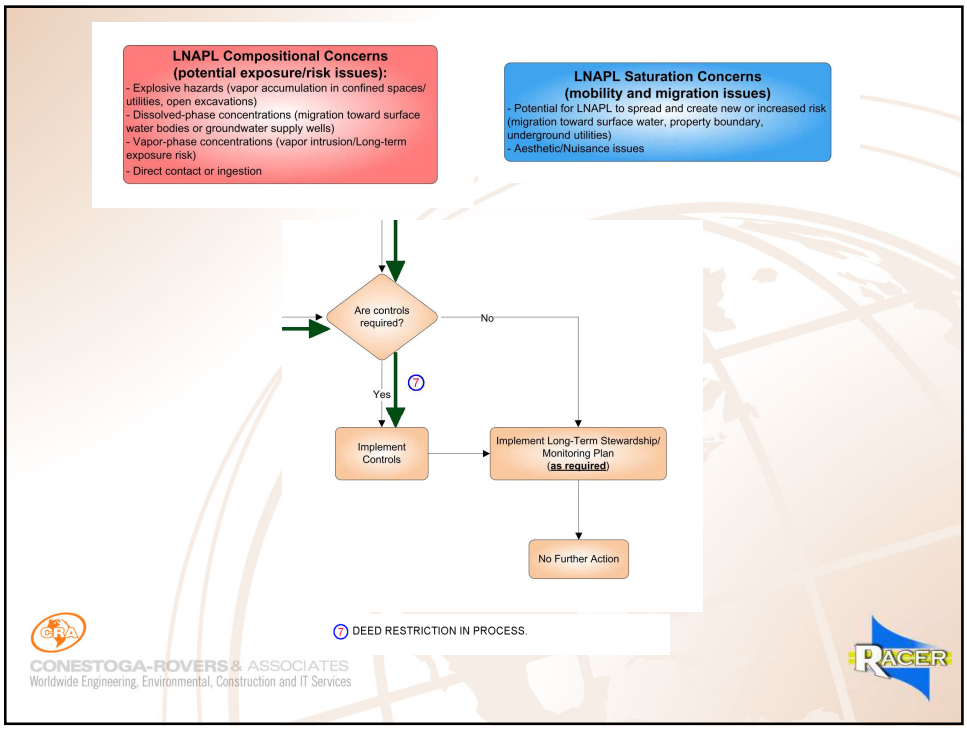
LNAPL Compositional Concerns
(potential exposure/risk issues):
- Explosive hazards (vapor accumulation in confined spaces/ utilities, open excavations)
- Dissolved-phase concentrations (migration toward surface water bodies or groundwater supply wells)
- Vapor-phase concentrations (vapor intrusion/Long-term exposure risk)
- Direct contact or ingestion
LNAPL Saturation Concerns
(mobility and migration issues)
- Potential for LNAPL to spread and create new or increased risk (migration toward surface water, property boundary, underground utilities)
- Aesthetic/Nuisance issues
Are controls required?
No
Yes
7
Implement Controls
Implement Long-Term Stewardship/ Monitoring Plan (as required)
No Further Action
7 DEED RESTRICTION IN PROCESS.
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3. Quench Pit Area

F. Conclusions

- LNAPL is a viscous, non-volatile hydraulic oil range fuel type
- LNAPL is effectively immobile, unrecoverable and stable/non-migrating overall in the bulk of the soil matrix
  - LNAPL transmissivity estimates are predominantly within MDEQ de minimis range
- LNAPL has the potential to migrate in the sewers, however, due to the current state of the water table (above the sewers), it is unlikely LNAPL will migrate to the stormwater pond. In addition, LNAPL has not been observed in the stormwater pond since before 2007
- No current unacceptable completed exposure pathways associated with the LNAPL
- Proposed Site restrictive covenant will prevent any potential future unacceptable completed exposure pathways

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3. Quench Pit Area

G. Recommendations

- Proposed Monitoring
  - Monitor downgradient sewer bedding monitoring wells (QPTW-09 and QPTW-11) quarterly to confirm LNAPL is not migrating along sewer bedding
  - Monitor all other Quench Pit monitoring wells (QPTW-01 to QPTW-13 and QP-1, QP-2, and QP-3) quarterly
  - Monitor nearby active sewers at MH K8.9 that ultimately discharge to the storm sewer then to the stormwater pond quarterly to confirm they are not impacted by LNAPL
  - Monitor nearby sewers that historically discharged to the City at MH 11.8, MH 13.0, MH L12.8, and MH L12.3 but have since been bulkheaded, quarterly to confirm they are not impacted by LNAPL
  - **Endpoint:** Monitoring at a given location will cease after 4 consecutive rounds of no measurable LNAPL or when all Quench Pit monitoring wells show transmissivity levels less than 0.5 ft^2/day
  - **Reporting:** Annual data summary reports

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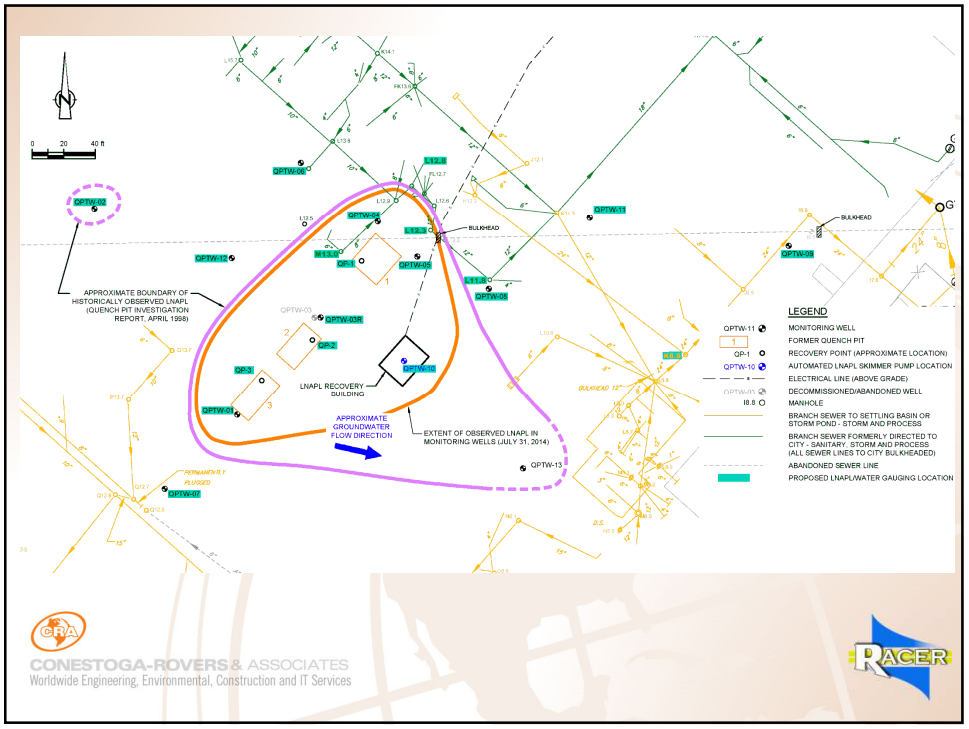

3. Quench Pit Area

G. Recommendations cont'd

- Implement restrictive covenant
  - Prevent direct contact exposures
  - Prevent use of Site groundwater as a potable source
  - Future land use restricted to non-residential
- Continue operation of skimmer pump in QPTW-10 until transmissivity levels are less than 0.5 ft^2/day
- Abandon monitoring wells following 4 consecutive rounds of no measurable LNAPL or when all Quench Pit monitoring wells show transmissivity levels less than 0.5 ft^2/day, with MDEQ concurrence
- **Contingency:** In the event measurable LNAPL is observed in the manholes or monitoring wells a proposed investigation will be submitted to MDEQ within sixty days of the annual report

4. Summary of Review

Southwest Plant LNAPL Area

- Conclusions
  - LNAPL is effectively immobile, unrecoverable and stable/non-migrating overall in the bulk of the soil matrix
  - LNAPL has the potential to migrate in the sewers, however, LNAPL has not been observed in the stormwater pond since before 2007
  - No current unacceptable exposure pathways associated with the LNAPL
  - Proposed Site restrictive covenant will prevent any potential future unacceptable exposures
- Recommendations
  - Implement restrictive covenant
  - Monitor LNAPL levels in nearby manholes, stormwater pond, and secondary pond to confirm LNAPL is not migrating

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4. Summary of Review

Quench Pit Area

- Conclusions
  - LNAPL is effectively immobile, unrecoverable and stable/non-migrating overall in the bulk of the soil matrix
  - LNAPL has the potential to migrate in the sewers, however, LNAPL has not been observed in the stormwater pond since before 2007
  - No current unacceptable exposure pathways associated with the LNAPL in place
  - Proposed Site restrictive covenant will prevent any potential future unacceptable exposures
- Recommendations
  - Implement restrictive covenant
  - Monitor LNAPL levels in nearby manholes and in Quench Pit monitoring wells to confirm LNAPL is not migrating or accumulating
  - Continue operating skimmer pump in QPTW-10 until transmissivity levels are less than 0.5 ft^2/day

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5. Discussion

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Attachment B
Proposed Monitoring Plant for Southwest Plant LNAPL Area – September 2014

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& ASSOCIATES

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Telephone: (519) 884-0510 Fax: (519) 884-0525
www.CRAworld.com

~~May 27~~September 8, 2014 Reference No. 007878

Ms. Susan Kaelber-Matlock ***Transmitted via E-mail***
Michigan Department of Environmental Quality
Remediation and Redevelopment Division
Saginaw Bay District Office
401 Ketchum Street, Suite B
Bay City, Michigan 48708

Dear Ms. Kaelber-Matlock:

Re: Proposed Monitoring Plan
Southwest Plant LNAPL Area
RACER Saginaw Malleable Industrial Land, Saginaw, MI

As discussed during our meeting on May 6, 2014, Conestoga Rovers & Associates (CRA) on behalf of Revitalizing Auto Communities Environmental Response (RACER) Trust is submitting the presentation provided during the meeting (Attachment A), and this proposed monitoring plan for the Southwest Plant Light Non Aqueous Phase Liquid (LNAPL) LNAPL area of the Former Saginaw Malleable Iron Plant (Site) in Saginaw, Michigan.

1.0 Background

LNAPL was first observed in monitoring wells in the Southwest Plant LNAPL area which were installed as part of the Remedial Investigation in 1995. Subsequent investigations were completed to define the extent of LNAPL impacts and investigate potential preferential pathways including the bedding of two large storm sewers that pass through the Southwest Plant LNAPL area. One of the two large storm sewers discharged to the City of Saginaw (City) sewer further downstream and bulkheads were placed on the sewer preventing further discharge of water from the Site into the City sewer in August 2011. The other sewer continues to discharge to the on-Site stormwater pond. Figure 1 presents an overall view of the Site and associated Site sewers.

Various remedial activities were completed to remove LNAPL and prevent infiltration of LNAPL into storm sewers including: sewer repairs (re-installation of sewers, sewer sleeve, cure-in-place lining), removal of approximately 5,000 gallons of LNAPL during a sewer repair, installation and operation of automated/active LNAPL recovery system for 10 years, and passive LNAPL recovery.

The automated LNAPL recovery system operated from 1997 until 2007 removing approximately 3,700 gallons of LNAPL, when it was turned off as a result of decommissioning activities at the plant. Prior to turning off the automated recovery system, the LNAPL recovery had decreased significantly and trace LNAPL thicknesses or no LNAPL were detected in wells prior to demolition of the plant structure in 2009. As a result of decommissioning activities the water table rebounded at the Site, further smearing and immobilizing the already relatively immobile/unrecoverable LNAPL. There has been no measurable LNAPL in monitoring wells since April 2012 (including wells where screens are not submerged). The residual LNAPL is effectively immobile, unrecoverable, and stable/non-migrating overall in the bulk of the soil matrix based on multiple lines of evidence including well observations, past LNAPL recovery performance, and hydraulic conditions. LNAPL has the potential to infiltrate into the sewers; however, the elevated water table post-demolition (above the sewers) is serving as a hydraulic barrier to LNAPL infiltration into the storm sewers and ultimately to the stormwater pond. LNAPL has not been observed in the stormwater pond since before 2007.

The following recommendations were made during the May 6, 2014 meeting to move toward closure for the Southwest Plant LNAPL area:

- Implement restrictive covenant to prevent direct contact exposures, prevent use of Site groundwater as a potable source, and to require further evaluation of vapor intrusion pathway should future development include buildings in the vicinity
- Further evaluate bulkheading sewers between Southwest Plant LNAPL area and the stormwater pond as a permanent control against the potential infiltration of LNAPL into and through the sewers to the stormwater pond
- Perform additional monitoring. The proposed monitoring program is further detailed in the remainder of the letter

See Attachment A for a copy of the presentation slides from the May 6, 2014 meeting which includes more detailed background information for the Site and the Southwest Plant LNAPL Area.

2.0 Proposed Monitoring Plan

CRA recommends monitoring the following locations for the presence/absence of LNAPL on a quarterly basis. The proposed monitoring will identify whether LNAPL persists at the manhole

on the abandoned 30-inch sewer resulting in the potential to migrate through the sewers should the water table drop significantly.

Manhole/other locations to be monitored:

- W6.8
- MH on abandoned 30-inch sewer line
- X8.2
- V3.6
- X5.9
- W13.1
- W10.3
- W9.6
- S5.6
- Stormwater pond/secondary pond
- Ground surface in Southwest Plant LNAPL area

Depth to water and LNAPL will be collected at all manhole locations. LNAPL, if present, will be recovered manually using a bailer or by installing LNAPL absorbent booms. LNAPL and used absorbent booms will be~~manually,~~ containerized, characterized, and disposed of off-Site at an approved facility. The monitoring will confirm the post-demolition seasonal range of water table fluctuation, which will indicate whether the water table will remain above the top of the sewers on a year-round basis.

The stormwater pond/secondary pond and the ground surface in Southwest Plant LNAPL area will also be inspected quarterly for the presence of visible LNAPL and if there is a significant precipitation event that results in a near-flood or flood condition.

Once there are four consecutive rounds of no measurable LNAPL at a given location, monitoring of that location will cease.

Remaining monitoring wells were not selected for monitoring as in most cases the water level is above the screen. Remaining monitoring wells will be abandoned when MDEQ has accepted that no further monitoring is required for this area.

Figure 2 presents the proposed monitoring locations in the Southwest Plant LNAPL Area. The cost to complete the proposed monitoring can be completed within the existing, approved 2014 budget.

3.0 Additional Activities

If LNAPL continues to collect in the manhole on the abandoned 30-inch sewer line, RACER may also evaluate bulkheading the sewer to the stormwater pond to eliminate the potential pathway for LNAPL to migrate to the stormwater pond. The evaluation will identify an appropriate location for the bulkhead and also evaluate whether bulkheading the sewer may cause LNAPL to come to the ground surface. The evaluation will be submitted to the MDEQ for review and approval.

4.0 Reporting

Annual data summary reports will be submitted to the MDEQ as part of the annual report currently submitted for the Site by December 15th and will summarize the LNAPL gauging data, inspection observations, the amount of product recovered, ~~and~~ the amount of product disposed of, if any, and recommendations for completing additional investigation, if necessary.

5.0 Contingency

LNAPL gauging information will be reviewed and submitted to MDEQ annually and ~~I~~in the event measurable LNAPL continues to be observed in the manholes ~~after eight routine quarterly monitoring events~~, a proposed investigation plan will be submitted to MDEQ within sixty (60) days of the ~~eight monitoring event~~annual report.

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In the event measurable LNAPL is identified at the ground surface or in the storm pond/secondary pond;

1. Spill Response materials, including oil-absorbent booms, will be maintained on-Site and utilized as an immediate action to the extent practical.
2. MDEQ will be notified via email within 24 hours.
3. A formal notification will be provided to MDEQ within 2 weeks. The formal notification will identify the location where LNAPL was identified, initial response activities, and any proposed measures to be implemented to mitigate the situation. The formal notification will also include a schedule for implementation, if appropriate.
4. An evaluation will be prepared and submitted to MDEQ within 60 days of the initial date LNAPL was identified at the ground surface or in the storm/secondary pond. The evaluation will identify the need and scope for additional investigation, and identify and evaluate ways to prevent further migration of LNAPL, and prevent future occurrences with a focus on bulkheading (other methods will be considered that may be technically effective). The evaluation will also include a schedule for implementation.

Please contact me if you would like to discuss this matter further.

Yours truly,

CONESTOGA-ROVERS & ASSOCIATES

Michael R. Tomka, P.E.

JEP/kf/3

Encl. Figure 1 – Site Plan
Figure 2 – Proposed Monitoring Locations
Attachment A – May 6, 2014 Presentation – Southwest Plant LNAPL Area Status

cc: Rhonda Klann, MDEQ (via e-mail)

Patricia Williams, MDEQ (via e-mail)
Ann Persons, MDEQ (via e-mail)
David Favero, RACER (via e-mail)
Lisa Coffey, Arcadis (via e-mail)
Matt Rousseau/John-eric Pardys, CRA (via e-mail)

Attachment C
Inspection Checklists

SAGINAW MALLEABLE INDUSTRIAL LAND - SITE INSPECTION

On-Site Personnel: Steve Hoevemeyer

Completed Date: 3/24/15

Completed By: SH

1. INSPECTIONS COMPLETED

[X] Southwest Plant LNAPL Area

[X] Quench Pit LNAPL Area

Weather mostly sun wind 5-10 mph

Temperature low 30's

2. SOUTHWEST PLANT LNAPL AREA

[N] Is there LNAPL present at the ground surface in the Southwest Plant LNAPL area?

[N] Is there LNAPL present at the stormwater pond?

[N] Is there LNAPL present at the secondary pond?

[Y] LNAPL Gauging

Manhole	LNAPL Reading (ft bgs)	Water Reading (ft bgs)	Amount of Product (feet)	Comments (amount bailed, date absorber sock installed, % sock saturated)
W6.8		7.58		sheen
V3.6		4.99	—	
MH on abandoned 30" line		4.51		sheen
X8.2		4.29		sheen
X5.9		7.47		
W13.1		4.79		
X10.3		3.20		
W9.6		5.13		
S5.6		4.63		ice
FV3.0		4.09		a little floating scum

3. QUENCH PIT AREA

[N] Is there LNAPL present at the ground surface in the Quench Pit area?

[Y] Is the LNAPL building secure?

[Y] Is skimmer pump running?

[Y] LNAPL Gauging

Monitoring Well	LNAPL Reading (ft bgs)	Water Reading (ft bgs)	Amount of Product (feet)	Comments (amount bailed, absorbent sock installed)
QP2	6.30	6.51	0.21	
QP3	6.34	6.36	0.02	
QPTW1	3.14	4.51	1.37	1/4 gal
QPTW4	3.02	4.66	1.64	1/4 gal
QPTW5	3.70	5.11	1.41	1/4 gal

Monitoring Well	Water Reading (ft bgs)	Comments	Monitoring Well	Water Reading (ft bgs)	Comments
QP1	7.55		QPTW10	pump	
QPTW2	3.20		QPTW11	4.04	
QPTW3R	3.55 / 3.56	LNAPL	QPTW12	3.31	
QPTW7	froze - ice		QPTW13	4.12	
QPTW8	4.14		MHM13.0	dry	
QPTW9	4.49		MHL11.8	4.50	

Amount of Product in Tote 55 gals

Notes

W6.0 4.52

SAGINAW MALLEABLE INDUSTRIAL LAND - SITE INSPECTION

On-Site Personnel: Steve Hoevemeyer
SH

Completed Date: 6/17/15
Completed By: SH

1. INSPECTIONS COMPLETED

[X] Southwest Plant LNAPL Area
[X] Quench Pit LNAPL Area

Weather: part sun high 60's
Temperature: wind ≈ 5 mph

2. SOUTHWEST PLANT LNAPL AREA

[N] Is there LNAPL present at the ground surface in the Southwest Plant LNAPL area?
[N] Is there LNAPL present at the stormwater pond?
[N] Is there LNAPL present at the secondary pond?
[Y] LNAPL Gauging

Manhole	LNAPL Reading (ft bgs)	Water Reading (ft bgs)	Amount of Product (feet)	Comments (amount bailed, date absorber sock installed, % sock saturated)
W6.8	—	4.59	—	a few drops of LNAPL, slight sheen
V3.6	—	4.69	—	slight sheen
MH on abandoned 30" line	—	3.46	—	sheen
X8.2	—	4.30	—	
X5.9	—	4.19	—	
W13.1	—	5.53	—	
X10.3	—	3.13	—	
W9.6	—	4.44	—	
S5.6	—	~~4.87~~ sed	—	
FV3.0	—	3.15	—	slight sheen + a little scum

3. QUENCH PIT AREA

[N] Is there LNAPL present at the ground surface in the Quench Pit area?
[Y] Is the LNAPL building secure?
[Y] Is skimmer pump running?
[Y] LNAPL Gauging

Monitoring Well	LNAPL Reading (ft bgs)	Water Reading (ft bgs)	Amount of Product (feet)	Comments (amount bailed, absorbent sock installed)
QP2	5.53	5.79	0.26	
QP3	5.18	5.20	0.02	
QPTW1	1.25	3.31	1.86	1/3 gal
QPTW4	2.05	3.51	1.46	1/4 gal
QPTW5	2.59	4.77	2.18	3/8 gal

Monitoring Well	Water Reading (ft bgs)	Comments	Monitoring Well	Water Reading (ft bgs)	Comments
QP1	6.51		QPTW10	pump - adjust level	
QPTW2	under H2O		QPTW11	2.92	
QPTW3R	2.72/3.36	product	QPTW12	2.33	
QPTW7	2.49		QPTW13	3.17	
QPTW8	3.08		MHM13.0	2.63	
QPTW9	3.75		MHL11.8	3.72	

Amount of Product in Tote: 55 gals

Notes

W6.0 4.27' NO LNAPL
W12.4 4.87 NO LNAPL

lots of rain last few days

SAGINAW MALLEABLE INDUSTRIAL LAND - SITE INSPECTION

On-Site Personnel: Steve Hoevemeyer
ALL

Completed Date: 9/9/15
Completed By: SH

1. INSPECTIONS COMPLETED

[X] Southwest Plant LNAPL Area
[X] Quench Pit LNAPL Area

Weather cloudy high 60's
Temperature wind ≈ 5mph

2. SOUTHWEST PLANT LNAPL AREA

[N] Is there LNAPL present at the ground surface in the Southwest Plant LNAPL area?
[N] Is there LNAPL present at the stormwater pond?
[N] Is there LNAPL present at the secondary pond?
[X] LNAPL Gauging

Manhole	LNAPL Reading (ft bgs)	Water Reading (ft bgs)	Amount of Product (feet)	Comments (amount bailed, date absorber sock installed, % sock saturated)
W6.8		4.99		few drops - little sheen
V3.6		5.13	—	
MH on abandoned 30" line		3.67		few drops - little sheen
X8.2		4.26	—	
X5.9		4.62	—	
W13.1		4.97		slight sheen
X10.3		3.11	—	
W9.6		5.31	—	
S5.6		6.30	—	
FV3.0		3.55	—	floating scum - less than 1/16"

3. QUENCH PIT AREA

[N] Is there LNAPL present at the ground surface in the Quench Pit area?
[Y] Is the LNAPL building secure?
[N] Is skimmer pump running?
[Y] LNAPL Gauging

Monitoring Well	LNAPL Reading (ft bgs)	Water Reading (ft bgs)	Amount of Product (feet)	Comments (amount bailed, absorbent sock installed)
QP2	5.36	5.71	0.35	4" well 8oz. bailed
QP3	5.09	5.12	0.03	
QPTW1	1.11	3.81	2.70	1/2 gal bailed
QPTW4	2.64	4.09	1.45	1 qt. bailed
QPTW5	2.49	5.30	2.81	1/2 gal bailed

Monitoring Well	Water Reading (ft bgs)	Comments	Monitoring Well	Water Reading (ft bgs)	Comments
QP1	6.12		QPTW10	2.85/2.99	0.14
QPTW2	1.84		QPTW11	3.08	
QPTW3R	product 2.46/2.74 H_2O		QPTW12	2.59	
QPTW7	2.36		QPTW13	3.17	
QPTW8	3.10		MHM13.0	2.66	
QPTW9	3.96		MHL11.8	2.67	

Amount of Product in Tote 70

Notes

W6.0 - 4.60 H_2O

W12.4 - 4.41 H_2O

L12.3 3.69

SAGINAW MALLEABLE INDUSTRIAL LAND - SITE INSPECTION

On-Site Personnel: Steve Hoevemeyer

Completed Date: 12/4/15

Completed By: SH

1. INSPECTIONS COMPLETED

[X] Southwest Plant LNAPL Area

[X] Quench Pit LNAPL Area

Weather cloudy; wind ≈ 5mph

Temperature high 30's

2. SOUTHWEST PLANT LNAPL AREA

[N] Is there LNAPL present at the ground surface in the Southwest Plant LNAPL area?

[N] Is there LNAPL present at the stormwater pond?

[N] Is there LNAPL present at the secondary pond?

[Y] LNAPL Gauging

Manhole	LNAPL Reading (ft bgs)	Water Reading (ft bgs)	Amount of Product (feet)	Comments (amount bailed, date absorber sock installed, % sock saturated)
W6.8		5.26	slight sheen	
V3.6		5.34	slight sheen	
MH on abandoned 30" line		4.77	sheen	
X8.2		4.26		
X5.9		4.88	very slight sheen	
W13.1		5.23	very slight sheen	
X10.3		3.13		
W9.6		5.53		
S5.6		6.57		
FV3.0	4.48	4.49	oily scum - boom installed	

3. QUENCH PIT AREA

[N] Is there LNAPL present at the ground surface in the Quench Pit area?

[Y] Is the LNAPL building secure?

[Y] Is skimmer pump running?

[Y] LNAPL Gauging

Monitoring Well	LNAPL Reading (ft bgs)	Water Reading (ft bgs)	Amount of Product (feet)	Comments (amount bailed, absorbent sock installed)
QP1		8.25		
QP2	6.88	7.35	0.47	bailed 1/8 gal
QP3	6.39	6.40	0.01	
QPTW1	3.48	4.70	1.22	bailed 1/4 gal
QPTW2		3.85		
QPTW3R		4.14		drops of LNAPL
QPTW4	3.51	5.56	2.05	bailed 1/3 gal
QPTW5	4.10	6.38	2.28	bailed 1/3 gal
QPTW7		3.78		
QPTW10		pump - removed ≈ 1.5 gals since 11/23		
QPTW12		3.84		
QPTW13	4.55			thick LNAPL - unable to get H2O level

Amount of Product in Tote 75

Notes

M13.0 - dry L12.4 - 4.67 W12.4 - dry

L11.8 - 4.46 W6.0 - 4.95 very slight sheen

Attachment D
LNAPL Transmissivity Estimation

Attachment D

LNAPL Transmissivity Estimation – Manual Skimming Technique

Field Procedure

This field procedure is a simplified version of the methodology presented in ASTM International Standard E2856-13 *Standard Guide for Estimation of LNAPL Transmissivity*. The manual skimming procedure provides a way to quantify LNAPL recoverability through the estimation of LNAPL transmissivity based on LNAPL recovery rates observed during a test. This is different than the baildown technique, which depends on changes in LNAPL drawdown or in-well thickness observed following an initial purge of LNAPL from a well. The fundamental premise of the manual skimming technique is that LNAPL is removed from a well such that a relatively consistent level of LNAPL drawdown is maintained until a stabilized/consistent removal rate is observed. The basic field procedure is as follows:

1. Gauge the test well using an oil-water interface probe and record initial depths to LNAPL and water. Calculate corresponding in-well LNAPL thickness.
2. Initially purge as much of the LNAPL from the test well as possible using a bailer or pump, taking care to minimize the amount of water removed with the LNAPL. Record the volume of LNAPL purged and the purging start and stop times.
3. Begin monitoring the recharge of LNAPL into the well by periodically recording depths to LNAPL and water and time of measurement.
4. Repeat removal of LNAPL from the well <u>before</u> the in-well thickness has recovered to 25 percent of its pre-purging value. Record start and stop times for each purging event and volume of LNAPL purged.
5. Repeat the purge/gauging cycle until the observed recovery rates are within 25 percent of each other for 3-4 purges (and there is not a consistent declining trend). Therefore, a complete test will consist of <u>at least</u> 4-5 purging events.
    a) The recovery rate for each purge event is estimated by dividing the volume of LNAPL recovered during the purge event (typically in gallons) by the time from the end of the previous purge event to the end of the current purge event (typically in minutes).

Notes:

- Most wells will not require tests to continue beyond one day.
- In the event of slow LNAPL recharge, re-purge the well whenever enough LNAPL accumulates to allow purging (i.e., do not wait for in-well thickness to recover to 25 percent of pre-test thickness if waiting will result in only 1 or 2 purges over the course of a day).
- ASTM suggests the following frequencies for purging/gauging events that can be adjusted in the field based on LNAPL recharge rate:
    - First hour: every 10 minutes (6 purges and/or measurements)
    - 2h – 4h: Every 30 minutes (4 purges and/or measurements)
    - 4h – End of Day: At least 1 purge and/or measurement
    - Subsequent Days (if needed): At least 2 purges and/or measurements

Data Reduction

The LNAPL recovery rates measured in the field are used to estimate LNAPL transmissivity according to the following equation (ASTM 2013, Eq. 16):

$$T_n = \frac{Q_n \ln\left(\frac{R_{oi}}{r_w}\right)}{2\pi S_n} \quad (1)$$

Where: T_n = LNAPL transmissivity (ft^2/day)

Q_n = stabilized LNAPL recovery rate (ft^3/day)

R_{oi} = radius of influence (ft)

r_w = well radius (ft)

S_n = LNAPL drawdown, the geometric mean of LNAPL drawdown values measured/calculated that correspond to the LNAPL recovery rate range used in the calculations (see below)

Notes:

1. ASTM indicates that assuming the $\ln(R_{oi}/r_w)$ term is equal to 4.6 is a common practice that introduces little additional error.
2. In cases where LNAPL recovery rates are still declining at the termination of a test, the use of the last LNAPL recovery rate estimate will provide a conservative/upper bound estimate of LNAPL transmissivity (i.e., continuation of the test would most likely only result in a lower LNAPL transmissivity estimate).
3. LNAPL transmissivity values are compared against a de minimis recoverability criterion of 0.5 ft^2/day as stipulated in MDEQ RRD Resource Materials Document 25-2014-01. The performance of LNAPL recovery where LNAPL recoverability is at de minimis levels is not considered to be technically feasible. In other words, LNAPL recovery where LNAPL recoverability is at de minimis levels would not be expected to provide much benefit since most of the LNAPL body will most likely be unaffected by the activity (i.e., most of the LNAPL is likely present as unrecoverable residual). The ITRC criterion can also serve as a practical end-point to LNAPL recovery activities.
4. The LNAPL drawdown calculation (S_n) will vary depending on whether LNAPL is present under confined, unconfined or perched conditions. The following discussion details the calculation of LNAPL drawdown at any given time (t) during a test for the different conditions.

Unconfined/Perched – Measured LNAPL Drawdown

The LNAPL drawdown at any point during the test is estimated via the following calculation where conditions are unconfined or perched (ASTM 2012):

$$S_{nt} = Z_{AN*} - Z_{AN(t)} \quad (2)$$

Where: Z_{AN*} = the air/oil interface (or top of LNAPL) elevation for equilibirium/pre-test conditions (ft)

$Z_{AN(t)}$ = the air/oil interface (or top of LNAPL) elevation at time t (ft)

S_{nt} = LNAPL drawdown at time t (ft)

Unconfined/Perched – Theoretical Maximum LNAPL Drawdown

The theoretical maximum LNAPL drawdown that can be achieved at a given site/well can be calculated to compare against measured LNAPL drawdown values according to the following methodology (ASTM 2012):

$$S_{n-unconfined} = b_n(1-\rho_r) \quad (3)$$

$$S_{n-perched} = b_{nf-perched} \quad (4)$$

Where: b_n = pre-recovery LNAPL thickness in a well (ft)

$b_{nf-perched}$ = LNAPL thickness in the formation, can be estimated as the difference between the equilibrium/pre-test air/LNAPL interface (or top of LNAPL) elevation and the elevation of the top of the perched layer in contact with the LNAPL (ft)

ρ_r = LNAPL relative density or specific gravity (dimensionless)

Notes:

1. Where measured LNAPL drawdowns exceed the theoretical maximum LNAPL drawdown, the following possibilities should be considered:
    a) The assumed conditions that the LNAPL is present under (unconfined, confined, perched) may not be correct. Review available well logs and historical well gauging data to confirm actual conditions.
    b) The extraction of water during the LNAPL purges may result in an apparent exaggeration of LNAPL drawdown. Where this is suspected as being the case, the theoretical maximum LNAPL drawdown should be used in lieu of the measured LNAPL drawdown values (where applicable).

Confined – Measured LNAPL Drawdown

For confined conditions, it will be necessary to have well logs available in order to assess the elevation of the bottom of the confining unit (in contact with LNAPL) and compare with measured elevations of the LNAPL/water interface (in-well) at a given location. Where the measured LNAPL/water interface is above the elevation of the confining unit and the water table is at equilibrium conditions, the following calculation is used to estimate LNAPL drawdown (ASTM 2012):

$$S_{nt} = b_{nf-confined}\left(\frac{1-\rho_r}{\rho_r}\right) \quad (5)$$

Where: $b_{nf-confined}$ = LNAPL thickness in the formation, can be estimated as the difference between the pre-test LNAPL/water interface elevation and the elevation of the bottom of the confining layer in contact with the LNAPL (ft)

Where the measured LNAPL/water interface is above the elevation of the confining unit and the water table is not at equilibrium conditions, the following calculation is used to estimate LNAPL drawdown (ASTM 2012):

$$S_{nt} = \frac{\left(Z_{AN*} - Z_{cc}\right)\rho_n - \left(Z_{NW(t)} - Z_{cc}\right)\rho_w - \left(Z_{AN(t)} - Z_{NW(t)}\right)\rho_n}{\rho_n} \quad (6)$$

Where: Z_{cc} = elevation of confining unit/LNAPL contact in formation (ft)

$Z_{NW(t)}$ = elevation of LNAPL/water interface in well at time t (ft)

Z_{AN*} = elevation of air/LNAPL interface in well for equilibrium conditions (ft)

ρ_n = LNAPL density (lb/ft^3)

ρ_w = groundwater density (lb/ft^3)

Notes:

1. Examples of non-equilibrium conditions include significant/frequent water table fluctuations (e.g., tidal areas) or recent LNAPL recovery events where LNAPL may not have fully recharged into a well about to be tested.

Where the measured LNAPL/water interface is below the elevation of the confining unit (before or at any point during a test), LNAPL drawdown is calculated consistent with unconfined conditions (Equation 2).

Confined – Theoretical Maximum LNAPL Drawdown

Under confined conditions, the theoretical maximum drawdown is calculated according to Equation 3.