

**Enbridge Line 6B MP 608
Marshall, MI Pipeline Release
Court Case No.: 15-1411-CE
No Further Action Report for Segment 3**

Prepared for Michigan Department of Environmental Quality

**Enbridge Energy, Limited Partnership
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Table of Contents

1.0 Introduction	1
1.1 Regulatory Definitions and Framework.....	2
1.2 Project Background	4
1.3 NFA Scope	6
1.3.1 Reach 3 Definition	6
1.3.2 Line 6B Crude Oil Characteristics and Hazardous Substances	6
1.3.3 Media Addressed in NFA	7
2.0 Reach 3 Response and Characterization	8
2.1 Site Setting and Land Use	8
2.2 Response and Remedial Actions	8
2.3 Facility Characterization	9
2.3.1 Soils.....	9
2.3.2 Groundwater.....	12
2.3.3 Sediment	12
2.3.4 Surface Water.....	12
2.4 Resolution of MDEQ Comments to the Reach3 Remedial Investigation Report..	13
2.4.1 Metals.....	13
2.4.1.1 Stability of Target Metals in Line 6B Crude Oil.....	14
2.4.1.2 Theoretical Maximum Concentration Increases to Soil	14
2.4.1.3 Distribution of Metals in Soil and Groundwater	16
2.4.1.4 MDEQ Comments on Metals Issues in Reach 3 RI Report...19	
2.4.1.5 MDEQ Evaluation of Metals	23
2.4.1.6 Conclusions	24
2.4.2 Elevated Reporting Limits.....	24
2.4.2.1 ERLs in PNA Groundwater Samples.....	25

2.4.2.2	ERLs in VOC Groundwater Samples	26
2.4.3	Laboratory Contaminants	27
2.4.4	UV Fluorescence	28
2.4.5	Non-Aqueous Phase Liquid.....	31
2.4.6	Aesthetics	32
2.4.6.1	Aesthetics Evaluation	33
2.4.6.2	MDEQ Executive Summary Comments	37
2.4.6.3	Determination of Actionable Aesthetic Conditions.....	40
2.4.6.4	Aesthetic Conclusions	45
2.5	Current Conditions.....	45
3.0	Basis for Concluding Remedial Action is Complete	47
3.1	Mobile or Migrating NAPL.....	47
3.2	Soil Contamination Above Residential Criteria	47
3.3	Soil Aesthetic Impacts	48
3.4	Groundwater Contamination Above Residential Criteria	48
3.5	Groundwater Aesthetic Impacts.....	48
3.6	Soil Gas Contamination Above Residential Vapor Intrusion Screening Levels	49
3.7	Conditions Immediately Dangerous to Life or Health	49
3.8	Fire and Explosive Hazards Related to Release	50
3.9	Contamination to Existing Drinking Water Supply	50
3.10	Imminent Threat to Drinking Water Supply.....	50
3.11	Impact to Surface Water	50
3.12	Ecological Impacts.....	51
3.12.1	Terrestrial Ecological Impacts	51
3.12.2	Aquatic Ecological Impacts.....	52
4.0	Summary and Conclusion.....	53

4.1	Response and Remediation Efforts.....	53
4.2	Characterization and Confirmation Efforts.....	54
4.3	Remediation Complete	55
4.4	Closure Request.....	55
5.0	References.....	56

FIGURES

Figure 1	Reach 3 Site Location and Reach Boundary
Figure 2	Reach 3 Extent of Excavation
Figure 3	Talmadge Creek Metals Evaluation Monitoring Well Locations
Figure 4	Reach 3 Remaining Potential Aesthetic Observations

TABLES

Table 1	Reach 3 Spill Area Property Identification
Table 2	Theoretical Maximum Increase in Target Metal Concentrations
Table 3	Talmadge Creek Metals Evaluation Monitoring Well Analytical Results
Table 4	Reach 3 Remaining Potential Aesthetic Observations

ATTACHMENTS

Attachment A	Remedial Investigation Report for Reach 3
Attachment B	Revised Figures and Tables for Remedial Investigation Report for Reach 3
Attachment C	Request for MDEQ Review of No Further Action (NFA) Report Forms

- Attachment D** **White Paper: Evaluation of Metals in Soil and Groundwater**
- Attachment E** **MDEQ Comment Package on Remedial Investigation Report for
Reach 3**
- Attachment F** **Talmadge Creek Groundwater Metals Evaluation Data**
- Attachment G** **White Paper: Evaluation of Line 6B Crude Oil NAPL Risk based on a
Weight of Evidence Approach**

LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CL	Cold Lake Blend
Criteria (Criterion)	Part 201 Residential Generic Cleanup Criteria (Criterion)
CSM	Conceptual Site Model
DCC	Part 201 Generic Residential Direct Contact Criteria
DWC	Part 201 Generic Residential Drinking Water Criteria
DWPC	Part 201 Generic Residential Soil Drinking Water Protection Criteria
Enbridge	Enbridge Energy, Limited Partnership
ECB	Erosion Control Blanket
ERL	Elevated Reporting Limit
Facility	Any area, place or property where a hazardous substance from the Enbridge Line 6B Marshall Release in excess of the concentrations that satisfy the cleanup criteria for unrestricted residential use has been released, deposited, disposed of, or otherwise comes to be located, as set forth at MCL 324.20101(1)(s). "Facility" does not include any area, place, or property where the conditions of MCL 324.20101(1)(s) (i)-(vi) have been satisfied.
FESL	Flammability and Explosivity Screening Level
ft	Feet
GSIC	Part 201 Generic Residential Groundwater Surface Water Interface Criteria (for groundwater)
GSIPC	Part 201 Generic Residential Groundwater Surface Water Interface Protection Criteria (for soils)
GVIAIC	Part 201 Generic Residential Groundwater Volatilization to Indoor Air Inhalation Criteria
IDLH	Immediately Dangerous to Life or Health
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
Line 6B Crude Oil	For the purpose of this document, refers to the crude oil consisting of a heavy crude blend of bitumen with an added diluent. The Line 6B crude oil at the time of the release was a blend of Western Canadian Select (WCS), Cold Lake (CL), and a diluent containing VOCs. Diluents are added to the bitumen to improve flow characteristics necessary for transportation of the crude oil bitumen through the pipeline network.
MDEQ	Michigan Department of Environmental Quality
MDEQ Executive Summary	<i>Executive Summary, MDEQ Comments on "Remedial Investigation Report for Reach 3" Enbridge, October 30, 2014, dated February 10, 2015.</i>
MDEQ Consent Judgment	<i>The Consent Judgment so agreed by the Michigan Department of Environmental Quality, Michigan Department of Attorney General, and Enbridge Energy Partners, L.P.; Enbridge Energy, Limited Partnership; Enbridge Pipelines (Lakehead) LLC; Enbridge Energy Management LLC; Enbridge Energy Company, Inc.; and Enbridge Employee Services, Inc. ordered, adjudged, and decreed pursuant to MCL 324.1701, MCL 324.3109, MCL 324.30112, MCL 324.30316, and MCL 324.20137, signed May 13, 2015.</i>

mg/kg	milligrams per kilogram
mg/l	milligrams per liter
MP	Mile Post, used to identify the affected portions of Talmadge Creek and the Kalamazoo River. Mile Posts begin where the Line 6B release entered Talmadge Creek, MP 0.00 and extend downstream to the Morrow Reservoir (MP 39.85).
NAPL	Non-Aqueous Phase Liquids
NAPL White Paper	<i>White Paper: Evaluation of Line 6B Crude Oil NAPL Risk based on a Weight of Evidence Approach</i> , submitted to the MDEQ on June 19, 2015
NFA	No Further Action
NTUs	nephelometric units
Part 201	Part 201 of Michigan's Act 451 of 1994, as amended
PEC	Probable Effect Concentration
PNAs	Polynuclear Aromatic Hydrocarbons
PSIC	Part 201 Generic Particulate Soil Inhalation Criteria
QAQC	Quality assurance Quality control
R5 ESLs	U.S. EPA Region 5 Ecological Screening Levels
Reach 3 RI Report	<i>Remedial Investigation Report for Reach 3</i> , submitted to the MDEQ on October 30, 2014
RL	Reporting Limit
SAP	<i>Sampling and Analysis Plan</i> , submitted to the MDEQ on August 30, 2011.
Segment 3	Segment 3, as defined in the October 26, 2015 Updated Exhibit G of the MDEQ Consent Judgment, includes only Reach 3 of the Spill Area which extends over approximately 0.75 miles along Talmadge Creek from MP 0.50 at Division Drive through the first portion of MP 1.25, ending at Interstate 69.
SORT	Shoreline and Overbank Reassessment Technique
SOTF	Submerged Oil Task Force
Source Area	A Subset of the Spill Area that encompasses the pipeline breach and approximately 5 acres of land where the Line 6B crude oil release emerged onto the ground surface.
Spill Area	The Facility created by the Enbridge Line 6B Marshall Release and also private and public properties that have been disturbed, destroyed, dredged, excavated, or otherwise altered or damaged as a result of the release or Response Activities taken to address the release, including but not limited to vegetation, surface waters, soils, sediments, groundwater, wetlands, floodplains, and overbank areas.
SPLP	Synthetic Precipitation Leaching Procedure
SSLs	Soil Screening Levels
SVIAC	Part 201 Generic Residential Soil Volatilization to Indoor Air Inhalation Criteria
Target metals	Beryllium, molybdenum, nickel, and vanadium
TCE	trichloroethene
TCRI	Talmadge Creek Remedial Investigation
ug/kg	micrograms per kilogram

ug/l	micrograms per liter
U.S. EPA	United States Environmental Protection Agency
UV	Ultraviolet
VOCs	Volatile Organic Compounds
WCS	Western Canadian Select

1.0 Introduction

This No Further Action (NFA) Report for Segment 3 of the Spill Area (Michigan Department of Environmental Quality (MDEQ) Facility ID 13000397 - Enbridge Spill – Talmadge Ck – Kalamazoo Riv) summarizes how the response activities conducted by Enbridge Energy, Limited Partnership (Enbridge) in the Reach 3 Spill Area have restored soil, sediment, groundwater, and surface water to conditions consistent with Part 201 of Michigan’s Act 451 of 1994, as amended (Part 201) unrestricted residential use. The Reach 3 Spill Area is a subset of the overall Spill Area associated with the crude oil release from Enbridge’s Line 6B pipeline (Line 6B) located south of Marshall, Michigan in July 2010 (see *Section 1.3.1* for a description of Reach 3).

This NFA Report summarizes response activities and characterizations (*Section 2*); the basis for concluding remedial actions are complete (*Section 3*); and provides a summary and conclusion (*Section 4*). The *Remedial Investigation Report for Reach 3*, submitted to the MDEQ on October 30, 2014 (Reach 3 RI Report) (Enbridge, 2014a) provides a detailed analysis of response activities, remedial excavations, and characterization/confirmation results. The Reach 3 RI Report is included as *Attachment A* to this NFA Report, although the reader is referred to *Attachment B* for revised tables and figures, which address MDEQ’s comments on the Reach 3 RI Report.

Throughout the course of the project the Conceptual Site Model (CSM), originally developed in November 2010, has presented a holistic, project-wide understanding of the effects of the Line 6B crude oil release on the environment. The CSM has been revised quarterly to document the evolution in the understanding of site conditions and to serve as a record of documents submitted for MDEQ’s administrative record. The current *Conceptual Site Model – January 2015* was submitted to the MDEQ on January 23, 2015 (Enbridge, 2015a).

1.1 Regulatory Definitions and Framework

Requirements for NFA reports are set forth under Section 324.20114d of Michigan's Natural Resources and Environmental Protection Act 451 of 1994 (on-line render April 23, 2015, effective December 14, 2010). Section 324.20101(hh) of the Act defines an NFA as:

“... a report under section MCL324.20114d detailing the satisfactory completion of remedial actions and including a postclosure plan and a postclosure agreement, if appropriate.”

Section 324.20101 defines a facility as a location where hazardous substances in excess of cleanup criteria exist. However, for this project, the MDEQ, in the *Consent Judgment so agreed by the Michigan Department of Environmental Quality, Michigan Department of Attorney General, and Enbridge Energy Partners, L.P.; Enbridge Energy, Limited Partnership; Enbridge Pipelines (Lakehead) LLC; Enbridge Energy Management LLC; Enbridge Energy Company, Inc.; and Enbridge Employee Services, Inc. ordered, adjudged, and decreed pursuant to MCL 324.1701, MCL 324.3109, MCL 324.30112, MCL 324.30316, and MCL 324.20137, signed May 13, 2015, (MDEQ Consent Judgment) (MDEQ, 2015a), defines the Facility for purposes of the Line 6B Marshall Release as “any area, place or property where a hazardous substance from the Enbridge Line 6B Marshall Release in excess of the concentrations that satisfy the cleanup criteria for unrestricted residential use has been released, deposited, disposed of, or otherwise comes to be located, as set forth at MCL 324.20101(1)(s). “Facility,” as defined in the MDEQ Consent Judgment, does not include any area, place, or property where the conditions of MCL 324.20101(1)(s) (i)-(vi) have been satisfied.” (referred to herein as the “Facility”).*

The MDEQ Consent Judgment further defines the “Spill Area” as the Facility created by “the Enbridge Line 6B Marshall Release and also private and public properties that have been disturbed, destroyed, dredged, excavated, or otherwise altered or damaged as a result of the release or Response Activities taken place to address the release, including but not limited to vegetation, surface waters, soils, sediments, groundwater, wetlands, floodplains, and overbank areas.” (referred to herein as the “Spill Area”).

Remedial investigation field work for Reach 3 was conducted in accordance with the *Administrative Consent Order and Partial Settlement Agreement entered In the Matter of Enbridge Energy Partners, L.P., and Enbridge Energy, Limited Partnership, proceedings under the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.101 et seq.*; issued November 1, 2010 (MDEQ, 2010). All assessment and remediation activities have been conducted pursuant to pertinent rules and regulations included in Part 201 including cleanup criteria. Relevant Part 201 Residential Generic Cleanup Criteria (Criteria) used to evaluate potential human health risk are as follows:

- Part 201 Generic Residential Direct Contact Criteria (DCC),
- Part 201 Generic Residential Soil Drinking Water Protection Criteria (DWPC),
- Part 201 Generic Residential Soil Groundwater Surface Water Interface Protection Criteria (for soils) (GSIPC),
- Part 201 Generic Residential Soil Volatilization to Indoor Air Inhalation Criteria (SVIAC),
- Part 201 Generic Residential Soil Ambient Air Infinite Source Volatile Soil Inhalation Criteria,
- Part 201 Generic Particulate Soil Inhalation Criteria (PSIC),
- Soil Saturation Screening Level,
- Part 201 Generic Residential Drinking Water Criteria (DWC),
- Part 201 Generic Residential Groundwater Surface Water Interface Criteria (for groundwater) (GSIC),
- Part 201 Generic Residential Groundwater Volatilization to Indoor Air Inhalation Criteria (GVIAIC), and
- Flammability and Explosivity Screening Level (FESL).

United State Environmental Protection Agency (U.S. EPA) Region 5 Ecological Screening Levels for soil (R5 ESLs) (U.S. EPA, 2003) and Soil Screening Levels (SSLs) (U.S. EPA, 2007) have been used to evaluate potential terrestrial risk.

The R5 ESLs and Probable Effect Concentrations (PECs) (MacDonald et al., 2000 and WDNR, 2003) for sediments have been used to screen sediment data. The analytical results for soil, sediment, groundwater, surface water, and potable water were compared to relevant Criteria. Algorithms used to develop Criteria do not account for saturated soil conditions; therefore, (as agreed upon with the MDEQ) analytical results for sediment and saturated soil samples were only compared to DCC for screening purposes.

In accordance with Section 20114d, Part 201, a completed *Request for DEQ Review of No Further Action (NFA) Report* form is included as *Attachment C* to this NFA Report.

1.2 Project Background

On July 26, 2010, Enbridge discovered a release of crude oil from the Enbridge Line 6B pipeline, which is located just south of Marshall, Michigan. The Line 6B crude oil was released below grade via a rupture in the pipeline at Mile Post (MP) 608. The Line 6B crude oil subsequently emerged at the ground surface and flowed over land, following the natural topography into Talmadge Creek. From that point, the Line 6B crude oil was subsequently carried approximately 40 miles down the Kalamazoo River to the Morrow Lake reservoir.

Emergency response actions were initiated immediately following the discovery of the release. In Reach 3, this included excavation of overbank areas adjacent to Talmadge Creek in 2010, followed by assessment activities, including Post-Response Shallow Soil Assessment, Submerged Oil Task Force (SOTF) Assessment, and Talmadge Creek Remedial Investigation (TCRI). Results from these efforts culminated in a second excavation between November 2011 and March 2012. During the second excavation, additional overbank areas, as well as the Talmadge Creek stream bed, were excavated to depths ranging from 0.5 foot (ft) to 8 ft below ground surface (bgs).

Between late 2012 and early 2013, auxiliary support areas (i.e., locations used to support response activities, including equipment staging, material storage, parking lots, access roads) in Reach 3 were decommissioned. Samples collected during these decommissioning activities, and the sampling results indicated no exceedances of Criteria attributable to Line 6B crude oil.

On August 9, 2013, Enbridge submitted the *Draft No Further Action Report Reach 3 – MP 0.50 to MP 1.00* (Enbridge, 2013) to the MDEQ. This report summarized response and remedial activities, as well as characterization and confirmation sampling that had been conducted to date. In response, the MDEQ offered comments on the report, which were subsequently discussed during meetings between Enbridge and the MDEQ in the fall of 2013. During these meetings, Enbridge and the MDEQ developed and agreed upon the overall scope and extent of a data gap evaluation.

In 2014, Enbridge completed the data gap evaluation in Reach 3. This work addressed, on a point-by-point basis, several of the issues that Enbridge and the MDEQ had discussed during the meetings, including: elevated reporting limits (ERLs) in soil samples; remaining ultraviolet (UV) fluorescence observations (used as a soil screening tool) in sub-surface soil samples where there was no evaluation of potential human health risks; and volatile organic compounds (VOCs) Criteria exceedances. The intent of the point by point data gap evaluation was to expand upon the existing robust dataset and from that, provide a holistic, CSM-type evaluation of Reach 3 specifically, as well as the entire Spill Area generally, with a goal of obviating the need for future point-by-point evaluation within the remaining portions of the Spill Area.

In October 2014, Enbridge submitted the Reach 3 RI Report, which provided a detailed history of the response and remediation activities undertaken by Enbridge, including a comprehensive discussion of the success of these activities. The Reach 3 RI Report additionally included characterization and confirmation sampling results, including the data gap evaluation results.

The Reach 3 RI Report demonstrated that impacts associated with the Line 6B crude oil release have been adequately addressed and mitigated, and that Reach 3 is suitable for NFA closure in accordance with unrestricted residential use. However, in February 2015, the MDEQ provided comments to Enbridge on the Reach 3 RI Report, identifying those areas that the agency believed needed additional clarification before an NFA closure could be issued. *Section 2.4* of this NFA Report addresses these issues raised in the MDEQ's comments, and explains the manner in which such issues have already been thoroughly and comprehensively addressed.

1.3 NFA Scope

This section summarizes the scope of this NFA Report, including: (i) a definition of Reach 3; (ii) a description of Line 6B crude oil (and associated hazardous substances); and (iii) a summary of the media that were potentially affected by the release and which were evaluated as part of Enbridge's response activities and site characterization.

1.3.1 Reach 3 Definition

The Spill Area, shown on *Figure 1*, extends from the Source Area, where the Line 6B crude oil release occurred, to Talmadge Creek, to the confluence with the Kalamazoo River, and downstream to Morrow Lake. For administrative purposes the Spill Area was segregated into 48 separate reaches. Reach 3 includes Talmadge Creek and associated overbank areas, which extends approximately 0.75 miles along Talmadge Creek from MP 0.50 at Division Drive through the first portion of MP 1.25, ending at Interstate 69 and including a small auxiliary area, as depicted on *Figure 1*.

1.3.2 Line 6B Crude Oil Characteristics and Hazardous Substances

At the time of the Release, the crude oil being transported in the Line 6B pipeline was transitioning from Western Canadian Select (WCS) blend to Cold Lake (CL) blend. As a result, the crude oil released at the Source Area was a mixture of these two oils with an estimated composition of 22.5% WCS and 77.5% CL. By way of background, WCS is a blend of Canadian heavy conventional and bitumen crude oils combined with diluents (added to improve flow characteristics). The CL component is a heavy crude blend of bitumen and diluent. Crude oil is a complex combination of hydrocarbons consisting primarily of paraffinic (straight and branched-chain alkanes), naphthenic (cycloalkanes or cycloparaffins), and aromatic hydrocarbons, including polynuclear aromatic hydrocarbons (PNAs). The PNAs found in Line 6B crude oil are typically dominated by alkylated compounds, although non-alkylated PNAs, including the 16 Priority Pollutant PNAs, are reported, albeit at lower concentrations ranging from <1 to approximately 170 milligrams per kilogram (mg/kg).

To improve flow characteristics of the heavy bitumen crude oil, a diluent containing VOCs was added to the Line 6B crude oil. Analytical results indicate that nearly all of the VOCs contained in the diluent and evaporated within days or weeks of the release.

Metals are also present within the crude oil that was released from Line 6B. The metals that are most important for this evaluation are beryllium, molybdenum, nickel, and vanadium, which are present at low concentrations (<5 to <150 mg/kg). The metals, particularly vanadium and nickel, are very stable within the Line 6B crude oil and not prone to leaching.

During the course of the project, the chemical analysis undertaken by Enbridge to identify impacts associated with Line 6B crude oil focused on metals, PNAs, and VOCs.

PNA analyses focused on the 16 Priority Pollutant non-alkylated PNAs which are present in Line 6B crude oil, but also attributable to background impacts in industrialized areas such as the Kalamazoo watershed. The PNAs analyzed consist of: 2-methylnaphthalene; acenaphthene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenzo(a,h)anthracene; fluoranthene; fluorene; indeno(1,2,3-cd)pyrene; naphthalene; phenanthrene; and pyrene.

VOC analyses have focused on the compounds identified in Line 6B crude oil that are associated with petroleum, including: 1,2,3-trimethylbenzene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; 2-methylnaphthalene; 4-isopropyltoluene; benzene; cyclohexane; ethylbenzene; isopropylbenzene; naphthalene; N-butylbenzene; N-propylbenzene; sec-butylbenzene; tert-butylbenzene; toluene, and, xylenes.

Metals analyses has focused on beryllium, molybdenum, nickel, and vanadium, which are trace constituents of Line 6B crude oil. However, this task has been complicated because these metals also are found naturally and ubiquitously in the environment.

1.3.3 Media Addressed in NFA

This NFA Report addresses all media which may have been affected by the Line 6B crude oil release in the Reach 3 Spill Area and for which there are applicable Criteria. This includes the following:

- Soil (both saturated and unsaturated),
- Sediment,
- Groundwater, and
- Surface Water.

2.0 Reach 3 Response and Characterization

This section includes a description of the site setting and land use, as well as a summary of Reach 3 response activities, remedial actions, and characterization. This section also provides a detailed discussion of how the fundamental issues for the project have been resolved as a result of Enbridge's response activities and remedial actions. This section demonstrates that Reach 3 conditions are consistent with unrestricted residential use and no further action is warranted based on existing data.

2.1 Site Setting and Land Use

Reach 3 Spill Area, depicted in *Figure 1*, consists largely of open space flood plain, including the Talmadge Creek channel that is located near the southwest corner of Marshall, Michigan. Reach 3 extends over seven separate parcels and occupies approximately 17.8 acres.

Table 1 summarizes the parcel ID, address, tax ID, and zoning/land use. Land use in Reach 3 is primarily open space with flood plain surrounded by agricultural fields, wood lots, and scattered rural residences.

2.2 Response and Remedial Actions

In 2010, immediately following the release, emergency response excavations were conducted on overbank areas adjacent to Talmadge Creek under direction of the U.S. EPA. These excavations recovered visible Line 6B crude oil from overbank areas while maintaining the integrity of the Talmadge Creek stream bed. The excavated areas, depicted in *Figure 2*, received U.S. EPA clearance as free of visual evidence of Line 6B crude oil prior to placement of approved clean backfill.

Post-excavation assessment revealed visible evidence of Line 6B crude oil remained and additional excavation was necessary. This additional excavation included areas that were not previously excavated, some areas that were previously excavated where visible Line 6B observations re-occurred, and the Talmadge Creek streambed. Results and observations from the 2011 – 2012 TCRI were also used to develop the preliminary excavation boundaries. Final boundaries were determined during the excavation when the extent of visible oil could be more clearly ascertained. The excavation, the extent of which is depicted in *Figure 2*, took place from November 2011 through early March 2012 when all visible observations of remaining Line 6B crude oil were targeted for removal.

The excavation covered approximately 50,000 square feet of the Reach 3 Spill Area and generated approximately 3,200 cubic yards of materials for off-site treatment and disposal in accordance with the specific Waste Treatment, Transportation, and Disposal Plan in place at the time the waste was generated.

As set forth in *Section 4.4* of the Reach 3 RI Report, in accordance with the MDEQ approved *Talmadge Creek Excavation Work Plan MP 0.50 – MP 1.00* (Enbridge, 2011a) and the approved *Analytical Sampling Approach at Excavation Sites Memorandum* (Enbridge, 2011b), Enbridge conducted post-excavation sampling from the side-walls and the excavation floor to evaluate the effectiveness of the excavations. A total of 127 post-excavation soil samples and 4 water samples were collected from the excavated areas.

2.3 Facility Characterization

The objective of the Reach 3 investigations was to characterize the nature and extent of contaminants in soil, sediment, groundwater, and surface water associated with the Line 6B crude oil release; confirm the effectiveness of the response activities; identify and evaluate potential migration pathways; assess potential human health and terrestrial risks; evaluate potential aesthetic impacts; and build upon the principles established in the CSM.

Reach 3 was the subject of multiple investigations including: SOTF, post-excavation sampling, Shoreline Overbank Reassessment Techniques (SORT), TCRI, auxiliary area assessments, and data gap assessments. As set forth in *Section 3.0* of the Reach 3 RI Report, samples were collected using MDEQ approved *Sampling and Analysis Plan (SAP)*, submitted to the MDEQ on August 30, 2011 (SAP) (Enbridge, 2011c).

2.3.1 Soils

A total of 1,223 soil samples were collected from the Reach 3 Spill Area for compositional laboratory analysis of metals, PNAs, and/or VOCs. In addition, 135 of these samples were analyzed further using Synthetic Precipitation Leaching Procedure (SPLP) testing to provide an additional line of evidence for leaching potentials of impacted soils to surrounding groundwater. From this data set, only five locations (SBTC0075L508, SBTC0100R501, ESTC0100L138, SBTC0100R524, and ESTC0100R154) reported analytical exceedances of Criteria for VOCs. There were no exceedances of Criteria for PNAs. The results of these tests with respect to Metals are discussed in *Section 2.4.1*. The remainder of this section

discusses the VOC exceedances, which were limited to trichloroethene (TCE), chloromethane, and toluene.

As set forth in *Section 6.1.3* of the Reach 3 RI Report, TCE was not detected in Line 6B crude oil. Environmental samples indicating the presence of TCE therefore may or may not be related to response activities completed in the Spill Area. Analytical results from a soil sample collected at SBTC0075L508 on January 1, 2014, reported a TCE exceedance of DWPC (100 micrograms per kilograms (ug/kg)) at 810 ug/kg. This sample was also tested using SPLP and showed a TCE exceedance of DWC (micrograms per liter (5 ug/l)) at a concentration of 10 ug/l. In order to evaluate whether these results reflected actual groundwater impact, a second boring, SBTC0075L508R1, was advanced at this location (offset less than 2 ft) on February 17, 2014. The soil sample from this boring indicated no detection for TCE, although it had an ERL of 320 ug/kg. An SPLP analysis of the soil sample revealed no detectable TCE with a reporting limit (RL) below the DWC. In addition, groundwater from a temporary well was sampled to identify the presence of TCE. No TCE was identified in the groundwater as a result of that testing, and the sampling results had a RL below the DWC. Given that TCE was not detected in the SPLP analysis of the additional soil sample or in the groundwater sample analysis, regardless of the source of TCE in the anomalous soil detection, the exposure pathway to groundwater is incomplete.

Further downstream in Reach 3, TCE exceeded the DWC (5 ug/L) at 6.2 ug/l in an SPLP soil sample collected from SBTC0100R501 on January 22, 2014. The compositional analysis from this soil sample reported no detection of TCE, although it had an ERL of 790 ug/kg. To evaluate whether these results reflected actual groundwater impact, a second boring, SBTC0100R501R1 was advanced at this location (offset less than 2 ft). The soil sample from this boring indicated an ERL of 1,400 ug/kg for TCE. An SPLP analysis of the soil sample revealed no detectable TCE with a RL below the DWC. In addition, groundwater from a temporary well was sampled to identify the presence of TCE. No TCE was identified in the groundwater as a result of that testing, and the sampling results had a RL below the DWC. Given the fact that the TCE detection could not be verified in soil or groundwater samples, regardless of the source of TCE in the anomalous soil detection, the exposure pathway to groundwater is incomplete.

As set forth in *Section 5.1.7* of the Reach 3 RI Report, chloromethane detections are laboratory artifacts. Furthermore, chloromethane was not reported as a constituent of Line 6B crude oil. In samples from ESTC0100L138 and SBTC0100R524 chloromethane was reported at 6,200 ug/kg and 2,500 ug/kg, respectively, which exceeds the SVIAC (2,300 ug/kg) and for ESTC0100L138 also the DWPC (5,200 ug/kg). However, an additional sample, SBTC0100L511 (collected adjacent to ESTC0100L138), reported no detection for chloromethane. As a result, even if there were an actual chloromethane detection in the environment (which there was not), the exposure pathway to groundwater is incomplete.

Toluene exceeded the GSIPC (5,400 ug/kg) in an excavation floor soil sample collected from location ESTC0100R154 (2 ft bgs) with a concentration of 8,600 ug/kg. However, a groundwater sample collected on February 18, 2014 at this location (designated SBTC0100R507) showed no exceedances of Criteria for VOCs indicating that toluene is not leaching to groundwater. As a result, even if this detection represents the presence of toluene in soil at this location, the exposure pathway to groundwater is incomplete.

Additionally, Enbridge compared all soil analytical results to the R5 ESLs to evaluate ecological risk. Concentrations of all chemicals were less than R5 ESLs except in two samples (Soil sample ESTC0075R134- naphthalene detection at a concentration of 350 ug/kg, which exceeded the soil R5 ESL of 99.4 ug/kg and soil sample ESTC0100R154 toluene detection at a concentration of 8,600 ug/kg, which exceeded the soil R5 ESL of 5,450 ug/kg.). All other analytical results were below corresponding R5 ESLs for Line 6B crude oil parameters.

These two isolated R5 ESLs exceedances do not pose significant ecological risks due to their isolated nature, relatively low magnitude, and infrequent occurrence; and because the average overall exposure of the masked shrew receptor would be to concentrations significantly lower than those detected at these discrete locations. Neither of these chemicals is bio-accumulative. In addition, both naphthalene and toluene biodegrade readily and will not persist in the environment.

Sufficient data have been collected, analyzed, and evaluated to establish that, following response actions, there are no spill-related to human health or ecological risks related to soil at Reach 3 and therefore no further action is necessary or appropriate.

2.3.2 Groundwater

A total of 164 groundwater samples were collected from the Reach 3 Spill Area. Analytical results show no exceedances of any VOCs or PNAs in any of the groundwater samples.

Sufficient data has been collected, analyzed, and evaluated to establish that, following response actions, there are no spill-related to human health or ecological risks related to groundwater at Reach 3 and therefore no further action is necessary or appropriate.

2.3.3 Sediment

A total of 44 sediment samples were collected from the Reach 3 Spill Area. Analytical results indicate that there were no exceedances of DCC in any of the sediment samples. The majority of these sediment sample locations were removed during the 2011/2012 excavation activities. Additionally, Enbridge compared all sediment analytical results to the sediment R5 ESLs to evaluate ecological risk. Concentrations of all chemicals were less than sediment R5 ESLs except in one sample (SOTF-B-Q1.07-R01) that was collected in 2010, where 2-butanone, acetone, 2-methylnaphthalene and toluene concentrations exceeded the R5 ESLs. The location of that prior sediment sample was re-sampled in 2014 (SETC0125R503), and concentrations did not exceed R5 ESLs for sediment.

Sufficient data has been collected, analyzed, and evaluated to establish that, following response actions, there are no spill-related to human health or ecological risks related to sediment at Reach 3 and therefore no further action is necessary or appropriate .

2.3.4 Surface Water

The occurrence of surface water within the overbank soils of the Reach 3 Spill Area was minimal. A total of four surface water samples were collected from the Reach 3 Spill Area in a wetland area situated north of Talmadge Creek, between MP 0.75 - MP 1.00 in 2011. Analytical results from these samples indicate no exceedances of GSIC.

Sufficient data has been collected, analyzed, and evaluated to establish that, following response actions, there are no spill-related risks to human health or the environment related to surface water at Reach 3 and therefore no further action is necessary or appropriate.

2.4 Resolution of MDEQ Comments to the Reach3 Remedial Investigation Report

The Reach 3 Spill Area has undergone extensive emergency response activities, excavations, characterization, and restoration. Comprehensive data has been collected to demonstrate that residual Line 6B crude oil no longer presents a risk to human health in the Reach 3 Spill Area and no further action is required. However, the MDEQ has repeatedly raised with Enbridge several “fundamental issues” concerning potential risks within Reach 3 that subsequently apply to the entire Spill Area. Resolution of the fundamental issues in Reach 3 is key in reaching no further action status throughout the Spill Area. Most recently, the MDEQ once again raised these same issues in the *Executive Summary, MDEQ Comments on “Remedial Investigation Report for Reach 3” Enbridge, October 30, 2014*, dated February 10, 2015 (MDEQ Executive Summary) (MDEQ, 2015b). Enbridge believes these concerns by MDEQ have been thoroughly addressed. This section reviews each of MDEQ’s concerns. It then explains the manner in which data and analysis establish that each “fundamental issue” is not a legitimate cause for concern and that the Reach 3 Spill Area has been restored to conditions consistent with Part 201 unrestricted residential use.

2.4.1 Metals

Laboratory analysis of Line 6B crude oil demonstrated that specific metals are present and as a result, metals were included in the laboratory analysis that was used to characterize the presence of Line 6B crude oil impacts. Over time, analyses focused on four metals, beryllium, molybdenum, nickel, and vanadium (target metals). The detection and occasional exceedance of these target metals are not attributable to Line 6B crude oil. Metals are present in crude oils in such low levels that the potential for human health risks and ecological impact is unlikely to be a major risk management consideration at crude oil spill sites (American Petroleum Institute, 2011).

This section presents three separate lines of evidence to demonstrate this finding:

1. A review of the stability of the target metals in Line 6B crude oil,
2. An assessment of the maximum concentration of the target metals that Line 6B crude oil could contribute to soil samples, and
3. An evaluation of the distribution of the metals in soil and groundwater, and their exceedances of Criteria across Reach 3, Talmadge Creek, and the Spill Area.

Multiple lines of evidence are presented to clarify the source of metals in soil and groundwater. This section also addresses the MDEQ's comments regarding metals from the Reach 3 RI Report.

2.4.1.1 Stability of Target Metals in Line 6B Crude Oil

This section discusses the stability of target metals generally, and vanadium and nickel in particular, in Line 6B crude oil. As previously noted, target metals are present as minor constituents of Line 6B crude oil. These metals are well-bound within the bitumen, which is a principle component of Line 6B crude oil. A primary component of bitumen is asphaltene, which can make up to 20% of the bitumen. Asphaltenes consists of insoluble, high molecular weight, aromatic compounds. Heavy metals in asphaltenes, such as vanadium and nickel, occur in organic porphyrin structures. The organic porphyrin structures are very stable and trapped within the asphaltenes. As a result, these metals are not readily weathered into inorganic forms in soil or groundwater. Studies further demonstrate that the partitioning of vanadium and nickel from the oil phase to the aqueous phase is extremely low and that most of the vanadium and nickel in the aqueous phase is primarily in an organic complex form, not an ionic form, which further reduces toxicity concerns (Cantu et al., 2000). Indeed, additional research demonstrates that these metals can only be released from the asphaltenes as a result of very high temperatures or other intense methods that *do not* occur under natural conditions (Health Canada, 2010; American Petroleum Institute, 2011). The metals are primarily in the form of stable molecular complexes that can be distilled at temperatures above 500° C (International Agency for Research on Cancer, 1989). As a result, heavy metals in the organic porphyrin complexes, including vanadium in particular, are not significantly leached or weathered from the Line 6B crude oil. The maximum concentration of vanadium as a porphyrin complex that would leach into water in direct contact with Line 6B crude oil is 0.46 ug/l (Criteria is 4.5 ug/l) based on the estimated log Kow of 5.47 (Cantu,2000) and the mean concentration of vanadium in the oil (*Table 2*).

2.4.1.2 Theoretical Maximum Concentration Increases to Soil

While *Section 2.4.1.1* documents that heavy metals are unlikely to leach from Line 6B crude oil because they are chemically bound in the oil, this section evaluates the theoretical maximum concentration of metals that could become incorporated into the soil.

This evaluation was conducted by calculating the maximum increase in target metal concentrations that Line 6B crude oil could contribute to the soil. This evaluation uses the average concentration of the target metals in Line 6B crude oil, which was obtained from chemical analysis of four samples of Line 6B crude oil collected in August and October 2010. *Table 2* presents a tabulated summary of the results.

As *Table 2* shows, the concentration of beryllium and nickel in the Line 6B crude oil is below the lowest applicable Criteria. Therefore, even if a soil sample was 100% Line 6B crude oil, it would not contain enough beryllium or nickel to exceed the Criteria (*Table 2*). Further, if an existing soil sample had a concentration of beryllium or nickel that was marginally below the Criteria, and was then impacted with Line 6B crude oil, the mixing of the oil with the soil sample would proportionately result in an overall decrease in the concentration of beryllium or nickel in the impacted soil sample. Based on this, beryllium and nickel contributions from Line 6B crude oil could not result in Criteria exceedances of soils.

Theoretical maximum increases in soil concentrations of molybdenum and vanadium that could be contributed by the Line 6B crude oil were calculated using their average concentrations in Line 6B crude oil (*Table 2*). The concentration increases in soil were then calculated as a proportion of Line 6B crude oil in impacted soil. For the purpose of the calculations, the maximum detected Line 6B crude oil concentration of 200,000 mg/kg in soil was used. As *Table 2* shows the molybdenum soil concentration increase is 1.0 mg/kg (compare to the DWPC of 1.5 mg/kg), and the vanadium soil concentration increase is 27 mg/kg (compare to the DWPC of 72 mg/kg).

These theoretical concentrations are below their respective Criteria. Thus, even in soil samples impacted by Line 6B crude oil, the contribution from Line 6B crude oil to molybdenum and vanadium concentrations in soil must be below Criteria.

This analysis demonstrates that, while it is true that the distribution of Line 6B crude oil was spatially heterogeneous, any exceedances of Criteria in soil cannot be attributable to the small amount of metals in the Line 6B crude oil.

2.4.1.3 Distribution of Metals in Soil and Groundwater

If metal exceedances are attributable to the Line 6B crude oil release, certain conditions would be expected:

- Samples with the highest target metal concentrations would also have other indicators of the Line 6B crude oil release, such as detections of PNAs and/or VOCs, oil globules, sheen, or fluorescence.
- Target metal concentrations would be higher in areas affected by the Line 6B crude oil release and lower in unaffected/background areas if the Line 6B crude oil was a significant source of metals.

These conditions, which are addressed in the *White Paper: Evaluation of Metals in Soil and Groundwater*, submitted to the MDEQ on June 4, 2014 (Enbridge, 2014b) and included as *Attachment D* to this NFA Report, were not observed in the Spill Area generally, or Reach 3, specifically.

Across the Spill Area, over 5,000 soil samples and over 2,000 groundwater samples were analyzed for the target metals, including 1,223 soil samples and 164 groundwater samples in Reach 3. The MDEQ initially required these analyses to evaluate whether potential Criteria exceedances in soil and groundwater were attributable to Line 6B crude oil. However, the results of the analyses, as summarized below, clearly demonstrate that the source of target metals Criteria exceedances cannot be attributable to Line 6B crude oil.

Soils

- Beryllium results indicated no exceedances of Criteria in Reach 3 or the overall Spill Area.
- Nickel results indicated no exceedances of Criteria in Reach 3, and only two exceedances in the Spill Area at locations 15 miles and 21 miles downstream from the Source Area.
- Molybdenum exceeded Criteria in approximately 1,500 samples across the Spill Area. Of these samples, approximately 1,200 samples were screened for the presence of Line 6B crude oil (visual oil, sheen, or fluorescence) and the vast majority (78%) reported no visual oil, sheen, or fluorescence. These samples had molybdenum concentrations of 1.6 mg/kg to 26 mg/kg. For the 22% of the samples which had molybdenum Criteria exceedances and reported visual oil, sheen, or fluorescence the

molybdenum concentrations were 1.6 mg/kg to 7 mg/kg. The samples without observations of Line 6B crude oil generally exhibited higher concentrations of molybdenum than those samples with observations. It is also notable that molybdenum exceeded Criteria in 55% of the background samples in Talmadge Creek. This included the highest molybdenum concentration detected on the project (67 mg/kg), which was reported in a background sample collected on Talmadge Creek upstream of the Source Area.

- Vanadium exceeded Criteria in 66 samples that were collected as part of assessment and excavation confirmation work across the Spill Area. Of these samples, 51 samples were screened for the presence of visual oil, sheen, or fluorescence and 50 samples (98%) reported no visual oil, sheen, or fluorescence. These samples had vanadium concentrations of 74 mg/kg to 360 mg/kg. For the single sample which had a vanadium Criteria exceedance and reported visual oil, sheen, or fluorescence, the vanadium concentration was 110 mg/kg. The samples without observations of Line 6B crude oil exhibited similar or higher concentrations of vanadium than the sample with reported observations of impact.
- The nine highest vanadium concentrations (170 mg/kg to 360 mg/kg) were collected in the same area of Reach 9, near the former Ceresco Reservoir. Three of these samples were from the Marshall Sandstone bedrock. The vanadium concentration in these three samples ranged from 170 mg/kg to 300 mg/kg. Given the weight of evidence based on soil samples collected from the Marshall Sandstone, the higher vanadium concentrations are likely attributable to the Marshall Sandstone.

Groundwater

- The vast majority of the groundwater samples were collected from temporary wells where sediment is routinely entrained in the sample matrix resulting in elevated turbidity and target metals concentrations.
- There were no exceedances of Criteria for beryllium or molybdenum in the Reach 3 Spill Area.
- Only one groundwater sample exceeded the Criteria for nickel in Reach 3. This sample, collected from a temporary well, contained elevated suspended sediment, as reflected in a turbidity of 1,000 nephelometric units (NTUs), which resulted in the elevated nickel concentration.

- Vanadium was detected more frequently than other target metals. In Reach 3, a total of 23 groundwater samples collected from 130 temporary wells exceeded the vanadium Criteria. With one exception, these samples all had elevated turbidity readings of 22.7 NTUs to 1,245.4 NTUs. The elevated turbidity in these samples resulted in the vanadium exceedances of Criteria. The one exception occurred at SBTC0100L030, a deep temporary well (screened 7.5 ft to 8.5 ft bgs) where the turbidity was only 8.7 NTUs. This well was artesian, with a water level approximately 1.3 ft above ground surface and the boring log indicates that the sample was collected from a well-graded sand that was overlain by approximately 7.4 ft of low plasticity clay. The confined conditions within the well-graded sand reflect an upward, discharging gradient. This reflects hydraulic potential from a deeper, more regional groundwater flow system, most likely the underlying Marshall Sandstone bedrock. As a result, the groundwater sample reflects background conditions in that deeper flow system where vanadium concentrations are higher than they are in the shallow flow system. As described in *Section 2.4.1.4.2*, groundwater samples indicated vanadium Criteria exceedances were typically collected 2.5 ft deeper than those not showing Criteria exceedances. Together, these conditions demonstrate that deeper groundwater samples with elevated vanadium, likely reflect the influence of the underlying sandstone bedrock.
- Across the entire Spill Area only 3% of the detected vanadium concentrations from filtered samples exceeded Criteria (7 samples out of a total of 222 filtered samples). These exceedances occurred at four permanent wells and one soil boring. Of these exceedances, the locations with the highest vanadium concentrations were measured in two monitoring wells screened within the Marshall Sandstone (MWKR0570L03 and MWKR0580R03) that were located north and south of the Kalamazoo River immediately upstream of the former Ceresco Dam. Both wells were located outside the inundation zone as well as outside the potential flow paths related to the Ceresco Dam backwater. Following removal of the Ceresco Dam in 2013, the water elevation in these wells dropped into the bedrock and left only 2 ft to 4 ft of water in the wells. During the December 2014 sampling event, both wells were purged dry before they could be sampled.
- In accordance with the approved *Sampling and Analysis Plan (SAP)*, submitted to the MDEQ on August 30, 2011 (SAP) (Enbridge, 2011c), the wells were allowed to recover and were then re-sampled the following day. The samples for both wells were

characterized as cloudy (elevated turbidity) and had vanadium concentrations of 0.840 milligrams per liter (mg/l) and 0.210 mg/l, respectively, which was approximately 5 to 20 times higher than any other vanadium detections. These circumstances indicate that the elevated vanadium concentrations are related to the Marshall Sandstone in the Kalamazoo River watershed, and are not attributable to the Line 6B Release.

This evaluation of the distribution of metals in soil and groundwater supports the MDEQ's goal of creating a robust CSM. The following is a project-wide summary of the distribution of metals:

- The elevated concentrations of the target metals do not correlate with detections of PNAs/VOCs, visible oil, oil globules, sheen, or fluorescence,
- Distribution of target metal Criteria exceedances is similar in both samples collected from the Spill Area and samples collected in unaffected areas located outside the Spill Area, and
- For vanadium, the highest concentrations in soil and groundwater were found near the former Ceresco Dam where Marshall Sandstone, a likely source of vanadium, is present near the ground surface.

2.4.1.4 MDEQ Comments on Metals Issues in Reach 3 RI Report

The MDEQ raised a number of comments in response to the Reach 3 RI Report conclusion that metal exceedances in sampling results are not attributable to the Line 6B Release. The MDEQ's comments are set forth in the MDEQ Executive Summary (*Attachment E*).

In addressing MDEQ's comments, it is first important to consider how sites with background conditions, such as the Line 6B Spill Area, are to be assessed. The U.S. EPA *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* (U.S. EPA, 2002a) states:

"For the purposes of this guidance, background refers to substances or locations that are not influenced by releases from a site, and are usually described as naturally occurring or anthropogenic:

- 1) Naturally occurring - substances present in the environment in forms that have not been influenced by human activity; and

- 2) Anthropogenic - natural and human-made substances present in the environment as a result of human activities (not specifically related to the CERCLA release in question)."

The U.S. EPA *Hazard Ranking System Guidance Manual* (U.S. EPA, 1992) defines background level as:

"The concentration of a hazardous substance that provides a defensible reference point that can be used to evaluate whether or not a release from the site has occurred. The background level should reflect the concentration of the hazardous substance in the medium of concern for the environmental setting on or near a site. Background level does not necessarily represent pre-release conditions, nor conditions in the absence of influence from source(s) at the site."

The U.S. EPA is clear that site cleanup decisions need to focus on substances released by the site or facility and not on substances present at levels that constitute natural or historic anthropogenic background. Specifically, the U.S. EPA indicates:

"In cases where background levels are high or present health risks, this information may be important to the public. Background information is important to risk managers because the CERCLA program, generally, does not clean up to concentrations below natural or anthropogenic background levels."

Generally, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), cleanup levels are not established at concentrations below natural background levels. Similarly, for anthropogenic contaminant concentrations, the CERCLA program typically does not set cleanup levels below anthropogenic background concentrations (U.S. EPA, 1989; U.S. EPA, 1991; U.S. EPA, 2002b). The U.S. EPA's *Risk Assessment Guidance for Superfund* (U.S. EPA, 1989) provides a similar definition of background as noted below:

"USEPA identifies two types of background levels of chemicals:

- 1) Naturally occurring levels, which are ambient concentrations of chemicals present in the environment that have not been influenced by humans; and
- 2) Anthropogenic levels, which are ambient concentrations of chemicals that are present in the environment resulting from human sources."

The guidance summarized above applies to the distribution of molybdenum in soil in Reach 3 specifically and the Spill Area more generally. The remainder of this section addresses the MDEQ's comments separately with respect to soil and groundwater.

2.4.1.4.1 Soil Comments

The MDEQ Executive Summary stated:

"Enbridge provided data that indicates metals that are constituents of the Line 6B pipeline release, specifically Molybdenum, are present in soil at concentrations in excess of Part 201 Drinking Water Protection Criteria (DWPC) in the spill area (see Figure 3 and Table 3)." ...and went on to add..."Synthetic precipitation leaching procedure (SPLP) was conducted at one of these locations with an exceedance of Part 201 Residential Drinking Water Criteria as a result."

Table 3 of the MDEQ Executive Summary comments identified 16 samples where molybdenum exceedances occurred. However, a review of the data identified in the MDEQ's comments indicates the following:

- Two of the samples are split-samples that were collected and analyzed by the MDEQ for their quality assurance quality control (QAQC) purposes. These results are QAQC samples for data validation purposes, and therefore, the MDEQ samples were not compared to Criteria or discussed Reach 3 RI Report or NFA Report. However, it should be noted that Enbridge conducted SPLP analyses on samples from both parent sample locations (ESTC0075L107 and ESTC0100R154) with no exceedance of the DWPC. No other samples listed in *Table 3* from the MDEQ Executive Summary were analyzed for SPLP.
- Three of the samples indicated no detectable molybdenum, but had ERLs of 1.6 mg/kg to 2.3 mg/kg above the target reporting limit of 1.5 mg/kg. These minor ERLs are insignificant, and are more specifically addressed in *Section 2.4.2*.

The remaining 11 samples, which include two duplicates, reported molybdenum above the DWPC (1.5 mg/kg) with concentrations between 2.6 mg/kg and 7.3 mg/kg. These samples included 1 post-excavation sample and 10 decommissioning samples located well outside the Talmadge Creek channel. These 11 samples were directly submitted for laboratory analysis with no characterization of impacts (no logging of visible oil or sheen and no UV fluorescence

screening). The laboratory analysis also reported no exceedances of PNAs or VOCs for these samples. The approved work plan did not require SPLP (Enbridge, 2011a).

In its comments, the MDEQ stated that only 1 of the 16 samples was tested for SPLP and that sample indicated a Criteria exceedance. The MDEQ's statement, however, appears to be in error – while it is true that only one sample was submitted for SPLP, that sample, ESTC0100R154 reported a molybdenum concentration of 0.037 mg/l, which is below the Criteria of 0.05 mg/l.

In summary, there is no indication that these molybdenum results are attributable to the Line 6B crude oil release.

2.4.1.4.2 Groundwater

The MDEQ Executive Summary stated:

“Enbridge provided data that indicates metals, which are constituents of the Line 6B Pipeline release, (primarily Vanadium, but also Nickel) are present in groundwater at concentrations in excess of Part 201 Residential Drinking Water Criteria (DWC) and Groundwater Surface Water Interface Criteria (GSIC) in the spill area.”...and went on to conclude...” Additional evaluation is required to assess the risks associated with Vanadium impact to groundwater.”

Table 5 of the MDEQ's Executive Summary comments identified 27 samples where vanadium exceeded DWC and/or GSIC. In addition, one sample identified by the MDEQ also reported a nickel exceedance of the GSIC. Two of the samples listed in *Table 5* were split-samples that were collected and analyzed by the MDEQ for their QAQC purposes. As stated previously, these results were from QAQC samples and were not compared to Criteria or discussed in the Reach 3 RI Report or NFA Report.

A review of the boring logs and groundwater sampling forms indicates that there were no observations of oil and only one location with sheen and fluorescence at the 25 locations listed in *Table 5* of the MDEQ Executive Summary. However, as noted in *Section 2.4.1.3*, the vanadium exceedances were generally associated with elevated turbidity ranging from 22.7 NTUs to 1,245.4 NTUs. This largely accounts for the exceedances of Criteria. In addition, upon closer inspection of the entire group of groundwater samples from temporary wells in Reach 3, it is noted that the vanadium exceedances are typically associated with

deeper samples. The 25 locations with vanadium exceedances were collected at an average depth of 6.7 ft bgs. The 82 samples which did not show vanadium exceedances were collected at an average depth of 4.2 ft bgs. This is contrary to what would be expected if the vanadium exceedances were attributable to the Line 6B crude oil, which was deposited at the ground surface.

A more plausible explanation for the exceedances (as opposed to the Line 6B Release) is that they are associated with deeper groundwater samples that more closely reflects the influence of the Marshall Sandstone parent material, as explained in detail above.

In its comments, the MDEQ also noted that one sample (SBTC0100R515) exceeded the nickel DWPC. This sample was collected from a location with the second highest turbidity measurement in Reach 3 (1,000 NTUs). The elevated turbidity resulted from the well purging dry before it could be sampled. In accordance with the SAP, the well was allowed to recover and was then re-sampled the following day without achieving stability which often results in elevated turbidity.

Collectively, these circumstances indicate that the vanadium and nickel exceedances identified by the MDEQ cannot be attributed to the Line 6B crude oil and/or response activities.

2.4.1.5 MDEQ Evaluation of Metals

In order to evaluate the detection of metals that exceed Criteria along Talmadge Creek, Enbridge met with the MDEQ on multiple occasions in 2015. The MDEQ developed an approach to evaluate if metal exceedances within soils are attributable to Line 6B crude oil. The MDEQ determined that metal exceedances along Talmadge Creek, including the entire Reach 3 Spill Area, were not attributable to Line 6B and therefore do not require further evaluation or action.

The MDEQ also developed an approach to determine if metal exceedances in groundwater along Talmadge Creek, primarily vanadium, are attributable to Line 6B crude oil. The MDEQ proposed and Enbridge agreed to install ten monitoring wells along Talmadge Creek (two of which are situated within the Reach 3 Spill Area) and to collect one round of groundwater samples. The MDEQ agreed that if the groundwater analytical results for the target metals were below Criteria, no further evaluation or action would be warranted and are not attributable to Line 6B crude oil. The monitoring well locations are depicted in *Figure 3* and the corresponding analytical results are presented in *Table 3*.

The monitoring wells were installed and developed between September 22 and September 29, 2015, and sampled between October 12 and October 13, 2015. The analytical results reported that all samples were non-detect at the method detection limit, therefore the metal Criteria exceedances in groundwater observed along Talmadge Creek are not attributable to Line 6B crude oil and no further evaluation or action is warranted. A copy of the monitoring well construction diagrams, low flow groundwater sampling collection records, laboratory analytical results, and the Level 1 Data Review Memoranda are included in *Attachment F*.

2.4.1.6 Conclusions

This analysis demonstrates that target metals, while trace constituents of Line 6B crude oil, are not easily leached from the Line 6B crude oil. Further, given the low levels of metals contained in Line 6B crude oil, any contribution of these metals from Line 6B crude oil would not have the ability to cause the exceedances discussed above. Indeed, a review of the distribution of target metals across Reach 3 specifically, and over the Spill Area more broadly, clearly indicates that the Criteria exceedances reflect natural variation of the presence and concentration of these metals in this portion of the Kalamazoo River watershed, as exists regardless of Line 6B crude oil. Thus, in accordance with the U.S. EPA guidance summarized in *Section 2.4.1.4*, the presence of these metals (and their concentrations) is not due to leaching from Line 6B crude oil and no action is necessary or appropriate. Further, both the additional soil evaluation performed by the MDEQ and the non-detect groundwater analytical results for metals from the 10 recently installed and sampled monitoring wells establishes that the observed Criteria exceedances for metals are not attributable to Line 6B crude oil.

2.4.2 Elevated Reporting Limits

An ongoing challenge to this project has been the presence of ERLs in soil and groundwater analytical sample results. An ERL is an acknowledgement that, due to certain natural field conditions, the analytical technique could not detect a constituent between the established Criteria level and the ERL. An ERL with a non-detect result does not indicate the constituent is present, rather that the absence of the constituent above the Criteria but below the ERL cannot be confirmed. An ERL with an analytical result above the Criteria does not indicate that the constituent in question is present, but instead that the absence of a constituent above the Criteria cannot be unequivocally established in that sample. The presence of ERLs is a widespread issue in environmental sampling throughout Michigan, and not a condition that is specific to the Enbridge Line 6B crude oil release.

Enbridge and the MDEQ discussed ERLs in meetings held on January 9, 2014 and January 16, 2014. During those meetings, the parties agreed that Enbridge would evaluate ERLs in both soil and groundwater. As set forth in *Section 4.5.7* of the Reach 3 RI, the evaluation relied on representative groundwater results, with no exceedance of the Criteria in question to address nearby samples with ERLs. More specifically, if a representative groundwater sample was located within approximately 25 ft of the sample with an ERL, then the ERL would not be considered a data gap. Representative groundwater samples include those collected from temporary wells as well as excavations.

MDEQ again raised groundwater ERLs as an issue in the MDEQ Executive Summary. The following sections specifically address the MDEQ's comments.

2.4.2.1 ERLs in PNA Groundwater Samples

The MDEQ Executive Summary states:

“A total of nine sample locations exhibited elevated reporting limits in excess of Part 201 Criteria (see Figure 7). No additional samples were collected and permanent wells were not installed in these locations. Additional evaluation is required to confirm the presence or absence of impact and assess the associated risks.”

The nine samples identified by the MDEQ are as follows: SBTC0075L001*, SBTC0075R032*, SBTC0075L050, SBTC0100L040*, SBTC0100R087*, SBTC0100R515, SBTC0100R516, SBTC0125L20*, and SBTC0125R512A*. Of these nine samples, six (identified with * above) are split-samples that were collected and analyzed by the MDEQ for their QAQC purposes. As set forth in *Section 3.4.4* in the Reach 3 RI Report, Enbridge included the results of these samples in data tables, but did not compare them to Criteria nor discuss them in the text. Accordingly, these sampling results are not used nor relied upon in this NFA Report. However, it should be noted that results from the parent samples associated with the six split-samples reported no detections with reporting limits that met the target detection limits.

The three remaining groundwater sample locations identified by the MDEQ (SBTC0075L050, SBTC0100R515, and SBTC0100R516) were addressed by temporary well samples collected within 25 ft of the location with an ERL, in accordance with the protocol agreed to by the MDEQ. The list below identifies the temporary well locations where no ERL was reported, as well as the corresponding locations with an ERL (in parentheses):

- SBTC0075L511 (SBTC0075L050),
- SBTC0100L509 (SBTC0100R515), and
- SBTC0100R077B (SBTC0100R516).

Using the protocols agreed to by MDEQ, these results eliminate any data gap due to an ERL. Therefore, no further testing or analysis is necessary.

2.4.2.2 ERLs in VOC Groundwater Samples

The MDEQ Executive Summary also stated that:

“Numerous groundwater samples within Reach 3 exhibited elevated reporting limits above Part 201 Criteria. Additional evaluation is required to confirm or deny the presence or absence of VOC impact to groundwater and assess the associated risks.”

Further, the MDEQ supplied a figure (*Figure 6*) which depicts 103 groundwater samples that had ERLs.

The ERLs identified by the MDEQ are for two compounds: dibromochloropropane and ethylene dibromide. As set forth in *Section 3.4.3* of the Reach 3 RI Report:

“In all cases, the RLs were elevated above DWPC for dibromochloropropane (1-2, Dibromo-3-chloropropane, CAS No 96-12-8) and ethylene dibromide (1,2-dibromoethane, CAS no. 106-93-4). This is due to the fact that, in the approved *Quality Assurance Project Plan (QAPP)*, submitted to the MDEQ on August 19, 2011 (QAPP) (Enbridge, 2011d) the RLs for these compounds were specified based on the standard RL achievable using U.S. EPA Method 8260, which is the analytical method that was used. However, the agreed upon standard U.S. EPA Method 8260 RLs for these compounds, in both soil and water, are above the lowest DWPC and the Target Detection Limit. Consequently, these compounds will always have an ERL. These ERLs are an artifact of the standard RL for the analytical method used, which was agreed to by the MDEQ at the time the QAPP was developed.”

Having agreed to use the U.S. EPA method and being aware of its limitations, MDEQ must accept the results of that method.

Perhaps more importantly, dibromochloropropane and ethylene dibromide were not detected in Line 6B crude oil. Therefore, there really is no spill-related reason to be looking for these contaminants. The ERLs for VOCs in groundwater are not relevant to actions to remediate the Release, and no further action is required.

2.4.3 Laboratory Contaminants

In the Reach 3 Spill Area, analytical data shows laboratory contaminants not associated with Line 6B crude oil (methylene chloride and chloromethane), which were sporadically detected in soil samples. Laboratory contaminants are considered sample artifacts and are not inherent in the samples themselves based on historical data from the site, and do not accurately represent the current conditions within the sampled media in the Reach 3 Spill Area. The detection of constituents known to be laboratory contaminants is a widespread issue throughout the country, and not a condition that is specific to the Enbridge Line 6B crude oil release. However, on a project like this where over 10,000 samples have been analyzed, the number of occurrences appear magnified.

Within this context the MDEQ Executive Summary stated:

“Enbridge provided data that indicates VOCs, which are constituents of the Line 6B pipeline release, are present in unsaturated soil at concentrations in excess of Part 201 DWPC and Groundwater Surface Water Interface Protection Criteria (GSIPC) in the spill area. Enbridge conducted SPLP analyses for two unsaturated soil samples with both sample results indicating the potential for VOC mobility at concentrations in excess of Part 201 Criteria (see Figure 4 and Table 4). Additionally, two other soil samples had VOC exceedances of Part 201 Criteria but did not have corresponding SPLP data to indicate that no risk to groundwater was present. Additional evaluation is required to confirm the presence, absence, and/or mobility of VOC impact.”

The two samples MDEQ noted as having SPLP Criteria exceedances (SBTC0075L508 and SBTC0100R501) reported the presence of TCE. These exceedances are addressed earlier in *Section 2.3.1*.

The two samples MDEQ noted as having Criteria exceedances without accompanying SPLP analysis (ESTC0100L138 and SBTC0100R046) reported the presence chloromethane and methylene chloride, respectively. Neither of these compounds have been identified in the analysis of Line 6B crude oil. As set forth in *Section 3.4.2* and *Section 5.1.7* of the Reach 3 RI Report, chloromethane and methylene chloride are known laboratory contaminants and are not inherent in the sampled media as evidenced by historical data from the site.

Based on this analysis, the reported Criteria exceedances of laboratory contaminants do not represent reliable data and, as a result do not present a data gap and no further action is required.

2.4.4 UV Fluorescence

During 2011, Enbridge and the MDEQ mutually agreed to employ UV fluorescence as a screening tool to evaluate the potential presence of Line 6B crude oil in subsurface soils. The use of UV fluorescence and high-resolution photography was adapted and enhanced from similar procedures used in oil exploration, but rarely employed in Michigan for environmental projects. As part of this effort, percentages of fluorescence in soil intervals were recorded and classified (0% to 5% – trace fluorescence, 6% and more – UV fluorescence).

Subsequent to this, during the TCRI in the Reach 3 Spill Area, the UV fluorescence classification was recorded at 94 of the 1,267 soil and sediment samples submitted for laboratory analysis (approximately 7%). None of these analytical samples reported exceedances of Criteria for PNAs or VOCs. Of the soil and sediment samples with a UV fluorescence classification, approximately 62% were then excavated during the 2011/2012 excavation to or below the depth of the UV fluorescence interval (fully excavated). An additional 12% of the locations with UV fluorescence were also excavated, although based upon the recorded average depth of these excavations it cannot be confirmed that the bottom depth of the sample interval with UV fluorescence was excavated.

During meetings with Enbridge and in the comments that the MDEQ provided in response to the *Draft No Further Action Report Reach 3 – MP 0.50 to MP 1.00*, submitted to the MDEQ on August 9, 2013 (Enbridge, 2013), the MDEQ expressed concern that the remaining locations with UV fluorescence may be associated with analytical exceedances of Criteria. As set forth in *Section 4.5.3* of the Reach 3 RI Report, Enbridge addressed this concern by reassessing 29 locations where UV fluorescence classification was recorded during the TCRI, analytical

samples were not collected, and the locations were not excavated. This represented approximately 80% of the remaining locations with UV fluorescence. Soil borings were advanced and soil samples were collected at the 29 locations. As an additional line of evidence, 21 temporary wells were installed to collect groundwater samples. Soil and groundwater analytical results from this effort reported no exceedances of Criteria for PNAs and VOCs. These results demonstrate that the remaining UV fluorescence signatures in the subsurface soils in Reach 3 do not result in exceedances of Criteria for VOCs and PNAs and does not represent a risk to human health.

The MDEQ Executive Summary states:

“Five locations exist where analytical sample data was not collected (see Figure 2 and Table 2). Enbridge did not provide data indicating observations of UV fluorescence do not result in potential exceedances of Part 201 Soil and/or Groundwater Criteria”.

The five locations (SBTC0125R015, SBTC0125L005, SBTC0100L086B, SBTC0100R076, and SBTC0100L059) identified by the MDEQ with UV fluorescence, but without supporting analytical data, were either: (i) excavated or (ii) additional soil and/or groundwater samples were collected in the vicinity (within 10 ft) of the location, and such samples indicated no human health risks associated with the UV fluorescence observations. A brief description of the excavation and sampling activities associated with the five locations is as follows:

- SBTC0125R015 (UV fluorescence 0 ft to 1.5 ft bgs) – This sample location was excavated to approximately 2 ft bgs during the 2011/2012 excavation. No further evaluation is warranted.
- SBTC0125L005 (UV Fluorescence 0 ft to 0.3 ft bgs) – This location was located less than a foot from the boundary of the excavation (1.5 ft bgs) and is presumed to have been excavated. During the excavation, a soil sample (ESTC0125L148) was collected from the excavation floor (approximately 1.5 ft bgs), 4 ft west from location SBTC0125L005. Analytical results indicate that there were no exceedances of Criteria in the saturated soil sample that was collected from location ESTC0125L148. Additionally there was a groundwater sample collected from a temporary well (SBTC0125L504) during the data gap assessment 4 ft south of location SBTC0125L005, and analytical results indicate no exceedances of VOC Criteria. No further evaluation is warranted.

- SBTC0100L086B (UV fluorescence from 0 ft to 1 ft bgs and trace UV fluorescence from 1.0 ft to 2.0 ft bgs) – This location was excavated to approximately 1 ft during the 2011/2012 excavation. A total of four soil samples (ESTC0100L269, ESTC0100L270, ESTC0100L271, and ESTC0100L272) were collected approximately 2 ft in each direction from SBTC0100L086B. Analytical results indicate that there were no exceedances of Criteria in the four excavation soil samples. No further evaluation is warranted.
- SBTC0100R076 (UV fluorescence 0 ft to 2.1 ft bgs) – This location was excavated to approximately 1.5 ft during the 2011/2012 excavation. During the excavation, a soil sample was collected from the excavation floor (approximately 1.0 ft bgs), 5 ft north of SBTC0100R076 at location ESTC0100R160. Analytical results indicate that there were no exceedances of Criteria. Additionally, a groundwater sample was collected from SBTC0100R515 during the data gap assessment, which is located approximately 6 ft south of location SBTC0100R076. Analytical results indicate that there were no exceedances of Criteria for VOCs or PNAs in the soil and groundwater samples. No further evaluation is warranted.
- SBTC0100L059 (UV fluorescence 0 ft to 0.2 ft bgs) – This location is located less than a foot from the boundary of the 2011/2012 excavation (1.5 ft bgs) and is presumed to have been excavated. A soil and groundwater sample were collected approximately 7 ft southwest, at location SBTC0100L060. Analytical results indicate that there were no exceedances of Criteria for VOCs or PNAs. No further evaluation is warranted.

Further, 97% of the locations sampled with UV fluorescence across the entire Talmadge Creek Spill Area (MP 0.01 - MP 2.25) did not report results with exceedances of Criteria for VOCs or PNAs. Thus, while UV fluorescence may be used as a screening tool for assessing the potential presence of Line 6B crude oil, it does not identify locations where Criteria exceedances are likely. Accordingly, remaining UV fluorescence observations in soil and sediment within Reach 3 and/or the Spill Area do not present a risk to human health and no further evaluation or action is required.

2.4.5 Non-Aqueous Phase Liquid

Non-Aqueous Phase Liquid (NAPL) is defined as a liquid, such as gasoline, diesel, or other petroleum-based fuel, waste oil, or crude oil that contains one or more organic compounds that are relatively insoluble in water (ASTM, 2007; ITRC, 2009; MDEQ 2014a). In the environment, NAPL exists as a separate phase that is immiscible with water. Line 6B crude oil meets the definition of NAPL and immediately following the release, NAPL was present in Reach 3. However, following response actions in 2010 and the remedial excavation in 2011/2012, NAPL, as a source area, NAPL body, or residual NAPL no longer existed in Reach 3. The only possible evidence of remaining NAPL in Reach 3 was sheen, which is could be vestige of NAPL. There have been no observations of sheen in Reach 3 since September 2011. The sheen observations, which are discussed in *Section 2.4.6*, were reported in *de minimis*, isolated locations.

The absence of a NAPL body in Reach 3 was established using extensive characterization and confirmation sampling following the 2011/2012 excavation. Results from these efforts were documented in the Reach 3 RI Report. However, the MDEQ Executive Summary stated:

“Enbridge provided observations of visible oil, oil globules, and/or sheen on groundwater or soil cores at 22 locations in Reach 3 (see Figure 1 and Table 1a).”

A review of these observations indicates that they are all reported as sheen in the borehole, sample, surface water, or ground surface at the core location. The nature of the sheen (biogenic and/or petroleum) was not determined at the time of recording. There are no remaining observations of visible oil or oil globules in Reach 3.

In accordance with American Society for Testing Materials *Standard Guide for Development of Conceptual Site Models and Remediation Strategies for Light Nonaqueous-Phase Liquids Released to the Subsurface* (ASTM, 2007), sheen is a secondary, weight of evidence indicator for the potential presence of NAPL. Given that none of the 22 locations included observations of oil, visible oil, or oil globules, the sheen observations represent minor, vestigial remnants of NAPL and cannot by themselves be considered a NAPL body or residual NAPL.

Moreover, as part of the data gap evaluation, Enbridge evaluated each of these locations and found no evidence of a NAPL body or exceedance of PNA or VOC Criteria. Given the historic presence of sheen at these locations, they have been subject to further evaluation for potential aesthetic impact and are discussed in *Section 2.4.6*.

As part of the MDEQ Executive Summary, the MDEQ also stated that NAPL mobility should be evaluated in Reach 3. However, this testing can only be conducted on soil samples that contain residual NAPL. The absence of residual NAPL in Reach 3 precludes this analysis.

Enbridge, working closely with the MDEQ, evaluated NAPL mobility at a series of eight locations selected from across the Spill Area which were judged as most likely to contain NAPL. The eight locations were spread across the entire Spill Area, although none were positioned in Reach 3. Results of this effort were reported in the *White Paper: Evaluation of Line 6B Crude Oil NAPL Risk based on a Weight of Evidence Approach*, submitted to the MDEQ on June 12, 2015 (NAPL White Paper) (Enbridge, 2015b), and included as *Attachment G*. In short, the NAPL White Paper demonstrates no NAPL mobility and low levels of NAPL saturation. Overall, the residual NAPL remaining in the Spill Area is *de minimis*, isolated, and immobile.

In summary, there are no records or observations that suggest the presence of NAPL, either as oil, visible oil, or oil globules in Reach 3. Observations of sheen have not been confirmed to show a source area, NAPL body, or exceedances of Criteria. Furthermore, a NAPL mobility evaluation over the entire Spill Area demonstrated that even at worst case locations, the remaining NAPL is *de minimis*, isolated, and immobile.

2.4.6 Aesthetics

Despite the extensive response and remedial actions conducted throughout the Reach 3 Spill Area, isolated, discontinuous, and *de minimis* observation of remaining Line 6B crude oil artifacts may remain as sheen observations in soil cores or on borehole water and odor noted in soil. Visible oil does not remain within Reach 3. While no human health or ecological risks exist with these remaining artifacts, these aesthetic observations require identification and evaluation to determine if they represent an actionable condition.

Enbridge developed a comprehensive process to identify and categorize aesthetic observations from all available records (e.g., soil boring logs, well construction reports, groundwater sampling logs, and field notes, etc.).

Because this process evolved following publication of the Reach 3 RI Report, this section first summarizes the comprehensive procedures that were used to review all available records and identify/categorize aesthetics observations. This section then reviews aesthetic comments provided in the MDEQ Executive Summary in light of this comprehensive process. From these efforts, a total of 20 locations are identified in Reach 3 where potential remaining aesthetic observations may exist. A detailed determination of actionable aesthetic conditions at each of the 20 locations is then provided.

2.4.6.1 Aesthetics Evaluation

Aesthetic observations are based on a subjective evaluation of the effects of a physical or chemical characteristic of a constituent which are observable (generally through sight or smell) and that may be objectionable to an individual who encounters them. Aesthetic observations are specifically not detrimental to human health (i.e., they do not exceed established risk-based criteria).

Enbridge has performed an aesthetics evaluation related to Line 6B crude oil release within Reach 3. This assessment was conducted in accordance with current Part 201 and Part 31 of Michigan's Act 451 of 1994, as amended rules and MDEQ-published guidance documents, which provide limited direction on what constitutes an aesthetic observation or what aesthetic observations are considered to be actionable. Based on Enbridge's review of current MDEQ Rules, aesthetic observations for groundwater, surface water, and soils were evaluated as follows:

Groundwater: All groundwater analytical results were compared to groundwater Criteria that are based on aesthetics.

Surface Water: Surface water samples were judged against the narrative water quality standards (Rule 323.1050), which include observations of oil films (or sheens) and odors. These apply to surface water only and not to soil or groundwater. The water quality standards are based on visual physical characteristics (turbidity, odor, oil films, floating solids, foams, settleable solids, suspended solids, and deposits) which are or may become injurious to any designated use. The narrative water quality standards are not chemical-specific concentrations.

Soil: Enbridge did not identify any MDEQ Rules that addressed aesthetic observations in soil.

To supplement the MDEQ Rules, Enbridge utilized the MDEQ website to identify instances where aesthetic impact notifications have been implemented on other projects and the specific aesthetic observations that led to the notification. In addition, Enbridge reviewed and considered the MDEQ's *Technical Review Comments – Aesthetic Concerns on the Remedial Investigation Report for Reach 1*, issued on May 14, 2014 (MDEQ, 2014b) and the MDEQ's *Technical Review Comments* within the *Notice of Insufficient Information in Reach 5 No Further Action Report*, issued on August 22, 2014 (MDEQ, 2014c). Finally, Enbridge contacted numerous MDEQ personnel from districts throughout Michigan seeking examples and guidance on the MDEQ position on both aesthetic observations and actionable aesthetic impacts. The compilation of this information was used as the basis for Enbridge's aesthetic evaluation.

The number of instances where aesthetic observations have been identified in the Spill Area have decreased dramatically as a result of response efforts performed to date. However, aesthetic observations, although rare, may be observed in the future.

2.4.6.1.1 Aesthetics Observation Categories

When aesthetic observations are made, they are divided into the following categories:

Visible Oil Within a Soil Core – Visible oil is observed within the soil core under natural light conditions. Visible oil observations range from small globules (generally pinhead to 0.5 millimeters in size) to pinhead sized flecks that are observable without magnification, small amounts of NAPL adhered to soil grains and highly weathered, residual Line 6B crude oil residue that remains on the ground surface and observed at the top of the soil core (former tar patty). Enbridge has only observed vertically and horizontally discontinuous and *de minimis* occurrences of visible oil. No observations of sub-surface, accumulated visible oil (NAPL bodies or source areas) have been encountered.

Visible Oil on Borehole Water – When a soil boring is advanced below the water table and the targeted soil interval is removed from the subsurface, groundwater often fills the borehole annulus. Small globules of visible oil may rarely be observed on the groundwater in the borehole. It is believed that the visible oil on the borehole water surface is the result of disturbance of the surrounding soil or impact carried down from the uppermost soil horizon which may contain small amounts of remaining crude oil. The advancement of the soil boring can result in sheening and small globules forming on the borehole water surface. Visible oil

has not been observed to cover the borehole water and no measurable product layer has ever been observed.

Odor in Soil – Petroleum odors are observed either within the borehole during advancement or in the soil core during logging.

Odor in Purge Water – Purge water collected in buckets during the sampling of a temporary well emits a petroleum odor.

Sheen Within a Soil Core – Sheen is observed within the soil core under natural light conditions. Once a soil core is cut open and is being logged, sheen may be observed near the top of the soil core or smeared along the soil core casing.

Sheen on Borehole Water – When a soil boring is advanced below the water table and the desired soils are removed from the subsurface, groundwater often fills the borehole annulus. Sheen may be observed on the groundwater in the borehole. It is believed that the sheen on the borehole water surface is the result of disturbance of the surrounding soil or impact carried down from the uppermost impacted soils to the borehole water during the manual advancement of the soil boring, resulting in sheening on the borehole water surface.

Sheen on Purge Water – Sheen is observed on the purged groundwater collected in buckets during the sampling of a temporary well.

Sheen on Ground Surface – Sheen is observed on standing water that collects on the ground surface of the overbank areas.

For Reach 3, remaining potential aesthetic observations are limited to odor in soil as well as sheen in soil cores and in borehole water.

2.4.6.1.2 Aesthetics Evaluation Process

Enbridge has categorized the remaining potential aesthetic observations in Reach 3 using the eight aesthetic categories presented above in order to make a determination if these occurrences require further investigation and/or response. The evaluation process includes, but is not limited to, the following:

- Determining whether MDEQ Rules indicate that the aesthetic observation requires action (i.e., exceedance of aesthetic groundwater Criteria);

- Evaluating existing MDEQ guidance;
- Evaluating the geographic distribution of aesthetic observations to one another within each Reach (are multiple aesthetic observations in immediate proximity to one another or are they isolated);
- Evaluating the depth of the aesthetic observation (is it likely that an individual would come into contact with the aesthetic observation and find it objectionable); and
- Determining if aesthetic observation would be considered *de minimis*.

De minimis is typically defined as lacking significance or importance. *De minimis* aesthetic observations will be identified on a case-by-case basis using best professional judgment supported by multiple lines of evidence. These lines of evidence may include, but are not limited to:

- The frequency of similar observations within the entire Reach 3 Spill Area.
- The magnitude or extent of the observations.
- The age of the observation. Older observations are more likely to be *de minimis* than more recent observations.
- Proximity to a “receptor.” Aesthetic observations not in proximity to homes or recreation areas are more likely to be *de minimis*.
- Proximity to surface water or wetlands. Aesthetic observations that are not in proximity to surface water or wetlands are more likely to be *de minimis*.
- Potential that the observation is caused by a source other than the Line 6B crude oil release.
- Duration. An aesthetic observation (such as odor) that is unlikely to persist is more likely to be *de minimis*.
- Habitat value. An aesthetic observation in an area with little habitat value or with degraded habitat unrelated to the Line 6B crude oil release is more likely to be *de minimis*.
- Land use. Aesthetic observations in or near industrial, commercial, or transportation facilities are more likely to be considered *de minimis*.
- Access. An aesthetic observation may be considered *de minimis* if access is limited or difficult (such as an island or area isolated by the river and wetlands).
- Precedents. Aesthetic observations for which further evaluation or remediation has not been required at sites other than this one may be *de minimis*.

A complete evaluation of the remaining potential aesthetic observations identified in Reach 3 is presented in *Section 2.4.6.3*.

2.4.6.2 MDEQ Executive Summary Comments

The MDEQ Executive Summary stated:

“Enbridge provided observations of oil, oil globules, oil sheen, and/or petroleum odor at approximately 24 locations in Reach 3 (see Figure 1 and Table 1b).”...and further that...”As such, these observations constitute aesthetic impacts that require further evaluation.”

As set forth in *Section 5.1.13.3* of the Reach 3 RI Report, based on data collected to date, visible oil does not remain within Reach 3. Remaining potential aesthetic observations in Reach 3 are limited to sheen and/or odor.

The MDEQ also supplied a table (*Table 1b*) and figure (*Figure 1*) in the MDEQ Executive Summary that provided details of 24 locations (SBTC0075L014, SBTC0075L038B, SBTC0075L040A, SBTC0075L042, SBTC0075R004, SBTC0075R048, SBTC0100L044A, SBTC0100L064, SBTC0100L074, SBTC0100L075, SBTC0100L079, SBTC0100L080A, SBTC0100L080B, SBTC0100L084, SBTC0100L084A, SBTC0100L086, SBTC0100L089, SBTC0100L090, SBTC0100L090A, SBTC0100R028, SBTC0100R061, SBTC0100R092E, SBTC0125L007, and SBTC0125R006) where aesthetic observations were identified.

A total of 8 (SBTC0075L038B, SBTC0075L042, SBTC0100L079, SBTC0100L084, SBTC0100L089, SBTC0100L090, SBTC0125L007, and SBTC0125R006) of the 24 locations were also identified by Enbridge and were included in *Table 14* in the Reach 3 RI Report.

Enbridge evaluated the remaining 16 locations that the MDEQ identified to determine if these aesthetic observations remained and warranted inclusion in *Table 4*. The following is a point-by-point evaluation of those 16 locations.

- SBTC0075L014 – Sheen observed on the ground surface in 2011. Enbridge revisited this location during the data gap activities in 2014 as set forth in *Section 4.5.1* of the Reach 3 RI Report and no surficial observations of sheen were observed. Therefore, this aesthetic observation from 2011 no longer remains relevant and this location was not added to *Table 4*.

- SBTC0075L040A – Sheen was observed in the soil core from a depth of 0 ft to 1.8 ft bgs in 2011. This area was excavated to a reported depth of 1.5 ft bgs. While these excavation activities targeted all visible observations of remaining Line 6B crude oil, it cannot be verified that the depth from 1.5 ft and 1.8 ft bgs were removed and therefore this observation may remain. This location was added to *Table 4*.
- SBTC0075R004 – Trace sheen was observed on the top of the soil core when it was collected on September 12, 2011. Enbridge revisited this location during the data gap field activities performed in 2014 as set forth in *Section 4.5.1* of the Reach 3 RI Report and no surficial observations of sheen were observed. It cannot be verified that this observation does not remain. This location was added to *Table 4*.
- SBTC0075R048 – Sheen was observed on the ground surface next to the borehole after the timber mat was removed in 2011. A data gap soil core (SBTC0075R503) and associated temporary well were installed adjacent to this location in 2014, and there were no observations of visible oil or sheen in the soil core, borehole water or purge water and no surficial observations of sheen on the ground surface. The lack of reproducible observations in 2014 confirm that the 2011 observation no longer exists and is not an aesthetic risk. This location was therefore not added to *Table 4*.
- SBTC0100L044A – A slight silver sheen was observed on the ground surface in 2011. Enbridge revisited this location during the data gap field activities performed in 2014 as set forth in *Section 4.5.1* of the Reach 3 RI Report and no surficial observations of sheen were observed. Therefore, this aesthetic observation from 2011 no longer remains and this location was not added to *Table 4*.
- SBTC0100L064 - Sheen and petroleum odors were observed in the soil core from a depth of 0 ft to 2.9 ft bgs in 2011. This area was excavated to a reported depth of 1.5 ft bgs. While the excavation activities targeted all visible observations of remaining Line 6B crude oil, it cannot be verified that the depth from 1.5 ft to 2.8 ft bgs were removed. Therefore, the observation of sheen and or odor may remain. This location was also addressed in the 2014 data gap activities (soil boring SBTC0100L510) and no observations of sheen or odor were noted or documented. Although it is likely that, based on the information provided above, these aesthetic observations of sheen and odor no longer remain, this location was added to *Table 4*.
- SBTC0100L074 – A slight silver sheen was observed on the borehole water in 2011. It cannot be verified whether or not this observation remains. This location was added to *Table 4*.

- SBTC0100L075 – Sheen was observed in the soil core from a depth of 0 ft to 1.9 ft bgs in 2011. This area was excavated to a reported depth of 1.5 ft bgs. While these excavation activities targeted all visible observations of remaining Line 6B crude oil, it cannot be verified that the depth from 1.5 ft to 1.9 ft bgs were removed. Therefore, this observation may remain and this location was accordingly added to *Table 4*.
- SBTC0100L080A – A slight silver sheen was observed on the borehole water in 2011. It cannot be verified whether or not this observation remains. This location was therefore added to *Table 4*.
- SBTC0100L080B – Sheen was observed on the ground surface in 2011. Enbridge revisited this location during the data gap field activities performed in 2014 as set forth in *Section 4.5.1* of the Reach 3 RI Report and no surficial observations of sheen were observed. Therefore, this aesthetic observation from 2011 no longer remains and this location was accordingly not added to *Table 4*.
- SBTC0100L084A – Sheen was observed on the ground surface in 2011. Enbridge revisited this location during the data gap field activities performed in 2014 as set forth in *Section 4.5.1* of the Reach 3 RI Report and no surficial observations of sheen were observed. Therefore, this aesthetic observation from 2011 no longer remains and this location was accordingly not added to *Table 4*.
- SBTC0100L086 - Sheen was observed in the soil core from a depth of 0 ft to 1.3 ft bgs in 2011. This location was also addressed in the 2014 data gap activities (soil boring SBTC0100L507) and no observations of sheen were noted or documented. Although it is likely that, based on the 2014 observations, the aesthetic observations of sheen no longer remain, this location was added to *Table 4*.
- SBTC0100L090A – Sheen was observed on the borehole water in 2011. It cannot be verified whether or not this observation remains. This location was therefore added to *Table 4*.
- SBTC0100R028 - Sheen and petroleum odors were observed in the soil core from a depth of 0 ft to 0.5 ft bgs and petroleum odors in 2011. This area was excavated to a reported depth of 1.5 ft bgs. The excavation activities targeted all visible observations of remaining Line 6B crude oil and remove the observation of sheen. Therefore, this aesthetic observation from 2011 no longer remains and this location was accordingly not added to *Table 4*.
- SBTC0100R061 – Petroleum odor was observed in the soil core from an unspecified depth in 2011. This area was excavated to a reported depth of 1.5 ft bgs. While the

excavation activities targeted all visible observations of remaining Line 6B crude oil, it cannot be verified that the observation of odor was removed and may remain.

Although it is likely that this aesthetic observation of odor no longer remains based on the information provided above, this location was added to *Table 4*.

- SBTC0100R092E – Sheen was observed on the ground surface in October of 2011. This area was further evaluated in January of 2012, when an adjacent soil boring and temporary well was installed. There were no observations of sheen on the ground surface and no observation of visible oil, sheen or odor in the soil core, borehole water or purge water. Further, due to the fact that further evaluation in 2012 did not observe this surficial sheening, the 2011 observation is over 4 years old, and the lack of observations in the adjacent soil boring/temporary supports that this aesthetic observation from 2011 no longer remains. Therefore, this location was not added to *Table 4*.

Based on the results of this evaluation, 7 (SBTC0075L014, SBTC0100L044A, SBTC0075R048, SBTC0100L080B, SBTC0100L084A, SBTC0100R028, and SBTC0100R092E) of the 16 remaining locations the MDEQ identified as aesthetic observations were excavated or were surficial observations that were not confirmed during 2014 visual inspections. As a result, these seven locations were not included in *Table 4* as described above. However, the nine remaining locations (SBTC0075L040A, SBTC0075R004, SBTC0100L064, SBTC0100L074, SBTC0100L075, SBTC0100L080A, SBTC0100L086, SBTC0100L090A, and SBTC0100R061) where the MDEQ identified aesthetic observations could not be excluded. As a result, these nine locations were added to *Table 4*.

2.4.6.3 Determination of Actionable Aesthetic Conditions

To fully evaluate aesthetic observations identified in the Reach 3 Spill Area, Enbridge compiled a list of aesthetic observations from documents that have been completed during the course of this project including soil boring logs, well construction reports, groundwater sampling logs, and field notes. These were compared to the observations identified in the MDEQ Executive Summary (see *Section 2.4.6.2* for details of this analysis) as well as the Reach 3 RI Report. During this review, three locations (SOTF-B-Q-1.07-R01, SBTC0075R046, and SBTC0075R052) were found to have been excavated after the original aesthetic observations were recorded in *Table 14* of the Reach 3 RI Report.

In accordance with the comprehensive process to identify and categorize aesthetic observations, these locations were removed from further consideration because of the date of the aesthetic observations preceded the subsequent excavations. The remaining potential aesthetic observations were divided into categories as defined in *Section 2.4.6.1. Table 4* presents the details of 20 remaining potential aesthetic observations by category and *Figure 4* depicts the locations of each remaining potential aesthetic observation by category.

Additionally, the groundwater analytical results from Reach 3 were compared to the aesthetic DWC (based on taste and odor). No groundwater samples collected in Reach 3 contained organic constituents attributable to Line 6B crude oil at concentrations exceeding the aesthetic DWC.

The following is a complete evaluation of each of the 20 potential aesthetic observations identified in Reach 3 along with a determination as to whether each location would be considered actionable.

SBTC0075L038B – Petroleum odor was noted in the 4 ft to 8 ft bgs soil core in 2011; however, no other observations of Line 6B crude oil were documented. This discrete and isolated aesthetic observation is *de minimis*, not actionable, and no further action is warranted.

SBTC0075L040A – Sheen was observed in the soil core from a depth of 0 ft to 1.8 ft bgs in 2011. This area was excavated to a reported depth of 1.5 ft bgs. A data gap soil core (SBTC0075L514) and associated temporary well were installed adjacent to this location in 2014, and there were no observations of visible oil or sheen in the soil core, borehole water, or purge water. The 2011 observation of sheen within the soil core between the depths of 1.5 ft and 1.8 ft bgs is discrete, isolated, and *de minimis*. Further, the lack of reproducible observations in the 2014 soil boring and temporary well confirm that the 2011 observation is not an aesthetic risk and therefore is not actionable. No further action is therefore warranted.

SBTC0075L042 – A slight silver sheen was observed on the borehole water in 2011; however, no other observations were noted from the soil core. While there are no adjacent locations to this observation, this discrete and isolated aesthetic observation from 2011 is *de minimis*, not actionable, and no further action is warranted.

SBTC0075R004 – Trace sheen was observed on the top of the soil core. Three soil borings located within 10 ft of this observation did not document observations of visible oil, sheen, or odor. This discrete and isolated aesthetic observation is *de minimis*, not actionable, and no further action is warranted.

SBTC0075R047 – Trace sheen was observed on the borehole water in 2011; however, no other observations were noted from the soil core. A data gap soil core (SBTC0075R503) and associated temporary well re-evaluated this location in 2014, and reported no observations of visible oil, odor or sheen in the soil core, borehole water, or purge water. The lack of reproducible observations in the 2014 soil boring and temporary well confirm that the 2011 observation is not an aesthetic risk. The observation is therefore not actionable, and no further action is warranted.

SBTC0100L064 - Sheen and petroleum odors were observed in the soil core from a depth of 0 ft to 2.9 ft bgs in 2011. This area was excavated to a reported depth of 1.5 ft bgs. A data gap soil core (SBTC0100L510) and associated temporary well were installed to re-evaluate this location in 2014, and there were no observations of visible oil, odor, or sheen in the soil core, borehole water or purge water. The lack of reproducible observations in the 2014 soil boring and temporary well confirm that the 2011 observation no longer remains and is not an aesthetic risk. The observation is therefore not actionable and no further action is warranted.

SBTC0100L074 – A slight silver sheen was observed on the borehole water in 2011; however no other observations were noted from the soil core. There is one adjacent location next to this observation that did not document any visible oil, sheen, or odor. This discrete and isolated aesthetic observation is *de minimis*, not actionable, and no further action is warranted.

SBTC0100L075 – Sheen was observed in the soil core from a depth of 0 ft to 1.9 ft bgs in 2011. This area was excavated to a reported depth of 1.5 ft bgs. A data gap soil core (SBTC0100L509) and associated temporary well were installed to re-evaluate this location in 2014, and there were no observations of visible oil, odor or sheen in the soil core, borehole water or purge water. The 2011 observation of sheen within the soil core from the depths of 1.5 ft to 1.9 ft bgs is discrete, isolated, and *de minimis*. Further, the lack reproducible observations in 2014 soil boring and temporary well confirm that the 2011 observation is not an aesthetic risk. Therefore, the observation is not actionable, and no further action is warranted.

SBTC0100L079 – Sheen was observed in the soil core from a depth of 0 ft to 0.9 ft bgs in 2011. A soil core (SBTC0100L080) and associated temporary well were installed adjacent to this location in 2011, and there were no observations of visible oil, odor or sheen in the soil core, borehole water or purge water. The 2011 observation of sheen within the soil core is discrete, isolated, and *de minimis*. Further, the observations in the adjacent soil boring and temporary well confirm that this observation is not an aesthetic risk. The observation is therefore not actionable, and no further action is warranted.

SBTC0100L080A – A slight silver sheen was observed on the borehole water in 2011. A temporary well was also installed at this location in 2011, and there were no observations of visible oil, sheen or odor in the purge water. The lack of observations in the temporary well purge water confirms this observation is not an aesthetic risk. The observation is therefore not actionable, and no further action is warranted.

SBTC0100L084 - Sheen was observed in the soil core from a depth of 0 ft to 0.7 ft bgs in 2011. A data gap soil core (SBTC0100L508) and associated temporary well were installed to re-evaluate this location in 2014, and there were no observations of visible oil, odor, or sheen in the soil core, borehole water or purge water. The 2011 observation of sheen within the soil core is discrete, isolated, and *de minimis*. Further, the lack of reproducible observations in the 2014 soil boring and temporary well confirm that the 2011 observation is not an aesthetic risk. The observation is therefore is not actionable, and no further action is warranted.

SBTC0100L086 - Sheen was observed in the soil core from a depth of 0 ft to 1.3 ft bgs in 2011. A data gap soil core (SBTC0100L507) and associated temporary well were installed to re-evaluate this location in 2014, and there were no observations of visible oil, odor or sheen in the soil core, borehole water or purge water. The 2011 observation of sheen within the soil core is discrete, isolated, and *de minimis*. Further, the lack of reproducible observations in the 2014 soil boring and temporary well confirm that the 2011 observation is not an aesthetic risk. The observation is therefore not actionable, and no further action is warranted.

SBTC0100L089 - Sheen was observed in the soil core from a depth of 0.6 ft to 1.5 ft bgs in 2011. A data gap soil core (SBTC0100L506) and associated temporary well were installed to re-evaluate this location in 2014, and there were no observations of visible oil, odor or sheen in the soil core, borehole water or purge water. The 2011 observation of sheen within the soil core is discrete, isolated, and *de minimis*. Further, the lack of reproducible observations in

2014 soil boring and temporary well confirm that the 2011 observation is not an aesthetic risk. The observation is therefore not actionable, and no further action is warranted.

SBTC0100L090 – Sheen was observed on the borehole water in 2011. A temporary well was also installed at this location in 2011, and there were no observations of visible oil, sheen or odor in the purge water. The 2011 observation of sheen within the soil core is discrete, isolated, and *de minimis*. Further, the lack of observations in the temporary well purge water confirm this observation is not an aesthetic concern. The observation is therefore not actionable, and no further action is warranted.

SBTC0100L090A – Sheen was observed on the borehole water in 2011; however no other observations were noted from the soil core. While there are no adjacent locations next to this observation, this discrete and isolated aesthetic observation from 2011 is *de minimis*, not actionable, and no further action is warranted.

SBTC0100R009A – Sheen was observed on the borehole water in 2011; however no other observations were noted from the soil core. There are several adjacent locations in the vicinity of this observation that did not document any visible oil, sheen or odor. This discrete and isolated aesthetic observation is *de minimis*, not actionable, and no further action is warranted.

SBTC0100R061 – Petroleum odor was observed in the soil core at an unknown depth interval in 2011. This area was excavated to a reported depth of 1.5 ft bgs. A data gap soil core (SBTC0100R508) and associated temporary well were installed to re-evaluate this location in 2014, and there were no observations of visible oil, sheen or odor in the soil core, borehole water or purge water. The 2011 observation of odor within the soil core is discrete, isolated, and *de minimis*. Further, the lack of reproducible observations in the 2014 soil boring and temporary well confirm that the 2011 observation is not an aesthetic risk. The 2011 observation is therefore not actionable, and no further action is warranted.

SBTC0125L002 – Sheen was observed on the borehole water in 2011. A temporary well was also installed at this location in 2011, and there were no observations of visible oil, sheen or odor in the purge water. The 2011 observation of sheen on the borehole water is discrete, isolated, and *de minimis*. Further, the lack observations in the temporary well purge water confirm this observation is not an aesthetic concern. The observation is therefore not actionable, and no further action is warranted.

SBTC0125L007 – Sheen was observed on the borehole water in 2011; however no other observations were noted from the soil core. There are two adjacent locations in the vicinity of this observation that did not document any visible oil, sheen or odor. This discrete and isolated aesthetic observation is *de minimis*, not actionable, and no further action is warranted.

SBTC0125R006 – Sheen was observed in the soil core from a depth of 4.0 ft to 4.1 ft bgs in 2011. A data gap soil core (SBTC0125R506) and associated temporary well were installed to re-evaluate this location in 2014, and there were no observations of visible oil, sheen or odor in the soil core, borehole water or purge water. The 2011 observation of sheen within the soil core is discrete, isolated, and *de minimis*. Further, the lack of reproducible observations in 2014 soil boring and temporary well confirm that the 2011 observation is not an aesthetic concern. The observation is therefore not actionable, and no further action is warranted.

2.4.6.4 Aesthetic Conclusions

Based on the data, visible oil does not remain within Reach 3. The instances where remaining potential aesthetic impacts have been observed in the Reach 3 Spill Area have dramatically decreased as a result of response and remedial efforts as well as natural degradation. Based on a thorough and comprehensive evaluation of remaining potential aesthetic observations in Reach 3, none require additional evaluation. All instances of remaining potential aesthetic observations where sheen or odor were documented within soil borings, borehole water or on the surface are considered discrete and isolated locations, are *de minimis*, and therefore are not actionable.

In addition, no groundwater samples collected from Reach 3 contained organic constituents attributable to Line 6B crude oil at concentrations exceeding the aesthetic DWC. Further, there were no petroleum odors noted associated with groundwater. No additional evaluation or action is necessary.

No further action for aesthetics within Reach 3 is warranted.

2.5 Current Conditions

At the conclusion of response actions in 2010 and immediately following the excavations in 2011/2012, Enbridge stabilized and restored the Talmadge Creek stream bed and overbank areas that were affected during excavation activities.

During the restoration activities, Enbridge carefully selected, analyzed, and used mineral substrate (sand and gravel natural aggregate) and wetland soils (muck, mineral muck, and peat) to backfill the Talmadge Creek stream bed and the overbank areas, respectively. The backfill was graded to return the stream bed and overbank areas to their approximate pre-excavation elevations, and the overbank areas were subsequently seeded with a native seed mix. Extensive erosion control efforts, including the placement of erosion control blankets (ECBs) on the overbank areas, coir logs along the banks, and rip rap in the areas around culverts, were implemented to ensure bank stabilization and to prevent soil erosion.

Decommissioning of auxiliary areas included equipment removal, liner removal, and the scraping of the top 6 inches of soil to remediate impacted areas where staining occurred. Areas were subsequently seeded with native seed mix and ECBs were installed wherever necessary.

Continued monitoring along Talmadge Creek ensured restoration efforts were successful at eliminating soil erosion and siltation to Talmadge Creek and re-establishing native vegetation in the overbank areas.

3.0 Basis for Concluding Remedial Action is Complete

In accordance with Part 201, Section 20114d(2), this section documents the basis that remedial actions are complete in Reach 3 and conditions are consistent with unrestricted residential land use.

Organization of this section is consistent with Section E (“Are/were the following present at the facility”) of the *Request for DEQ of No Further Action (NFA) Report* (form EQP 4030), which is presented in *Attachment C*. The basis and conclusions are presented for each sub-section below.

3.1 Mobile or Migrating NAPL

During the Line 6B crude oil release, NAPL was carried into Reach 3 with surface water flow from Talmadge Creek. Extensive response activities in 2010 and remedial excavation in 2011/2012 removed residual NAPL, including any NAPL body and the potential for mobile and migrating NAPL from Reach 3. Extensive characterization and confirmation sampling have shown the only remaining evidence of NAPL in Reach 3 is limited, sporadic observations of sheen, which exists as a vestige of the NAPL. The NAPL White Paper (*Attachment G*), while more broadly focused over the entire Spill Area, supports this finding.

Conclusion: All impacts of the Line 6B release have been addressed and there is no mobile or migrating NAPL remaining. Limited, sporadic observations of sheen, which may be a vestige of the NAPL associated with Line 6B crude oil remains. Such sheen does not constitute mobile or migrating NAPL.

3.2 Soil Contamination Above Residential Criteria

PNA and VOC analytical data for unsaturated soil samples are compared to residential Criteria (DCC, DWPC, GSIPC, and PSIC) while saturated soil and sediment data are compared to residential DCC.

The unsaturated soil samples indicate a few isolated exceedances of VOC Criteria. Additional analyses with respect to the exceedances – either as SPLP or groundwater samples – demonstrate no completed exposure pathways. Analytical results for saturated soil and sediment indicate no exceedances of PNA or VOC Criteria.

Conclusion: Response activities and remedial actions have addressed residual impacts from Line 6B crude oil; therefore, no threat to human health or the environment exists and no further evaluation or action is required.

3.3 Soil Aesthetic Impacts

No visible oil remains in Reach 3. The Line 6B crude oil release did not have other obvious aesthetic impacts on soil such as rubble, trash, rebar, demolition debris, or other waste materials. The topography of areas disturbed during response activities has been restored to conditions that existed before the Line 6B crude oil release. Disturbed areas also are re-vegetated with native plants.

Table 3 documents limited, sporadic observations of sheens or odors made during intrusive activities such as drilling and excavation. These discrete and isolated observations are in the flood plain, any subsurface sheen and odor are unlikely to reach the ground surface, and would not be observable and/or likely to be considered as objectionable from an individual's perspective. Infrequent observations of sheen and/or odor in subsurface soil samples or in boreholes are not an actionable aesthetic concern.

Conclusion: No actionable aesthetic conditions remain in soil within the Reach 3 Spill Area. The infrequent observations of sheen and/or odor in subsurface soils are not actionable aesthetic concerns.

3.4 Groundwater Contamination Above Residential Criteria

PNAs and VOC analytical data related to the Line 6B crude oil release show no exceedances of DWC or GSIC in any representative groundwater sample collected from temporary wells installed in the Reach 3 Spill Area.

Conclusion: Concentrations of Line 6B crude oil related constituents in groundwater do not exceed Criteria; therefore, no threat to human health or the environment exists and no further evaluation or action is required.

3.5 Groundwater Aesthetic Impacts

The groundwater aesthetic assessment was conducted primarily by comparing groundwater analytical results to aesthetics-based DWC. These are chemical-specific criteria based on taste and odor. Concentrations of Line 6B crude oil constituents in groundwater samples from Reach 3 did not exceed the aesthetic DWC.

Other than the chemical-specific aesthetic criteria, groundwater aesthetic impacts are not defined by Part 201, Part 201 administrative rules, or Part 201 guidance documents. Sheen was observed on borehole water at several locations. Infrequent sheen observations on borehole water do not constitute an actionable aesthetic concern. Petroleum odors in groundwater were not identified within Reach 3.

Conclusion: No actionable aesthetic impacts are present with regard to groundwater within the Reach 3 Spill Area. The infrequent observations of sheen on borehole water do not constitute actionable aesthetic concern.

3.6 Soil Gas Contamination Above Residential Vapor Intrusion Screening Levels

Concentrations of constituents related to the Line 6B crude oil release in soil show no exceedances of SVIAC.

Conclusion: Concentrations of Line 6B crude oil related constituents in soil do not exceed SVIAC; therefore, no threat to human health or the environment exists.

3.7 Conditions Immediately Dangerous to Life or Health

The Occupational Safety and Health Administration (OSHA) defines an Immediately Dangerous to Life or Health (IDLH) air concentration in their hazardous waste operations and emergency response regulation as “an atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere” (OSHA, 2013). IDLH values are not Criteria. IDLH values are concentrations in air, which were not directly measured during remedial investigations, but which can be evaluated indirectly based on SVIAC and GVIAIC.

SVIAC and GVIAIC are based on chronic toxicity, whereas IDLH are based on acute toxicity. Acutely toxic concentrations are higher than the chronically toxic concentrations used for SVIAC and GVIAIC. Therefore, soil and groundwater concentrations that will not result in chronically toxic indoor air will also not result in acutely toxic indoor air. Chronic or acute effects are not expected if SVIAC and GVIAIC are not exceeded.

Soil and groundwater data were compared to SVIAC and GVIAIC. Concentrations of Line 6B crude oil related constituents in soil and groundwater demonstrate no exceedances of these Criteria.

Conclusion: All results from the Reach 3 Spill Area soil and groundwater sample analyses are less than SVIAC and GVIAIC; therefore, no threat to human health or the environment exists.

3.8 Fire and Explosive Hazards Related to Release

All results from Reach 3 sample analyses show no exceedances of the FESL and conditions are suitable for closure with unrestricted residential access.

Conclusion: All results from Reach 3 sample analyses demonstrate no exceedances of the FESL; therefore, no fire or explosion hazard related to the release exists.

3.9 Contamination to Existing Drinking Water Supply

There are no public drinking water supplies or well head protection zones in Reach 3. One potable well is located within the Reach 3 Spill Area, and an additional four potable wells are located near Reach 3, but are located outside of the Spill Area boundary (*Figure 1*). These five potable wells have been sampled on multiple occasions. Concentrations of Line 6B crude oil related constituents in groundwater demonstrate no exceedances of DWC in the potable well samples.

Conclusion: Concentrations of Line 6B crude oil related constituents in groundwater do not exceed DWC in existing drinking water supplies; therefore, there is no contamination to existing drinking water supplies requiring further action.

3.10 Imminent Threat to Drinking Water Supply

As demonstrated in *Sections 3.2 and 3.4*, the exposure pathway to groundwater is incomplete.

Conclusion: Concentrations of Line 6B crude oil related constituents in soil and groundwater do not pose a threat to drinking water requiring further action.

3.11 Impact to Surface Water

Reach 3 surface water data were compared to GSIC (which are the same as Michigan's water quality values). GSIC incorporate water quality values for protection of human health and

aquatic life. Concentrations of Line 6B crude oil related constituents in surface water demonstrate no exceedances of GSIC.

Conclusion: Concentrations of Line 6B crude oil related constituents in surface water samples from Reach 3 do not exceed GSIC; therefore, no further action is warranted.

3.12 Ecological Impacts

This section presents the NFA basis for both terrestrial and aquatic ecological evaluation. The analytical results support that no potential ecological impacts remain and no further action is warranted.

3.12.1 Terrestrial Ecological Impacts

Analytical data for saturated and unsaturated soil were compared to the R5 ESLs for soil.

The R5 ESLs are screening criteria, not Part 201 cleanup criteria, and compliance with the R5 ESLs for every sample is not required for protection of exposed populations.

Concentrations of all chemicals in soil indicate no exceedances of the R5 ESLs with two exceptions:

- Soil sample ESTC0075R134: Naphthalene concentration of 350 ug/kg, which exceeded the soil R5 ESL of 99.4 ug/kg, but did not exceed the Low Molecular Weight PNA SSL of 29,000 ug/kg. The SSLs are preferred to the R5 ESLs because they were developed using a consistent, documented process more recently than the R5 ESLs. The naphthalene R5 ESL exceedance does not pose a significant ecological risk because the concentration is less than the preferred SSL.
- Soil sample ESTC0100R154: Toluene concentration of 8,600 ug/kg, which exceeded the soil R5 ESL of 5,450 ug/kg.

The R5 ESLs for toluene is based on the masked shrew (*Sorex cinereus*) receptor, which is a small predator of soil invertebrates. The single exceedance of the R5 ESL for toluene at one location does not indicate the presence of a “hot spot”. Masked shrews have a typical home range of approximately 1 acre (U.S. EPA, 1993). This home range is much larger than the area represented by this isolated soil sample, therefore the shrew population would be exposed to significantly lower average concentrations of toluene.

The toluene R5 ESLs exceedance does not pose significant ecological risk due to the relatively low magnitude, and single occurrence. Also, because the average overall exposure of the masked shrew receptor would be to concentrations significantly lower than those detected at this location, no significant ecological risk is presented by the toluene exceedance. Further, toluene is not bio-accumulative, biodegrades readily and will not persist in the environment.

Conclusion: Reasonable exposure scenarios for the receptor that is the basis for soil R5 ESLs would not result in exposure to concentrations above the screening levels; therefore, no threat to terrestrial organisms exists and no further action is required.

3.12.2 Aquatic Ecological Impacts

The occurrence of surface water and sediments within the overbank soils with the Reach 3 Spill Area was minimal. Remedial activities performed in 2011 removed the entire creek bed and associated sediments. A total of eight sediment samples were collected from Talmadge Creek in Reach 3 following these excavations. The sediment data were compared to sediment screening levels, the R5 ESLs for sediment and to PECs. Concentrations of all chemicals were less than sediment screening levels except in one sample (SOTF-B-Q1.07-R01) collected in 2010, where 2-butanone, 2-methylnaphthalene, acetone, and toluene concentrations exceeded sediment screening levels. This location was re-sampled in 2014 (SETC0125R503), and concentrations of constituents did not exceed R5 ESLs for sediment.

Conclusion: Concentrations of constituents in sediment samples are less than sediment screening levels, with the exception of one sample. This location was re-sampled and concentrations did not exceed sediment screening levels. No threat to aquatic organism exists and no further action is required.

4.0 Summary and Conclusion

This section presents a summary of response and remediation efforts, characterization and confirmation sampling, documentation that remediation is complete, and a request for Part 201 regulatory closure with unrestricted residential use. In addition to Enbridge's internal review, this NFA Report for Segment 3 was reviewed by three members of the MDEQ Response Activity Review Panel (MDEQ, 2012). Each member concurred that the remedial efforts and associated confirmation sampling support MDEQ determining that no further action is warranted.

4.1 Response and Remediation Efforts

The Reach 3 Spill Area has undergone extensive emergency response actions and remedial excavation. In 2010, immediately following the Line 6B crude oil release, crude oil was recovered, stream banks were stabilized, and overbank areas were excavated. These response actions were conducted in a manner that preserved the integrity of the Talmadge Creek stream bed. Test pits were used to assess the success of the excavation and the entire Reach 3 area was restored with clean imported fill, and ECBs. This response was summarized in the *Source Contamination Removal and Verification Summary Report Talmadge Creek: Section 1 to Section 10*, submitted to the U.S. EPA on September 26, 2010 (Enbridge, 2010).

Additional excavation in Reach 3 was performed from late 2011 through early 2012. During this effort, Line 6B crude oil-impacted soil and sediment identified following the 2010 response excavation was removed. This excavation included the stream bed of Talmadge Creek, selected overbank, and wetland areas. Post-excavation assessments confirmed the success of the excavations. The work was completed in accordance with the *Talmadge Creek Excavation Work Plan MP 0.50 – MP 1.00*, submitted to the MDEQ on December 7, 2011 (Enbridge, 2011a) and *Talmadge Creek Excavation Work Plan MP 1.00 - MP 2.25*, submitted to the MDEQ on February 16, 2012 (Enbridge, 2012).

As a result of these activities, the conditions within the Reach 3 Spill Area have been restored to their pre-release conditions, specifically at those locations where soil, sediment, surface water, and groundwater impacts related to the Line 6B crude oil release were observed. Any remaining impacts are minor and do not present a risk to human health or

the environment and no actionable aesthetic conditions exist. No further response actions are warranted in the Reach 3 Spill Area.

4.2 Characterization and Confirmation Efforts

The objectives of the Reach 3 characterization and confirmation efforts were to evaluate the success of response actions immediately following the release in 2010 and the subsequent remedial excavation in 2011/2012. These activities characterized the nature and extent of any remaining impacts to soil, sediment, groundwater, and surface water associated with the Line 6B crude oil release; confirmed the effectiveness of the response activities; identified and evaluated potential migration pathways; assessed potential human health and terrestrial risks; evaluated potential aesthetic impacts; and built upon the principles established in the CSM to document that current conditions in Reach 3 are suitable for unrestricted residential use.

Following the emergency response activities, a series of separate and distinct efforts were conducted across the Spill Area, including Reach 3. These efforts included the post-excavation assessment, SOTF, SORT, and TCRI. Extensive sampling, both for qualitative characterization and laboratory analytical purposes, conducted as part of these efforts demonstrated that residual impacts remained within Talmadge Creek, and most particularly, within the stream bed sediments. Results from these efforts were used to develop the preliminary excavation boundaries for the 2011/2012 remedial excavation.

As the 2011/2012 excavation progressed, Enbridge collected 127 post-excavation soil samples and 4 water samples within Reach 3. Sampling was generally conducted in accordance with the *Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria*, issued August 2002 by the MDEQ (MDEQ, 2002) and the approved *Analytical Sampling Approach at Excavation Sites Memorandum*, submitted to the MDEQ on December 21, 2011 (Enbridge, 2011b). Based on the results of this extensive sampling effort, residual detected Line 6B crude oil chemicals were below Criteria and screening levels, except for a few instances where there was no transport mechanism to allow the chemicals to reach a receptor. Therefore, exposure pathways are not complete, indicating no risk to human health and the environment remains.

While the 2011/2012 post-excavation sampling evidenced successful remedial efforts, the MDEQ expressed concerns on several issues, including visual surficial observations of oil/sheen, UV fluorescence (both as trace fluorescence and as UV fluorescence), additional

VOC/PNA exceedance verification, adequacy of excavation delineation, sample density at Wolverine and Panhandle pipeline intersections, and ERLs. In response to these concerns, Enbridge conducted an extensive data gap assessment sampling program, including conducting 66 soil samples and 67 groundwater samples for VOCs and/or PNAs. None of these samples reported exceedances of Criteria, providing further evidence of no risk to human health and the environment.

The characterization and confirmation efforts provide a robust data set to demonstrate that the response and remediation efforts have successfully restored the soil, sediment, surface water, and groundwater to their pre-release conditions. No further characterization or response actions are warranted in the Reach 3 Spill Area.

4.3 Remediation Complete

Impacts in Reach 3 that resulted from the Line 6B crude oil release have been successfully addressed by the response and remedial actions described in this NFA Report. Each of the exposure pathways represented by Part 201 residential Criteria have been evaluated through characterization and confirmation sampling. Results from these efforts demonstrate that post-response/remediation conditions are consistent with unrestricted residential use. Terrestrial and aquatic ecological impacts were also evaluated using U.S. EPA screening levels and no impacts to ecological receptors were identified. Remediation is therefore complete.

4.4 Closure Request

This NFA Report for Segment 3 demonstrates that Enbridge's successful response and remediation efforts performed within the Reach 3 Spill Area satisfy the requirements of Part 201. Based on this documentation and pursuant to Section 20114d(3)(a) of Part 201, Enbridge respectfully requests the MDEQ provide approval of this NFA Report for Segment 3 as an "unrestricted residential closure".

Attachment C contains the *Request for DEQ Review of No Further Action (NFA) Report* (Form EQP4030) as well as the required notarized affidavits and certificate of insurance.

Enbridge will retain all relevant records for a minimum of 10 years after approval of this NFA Report.

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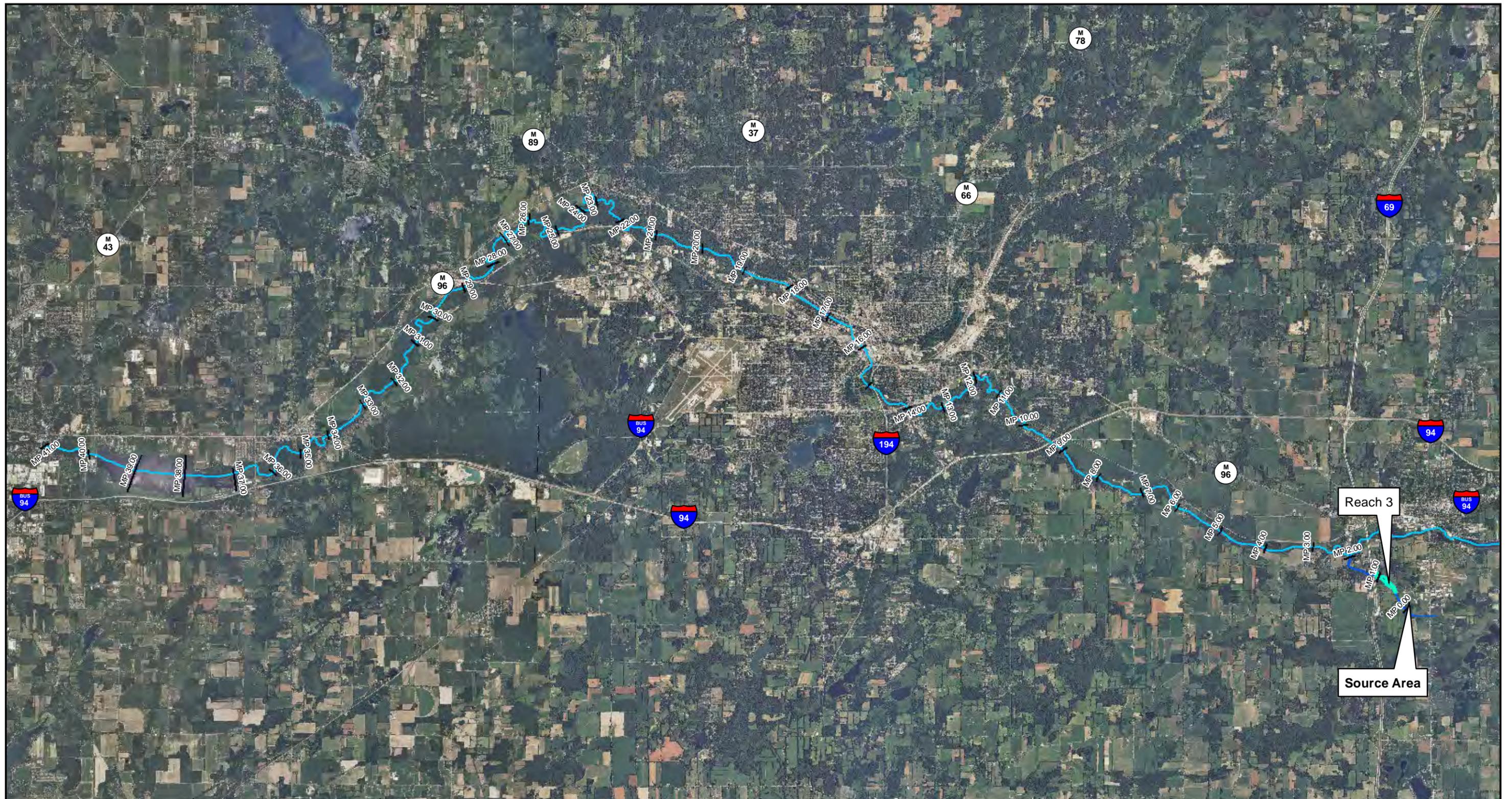
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Figures



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 Project #: 60339671



Legend

- Reach 3 Spill Area
- Kalamazoo River
- Talmadge Creek
- Mile Grid Segments

N

0 5,000 10,000 20,000

Scale in Feet

FIGURE 1
REACH 3
 SITE LOCATION AND REACH BOUNDARY
 SHEET 1 OF 2

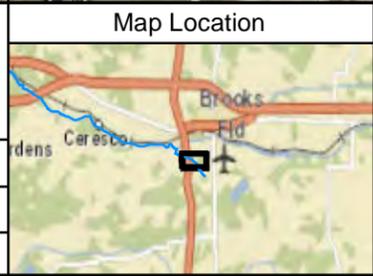
ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: 2010



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 Project #: 60339671



Legend	
Potable Well	Reach 3 Spill Area
Zoned Agricultural	Parcel
Pipeline	Quarter Mile Grid Segments

N

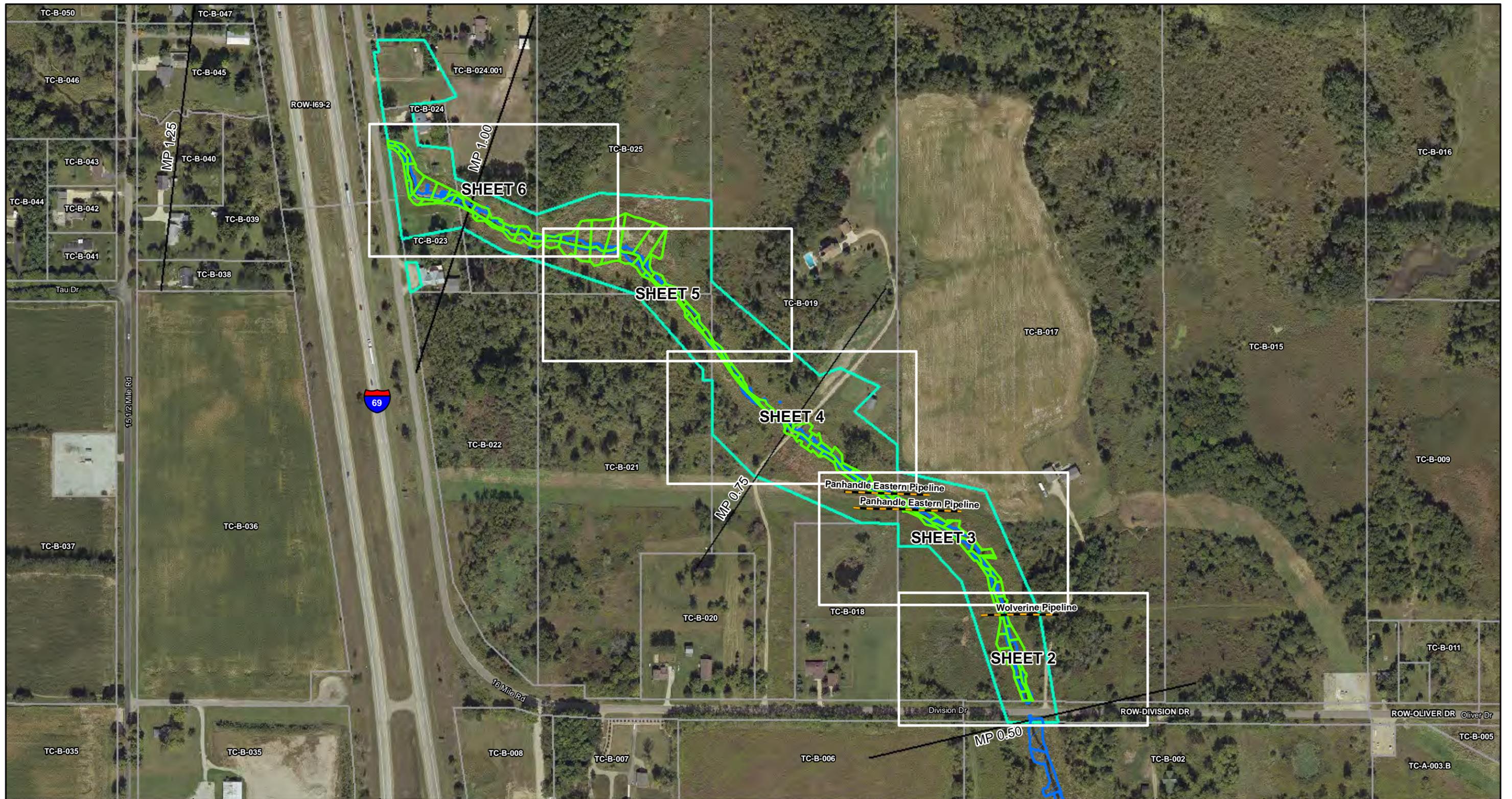
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Scale in Feet

FIGURE 1
REACH 3
SITE LOCATION AND REACH BOUNDARY
SHEET 2 OF 2

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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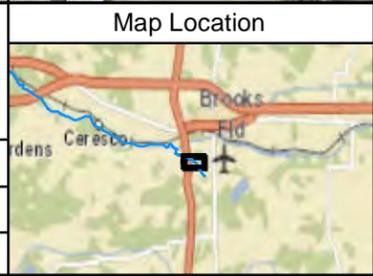


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Approved: JB 11/2/2015

Project #: 60339671



Legend

2011/2012 Talmadge Excavation Area	Reach 3 Spill Area
2010 U.S. EPA Clearance Areas	Parcel
A - Excavated to Visual Extent	Quarter Mile Grid Segments
B - Excavated to Water	Pipeline
C - Excavated to Confining Layer	
Special - Does not Meet A, B, or C Criteria	
2 ft Excavation Depth	

N

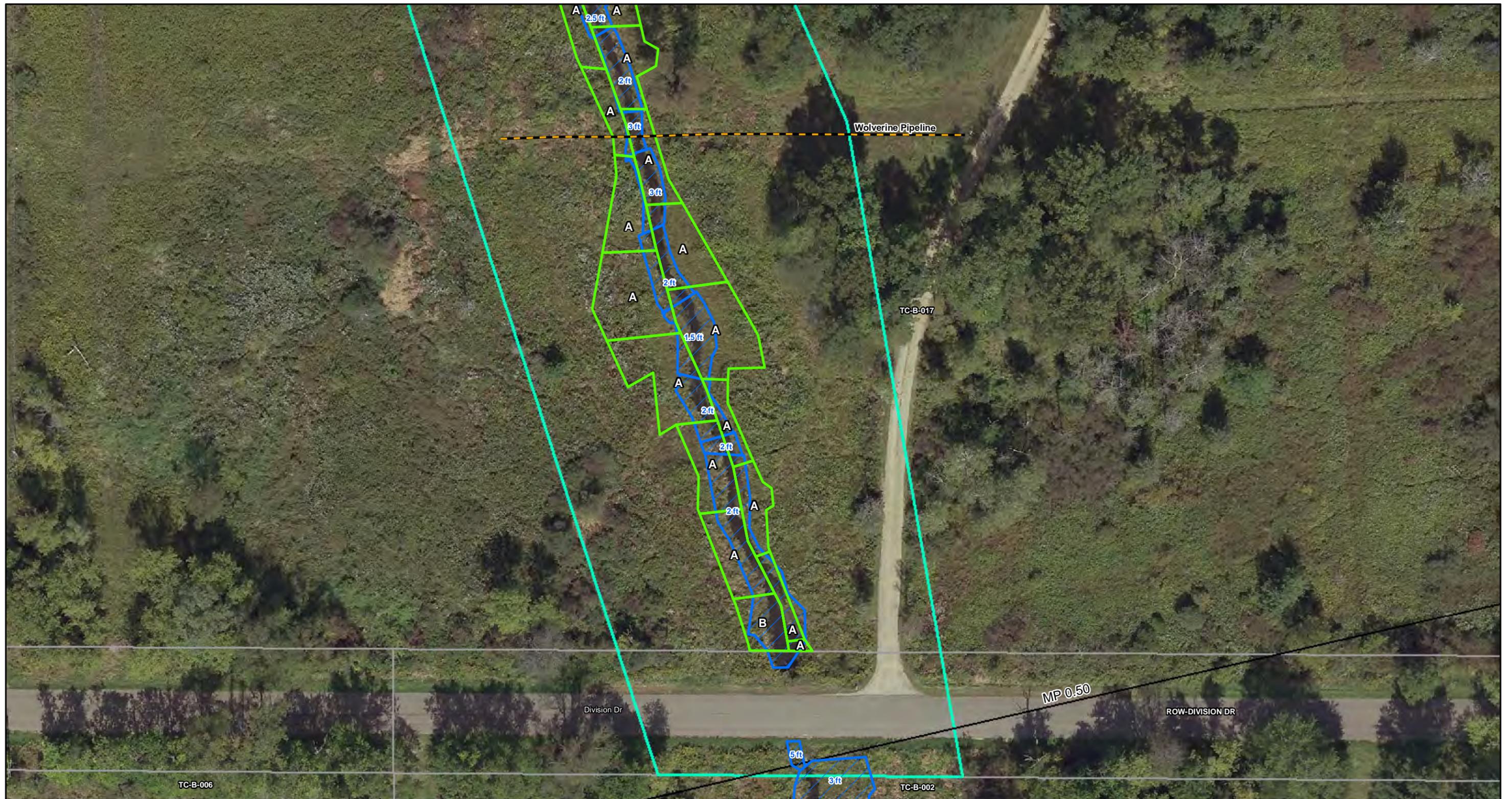
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Scale in Feet

FIGURE 2
REACH 3
EXTENT OF EXCAVATION
SHEET 1 OF 6

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

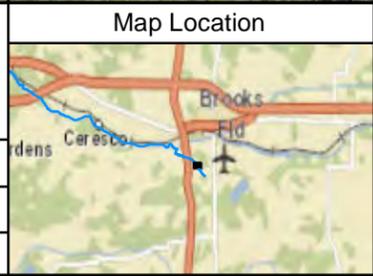


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Project #: 60339671



Legend

- 2011/2012 Talmadge Excavation Area
- Reach 3 Spill Area
- 2010 U.S. EPA Clearance Areas
 - A - Excavated to Visual Extent
 - B - Excavated to Water
 - C - Excavated to Confining Layer
 - Special - Does not Meet A, B, or C Criteria
- Parcel
- Quarter Mile Grid Segments
- Pipeline
- 2 ft Excavation Depth

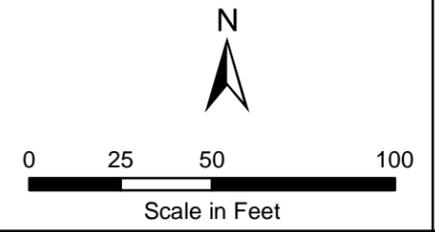
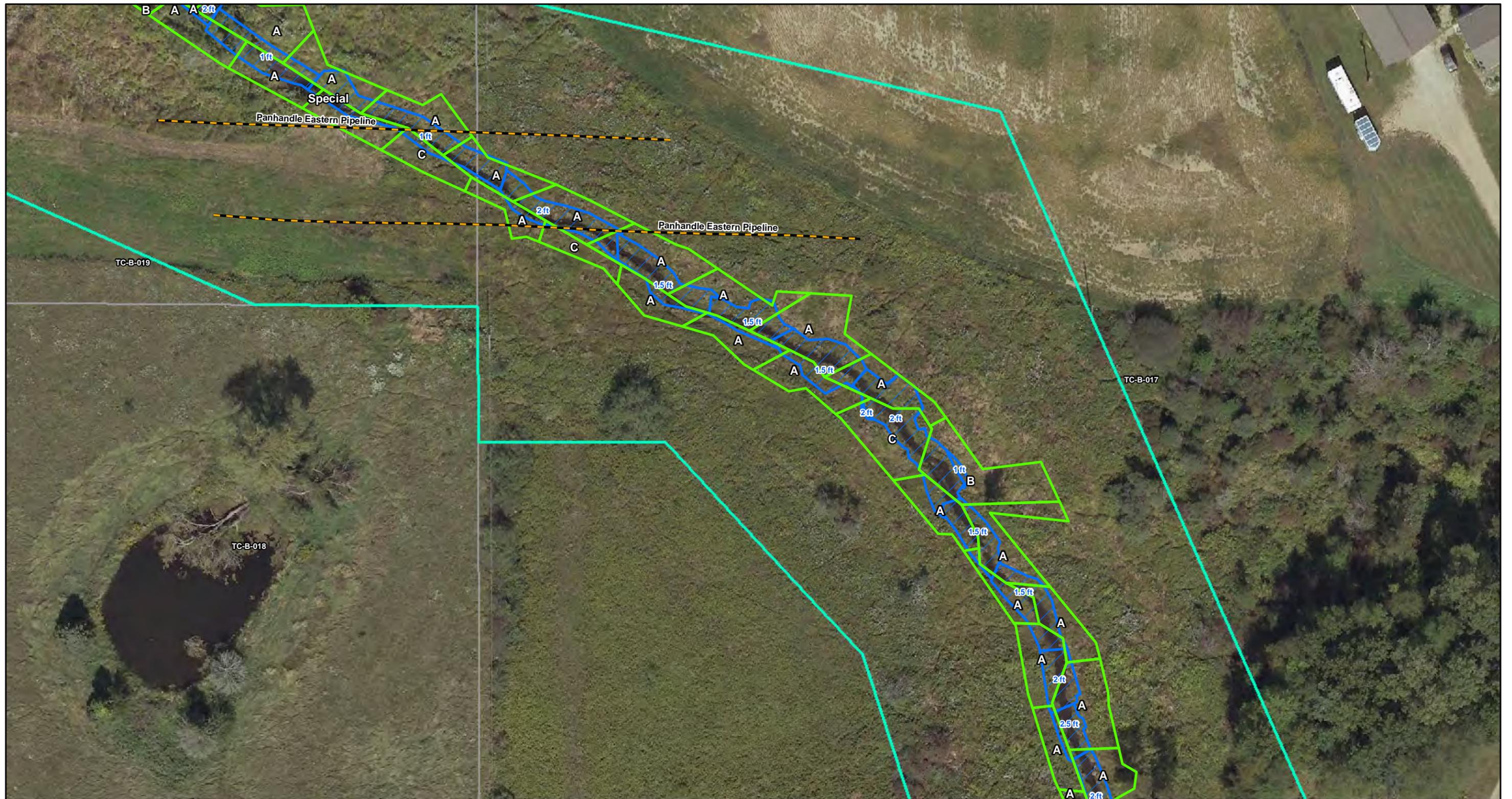


FIGURE 2
REACH 3
EXTENT OF EXCAVATION
SHEET 2 OF 6

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

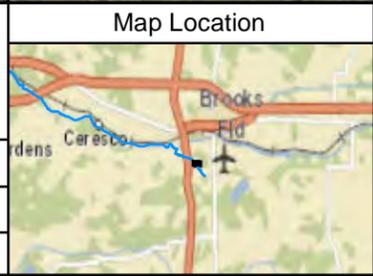


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Project #: 60339671



Legend

- 2011/2012 Talmadge Excavation Area
- Reach 3 Spill Area
- 2010 U.S. EPA Clearance Areas
 - A - Excavated to Visual Extent
 - B - Excavated to Water
 - C - Excavated to Confining Layer
 - Special - Does not Meet A, B, or C Criteria
- Parcel
- Quarter Mile Grid Segments
- Pipeline
- 2 ft Excavation Depth

FIGURE 2
REACH 3
EXTENT OF EXCAVATION
SHEET 3 OF 6

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

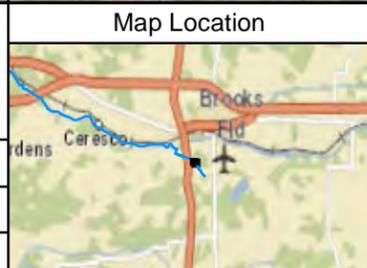
Aerial Photography Date: September 2015



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Approved: JB 11/2/2015

Project #: 60339671



Legend

- 2011/2012 Talmadge Excavation Area
- Reach 3 Spill Area
- 2010 U.S. EPA Clearance Areas
- Parcel
- A - Excavated to Visual Extent
- B - Excavated to Water
- C - Excavated to Confining Layer
- Special - Does not Meet A, B, or C Criteria
- Quarter Mile Grid Segments
- Pipeline
- 2 ft Excavation Depth

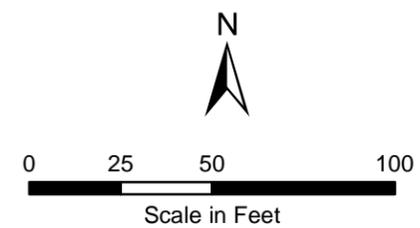


FIGURE 2
REACH 3
EXTENT OF EXCAVATION
SHEET 4 OF 6

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

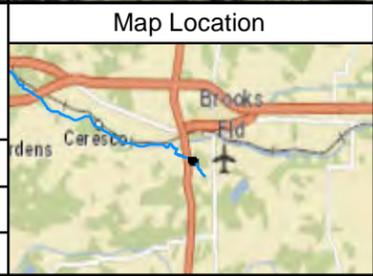


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Drawn: NS 11/2/2015

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Project #: 60339671



Legend

- 2011/2012 Talmadge Excavation Area
- Reach 3 Spill Area
- 2010 U.S. EPA Clearance Areas
 - A - Excavated to Visual Extent
 - B - Excavated to Water
 - C - Excavated to Confining Layer
 - Special - Does not Meet A, B, or C Criteria
- Parcel
- Quarter Mile Grid Segments
- Pipeline
- 2 ft Excavation Depth

N
 0 25 50 100
 Scale in Feet

FIGURE 2
REACH 3
EXTENT OF EXCAVATION
SHEET 5 OF 6

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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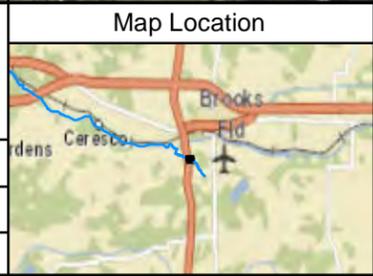


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Project #: 60339671



Legend

- 2011/2012 Talmadge Excavation Area
- Reach 3 Spill Area
- 2010 U.S. EPA Clearance Areas
 - A - Excavated to Visual Extent
 - B - Excavated to Water
 - C - Excavated to Confining Layer
 - Special - Does not Meet A, B, or C Criteria
- Parcel
- Quarter Mile Grid Segments
- Pipeline
- 2 ft Excavation Depth

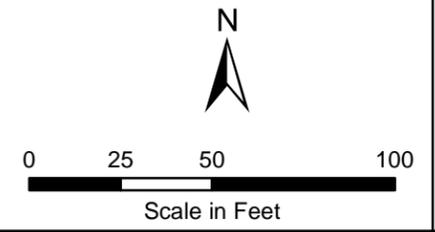
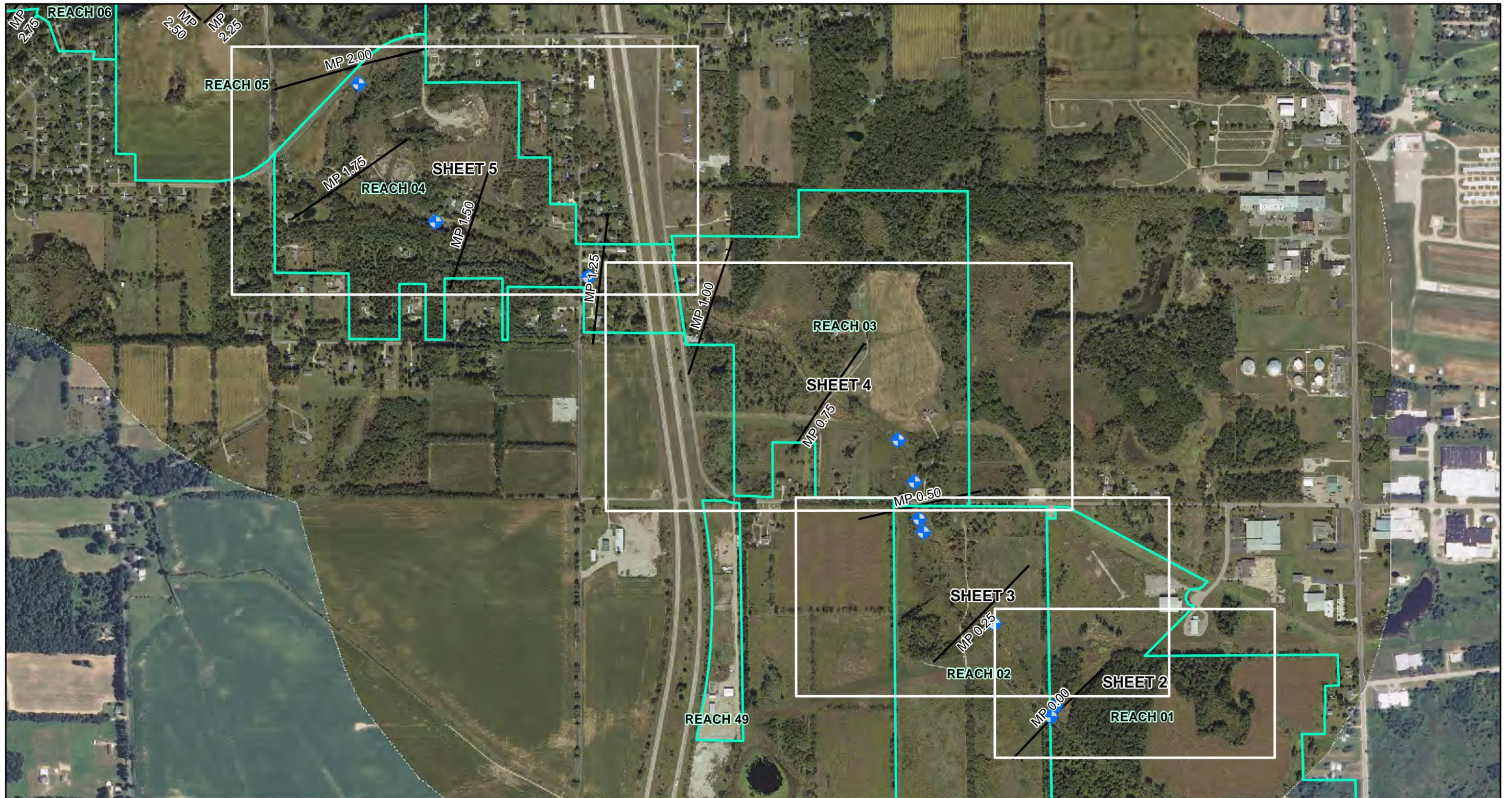


FIGURE 2
REACH 3
EXTENT OF EXCAVATION
SHEET 6 OF 6

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

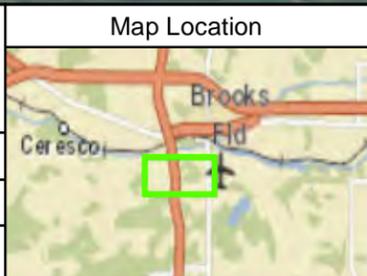


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Project #: 60339671



- Legend
- Monitoring Well
 - Reach Boundary
 - Parcel Boundary
 - Quarter Mile Grid Segments

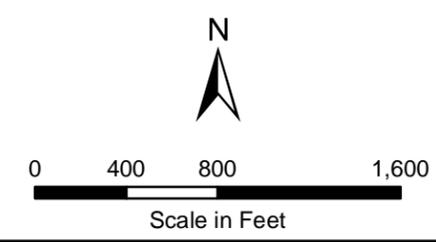


FIGURE 3
TALMADGE CREEK METALS EVALUATION
MONITORING WELL LOCATIONS
SHEET 1 OF 5

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

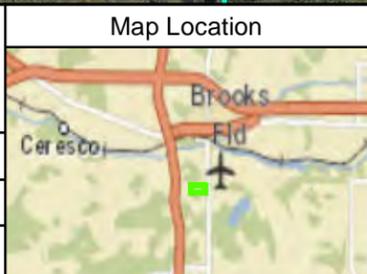


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Approved: JC 11/2/2015

Project #: 60339671



Legend

- Monitoring Well
- Reach Boundary
- Parcel Boundary
- Quarter Mile Grid Segments

0 75 150 300

Scale in Feet

FIGURE 3
TALMADGE CREEK METALS EVALUATION
MONITORING WELL LOCATIONS
SHEET 2 OF 5

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

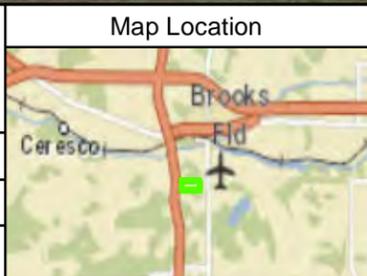


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Project #: 60339671



- Legend
- Monitoring Well
 - Reach Boundary
 - Parcel Boundary
 - Quarter Mile Grid Segments

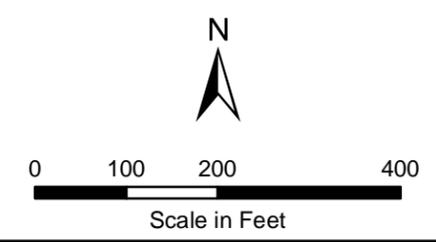
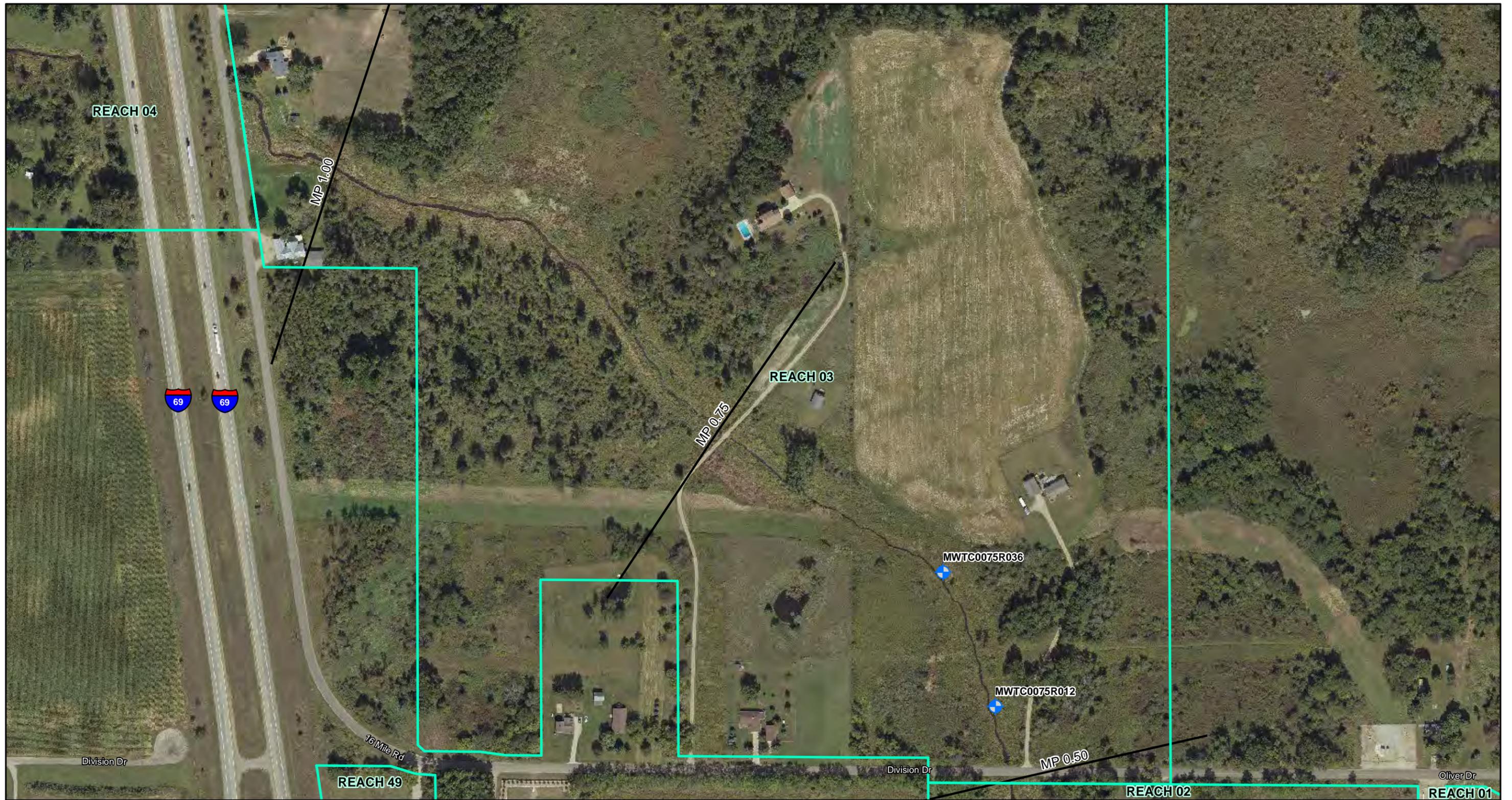


FIGURE 3
TALMADGE CREEK METALS EVALUATION
MONITORING WELL LOCATIONS
SHEET 3 OF 5

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

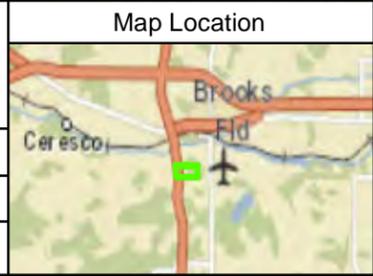


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Project #: 60339671



Legend

- Monitoring Well
- Reach Boundary
- Parcel Boundary
- Quarter Mile Grid Segments

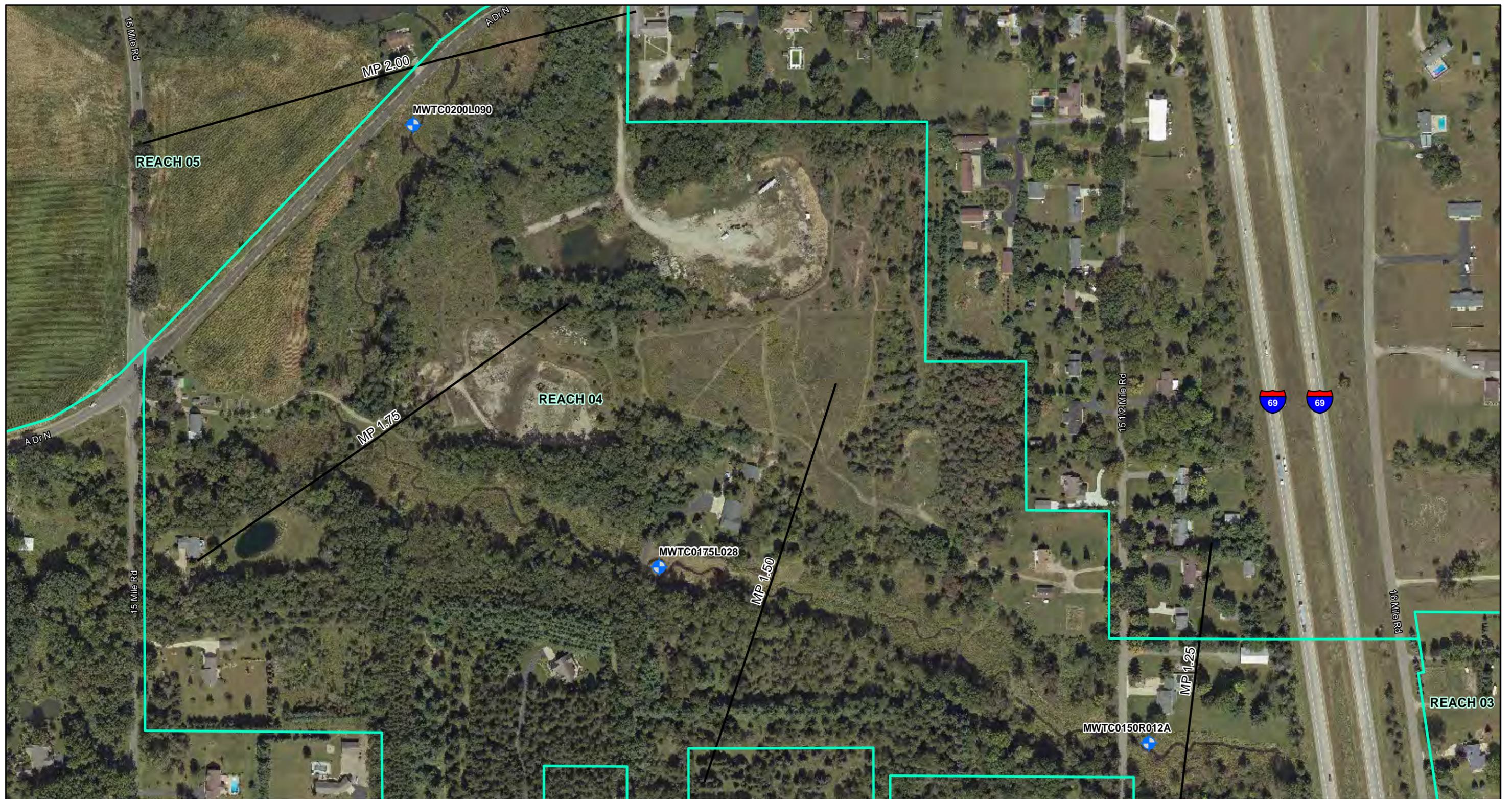
N

0 125 250 500

Scale in Feet

FIGURE 3
TALMADGE CREEK METALS EVALUATION
MONITORING WELL LOCATIONS
SHEET 4 OF 5

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

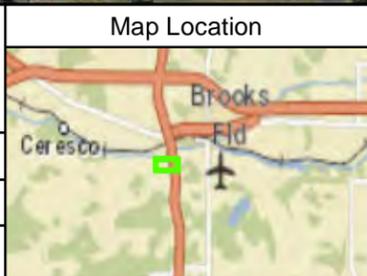


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Drawn: NS 11/2/2015

Approved: JC 11/2/2015

Project #: 60339671



- Legend
- Monitoring Well
 - Reach Boundary
 - Parcel Boundary
 - Quarter Mile Grid Segments

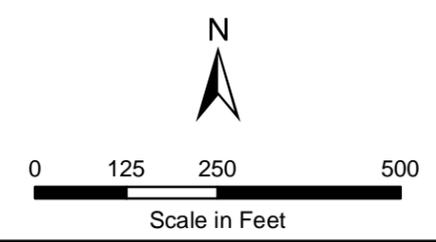
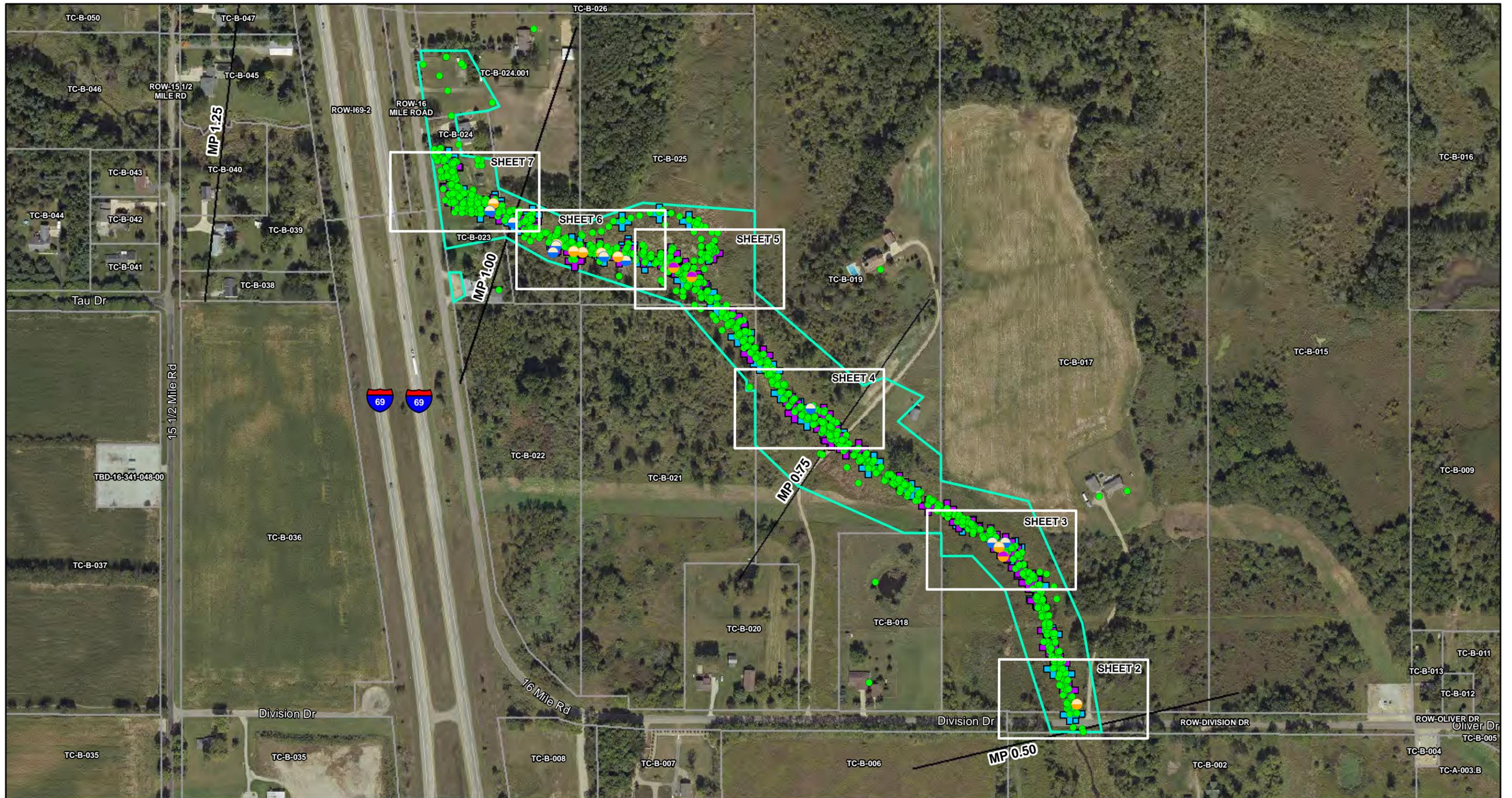


FIGURE 3
TALMADGE CREEK METALS EVALUATION
MONITORING WELL LOCATIONS
SHEET 5 OF 5

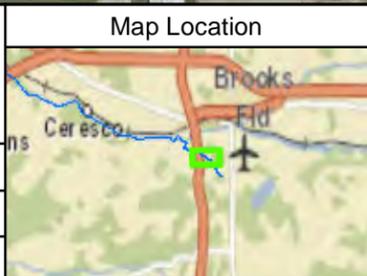
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 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



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 Project #: 60339671



Legend

Aesthetic Observations

- Location With No Aesthetic Observation
- Visible Oil
- Visible Oil on Borehole Water
- Odor in Soil
- Odor in Purge Water
- Sheen Within Soil Core
- Sheen on Borehole and/or Purge Water
- Sheen on Ground Surface
- ✚ Data Gap Temp Well
- ✚ TCRI Temp Well
- Location With Multiple Aesthetic Observations
- ▭ Reach 3 Spill Area
- ▭ Parcel
- Quarter Mile Grid Segments

0 150 300 600
Scale in Feet

FIGURE 4
REACH 3
REMAINING POTENTIAL AESTHETIC OBSERVATIONS
SHEET 1 OF 7

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

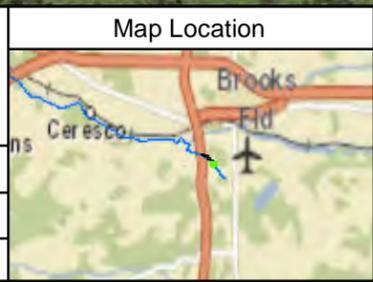


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Project #: 60339671



Legend

Aesthetic Observations

- Visible Oil
- Visible Oil on Borehole Water
- Odor in Soil
- Odor in Purge Water
- Sheen Within Soil Core
- Sheen on Borehole and/or Purge Water
- Sheen on Ground Surface

- Location With No Aesthetic Observation
- + Data Gap Temp Well
- + TCRI Temp Well
- Location With Multiple Aesthetic Observations

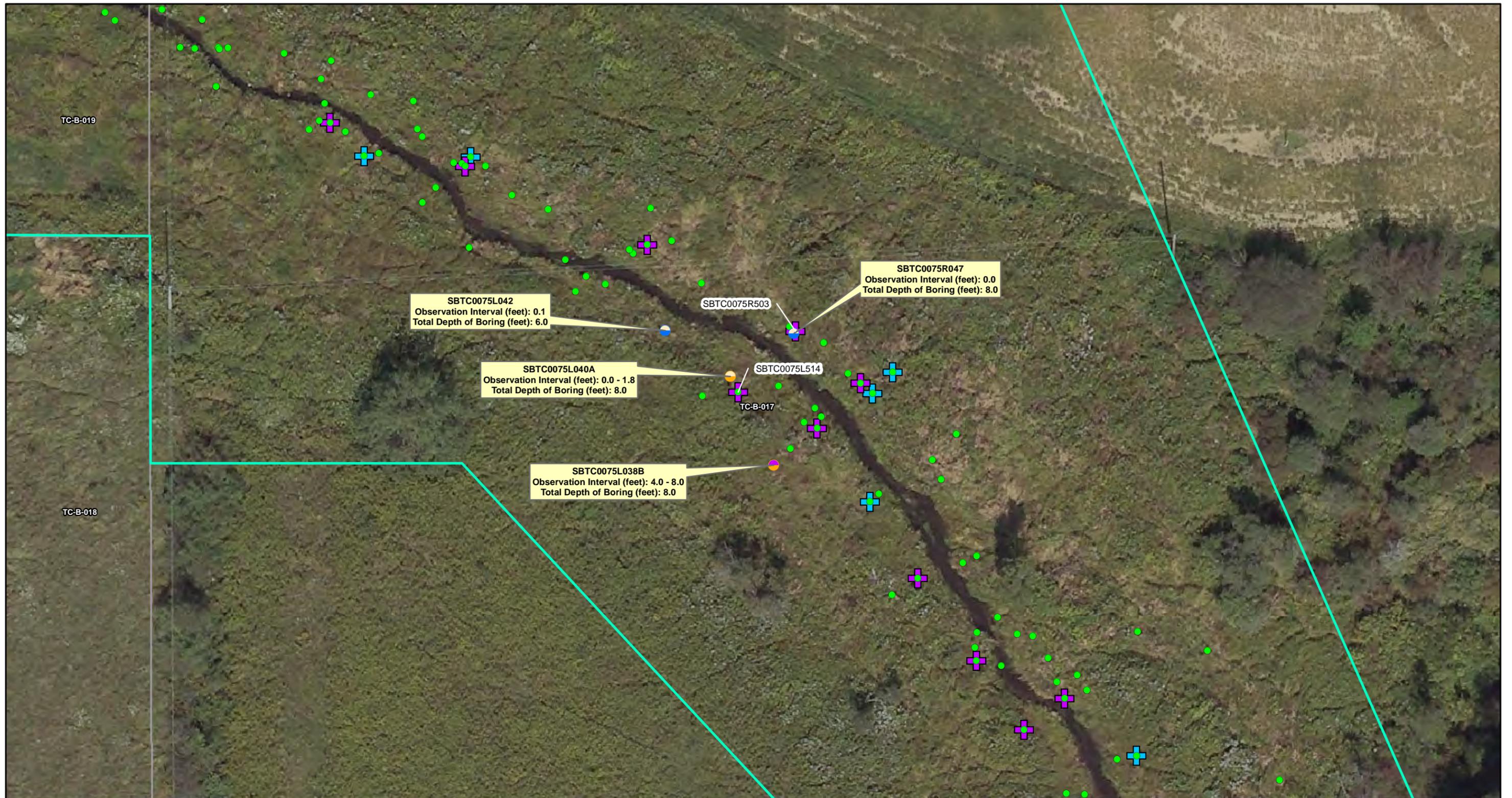
- Reach 3 Spill Area
- Parcel
- Quarter Mile Grid Segments

0 15 30 60
Scale in Feet

FIGURE 4
REACH 3
REMAINING POTENTIAL AESTHETIC OBSERVATIONS
SHEET 2 OF 7

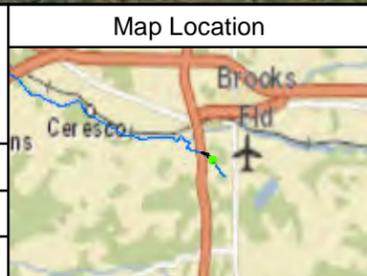
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



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 Approved: JC 11/2/2015
 Project #: 60339671



Legend

Aesthetic Observations

- Location With No Aesthetic Observation
- Visible Oil
- Visible Oil on Borehole Water
- Odor in Soil
- Odor in Purge Water
- Sheen Within Soil Core
- Sheen on Borehole and/or Purge Water
- Sheen on Ground Surface
- ✚ Data Gap Temp Well
- ✚ TCRI Temp Well
- Location With Multiple Aesthetic Observations

Reach 3 Spill Area
 Parcel
 Quarter Mile Grid Segments

0 15 30 60
 Scale in Feet

N

FIGURE 4
 REACH 3
 REMAINING POTENTIAL AESTHETIC OBSERVATIONS
 SHEET 3 OF 7

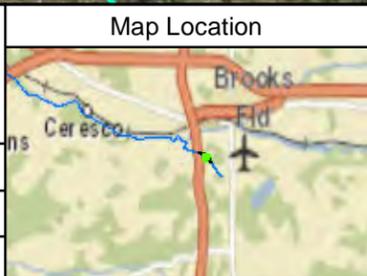
ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



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 Approved: JC 11/2/2015
 Project #: 60339671



Legend

Aesthetic Observations

- Location With No Aesthetic Observation
- Visible Oil
- Visible Oil on Borehole Water
- Odor in Soil
- Odor in Purge Water
- Sheen Within Soil Core
- Sheen on Borehole and/or Purge Water
- Sheen on Ground Surface
- ✚ Data Gap Temp Well
- ✚ TCRI Temp Well
- Location With Multiple Aesthetic Observations
- ▭ Reach 3 Spill Area
- ▭ Parcel
- Quarter Mile Grid Segments

0 15 30 60
Scale in Feet

N

FIGURE 4
 REACH 3
 REMAINING POTENTIAL AESTHETIC OBSERVATIONS
 SHEET 4 OF 7

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

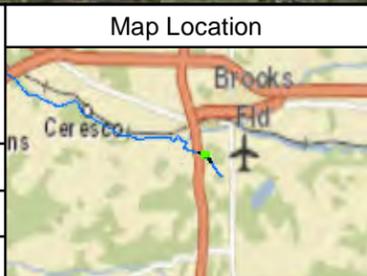


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Drawn: NS 11/2/2015

Approved: JC 11/2/2015

Project #: 60339671



Legend

Aesthetic Observations

- Visible Oil
- Visible Oil on Borehole Water
- Odor in Soil
- Odor in Purge Water
- Sheen Within Soil Core
- Sheen on Borehole and/or Purge Water
- Sheen on Ground Surface

- Location With No Aesthetic Observation
- ✚ Data Gap Temp Well
- ✚ TCRI Temp Well
- Location With Multiple Aesthetic Observations

- ▭ Reach 3 Spill Area
- ▭ Parcel
- Quarter Mile Grid Segments

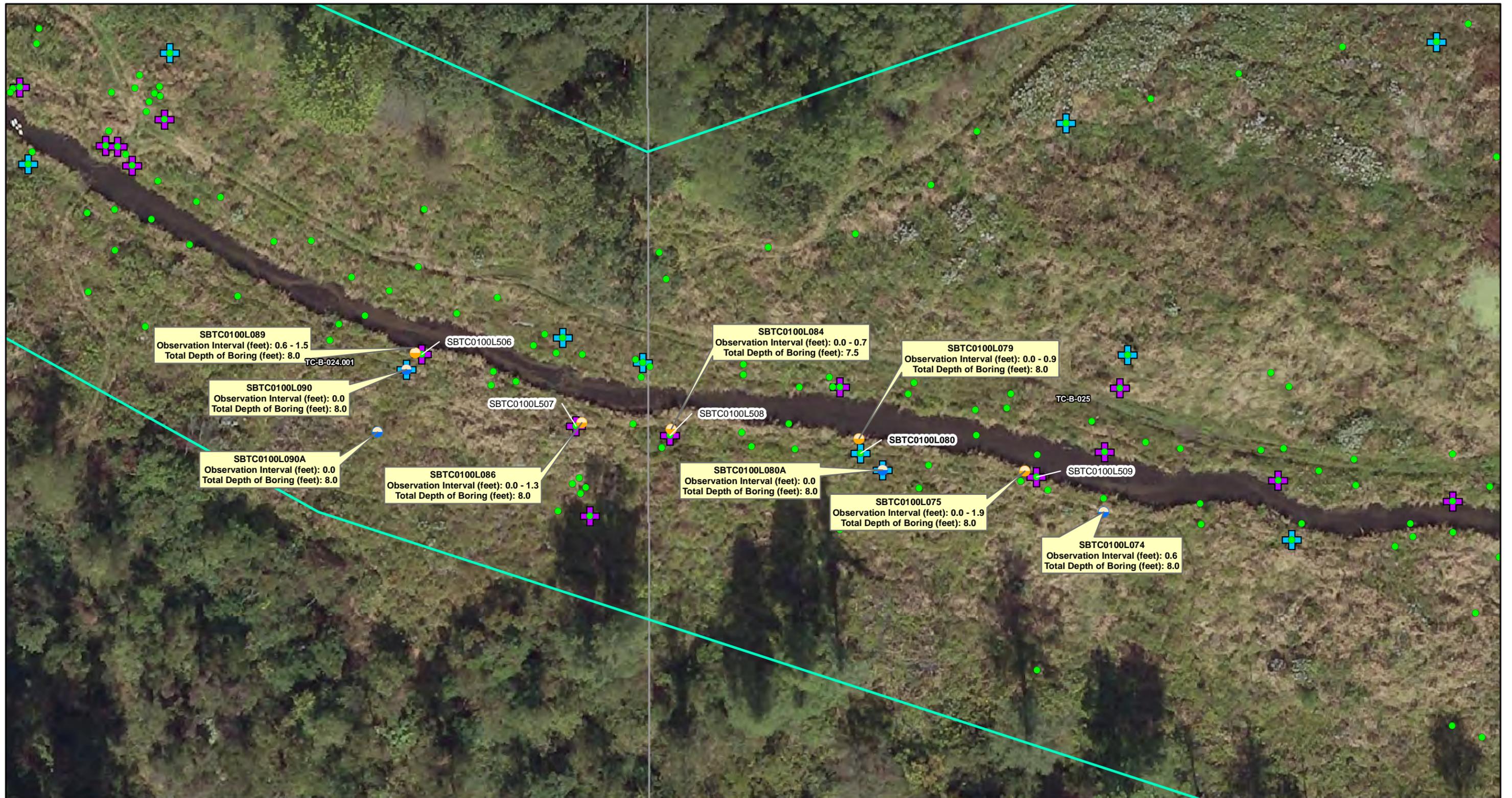
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Scale in Feet

N

FIGURE 4
REACH 3
REMAINING POTENTIAL AESTHETIC OBSERVATIONS
SHEET 5 OF 7

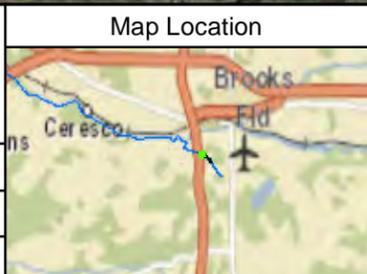
ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



ENBRIDGE

Drawn: NS 11/2/2015
 Approved: JC 11/2/2015
 Project #: 60339671



- Legend
- Aesthetic Observations**
- Visible Oil
 - Visible Oil on Borehole Water
 - Odor in Soil
 - Odor in Purge Water
 - Sheen Within Soil Core
 - Sheen on Borehole and/or Purge Water
 - Sheen on Ground Surface

- Location With No Aesthetic Observation
- ✚ Data Gap Temp Well
- ✚ TCRI Temp Well
- Location With Multiple Aesthetic Observations

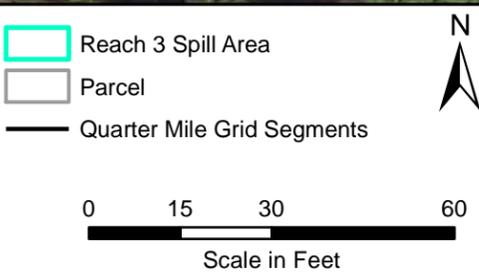


FIGURE 4
 REACH 3
 REMAINING POTENTIAL AESTHETIC OBSERVATIONS
 SHEET 6 OF 7

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

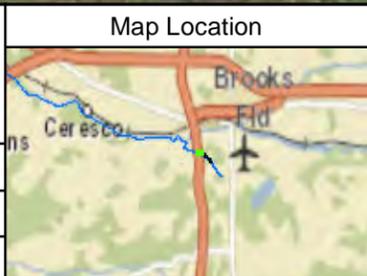


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Drawn: NS 11/2/2015

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Legend

Aesthetic Observations

- Visible Oil
- Visible Oil on Borehole Water
- Odor in Soil
- Odor in Purge Water
- Sheen Within Soil Core
- Sheen on Borehole and/or Purge Water
- Sheen on Ground Surface

- Location With No Aesthetic Observation
- ✚ Data Gap Temp Well
- ✚ TCRI Temp Well
- Location With Multiple Aesthetic Observations

- ▭ Reach 3 Spill Area
- ▭ Parcel
- Quarter Mile Grid Segments

0 15 30 60
Scale in Feet

N

FIGURE 4
REACH 3
REMAINING POTENTIAL AESTHETIC OBSERVATIONS
SHEET 7 OF 7

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

Tables

Table 1. Reach 3 Spill Area Property Identification
 Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
 Enbridge Energy, Limited Partnership

Parcel ID	Address	Tax ID	Zoning/Land Use
TC-B-017	16235 Division Drive	16-350-030-01	Agricultural
TC-B-019	16195 Division Drive	16-350-030-03	Agricultural
TC-B-021	Division Drive/Vacant	16-350-030-05	Agricultural
TC-B-023	12224 16 Mile Road	16-341-051-03	Agricultural
TC-B-024	12374 16 Mile Road	16-341-051-01	Agricultural
TC-B-024.001	12400 16 Mile Road	16-341-051-06	Agricultural
TC-B-025	16 Mile Road/Vacant	16-350-030-06	Agricultural

Table 2. Theoretical Maximum Line 6B Contribution To Target Metal Concentrations
 Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
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Date Sampled	Line 6B Crude Oil Samples					Theoretical maximum concentration increase if soil contains crude oil at 200,000 mg/kg concentration*	DWPC	GSIPC
	August 1, 2010		October 1, 2010		Average			
Constituent	Sample 1 (AB59823)	Sample 2 (AB59824)	Sample 1 (AB63754)	Sample 2 (AB63755)				
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Metals								
Beryllium	0.4	0.8	0.3	0.3	0.5	0.09	51	250
Molybdenum	<u>2.5</u>	9.3	6.4	<u>2.5</u>	5.2	1.0	1.5	64
Nickel	59	67	55	54	59	12	100	110
Vanadium	130	140	140	130	135	27	72	430

Footnotes:

*assumes all crude oil in soil is from Line 6B crude oil at a concentration of 200,000 mg/kg, which is the maximum detected in soil.

Numbers in parenthesis are laboratory sample numbers from Michigan Department of Environmental Quality Environmental Laboratory, which reported results in September, 2010.

DWPC = Part 201 Generic Residential Drinking Water Protection Criteria.

GSIPC = Part 201 Generic Residential Groundwater Surface Water Interface Protection Criteria.

mg/kg = milligrams per kilogram.

ND = No detection limit given.

Underline = ND reported at one-half detection level.

Table 3. Talmadge Creek Metals Evaluation Monitoring Well Locations
 Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
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Analyte	Date / Time Collected	Part 201 Generic Residential Cleanup Criteria			Target Detection Limits - Water	10/12/2015 12:40 PM	10/12/2015 12:40 PM	10/12/2015 2:55 PM	10/12/2015 9:40 AM	10/12/2015 4:40 PM	10/12/2015 5:55 PM	10/13/2015 9:00 AM	10/13/2015 11:00 AM	10/13/2015 12:15 PM
	Location	Residential Drinking Water Criteria	Groundwater Surface Water Interface Criteria	Residential Groundwater Volatilization to Indoor Air Inhalation Criteria		MWTC0025L 25	MWTC0025L 25	MWTC0025L 505	MWTC0025 R001	MWTC0050L 05E	MWTC0050L 14B	MWTC0075 R012	MWTC0075 R036	MWTC0150 R012A
	Sample					MWTC0025L 25S 101215G075	MWTC0025L 25D 101215G075	MWTC0025L 505S 101215G014	MWTC0025R 001S 101215G055	MWTC0050L 05ES 101215G079	MWTC0050L 14BS 101215G050	MWTC0075R 012S 101315G082	MWTC0075R 036S 101315G083	MWTC0150R 012AS 101315G076
	Depth					7 - 8 ft	7 - 8 ft	1.15 - 1.6 ft	5 - 6 ft	7.4 - 8.4 ft	4.5 - 5.5 ft	7.7 - 8.7 ft	7.75 - 8.75 ft	7.1 - 8.1 ft
	Dissolved / Total					T	T	T	T	T	T	T	T	T
Units	Result	Duplicate	Result	Result	Result	Result	Result	Result	Result					
Field														
Depth to Water	ft	NCE	NCE	NCE	NCE	3.72	3.72	3.39	4.83	5.64	3.52	5.73	2.64	4.40
Dissolved Oxygen	mg/l	NCE	NCE	NCE	NCE	0	0	1.48	0	0	0	0	0	0
Oxidation Reduction Potential	millivolts	NCE	NCE	NCE	NCE	-2	-2	59	-53	-63	-37	-67	-94	-62
pH	su	8.5(E)	9	ID	NCE	6.80	6.80	6.71	6.95	6.96	6.92	6.71	6.92	6.71
Specific Conductance	mS/cm	NCE	NCE	NCE	NCE	0.498	0.498	0.523	0.532	0.4	0.559	0.560	0.589	0.640
Temperature	deg c	NCE	NCE	NCE	NCE	15.44	15.44	19.43	13.21	18.83	15.03	12.20	13.06	13.54
Turbidity	ntu	NCE	NCE	NCE	NCE	8.9	8.9	3.1	9.8	3.4	3.8	2.4	3.2	1.3
Metals														
Beryllium	mg/l	0.004(A)	0.02(G)	NLV	0.001	---	---	---	---	< 0.0010	< 0.0010	---	---	---
Nickel	mg/l	0.1(B)(A)	0.11(B)(G)	(B)NLV	0.02	---	---	---	---	< 0.020	< 0.020	---	---	---
Vanadium	mg/l	0.0045	0.027	NLV	0.004	< 0.0040	< 0.0040	< 0.0040	< 0.0040	< 0.0040	< 0.0040	< 0.0040	< 0.0040	< 0.0040

Table 3. Talmadge Creek Metals Evaluation Monitoring Well Locations
 Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
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	Date / Time Collected	10/13/2015 2:05 PM	10/13/2015 3:20 PM
	Location	MWTC0175L 028	MWTC0200L 090
	Sample	MWTC0175L 028S 101315G074	MWTC0200L 090S 101315G017
	Depth	6.9 - 7.9 ft	1.2 - 2.2 ft
	Dissolved / Total	T	T
Analyte	Units	Result	Result
Field			
Depth to Water	ft	4.30	4.13
Dissolved Oxygen	mg/l	0	0
Oxidation Reduction Potential	millivolts	-23	-44
pH	su	6.89	6.59
Specific Conductance	mS/cm	0.518	1.22
Temperature	deg c	13.27	14.27
Turbidity	ntu	3.1	0.9
Metals			
Beryllium	mg/l	---	< 0.0010
Nickel	mg/l	---	< 0.020
Vanadium	mg/l	< 0.0040	< 0.0040

Table 3. Footnotes - Talmadge Creek Metals Evaluation Monitoring Well Locations
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Groundwater Footnotes:
Criteria were originally promulgated December 21, 2002 within the Administrative Rules for Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. This table reflects new criteria rules, numbered from 299.1 to 299.50 which became effective on December 30, 2013.
Bold values are concentrations detected above the reporting limit.
(A) = Criterion is the state of Michigan drinking water standard established pursuant to Section 5 of 1976 PA 399, MCL 325.1005.
(B) = Background, as defined in R 299.1(b), may be substituted if higher than the calculated cleanup criterion. Background levels may be less than criteria for some inorganic compounds.
(E) = Criterion is the aesthetic drinking water value, as required by Section 20120a(5) of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). A notice of aesthetic impact may be employed as an institutional control mechanism if groundwater concentrations exceed the aesthetic drinking water criterion, but do not exceed the applicable health-based drinking water value provided in a table available on the Department of Environmental Quality (DEQ) internet web site. (See R 299.49 Footnotes for generic cleanup criteria tables for additional information.)
(G) = Groundwater surface water interface (GSI) criterion depends on the pH or water hardness, or both, of the receiving surface water. The final chronic value (FCV) for the protection of aquatic life shall be calculated based on the pH or hardness of the receiving surface water. Where water hardness exceeds 400 mg CaCO ₃ /L, use 400 mg CaCO ₃ /L for the FCV calculation. The FCV formula provides values in units of ug/L or ppb. The generic GSI criterion is the lesser of the calculated FCV, the wildlife value (WV), and the surface water human non-drinking water value (HNDV). The soil GSI protection criteria for these hazardous substances are the greater of the 20 times the GSI criterion or the GSI soil-water partition values using the GSI criteria developed with the procedure described in this footnote. A spreadsheet that may be used to calculate GSI and GSI protection criteria for (G)-footnoted hazardous substances is available on the Department of Environmental Quality (DEQ) internet web site. (See R 299.49 Footnotes for generic cleanup criteria tables for additional information.)
--- = not completed/not analyzed.
deg c = degrees Celsius.
ft = feet.
ID = insufficient data to develop criterion.
mg/l = milligram per liter.
mS/cm = millisiemens per centimeter.
NCE = no criteria established.
NLV = hazardous substance is not likely to volatilize under most conditions.
ntu = nephelometric turbidity unit.
pH = a measure of the acidity or basicity of an aqueous solution.
su = standard unit.
T = total (unfiltered).

Table 4. Reach 3 Remaining Potential Aesthetic Observations
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Location Code	Date	Depth Interval (ft.)	Total Depth of Boring (ft.)	Sheen				Odor ⁶		Visible Oil ⁴		Percent Visible Oil (%) ⁵	Excavated	Comments
				In Core ¹	On Borehole Water ²	On Purge water ³	On Ground Surface ⁴	In Soil	In Purge Water	Within Soil Core ¹	On Borehole Water ²			
SBTC0075L038B	9/22/2011	4.0-8.0	8					Yes					Not excavated	
SBTC0075L040A	9/21/2011	0-1.8	8	Yes									Not fully excavated	Excavation to 1.5 ft. Location further evaluated during Data Gap field work (SBTC0075L514). No surficial or subsurface impacts observed in the Data Gap core.
SBTC0075L042	9/15/2011	0.1	6		Yes								Not excavated	
SBTC0075R004	9/12/2011	0	8	Yes									Not excavated	Trace sheen on top of core.
SBTC0075R047	9/14/2011	0	8		Yes								Not excavated	
SBTC0100L064	9/19/2011	0-2.9	8	Yes				Yes					Not fully excavated	Excavation to 1.5 ft. Location further evaluated during Data Gap field work (SBTC0100L510). No surficial or subsurface impacts observed in the Data Gap core.
SBTC0100L074	9/23/2011	0.6	8		Yes								Not excavated	Inspected during Data Gap field work and no surficial sheen observations were noted.
SBTC0100L075	9/23/2011	0.0-1.9	8	Yes									Not fully excavated	Excavation to 1.5 ft. Location further evaluated during Data Gap field work (SBTC0100L509). No surficial or subsurface impacts observed in the Data Gap core.
SBTC0100L079	9/23/2011	0-0.9	8	Yes									Not excavated	
SBTC0100L080A	9/23/2011	0	8		Yes								Not excavated	
SBTC0100L084	9/24/2011	0-0.7	7.5	Yes									Not excavated	Location further evaluated during Data Gap field work (SBTC0100L508). No surficial or subsurface impacts observed in the Data Gap core.
SBTC0100L086	9/24/2011	0-1.3	8	Yes									Not excavated	Location further evaluated during Data Gap field work (SBTC0100L507). No surficial or subsurface impacts observed in the Data Gap core.
SBTC0100L089	9/24/2011	0.6-1.5	8	Yes									Not excavated	Location further evaluated during Data Gap field work (SBTC0100L506). No surficial or subsurface impacts observed in the Data Gap core.
SBTC0100L090	9/24/2011	0	8		Yes								Not excavated	
SBTC0100L090A	9/26/2011	0	8		Yes								Not excavated	
SBTC0100R009A	9/21/2011	0	8		Yes								Not excavated	
SBTC0100R061	9/27/2011	Unknown	8					Yes					Not fully excavated	Excavated to 1.5 ft. Petroleum odor noted at borehole.
SBTC0125L002	9/26/2011	0	8		Yes								Not excavated	
SBTC0125L007	9/22/2011	0	8		Yes								Not excavated	
SBTC0125R006	9/20/2011	4.0-4.1	8	Yes									Not excavated	Location further evaluated during Data Gap field work (SBTC0125R506). No surficial or subsurface impacts observed in the Data Gap core.

- 1: Information from Soil Core Completion Detail- Materials description column on Soil Core log sheet
- 2: Information from Coring/Logging comments at bottom of Soil Core log sheet
- 3: Information from Low Flow Groundwater Sampling logs
- 4: Information from Soil Core log sheet and field records
- 5: Information from Soil Core Completion Detail- Core Under Visible Light, % column on Soil Core log sheet
- 6: Information from 1, 2, and 3

ft.= Foot

Aesthetic observations identified in the MDEQ Executive Summary Comments dated February 10, 2015 that were not included in the Reach 3 RI Report.