

MONTHLY UPDATE REPORT - PRIMROSE SOUTH 09-21-067-04 W4M

JUNE 23 TO JULY 20, 2015

1 Introduction

The Canadian Natural Resources Limited Primrose South in situ oil sands project is located in the Cold Lake Air Weapons Range (CLAWR) approximately 65 km north-northeast of Bonnyville, Alberta. Canadian Natural operations staff discovered a bitumen emulsion flow to surface (FTS) area at 09-21-067-04 W4M on June 24, 2013. The bitumen emulsion FTS area is beneath an unnamed water body located within the Canadian Natural Primrose South production area.

On September 24, 2013, Alberta Environment and Sustainable Resource Development (currently Alberta Environment and Parks) issued an Environmental Protection Order (EPO No. EPO-2013-33/NR). Requirements of the EPO included the preparation of a Comprehensive Remedial Plan (CRP), as well as the preparation of a monthly progress report in connection with the assessment and remediation efforts carried out at the FTS site. This report addresses the requirement of the progress report and includes data collected and reported between June 23 and July 20, 2015.

2 Summary of Activities to Date

2.1 Individual Plan Submissions

As required by the EPO, the CRP includes the development, submission, and implementation of several specific work plans. As of July 20, 2015, the status of these plans has not changed.

3 Water Body Monitoring

In accordance with the Water Body Restoration Plan, an extensive water quality and water quantity monitoring program was implemented on March 19, 2014. Monitoring as part of this plan complements the ongoing water quality and quantity monitoring implemented in June 2013.

Details of the monitoring programs are provided in the following subsections.

3.1 Water Quantity Monitoring

3.1.1 Basins 1, 3, and 4 and Fen

Water level staff gauges and monitoring locations are shown on Figure 1. The staff gauges have not been resurveyed since breakup and the water body elevations are approximate; these staff gauges will be resurveyed in August 2015. Staff gauges (13-SG2, 13-SG4, 13-SG11, and 13-SG12) were monitored on June 26, 2015. Staff gauge 13-SG6 was re-installed and staff gauges (13-SG2, 13-SG4, 13-SG6, 13-SG11, and 13-SG12) were monitored on July 7, 2015. The results of the staff gauge readings and corresponding water elevations for Basins 3 and 4 are shown on Appendix A1. The results of the staff gauge readings and corresponding water elevations for the fen are shown on Appendix A2. The water level elevations within Basins 3 and 4 ranged from 699.5 to 699.7 m above sea level.

3.2 Water Quality Monitoring

Water quality was compared to the *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014a). Sampling locations are shown on Figures 2 and 3.

3.2.1 Basins 1, 3, and 4 and Fen

Water samples for quality testing were collected on July 7 and 8, 2015 from the surface water sampling sites in Basins 1, 3, and 4, the fen, and one shallow groundwater sampling site (drive-point piezometer 13-DP1; Figure 2). The samples were tested to confirm that water quality in the water body remains within applicable guidelines. Water quality results are provided in Appendix B.

- Laboratory analyses of water samples was carried out for benzene, toluene, ethylbenzene, and xylenes (BTEX); petroleum hydrocarbons (PHCs) fraction 1 (F1; C₆-C₁₀, excluding BTEX) and fraction 2 (C_{>10}-C₁₆); and polycyclic aromatic hydrocarbons (PAHs).
 - ✦ All water quality results were within applicable guidelines except toluene which was detected at one sample location. Intermittent low-level toluene was also detected at that sample location throughout 2014. Toluene is widespread in the environment and have many sources not related to bitumen emulsion, including motor vehicle exhaust.

3.2.2 Within Containment Structure and/or Trench Beneath Access Pad

The containment structure area is now flooded and considered to be part of the water body although the containment wall remains in place. Water quality samples were collected from within the flooded containment structure (14-SW81) on July 7, 2015 and from within the water collection trench located beneath the access pad (East Sump C2) on June 26, 2015 (Figure 3).

Laboratory analysis of water samples was carried out for routine and inorganic parameters, total metals, BTEX; PHCs F1 and F2, PAHs. The routine and total metals analyses were conducted for the determination of the source of the water within the water collection trench and containment structure. PHC and PAH water quality results are provided in Appendix B. All water quality results were within applicable guidelines.

3.3 Aquatic Surveillance

The water body was monitored on July 8, 2015 and there were no reported occurrences of bitumen emulsion or sheen on the water body.

3.4 Erosion and Sedimentation Prevention

Before and following the pumping of water from the water collection trench into the water body, turbidity measurements at the discharge location were taken to ensure no appreciable changes in turbidity were noted. The measured turbidity remained consistent and ranged from 2.25 to 6.35 Nephelometric Turbidity Units

No other activities taking place during the reporting period were expected to cause erosion or sedimentation issues and no monitoring activities were completed.

3.5 Bitumen Emulsion Containment

Construction of the fissure containment structure (FCS) is complete and regular monitoring of the bitumen emulsion recovery pipes is ongoing. No bitumen emulsion was recovered from the FCS during this reporting period.

3.6 Wildlife Management

No injured, distressed, or deceased wildlife were observed within or around the water body during this reporting period.

3.7 Waste Management

The recovery of fluids from the FCSs began on December 19, 2014. No fluid was recovered from the FCSs during this reporting period.

4 Summary

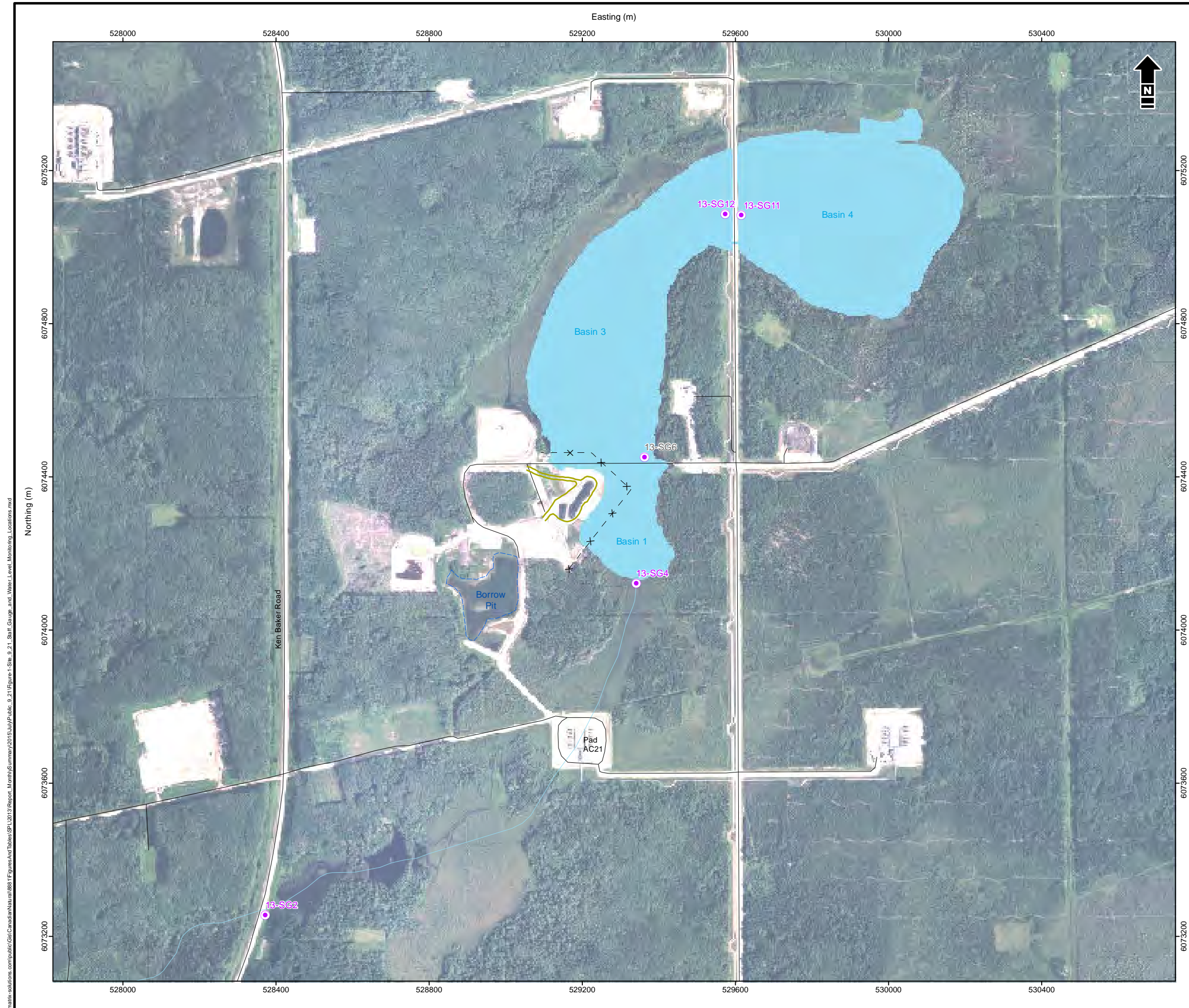
Monthly monitoring activities at the 9-21 FTS site were completed between June 23 to July 20, 2015. The scheduled field activities completed over the reporting period included:








- surface water quality sampling in the water body, containment structure, shallow groundwater sampling from one location, and water collection trench
- water level readings in the water body and fen
- bitumen emulsion monitoring on the water body

The work completed at the 9-21 site over this reporting period was routine and scheduled. The findings were as anticipated and were consistent with those for the previous reporting period.

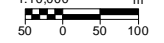
5 References

- Alberta Environment and Sustainable Resource Development (ESRD). 2014a. *Environmental Quality Guidelines for Alberta Surface Waters*. Water Policy Branch, Policy Division. Edmonton, Alberta. July 14, 2014. ISBN: 978-1-4601-1524-4.
<http://esrd.alberta.ca/water/education-guidelines/documents/EnvironmentalQualitySurfaceWaters-Jul14-2014.pdf>
- Alberta Environment and Sustainable Resource Development (ESRD). 2014b. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*. 2014 and Updates. Final Draft. Land and Forestry Policy Branch, Policy Division. Edmonton, Alberta. May 23, 2014.
<http://esrd.alberta.ca/lands-forests/land-industrial/inspections-and-compliance/documents/AlbertaTier1Guidelines-May23-2014.pdf>



-  Borrow Pit
-  Water Body
-  Watercourse
-  Road
-  Containment Wall
-  Top of Access Pad
-  Staff Gauge Location

Reference: Data obtained from AtlaLIS © Government of Alberta and GeoBase® used under license. GDM transportation infrastructure data provided by IHS © 2015 used under license. Site features provided through Matrix Solutions Inc. field efforts. Imagery (dated August 2014) obtained from Canadian Natural Resources Limited (September 2014) used under license.

1:10,000

 50 0 50 100
 NAD 1983 UTM Zone 12N

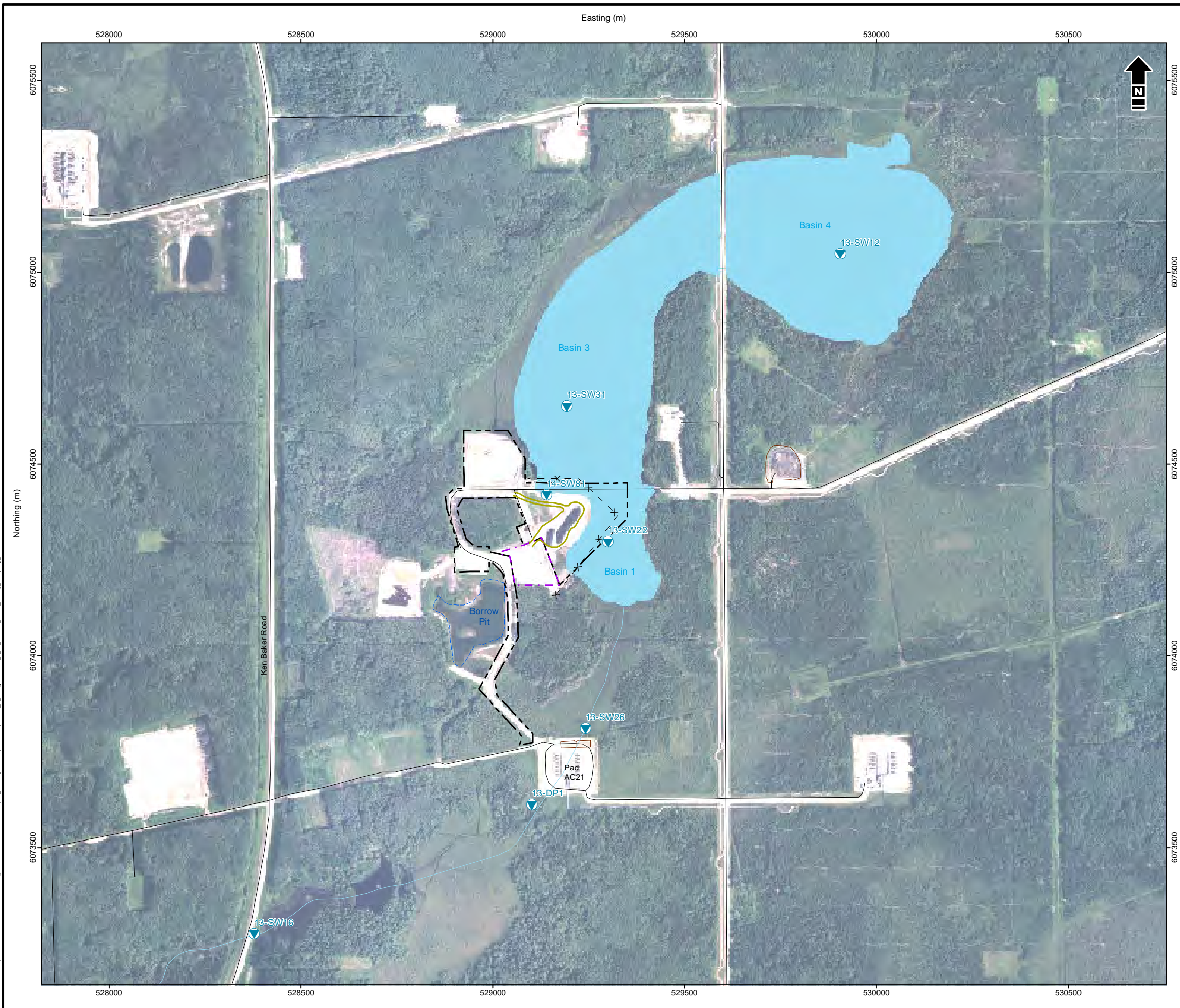


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Site 9-21 Staff Gauge and Water Level Monitoring Locations

Date: 23 Jul 2015	Project: 8881-523	Technical: A. Ward	Reviewer: P. Hum	Drawn: K. Andruchow
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Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.



- Borrow Pit
- Water Body
- Watercourse
- Road
- Containment Wall
- Top of Access Pad
- Surface Water Sample Location

Reference: Data obtained from AltaLIS © Government of Alberta and GeoBase® used under license. GDM transportation infrastructure data provided by IHS © 2015 used under license. Site features provided through Matrix Solutions Inc. field efforts. Imagery (dated August 2014) obtained from Canadian Natural Resources Limited (September 2014) used under license.

1:10,000
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NAD 1983 UTM Zone 12N

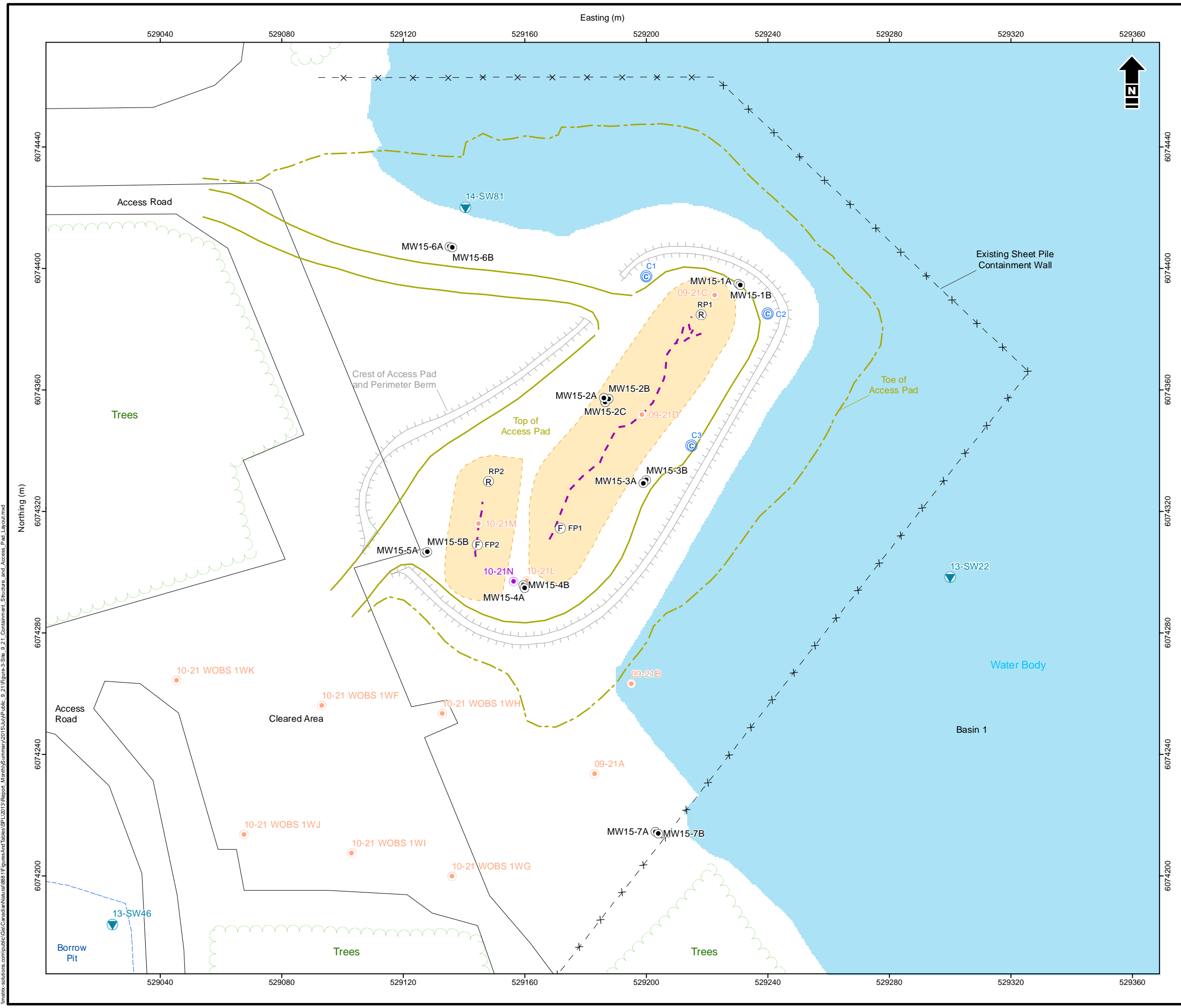


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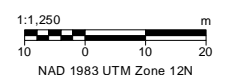
Site 9-21 Surface Water Quality Sampling Locations

Date: 23 Jul 2015 Project: 8881-523 Technical: A. Ward Reviewer: P. Hum Drawn: K. Andruchow

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- Fissure Containment Structure
- Borrow Pit
- Water Body
- Berm
- Containment Wall
- Fissure within Containment Structure
- Top of Access Pad
- Toe of Access Pad
- Bitumen Emulsion Recovery Pipe
- Flush Pipe
- Surface Water Sample Location
- Water Collection Trench Recovery Sump
- Phase II Shallow Monitoring Well
- Deep Quaternary Monitoring Well (Screened Formation)
- Ethel Lake Formation Monitoring Well
- Sand River Formation Monitoring Well



Reference: Site features provided through Matrix Solutions Inc. field efforts.



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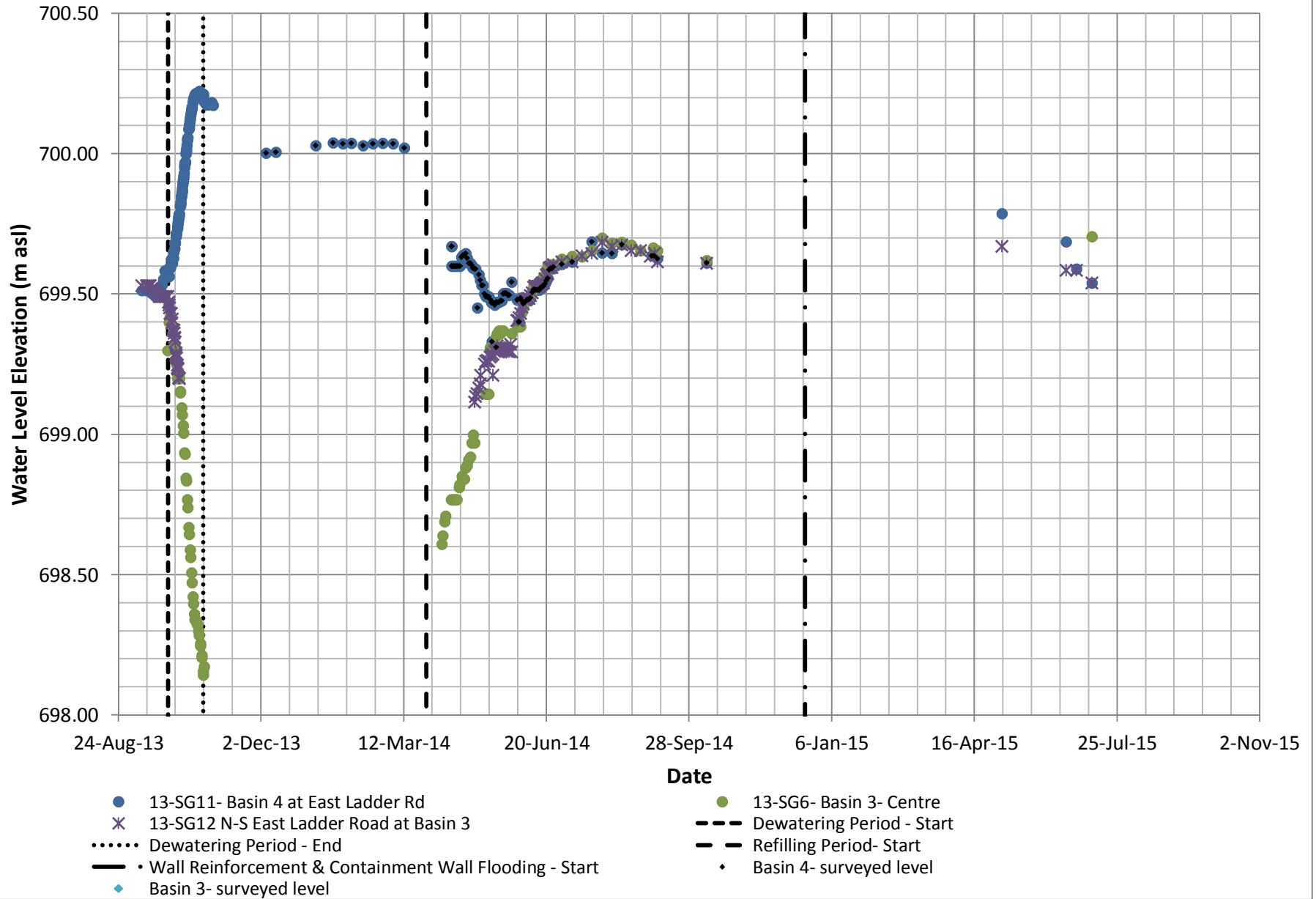
Site 9-21 Containment Structure and Access Pad Layout

Date: 23 Jul 2015	Project: 8881-523	Technical: A. Ward	Reviewer: P. Hum	Drawn: K. Andruchow
<small>Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.</small>				Figure 3

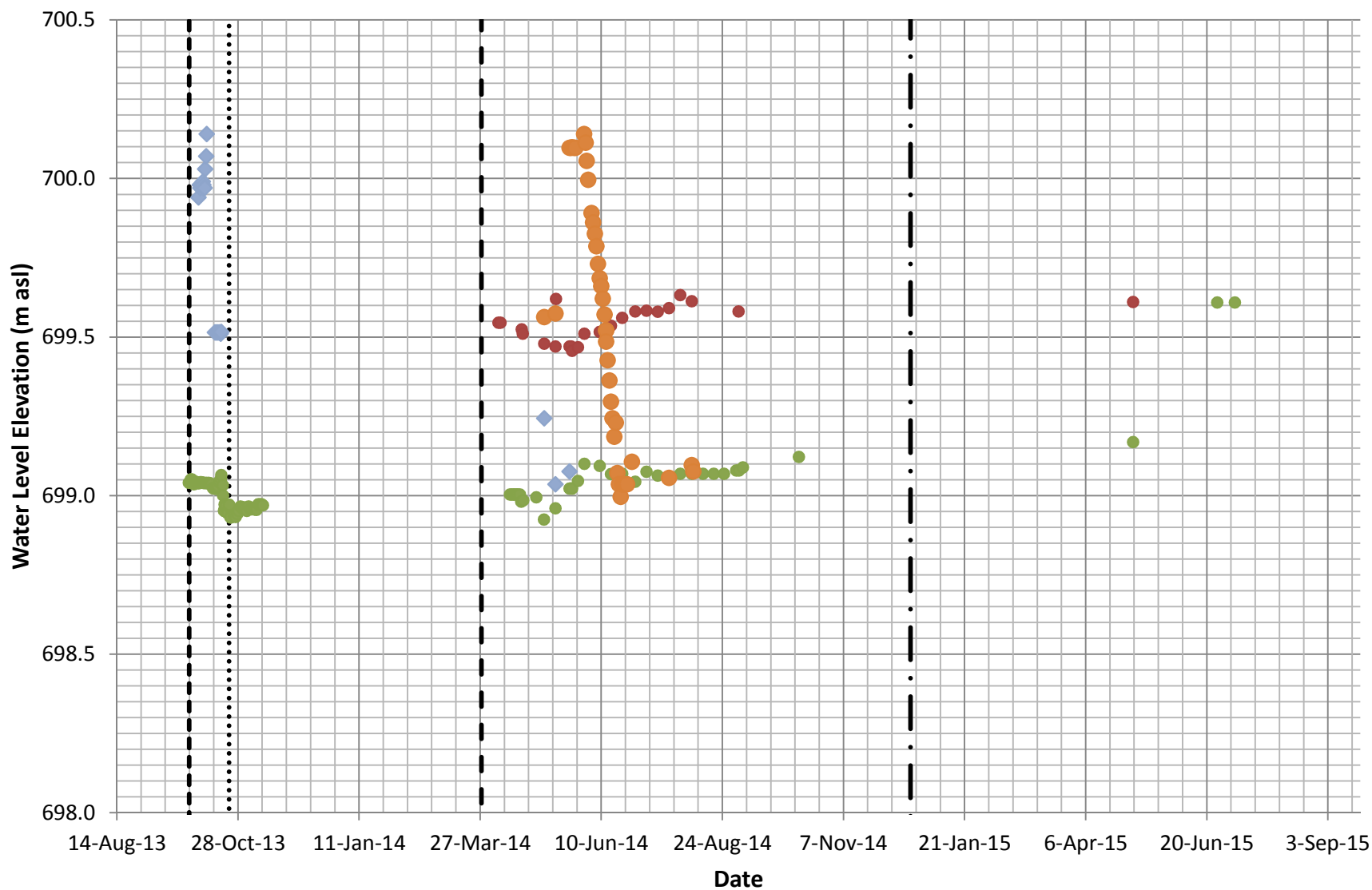
APPENDIX A

Water Levels

Appendix A1: Water Levels at 9-21 Water Body



Appendix A2: Water Levels in the Downstream Fen and Borrow Pit



● 13-SG2- Fen at Ken Baker Road (+3m)

◆ Borrow Pit - Surveyed Data (-1 m)

— Refilling Period - Start

● 13-SG4- Fen, South of Basin 1

--- Dewatering Period - Start

- · - Wall Reinforcement and Containment Wall Flooding - Start

● 13-SG13- Borrow Pit (-1 m)

..... Dewatering Period - End

APPENDIX B

Water Quality Results

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

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Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C ₇₋₁₀ -C ₁₆ mg/L	F3 C ₇₋₁₆ -C ₃₄ mg/L	F4 C ₇₋₃₄ -C ₅₀ mg/L
Surface Water Samples									
13-SW12	19-Mar-14	<0.0004	0.0044	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	27-Mar-14	<0.0004	0.0085	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	01-Apr-14	<0.0004	0.0006	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	08-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	15-Apr-14	<0.0004	0.0180	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	22-Apr-14	<0.0004	0.0040	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	29-Apr-14	<0.0004	0.0140	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW12	22-May-14	<0.00040	0.0055	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW12	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW12	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW12	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW12	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	23-Jun-14	<0.00040	0.00130	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW12	08-Jul-14	<0.00040	0.00170	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	05-Aug-14	<0.00040	0.00380	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	02-Sep-14	<0.00040	0.01100	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW12	07-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

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Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C ₁₀ -C ₁₆ mg/L	F3 C ₁₆ -C ₃₄ mg/L	F4 C ₃₄ -C ₅₀ mg/L
Surface Water Samples									
13-SW16	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW16	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW16	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW16	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW16	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW16	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW16	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	15-Jul-14	<0.00040	0.00068	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	22-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	29-Jul-14	<0.00040	0.00064	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	05-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	12-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	18-Aug-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.10	<0.10	---	---
13-SW16 dup	18-Aug-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.10	<0.10	---	---
13-SW16	25-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	02-Sep-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW16	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW16	07-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

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Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C ₇₋₁₀ -C ₁₆ mg/L	F3 C ₇₋₁₆ -C ₃₄ mg/L	F4 C ₇₋₃₄ -C ₅₀ mg/L
Surface Water Samples									
13-SW22	01-Apr-14	<0.0004	0.00230	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	08-Apr-14	<0.0004	0.00084	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	15-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	22-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	29-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW22	06-May-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW22	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW22	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW22	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW22	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW22	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW22	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW22	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	05-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	02-Sep-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW22	07-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW22	08-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

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WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited
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Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C ₇₋₁₀ -C ₁₆ mg/L	F3 C ₇₋₁₆ -C ₃₄ mg/L	F4 C ₇₋₃₄ -C ₅₀ mg/L
Surface Water Samples									
13-SW26	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	0.23	<0.20
13-SW26	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW26	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW26	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW26	09-Jun-14	<0.00040	0.00290	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW26	16-Jun-14	<0.00040	0.00100	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	23-Jun-14	<0.00040	0.00150	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	01-Jul-14	<0.00040	0.00670	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW26	08-Jul-14	<0.00040	0.00500	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	15-Jul-14	<0.00040	0.00450	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26 dup	15-Jul-14	<0.00040	0.00370	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	22-Jul-14	<0.00040	0.00130	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	29-Jul-14	<0.00040	0.00120	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	05-Aug-14	<0.00040	0.00190	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	12-Aug-14	<0.00040	0.00320	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	18-Aug-14	<0.0004	0.00540	<0.0004	<0.0008	<0.10	<0.10	---	---
13-SW26	19-Aug-14	<0.0004	0.00160	<0.0004	<0.0008	<0.10	---	---	---
13-SW26	25-Aug-14	<0.00040	0.00094	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	02-Sep-14	<0.00040	0.00280	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	09-Oct-14	<0.0004	0.00170	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW26	16-Oct-14	<0.0004	0.01600	<0.0004	<0.0008	<0.1	---	---	---
13-SW26	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW26	07-Jul-15	<0.00040	0.00800	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited
09-21-067-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C ₁₀ -C ₁₆ mg/L	F3 C ₁₆ -C ₃₄ mg/L	F4 C ₃₄ -C ₅₀ mg/L
Surface Water Samples									
13-SW31	08-Apr-14	<0.0004	0.0011	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	15-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31 dup	15-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	22-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31 dup	22-Apr-14	<0.0004	0.00043	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	29-Apr-14	<0.0004	0.0017	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW31 dup	29-Apr-14	<0.0004	0.0150	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW31	06-May-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	06-May-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	0.11	<0.20	<0.20
13-SW31	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW31 dup	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW31	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW31	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW31 dup	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW31	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31 dup	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31 dup	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW31 dup	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	0.11	<0.10	---	---
13-SW31	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31 dup	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	22-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	29-Jul-14	<0.00040	0.00042	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	05-Aug-14	<0.00040	0.00520	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	12-Aug-14	<0.00040	0.00710	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	25-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	02-Sep-14	<0.00040	0.00110	<0.00040	<0.00080	<0.10	0.13	---	---
13-SW31 dup	02-Sep-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW31 dup	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW31	07-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW31 dup	07-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW31	08-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31 dup	08-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-067-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C ₇₋₁₀ -C ₁₆ mg/L	F3 C ₇₋₁₆ -C ₃₄ mg/L	F4 C ₇₋₃₄ -C ₅₀ mg/L
Containment Structure Samples									
14-SW81	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
14-SW81	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
14-SW81	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	0.2	---	---
14-SW81	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	05-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	09-Oct-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	26-Jun-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	07-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
Water Collection Trench Recovery Sumps									
East Sump C2	19-Feb-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
East Sump C2	07-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
East Sump C2	11-Jun-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
East Sump C2	26-Jun-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
Minimal Detection Limit		0.0004	0.0004	0.0004	0.0008	0.1	0.1	0.2	0.2
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

Notes:

--- - not analyzed

NS - guideline not specified

ST - see applicable guidelines for short-term exposure guideline

* - *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014)

Italics - indicates values do not meet applicable guidelines

APPENDIX B2.

WATER QUALITY RESULTS - POLYCYCLIC AROMATIC HYDROCARBONS

Canadian Natural Resources Limited
09-21-067-04 W4M

Sample Point	Date	Acenaphthene µg/L	Acenaphthylene µg/L	Acridine µg/L	Anthracene µg/L	Benzo[a]anthracene µg/L	Benzo[b,]fluoranthene µg/L	Benzo[k]fluoranthene µg/L	Benzo[g,h,i]perylene µg/L	Benzo[c]phenanthrene µg/L	Benzo[a]pyrene µg/L	Benzo[e]pyrene µg/L	Chrysene µg/L	Dibenz[a,h]anthracene µg/L	Fluoranthene µg/L	Fluorene µg/L	Indeno[1,2,3-cd]pyrene µg/L	Naphthalene µg/L	2-Methylnaphthalene µg/L	Perylene µg/L	Phenanthrene µg/L	Pyrene µg/L	Quinoline µg/L	TOTAL PAH µg/L
Containment Structure Samples																								
14-SW81	02-Jun-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	09-Jun-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	16-Jun-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	23-Jun-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	01-Jul-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.020	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	08-Jul-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	05-Aug-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	09-Oct-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	05-May-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	07-Jul-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
14-SW81	26-Jun-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
Water Collection Trench Recovery Sumps																								
East Sump C2	19-Feb-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
East Sump C2	07-May-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
East Sump C2	11-Jun-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
East Sump C2	26-Jun-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
Minimal Detection Limit		0.1	0.1	0.2	0.01	0.0085	0.0085	0.0085	0.0085	0.05	0.0075	0.05	0.0085	0.0075	0.01	0.05	0.0085	0.1	0.1	0.05	0.05	0.02	0.2	-
ESRD Freshwater Aquatic Life*		5.8	NS	4.4	0.012	0.018	NS	NS	NS	NS	0.015	NS	NS	NS	0.04	3	NS	1	NS	NS	0.4	0.025	3.4	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes:

--- - not analyzed

NS - not specified

ND - not detected

* - *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014)

Italics - indicates values do not meet applicable guidelines

APPENDIX B3.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-064-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C _{>10} -C ₁₆ mg/L	F3 C _{>16} -C ₃₄ mg/L	F4 C _{>34} -C ₅₀ mg/L
Drive Point Samples									
13-DP1	15-Jul-14	<0.00040	<i>0.0300</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	29-Jul-14	<0.00040	<i>0.0080</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	05-Aug-14	<0.00040	<i>0.0100</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	12-Aug-14	<0.00040	<i>0.0087</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	18-Aug-14	<0.00040	<i>0.0210</i>	<0.00040	<0.00080	<0.10	<0.22	---	---
13-DP1	19-Aug-14	<0.00040	<i>0.0170</i>	<0.00040	<0.00080	<0.10	---	---	---
13-DP1	25-Aug-14	<0.00040	<i>0.0290</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	02-Sep-14	<0.00040	<i>0.0170</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	09-Oct-14	<0.00040	<i>0.0041</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	07-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
Minimal Detection Limit		0.0004	0.0004	0.0004	0.0008	0.1	0.1	0.2	0.2
ESRD Freshwater Aquatic Life**		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation**		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock**		NS	0.024	0.0024	NS	NS	NS	NS	NS

Notes:

NS - not specified

** - *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014)

Italics - values do not meet applicable ESRD guidelines

APPENDIX B4.

WATER QUALITY RESULTS - POLYCYCLIC AROMATIC HYDROCARBONS

Canadian Natural Resources Limited

09-21-064-04 W4M

Sample Point	Date	Acenaphthene µg/L	Acenaphthylene µg/L	Acridine µg/L	Anthracene µg/L	Benz[a]anthracene µg/L	Benzo[b,f]fluoranthene µg/L	Benzo[k]fluoranthene µg/L	Benzo[g,h,i]perylene µg/L	Benzo[c]phenanthrene µg/L	Benzo[a]pyrene µg/L	Benzo[e]pyrene µg/L	Chrysene µg/L	Dibenz[a,h]anthracene µg/L	Fluoranthene µg/L	Fluorene µg/L	Indeno[1,2,3-cd]pyrene µg/L	Naphthalene µg/L	2-Methylnaphthalene µg/L	Perylene µg/L	Phenanthrene µg/L	Pyrene µg/L	Quinoline µg/L	TOTAL PAH µg/L
Drive Point Samples																								
13-DP1	15-Jul-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<i>0.037</i>	<0.20	0.037
13-DP1	29-Jul-14	<0.12	<0.12	<0.24	<0.012	<0.010	0.010	<0.010	<0.010	<0.06	<0.0089	<0.06	<0.010	<0.0089	0.023	<0.060	<0.010	<0.12	<0.12	<0.060	<0.060	<0.024	<0.24	0.033
13-DP1	05-Aug-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	0.013	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	0.013
13-DP1	12-Aug-14	<0.12	<0.12	<0.23	<0.012	<0.0099	<0.0099	<0.0099	<0.0099	<0.058	<0.0087	<0.058	<0.0099	<0.0087	<0.012	<0.058	<0.0099	<0.12	<0.12	<0.058	<0.058	<0.023	<0.23	ND
13-DP1	18-Aug-14	<0.15	<0.15	<0.29	<0.015	<0.012	0.015	<0.012	<0.012	<0.073	<0.011	<0.073	0.012	<0.011	0.026	<0.073	<0.012	<0.15	<0.15	<0.073	<0.073	<0.029	<0.29	0.053
13-DP1	25-Aug-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	0.015	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	0.015
13-DP1	02-Sep-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
13-DP1	09-Oct-14	<0.11	<0.11	<0.22	<0.011	<0.0092	<0.0092	<0.0092	<0.0092	<0.054	<0.0082	<0.054	<0.0092	<0.0082	0.023	<0.054	<0.0092	<0.11	<0.11	<0.054	<0.054	<0.022	<0.22	0.023
13-DP1	05-May-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
13-DP1	07-Jul-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
Minimal Detection Limit		0.1	0.1	0.2	0.01	0.0085	0.0085	0.0085	0.0085	0.05	0.0075	0.05	0.0085	0.0075	0.01	0.05	0.0085	0.1	0.1	0.05	0.05	0.02	0.2	-
ESRD Freshwater Aquatic Life**		5.8	NS	4.4	0.012	0.018	NS	NS	NS	NS	0.015	NS	NS	NS	0.04	3	NS	1	NS	NS	0.4	0.025	3.4	NS
ESRD Agriculture - Irrigation**		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock**		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes:

--- - not analyzed

ND - not detected

NS - not specified

** - *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014)

Italics - values do not meet applicable ESRD guidelines