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

MARCH 3, 2014

1 Introduction

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

On September 24, 2013, Alberta Environment and Sustainable Resource Development (ESRD) issued an Environmental Protection Order (EPO No. EPO-2013-33/NR), requesting the preparation of a Comprehensive Remedial Plan (CRP), as well as the preparation of a monthly progress report. This report summarizes the progress towards the realization of this plan and includes data collected and reported up to February 17, 2014. The information in this report focuses on data collected since January 25, 2014.

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 plans. The status of these plans is indicated in Table 1 below:

Table 1: Components of the Comprehensive Remedial Plan

Item	Plan Name	Due Date	Submission Date	Approval Date	Implementation Start Date	Completion Date	Section Discussed
1.	**Water Management Plan for Dewatering**	September 26, 2013	September 26, 2013	September 27, 2013	September 27, 2013	October 22, 2013	2.2
2.	**Water Body Monitoring Plan**	September 26, 2013	September 26, 2013	September 27, 2013	September 27, 2013	Ongoing	3.0
3.	**Erosion and Sedimentation Prevention Plan**	September 26, 2013	September 26, 2013	September 27, 2013	September 27, 2013	Ongoing	3.2
4.	**Phase II Environmental Assessment Plan**	October 15, 2013	October 3, 2013	October 17, 2013	January 6, 2014	Ongoing	3.3
5.	**Bitumen Emulsion Delineation and Containment Plan**	October 6, 2013	October 3, 2013	October 17, 2013	October 18, 2013	Ongoing	3.4

Item	Plan Name	Due Date	Submission Date	Approval Date	Implementation Start Date	Completion Date	Section Discussed
6.	**Amphibian Salvage Plan**	September 26, 2013	September 25, 2013	September 27, 2013	September 27, 2013	October 22, 2013	Complete
7.	**Fish and Fish Habitat Assessment Plan**	September 26, 2013	September 25, 2013	September 27, 2013	September 27, 2013	October 30, 2013	Complete
8.	**Wetlands Impact Assessment Plan**	September 30, 2013	September 25, 2013	September 27, 2013	September 27, 2013	October 30, 2013	Complete
9.	**Water Body Restoration Plan**	November 30, 2013	November 27, 2013	February 7, 2014	No later than April 1, 2014	Pending	N/A
10.	**Wildlife Management Plan**	N/A	Revised Plan October 23, 2013	October 23, 2013	October 23, 2013	Pending	3.5
11.	**Waste Management Plan**	N/A	Revised Plan October 24, 2013	October 24, 2013	October 24, 2013	Pending	3.6
12.	**Management of Residual Bitumen Emulsion Plan**	N/A	December 22, 2013	February 7, 2014	Pending	Pending	N/A
13.	**Mechanical Transplants of Aquatic Shoreline Vegetation Plan - Extension II**	N/A	January 14, 2014	February 7, 2014	Pending	Pending	N/A

2.2 Water Management for Dewatering

The water body was divided in four basins as indicated on Figure 1. Basins 1, 2 and 3 were dewatered, while Basin 4 and a nearby borrow pit are being used to store the water from Basins 1, 2 and 3. Three independent pumping systems were used to pump water from Basins 1, 2 and 3. This configuration allowed Canadian Natural to adjust pumping rates in the various basins as specified in the approved Water Management Plan for Dewatering.

Pumping started on September 27, 2013. The volume of water pumped from each basin is presented in Appendix A. On October 22, 2013, pumping was stopped.

Between January 23 and February 17, 2014, no water was pumped to surrounding areas as all water in Basins 1, 2 and 3 is frozen. Furthermore, due to freezing conditions, no fluid entered the excavations; therefore, no fluid (bitumen emulsion and surface water) was recovered from the 9-21 FTS site for disposal. The cumulative total fluid volume (bitumen emulsion and surface water) recovered at the 9-21 FTS site between July 15, 2013 and February 17, 2014 was 1,429 m^3 and the cumulative volume of bitumen emulsion recovered was 154 m^3.

The dewatering activities took place in accordance to the conditions specified in the Water Management Plan for Dewatering and in the Erosion and Sedimentation Prevention Plan (Table 1, Items 1 and 3).

3 Water Body Monitoring

In accordance with the Water Body Monitoring Plan (Table 1, Item 2), an extensive water quality and water quantity monitoring program was implemented on September 27, 2013. This ongoing program is tailored to the level of activity taking place at the 9-21 FTS site and complements the ongoing water quality and quantity monitoring implemented in June 2013.

3.1 Dewatering Water Quality

Weekly water sampling was discontinued after November 12, 2013 due to freeze-up and completion of dewatering, except weekly sampling, was continued through February 2014 in one shallow groundwater monitoring well (13-DP-4, Section 3.1.3). During the dewatering program, water quality was within *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (Tier 1) at all sampling locations. Sampling locations are shown on Figure 2.

3.1.1 Dewatering Water Quantity

The amount of water pumped from Basins 1, 2 and 3 as of December 7, 2013, was 404,378 m^3. Pumping to remove water seeping into Basin 1 was discontinued after November 24, 2013, due to freezing temperatures.

3.1.2 Surface Water Quality

Water quality samples were collected weekly from Basins 1, 2 and 3, during the dewatering period, and from Basin 4 and the downstream fen until freeze-up, which occurred between October 29 and November 12, 2013 (Figure 2). The samples were tested to ensure water quality in the receiving environment was not being affected by the dewatering operations. Water quality results are presented in Appendix B. No water quality samples were collected from the water body or downstream fen after November 12, 2013, due to frozen conditions.

3.1.3 Shallow Groundwater

Shallow groundwater quality samples underlying the north end of Basin 3 of the water body were collected from one shallow drive-point piezometer well (13-DP4) on January 28, February 5 and February 12, 2014 (Figure 3). Water quality results are presented in Appendix B.

Water quality from the shallow groundwater locations was within freshwater aquatic life guidelines. Hydrocarbons were not detected in any shallow groundwater samples taken on January 28 and February 5 and 12, 2014. Polycyclic aromatic hydrocarbons (PAHs) were not detected in any shallow groundwater samples taken on January 28 and February 5 and 12, 2014, with the exception of naphthalene, which was detected in the February 5 sample at a level well below the aquatic life guideline. Naphthalene is a common PAH found in petroleum products and as by-products of combustion (including cigarette smoke). The source of naphthalene in the shallow groundwater sample is unknown and, if persistent, will be investigated further. Chlorides were below detection in all samples.

3.2 Erosion and Sedimentation Prevention

The dewatering activities took place in accordance to the conditions specified in the Erosion and Sedimentation Prevention Plan (Table 1, Item 3). All erosion and sediment control structures, which were set up during the dewatering program, were removed once pumping was suspended on

October 22, 2013. However, containment structures, such as the aquadams located in Basin 4 and at the south end of Basin 1, will be removed in spring 2014. There were no signs of erosion or sedimentation associated with the dewatering program.

Erosion and sediment control structures are currently not required as all remedial works are being completed within the dewatered water body. Any water that was intermittently collected from the water body, after the dewatering phase was suspended on October 22, 2013, was stored in tanks and disposed offsite. Erosion and sediment control structures may be implemented during the water body refilling phase, as required.

3.3 Phase II Environmental Assessment

ESRD approved a plan for conducting an interim Phase II environmental site assessment (ESA) of shallow soils at the site on October 17, 2013. As part of the interim ESA in December 2013, boreholes were drilled in Basins 1 and 2 as well as the south portion of Basin 3, to assess soil types and the potential presence of bitumen emulsion in the soils underlying the water body. The drilling of shot holes, used for the placement of charges for a seismic survey in Basin 3 (the seismic program was unrelated to the Phase II ESA or to the investigation of the bitumen emulsion release) was completed between February 8 and 10, 2014. Over 200 shot holes were drilled to depths between 6 and 9 m in Basin 3 and provide additional subsurface Information such as ice thickness, organic material thickness and presence/ absence of bitumen emulsion. Based on observations, no bitumen emulsion was encountered in any of the shot holes. The final phase of the seismic survey is scheduled to be completed in Basins 1 and 2 at the end of February.

Interim Phase II ESA drilling was completed in early January 2014. Preliminary results indicate that there were measured concentrations of petroleum hydrocarbon (PHC) fraction 2 ($C_{>10}$-C_{16}), fraction 3 ($C_{>16}$-C_{34}), fraction 4 ($C_{>34}$) and a few PAH compounds in some soil samples, but all concentrations were below Tier 1 guidelines. No benzene, toluene, ethylbenzene and xylenes (BTEX) or PHC fraction 1 (C_6-C_{10}, excluding BTEX) concentrations above laboratory detection limits were found and no salinity impacts were detected either.

3.4 Bitumen Emulsion Remediation and Containment

3.4.1 Remedial Activities of the Release Point for Bitumen Flow to Surface

From January 25 to February 17, 2014, the following activities were carried out as part of the plan to characterize and contain the bitumen emulsion release point:

- Testing of ice thickness in Basins 1 and 3 was suspended in January 2014 due to temperatures measured below -15°C, and the last ice thickness measurement from early December 2013 indicated that the ice was at least 30 cm thick. Ice thickness measurements were conducted on January 29, 2014, before seismic survey activities started and the ice thicknesses measured were still at least 30 cm thick. Regular ice thickness measurements may be conducted again should temperatures rise above freezing to confirm that heavy equipment can still safely access the ice-covered areas.

- Excavation at the western shore of the water body, in the area of the fissure was completed on February 15, 2014. This included the enlargement of the excavation to encompass the area required for the approved fissure containment structure and drilling pad. The fissure has been fully exposed and delineated. Clean organic sediment from the enlargement of the fissure excavation was stockpiled in the scraped shoreline areas north of the Basin 2 excavation. To date, approximately 7,576 m^3 of material has been stockpiled in Zones 3.1, 3.2, 3.3 and 3.4 (Figure 4). Approximately 1,224 m^3 of potentially clean clay from the removal of the ice road within the excavation was stockpiled in Zone 3.5.

- Bitumen-impacted excavated material was stockpiled in containment cells for temporary storage before trucking to landfill. Confirmatory samples collected in a grid pattern from the base of the area excavated between January 25 to February 15, 2014 to remove material containing bitumen emulsion and to expose the fissure, were submitted for analysis of hydrocarbons. Confirmatory sampling was completed on February 15, 2014. The results from this testing will be included in the next monthly report. Ice and high ice content frozen sediments with bitumen emulsion were temporarily placed in lined cells. The material will be allowed to melt so that the water and sediments can be disposed separately.

- Excavation of bitumen-impacted soil and ice, and removal of affected vegetation from shoreline areas continued intermittently between January 25 and February 17, 2014. This was due to deadlines for enlarging the fissure excavation to enable installation of the temporary workspace containment structure (containment wall). Scraping activities were started on the southern portion of Basin 1 on February 17, 2014. Scraping of the areas north of the main excavation in Basin 3 (Figure 4) is complete and confirmatory sampling has been completed. The sediments were scraped to a depth of approximately 30 cm based on the visual observation of bitumen emulsion, and confirmatory samples were collected based on a 10 m linear grid pattern and tested for hydrocarbons. The bitumen-impacted soil and ice was transported either to containment Cells A and B for offsite disposal or containment Cell C for storage.

- The shoreline sediment excavation is ongoing and efforts are being made to minimize the removal of vegetative rhizomes during scraping activities. All unaffected sediment and rhizomes that were removed during scraping activities will be placed within the scraped areas of the water body along the shoreline. This will facilitate recolonization of macrophyte communities during open water conditions.

3.4.2 Containment of Bitumen Emulsion

Due to frozen conditions and the slow seepage of bitumen emulsion from the fissure, the temporary containment of bitumen emulsion during fissure exposure and material excavation was not required. However, due to construction activities within the excavation, a temporary low (0.5 to 1.0 m high) clay berm was constructed on February 14 and 15, 2014, surrounding the fissure to ensure equipment would not come in contact with the bitumen emulsion. Water recovered from the excavation is currently collected in depressions within the excavation, removed by vacuum truck and disposed at the Tervita

Corporation disposal facility in Lindbergh, Alberta. Between January 25 and February 17, 2014, 22 m^3 of water was collected and removed for disposal.

3.4.3 Final Design for Permanent Containment of Bitumen Emulsion Seepage from Fissure

ESRD granted approval of the Temporary Workspace Containment Structure Plan (containment wall) on January 24, 2014. The containment wall is to be located in Basin 1 (Figure 4) to provide a temporary work space for completing bitumen emulsion containment berms around the fissure, as well as construction of the drilling pad. Construction of the containment structure is scheduled to start February 18, 2014. It is planned to start refilling the water body on March 15, 2014.

The fissure containment structure will be similar to the structures completed at the 10-1, 10-2 and 2-22 FTS sites. The fissure will be surrounded by a low earthen berm, a steam pipe will be installed to facilitate bitumen emulsion removal in cold weather and the space within the bermed area containing the fissure will be filled with corduroy to allow the bitumen emulsion to collect. An impermeable liner will be placed over the corduroy and the structure covered with clay fill. When complete, the structure will be buried beneath the drilling pad and recovery culverts and monitoring wells installed to recover the bitumen emulsion and to track possible seepage outside of the structure.

In preparation for the containment wall and drilling pad construction, timber salvage was conducted on February 6 to 12, 2014. The salvage was done at two locations on the west shore to accommodate the north and south ends of the containment wall. Trees/willows/shrubs were removed from the containment structure and pad construction area along the western shoreline of the water body with a mulcher and buncher/feller.

Monitoring wells and recovery culverts will be installed through the drill pad, around the fissure containment structure and into the corduroy to allow monitoring and recovery of the bitumen emulsion seepage.

Given the current location and length of the exposed fissure, the final alignment and size of the containment wall has been modified from that planned in the Bitumen Emulsion Delineation and Containment Plan (Table 1, Item 5).

3.4.4 Schedule of Implementation

The schedule of implementation was provided in the approved Bitumen Emulsion and Delineation Plan; there have been no deviations to date.

3.5 Wildlife Management

Wildlife management activities between January 25 and February 17, 2014 included maintaining perimeter fencing; installing, maintaining and frequently relocating wildlife scare cannons; and conducting daily inspections. Current focus is on large mammals as most other species are not found near the site due to winter conditions.

3.6 Waste Management

Waste generated as part of the remediation program includes liquid bitumen emulsion, vegetation containing bitumen emulsion, oily absorbents, fluids and soil and sediment containing bitumen emulsion. All waste was collected in bags, bins or barrels or was trucked to lined containment cells for temporary storage. Waste is tested to ensure that it meets landfill requirements and is suitable to transport by truck. All waste is manifested for transportation and is disposed at certified waste management facilities. Soils near waste storage areas onsite are tested before collection and will be assessed following completion of the remediation program.

The waste management program is summarized as follows:

- Impacted soil temporarily stockpiled in Cells A and B continue to be transported to the landfill for disposal. Materials in Cell C will be transported to the landfill for disposal in spring 2014, after the material has been dewatered to meet landfill criteria.

- A fourth lined containment cell (Cell D) is currently being constructed at former lease 14-1, located northeast of the water body. Cell D is being constructed to hold organic and mineral soils that cannot be transported to the landfill due to high water content. Cell C that was constructed to hold the same material is almost at capacity. Soils forming the base of Cell D were sampled before cell installation to provide baseline soil quality information. Construction is scheduled to be completed near the end of February. Trucks continued hauling 4,494 tonnes of impacted material to the Tervita Bonnyville landfill between January 25 and February 17, 2014. To date, a cumulative total of 31,171 tonnes of soil containing bitumen emulsion has been taken to the Tervita Bonnyville landfill. Based on the bitumen content of the soil, a cumulative total of 104 tonnes of bitumen emulsion have been removed from the site as part of the impacted materials.

- Daily landfill composite samples and paint filter test samples were collected from soil being trucked to landfill. Most paint filter tests conducted between January 25 and February 17, 2014 passed, with the exception of filter tests on January 26, 30 and 31, 2014. Impacted material transport from shoreline scrape areas to containment Cells A and B was suspended for the remainder of the day after each failed test. Excavation operations were revised to ensure the issue was addressed and transport resumed.

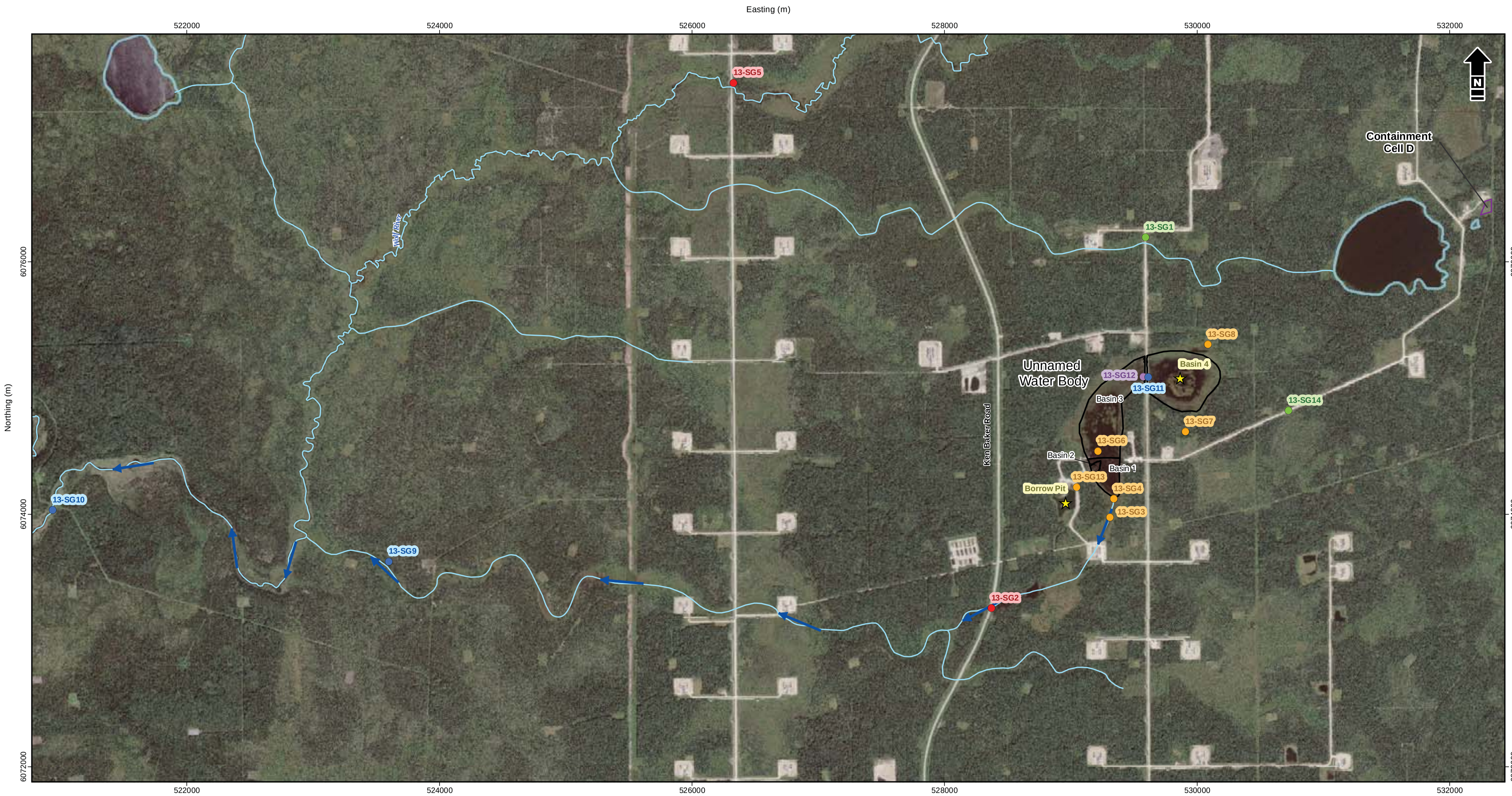
4 Conclusions

The data collected between January 25 and February 17, 2014, indicate that dewatering and subsequent remediation activities have not had any detectable adverse effect on the hydrology and water quality in the surrounding environment. Furthermore, continued compliance with requirements of the EPO has been demonstrated throughout the monitoring period.

Excavation of impacted soil within the fissure area is complete. Enlargement of the excavation to encompass the area needed for the fissure containment structures including the containment wall and future drilling pad footprint is also complete. Scraping of the impacted sediments along the shoreline in

Basin 3 is complete and is ongoing in Basin 1. Installation of the containment structure wall is scheduled to start February 18, 2014.

The work is progressing as planned and the objectives, as required by the EPO, are being achieved within the required time frame.



Basin Boundary
Containment Cell D
Water Body
Watercourse
Direction of Flow

Staff Gauge Location (Discontinued on October 6, 2013)
Staff Gauge Location (Discontinued on October 23, 2013)
Staff Gauge Location (Discontinued on October 29, 2013)
Staff Gauge Location (Discontinued on November 5, 2013)
Staff Gauge Location (Discontinued on November 12, 2013)
Water Level Monitoring Location

1:30,000
310 0 310 620 m
NAD 1983 UTM Zone 12N

Reference: Data obtained from AltaLIS © Government of Alberta and GeoBase® used under license. Imagery obtained from client (September 2013) used under license.

Canadian Natural

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

Staff Gauge, Discharge, and Water Level Monitoring Locations

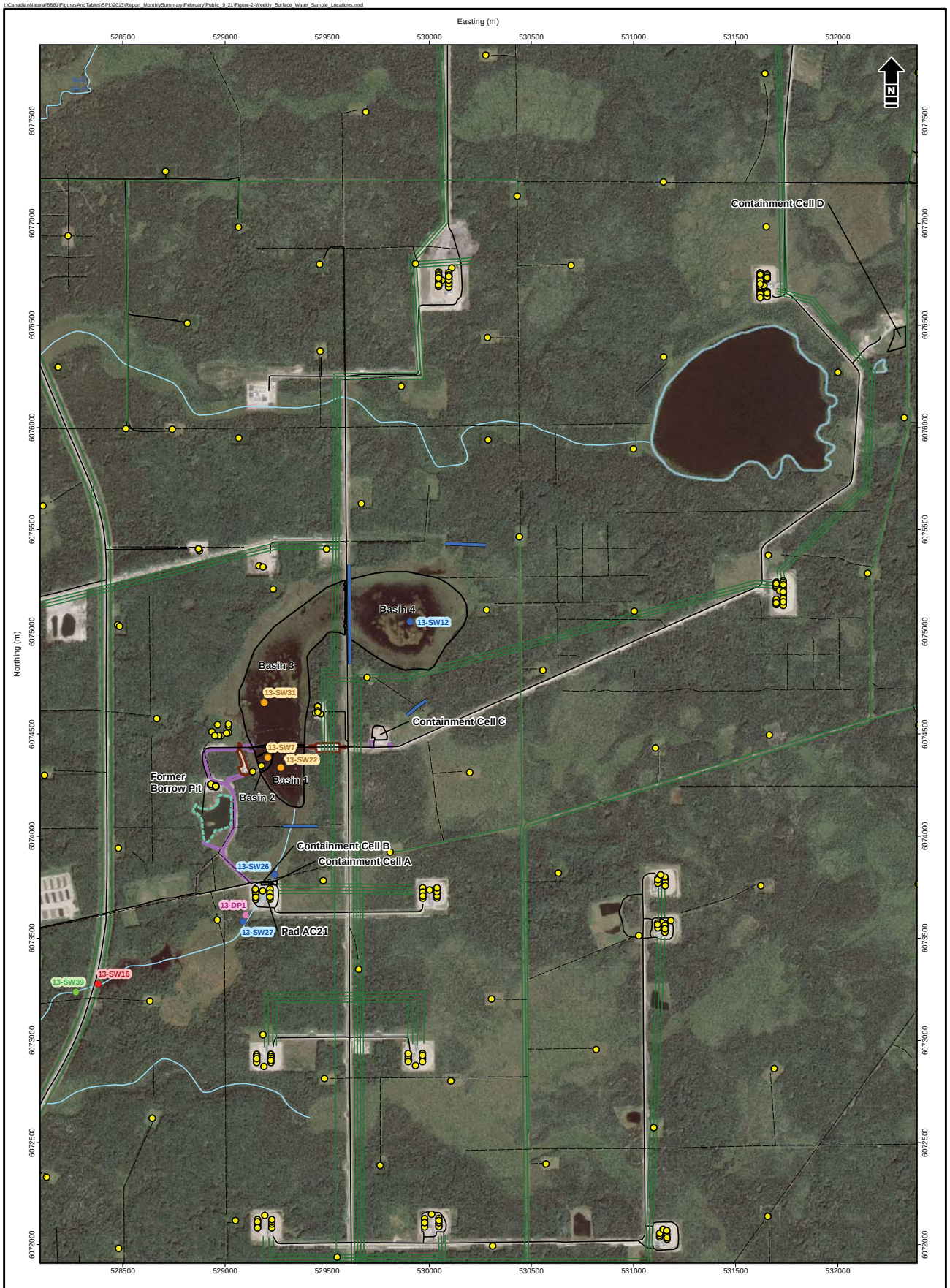
Date:	Project:	Technical:	Reviewer:	Drawn:
18 Feb 2014	8881-523	A. Ward	P. Hum	R. Keller

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.

Figure 1

I:\CanadianNatural\8881\FiguresAndTables\SPL\2013\Report_MonthlySummary\February\Public_9_21\Figure-1-Staff_Gauge_and_Discharge_Monitoring_Locations.mxd

I:\CanadianNatural\8881\FiguresAndTables\GPL\2013\Report_MonthlySummary\February\Public_9_21\Figure-2-Weekly_Surface_Water_Sample_Locations.mxd



Basin Boundary
Old Borrow Area
Access
Containment Cell
Matted Area
Watercourse
Aqua Dam
Road
Cut Line
Pipeline

Weekly Surface Water Monitoring Location (Discontinued on October 9, 2013)
Weekly Surface Water Monitoring Location (Discontinued on October 29, 2013)
Weekly Surface Water Monitoring Location (Discontinued on November 5, 2013)
Weekly Surface Water Monitoring Location (Discontinued on November 12, 2013)
Drivepoint Piezometer Sample Location (Discontinued on October 29, 2013)
Production Well

1:17,500
180 0 180 360 m
NAD 1983 UTM Zone 12N

Canadian Natural

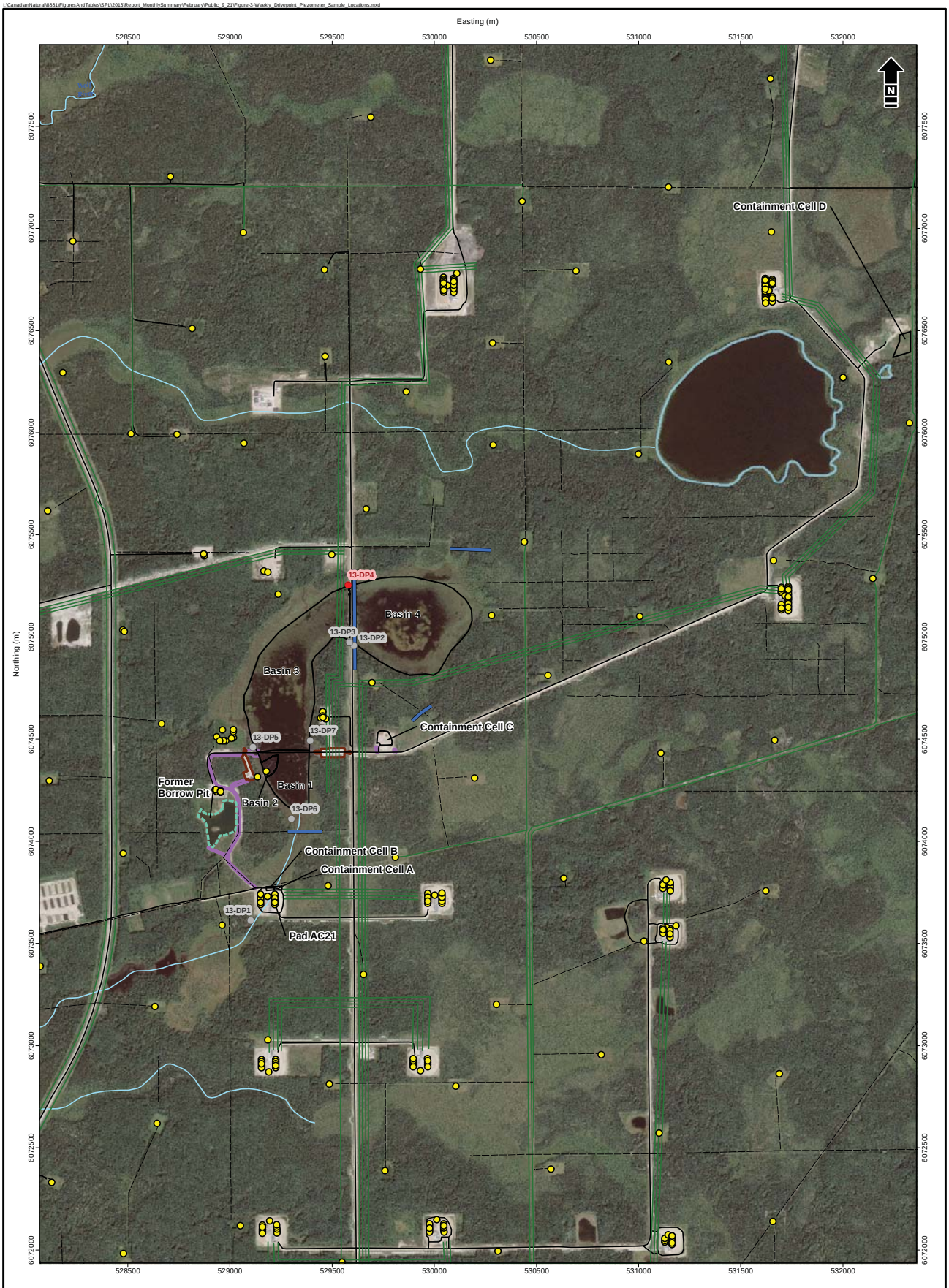
Canadian Natural Resources Limited
Primrose 09-21-067-04 W4M

Weekly Surface Water Monitoring Locations as of February 25, 2014

Date:	Project:	Technical:	Reviewer:	Drawn:
18 Feb 2014	8881-523	A. Ward	P. Hum	R. Keller

Figure 2

I:\CanadianNatural\8881\FiguresAndTables\GPL\2013\Report_MonthlySummary\February\Public_9_21\Figure-3-Weekly_Drivepoint_Piezometer_Sample_Locations.mxd



- Basin Boundary
- Old Borrow Area
- Access
- Containment Cell
- Matted Area
- Watercourse
- Aqua Dam
- Road
- Cut Line
- Pipeline
- Drivepoint Piezometer Sample Location
- Discontinued Drivepoint Piezometer Sample Location (Discontinued on November 12, 2013)
- Production Well

1:17,500
180 0 180 360 m
NAD 1983 UTM Zone 12N

Canadian Natural

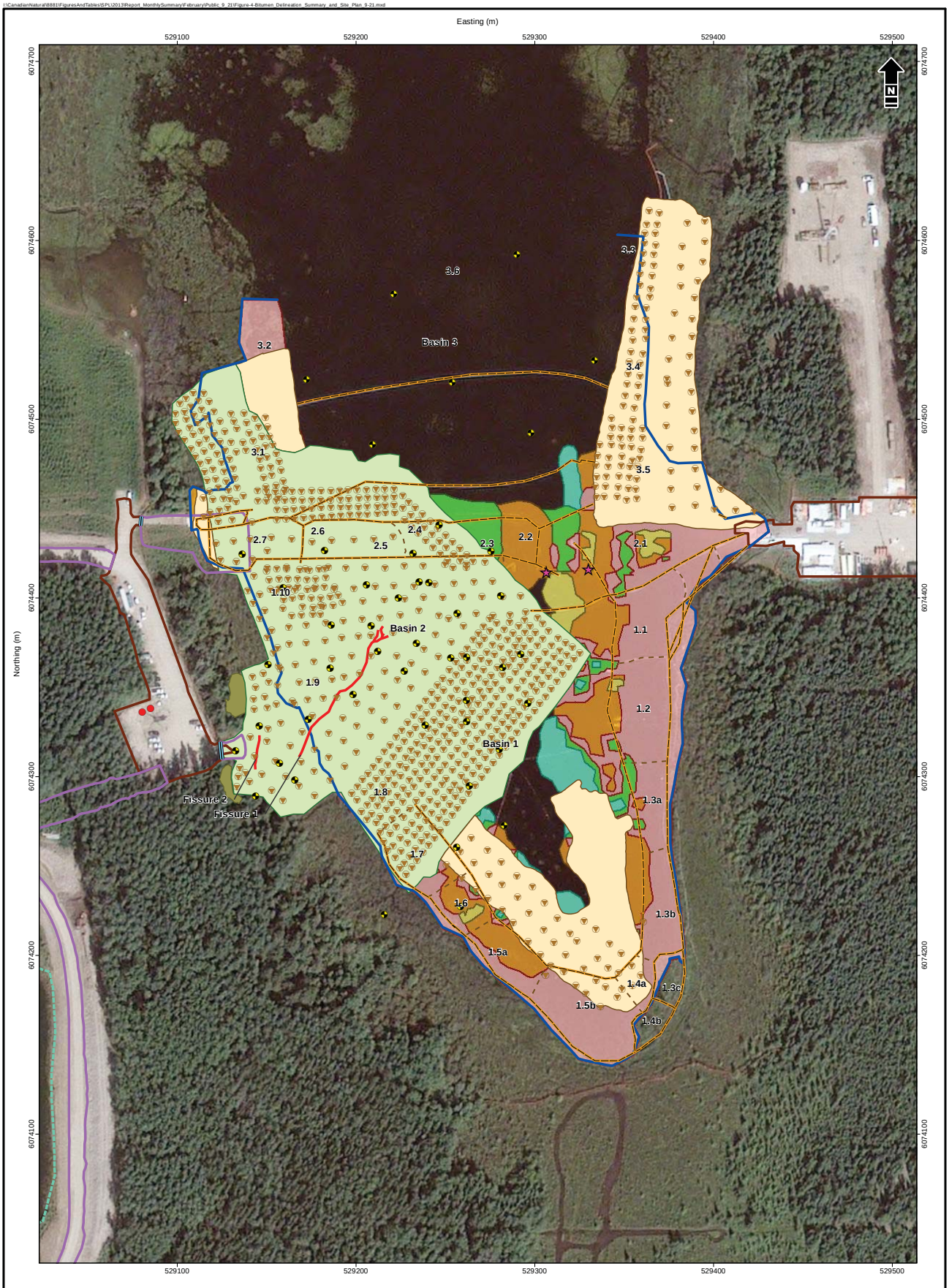
Canadian Natural Resources Limited
Primrose 09-21-067-04 W4M

Weekly Drivepoint Piezometer Sample Locations

Date:	Project:	Technical:	Reviewer:	Drawn:
18 Feb 2014	8881-523	A. Ward	P. Hum	R. Witty

Figure 3

I:\CanadianNatural\8881\FiguresAndTables\SPL\2013\Report_MonthlySummary\February\Public_9_21\Figure-4-Bitumen_Delineation_Summary_and_Site_Plan_9-21.mxd



- Scraped to 30cm
- Excavation to Clay
- Potentially clean peat
- Old Borrow Area

Recommended Removal Option

- 1 - Manual Soil Removal and Full Vegetation Removal
- 2 - Manual Soil Removal and Partial Vegetation Removal
- 3 - Mechanical Soil Removal and Full Vegetation Removal
- 4 - Mechanical Soil Removal and Partial Vegetation Removal
- 5 - No Remediation Required

- Access
- Rig Matting
- Boom
- Gate
- Exposed fissure
- Silt Fence
- Edge of Bitumen Emulsion Survey Assessment

- Piling
- Borehole
- Baseline Floor Sample
- Excavation Floor Sample

Scraped to 30cm - 17,885 m^2
Excavation to Clay - 34,657 m^2

Note: Removal Option Numbers (1 through 5) are described in Table 1 and presented in Appendix A.

1:2,000
m
20 0 20 40
NAD 1983 UTM Zone 12N

Reference: Imagery obtained from client (September 2013).

Canadian Natural

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

Bitumen Delineation Summary and Site Plan

Date:	Project:	Technical:	Reviewer:	Drawn:
19 Feb 2014	8881-523	A. Ward	P. Hum	R. Keller

Figure 4

APPENDIX A
DEWATERING DATA

Appendix A1: Daily Flow Volumes

CNRL Primrose 09-21 Water Body: Dewatering Phase

Date	Daily Total Discharge (m^3/day)	Cumulative Pumped (m^3)	Daily Total Discharge m^3/day	Cumulative Pumped (m^3)	Daily Total Discharge m^3/day	Cumulative Pumped (m^3)	Daily Volume from Water Body (m^3/day)	Cumulative Total from Water Body (m^3)
	Basin 1		Basin 2		Basin 3			
Design Rate:	**5,800**	-	**430**	-	**15,000**	-	**21,230**	
27-Sep-13	838	838	180	180	375	375	1,393	1,393
28-Sep-13	5,277	6,115	1,184	1,364	5,431	5,806	11,892	13,285
29-Sep-13	2,830	8,945	450	1,814	7,072	12,878	10,352	23,637
30-Sep-13	3,696	12,641	124	1,938	8,767	21,645	12,587	36,224
01-Oct-13	4,242	16,883	399	2,337	12,618	34,263	17,259	53,483
02-Oct-13	5,388	22,271	524	2,861	12,120	46,383	18,032	71,515
03-Oct-13	6,336	28,607	414	3,275	11,180	57,563	17,930	89,445
04-Oct-13	4,832	33,439	213	3,488	10,858	68,421	15,903	105,348
05-Oct-13	3,954	37,393	455	3,943	9,713	78,134	14,122	119,470
06-Oct-13	5,190	42,583	462	4,405	18,515	96,649	24,167	143,637
07-Oct-13	3,856	46,439	475	4,880	20,754	117,403	25,085	168,722
08-Oct-13	3,516	49,955	538	5,418	24,084	141,487	28,138	196,860
09-Oct-13	4,970	54,925	468	5,886	23,992	165,479	29,430	226,290
10-Oct-13	5,940	60,865	160	6,046	22,813	188,292	28,913	255,203
11-Oct-13	5,588	66,453	1,194	7,240	22,026	210,318	28,808	284,011
12-Oct-13	5,122	71,575	2,041	9,281	22,665	232,983	29,828	313,839
13-Oct-13	6,117	77,692	1,142	10,423	22,400	255,383	29,659	343,498
14-Oct-13	2,110	79,802	0	10,423	15,453	270,836	17,563	361,061
15-Oct-13	0	79,802	0	10,423	11,198	282,034	11,198	372,259
16-Oct-13	1,201	81,003	0	10,423	7,010	289,044	8,211	380,470
17-Oct-13	676	81,679	0	10,423	1,900	290,944	2,576	383,046
18-Oct-13	615	82,294	0	10,423	3,660	294,604	4,275	387,321
19-Oct-13	873	83,167	0	10,423	4,261	298,865	5,134	392,455
20-Oct-13	704	83,871	0	10,423	4,729	303,594	5,433	397,888
21-Oct-13	577	84,448	0	10,423	3,716	307,310	4,293	402,181
22-Oct-13	233	**84,681**	0	**10,423**	1,964	**309,274**	2,197	**404,378**

APPENDIX B

WATER QUALITY DATA – WATER BODIES AND WATERCOURSES

APPENDIX B1.

SURFACE 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} mg/L	F2 $C_{>10}$-C_{16} mg/L	F3 $C_{>16}$-C_{34} mg/L	F4 $C_{>34}$-C_{50} mg/L
impacted water taken out of the excavation with vac trucks right over the fissure									
9-21	22-Nov-13	0.00073	*0.0042*	0.00068	0.0035	0.14	0.67	1.9	0.64
9-21	27-Nov-13	<0.00040	0.00047	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
9-21 13-DP4	03-Dec-13	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	---	---	---
9-21 13-DP4	04-Dec-13	---	---	---	---	---	<0.10	<0.20	<0.20
9-21 13-DP4	10-Dec-13	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
9-21 13-DP4	17-Dec-13	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
9-21 13-DP4	06-Jan-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
9-21 13-DP4	14-Jan-14	<0.00040	0.00056	<0.00040	<0.00080	<0.1	<0.15	<0.30	<0.30
9-21 13-DP4	22-Jan-14	<0.00040	0.00056	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
9-21 13-DP4	28-Jan-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
9-21 13-DP4	05-Feb-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
9-21 13-DP4	12-Feb-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
Minimal Detection Limit		**0.0004**	**0.0004**	**0.0004**	**0.0008**	**0.1**	**0.1**	**0.2**	**0.2**
AENV Freshwater Aquatic Life*		**0.37^**	**0.002^**	**0.09^**	**NS**	**NS**	**NS**	**NS**	**NS**
AENV Agriculture - Irrigation*		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
AENV Agriculture - Livestock*		**NS**	**0.024^**	**0.0024^**	**NS**	**NS**	**NS**	**NS**	**NS**

Notes:

--- - not analyzed

NS - guideline not specified

^ - Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, acessed on line July 2012)

* - Alberta Environment Surface Water Quality Guidelines for use in Alberta (AENV, 1999)

Italics - indicates values do not meet applicable guidelines

APPENDIX B2.

SURFACE 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+j]fluoranthene µg/L	Benzo[k]fluoranthene µg/L	Benzo[g,h,i]perylene µg/L	Benzo[a]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	Phenanthrene µg/L	Pyrene µg/L	Quinoline µg/L
Impacted water taken out of the excavation with vac trucks right over the fissure																			
9-21	22-Nov-13	0.22	<0.10	0.36	<0.010	*0.03*	0.028	<0.0085	0.027	<0.0075	0.071	<0.0075	*0.051*	0.4	0.033	0.49	*0.84*	*0.097*	<0.20
9-21	27-Nov-13	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	0.17	<0.050	<0.020	0.17
9-21 13-DP4	10-Dec-13	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.050	<0.020	<0.20
9-21 13-DP4	17-Dec-13	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.050	<0.020	<0.20
9-21 13-DP4	06-Jan-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.050	<0.020	<0.20
9-21 13-DP4	14-Jan-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.050	<0.020	<0.20
9-21 13-DP4	22-Jan-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.050	<0.020	<0.20
9-21 13-DP4	28-Jan-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.050	<0.020	<0.20
9-21 13-DP4	05-Feb-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	0.11	<0.050	<0.020	<0.20
9-21 13-DP4	12-Feb-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.0075	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.050	<0.020	<0.20
Minimal Detection Limit		**0.1**	**0.1**	**0.2**	**0.01**	**0.0085**	**0.0085**	**0.0085**	**0.0085**	**0.0075**	**0.0085**	**0.0075**	**0.01**	**0.05**	**0.0085**	**0.1**	**0.05**	**0.02**	**0.2**
AENV Freshwater Aquatic Life*		**5.8^**	**NS**	**4.4^**	**0.012^**	**0.018^**	**NS**	**NS**	**NS**	**0.015^**	**NS**	**NS**	**0.015^**	**3^**	**NS**	**1.1^**	**0.4^**	**0.025^**	**3.4^**
AENV Agriculture - Irrigation*		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
AENV Agriculture - Livestock*		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Notes:

--- - not analyzed

NS - not specified

^ - Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, acessed on line July 2012)

* - Alberta Environment Surface Water Quality Guidelines for use in Alberta (AENV, 1999)

Italics - indicates values do not meet applicable guidelines

APPENDIX B3.

SURFACE WATER QUALITY RESULTS - ROUTINE WATER CHEMISTRY

Canadian Natural Resources Limited

09-21-064-04 W4M

Sample Point	Sample Date	Lab pH	Lab EC	Ca	Mg	Na	K	Cl	SO_4	NO_2-N	NO_3-N	NO_3+NO_2-N	Total Alkalinity^	HCO_3	Hardness^	TDS	TSS	Turbidity
			µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU
impacted water taken out of the excavation with vac trucks right over the fissure																		
9-21	22-Nov-13	6.58	290	30	10	2.9	9.3	2.8	<1.0	<0.003	0.0047	0.0047	140	170	120	140		
9-21 13-DP4	04-Dec-13	7.06	410	55	19	2.6	2.7	<1.0	<1.0	<0.003	0.030	0.030	220	270	220	210	---	---
9-21 13-DP4	11-Dec-13	6.95	400	50	18	2.5	3.0	<1.0	<0.5	<0.003	<0.003	<0.003	230	280	200	210	---	---
9-21 13-DP4	19-Dec-13	6.68	400	50	19	2.5	3.3	<1.0	<0.5	<0.003	<0.003	<0.003	210	260	200	210	44	11
9-21 13-DP4	06-Jan-14	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	18	14
9-21 13-DP4	14-Jan-14	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	86	30
9-21 13-DP4	22-Jan-14	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	12	5.9
9-21 13-DP4	28-Jan-14	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	430	220
9-21 13-DP4	05-Feb-14	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	610	370
9-21 13-DP4	12-Feb-14	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	290	140
Minimal Detection Limit		**0.1**	**1**	**0.3**	**0.2**	**0.5**	**0.3**	**1**	**0.5**	**0.003**	**0.003**	**0.003**	**0.5**	**0.5**	**0.5**	**10**	**3**	**0.1**
AENV Freshwater Aquatic Life*		**6.5-8.5**	**NS**	**NS**	**NS**	**NS**	**NS**	**230^{cc}**	**NS**	**0.06*** **	**3***^{b}**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
AENV Agriculture - Irrigation*		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**100^^**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**500^^**	**NS**	**NS**
AENV Agriculture - Livestock*		**NS**	**NS**	**1000**	**NS**	**NS**	**NS**	**NS**	**1000**	**10**	**NS**	**100**	**NS**	**NS**	**NS**	**3000**	**NS**	**NS**

Notes:

--- - not analyzed

NS - not specified

^ - expressed as $CaCO_3$

^^ - guideline level is crop dependent; criterion shown is most stringent value

^{cc} - continuous concentration guideline, National Recommended Water Quality Criteria (USEPA, 2009)

^{A} - 1 day minimum, acute guideline

^{b} - indicates long-term exposure guideline; short-term exposure guideline = 124 mg/L

* - Alberta Environment Surface Water Quality Guidelines for use in Alberta (AENV, 1999)

*** - Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, acessed on line July 2012)

Italics - indicates values do not meet applicable guidelines