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

APRIL 22 TO MAY 19, 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 bitumen emulsion 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 between April 22 and May 19, 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:

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	3.4
4.	**Phase II Environmental Assessment Plan**	October 15, 2013	October 3, 2013	October 17, 2013	December 16, 2013	Ongoing	--
5.	**Bitumen Emulsion Delineation and Containment Plan**	October 6, 2013	October 3, 2013	October 17, 2013	October 18, 2013	Ongoing	3.5

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	Revised Plan March 27, 2014	March 27, 2014	March 27, 2014	Ongoing	2.2, 3
10.	**Wildlife Management Plan**	N/A	Revised Plan October 23, 2013	October 23, 2013	October 23, 2013	Ongoing	3.6
11.	**Waste Management Plan**	N/A	Revised Plan October 24, 2013	October 24, 2013	October 24, 2013	Ongoing	3.7
12.	**Bitumen Emulsion Delineation and Containment Plan**	October 6, 2013	Revised Plan December 22, 2013	February 7, 2014	November 27, 2013	Pending	3.5

2.2 Water Management for Dewatering and Refilling

The water body was divided into four basins as indicated on Figure 1. Basins 1, 2, and 3 were dewatered, while Basin 4 and a nearby borrow pit were 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 and on October 22, 2013 pumping was stopped.
The dewatering activities took place in accordance with the conditions specified in the Water Management Plan for Dewatering and in the Erosion and Sedimentation Prevention Plan (Table 1, Items 1 and 3).

Refilling of the water body from Basin 4 was initiated on March 27, 2014 and was completed on May 16, 2014. All of the refilling activities are taking place in accordance with the conditions specified in the Water Body Restoration Plan (Table 1, Item 9).

3 Water Body Monitoring

In accordance with the Water Body Restoration Plan (Table 1, Item 9), an extensive water quality and water quantity monitoring program was implemented on March 19, 2014. This ongoing program is tailored to the refilling taking place at the 9-21 FTS site and complements the ongoing water quality and quantity monitoring implemented in June 2013.

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

3.1 Refilling Water Quantity

3.1.1 Basins 1, 3, and 4, Borrow Pit, and Downstream Fen

- Refilling of Basin 3 continued until May 16, 2014, when estimated water levels between Basins 3 and 4 were within 10 cm of equilibrium.

- The cumulative volume of water pumped from Basin 4 into Basins 1 and 3 since March 27, 2014 is 227,000 m^3. A summary of daily pumping results from April 22 through May 16, 2014 is presented in Appendix A1 and on Appendix A2.

- Daily staff gauge monitoring was initiated on March 27, 2014, coinciding with spring breakup and the beginning of water body refilling. An overview of the staff gauge and water level monitoring locations is presented on Figure 2. The results of the staff gauge readings for Basins 3 and 4 are shown on Appendix A3. The results of the staff gauge readings for the downstream fen and the borrow pit are shown on Appendix A4. Throughout this time period, several of the gauges remained ice bound; therefore, no readings could be taken and only the available data is presented. At the end of pumping, the water level in Basins 3 and 4 was approximately 699.3 metres above sea level.

3.1.2 Containment Structure

- In addition to water being pumped from Basin 4 into Basin 3, water was also pumped from within the containment area (inside the containment wall) and discharged directly back into Basin 1 (Figure 3). Water volumes pumped into Basin 1 from the containment area are shown in Appendix A5 and on Appendix A6.

3.2 Refilling Water Quality

Weekly water sampling was initiated March 19, 2014. During the refilling program, water quality was compared to the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (ESRD 2014a) and/or *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014b) at all sampling locations. Sampling locations are shown on Figure 4. New ESRD guidelines for surface water quality were released on April 11, 2014; these guidelines are currently being used for this report and subsequent monthly reports.

3.2.1 Basins 1, 3, and 4 and Downstream Fen

Water quality samples were collected weekly from established surface water sampling sites in Basins 1, 3, and 4 and the downstream fen (Figure 4). The samples were tested to ensure that water quality in the water body was not being affected by the refilling operations. Water quality results are presented in Appendix B.

- Laboratory analysis of water samples was carried out for benzene, toluene, ethylbenzene, and xylenes (BTEX); petroleum hydrocarbons (PHCs) fraction 1 (F1; C_6-C_{10}, excluding BTEX), fraction 2 (F2; $C_{>10}$-C_{16}), fraction 3 (F3; $C_{>16}$-C_{34}), and fraction 4 (F4; $C_{>34}$); polycyclic aromatic hydrocarbons (PAHs); chlorides; total suspended solids; and turbidity.

- Water quality results were within freshwater aquatic life guidelines with the exception of six toluene measurements and five pyrene measurements. Toluene is widespread in the environment and a common source is motor vehicle exhaust. Based on the quality assurance and quality control checks, the pyrene detections were deemed to be a result of laboratory interference.

3.2.2 Containment Area, Containment Cells, and Potentially Impacted Water System

Water samples were collected from within the containment structure and from the potentially impacted water (PIW) system while it was operational. This system is designed to treat ice and water stored in containment Cells C and D. Sample results are presented in Appendix B.

- No BTEX, PHCs F1 to F4, PAHs, or routine parameters were detected at levels above the freshwater aquatic life guidelines in the containment structure sample from Swale 1.

- Pyrene was detected at 0.00033 mg/L on May 6, 2014, but was ruled to be the result of laboratory interference (see Section 3.2.1). Pyrene was not detected in samples collected on May 13, 2013.

- Sampling of the PIW system was conducted on April 28, 2014 and confirmed that water was being treated effectively.

- The PIW system was operational May 12, 2014 and from May 16 to 19, 2014. A total of 432 m^3 of impacted water was treated during this time.

3.2.3 Shallow Groundwater

No shallow groundwater quality samples were collected from April 22 to May 19, 2014.

3.3 Aquatic Surveillance

Ongoing daily monitoring for signs of bitumen emulsion (pellets or sheen) within Basins 1 and 3 (aquatic surveillance) is conducted and documented by Canadian Natural contractors. This monitoring is conducted from the shoreline of the 9-21 water body and by boat.

Traces of sheen and isolated bitumen emulsion pellets were observed in the water body on April 26 and 30 and May 1, 3, and 18, 2014. These occurrences are shown on Figure 5. The source of the sheen and pellets was residual material remaining from the bitumen emulsion release that has been remobilized into the water column during the refilling. All observed bitumen emulsion pellets and sheen were collected, using absorbent material, and disposed in the onsite hazardous waste bin. Since refilling began in 2014, less than 2 L of bitumen emulsion has been collected from Basins 1 and 3.

3.4 Erosion and Sedimentation Prevention

The refilling activities are taking place in accordance with the conditions specified in Extension 4 of the Water Body Restoration Plan (Table 1, Item 9).

- Discharge locations from within the containment structure were visually assessed several times daily to ensure that water being discharged was clear and free from excess suspended solids. The intake hoses for all of the discharge pumps contain filter screens and were moved as needed to prevent

sediment intake as the water level in the swales changed. Daily qualitative and quantitative assessments of turbidity were conducted across the water body with no issues identified.

- The fen to the south of the water body also showed no signs of erosion or channelization.

3.5 Bitumen Emulsion Containment

3.5.1 Temporary Containment of Bitumen Emulsion

Low clay berms have been constructed around the two fissures at 9-21 to provide temporary containment of bitumen emulsion from the fissures, and to keep surface runoff from coming into contact with the bitumen emulsion. These features are shown on Figure 3. The removal of bitumen emulsion accumulating within the berms was not necessary during the reporting period.

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

Designs for long-term fissure containment and an access pad have been proposed and are under discussion with Alberta Energy Regulator.

In early May 2014, the fissure containment structure was approved. On May 4, 2014, a Canadian Natural construction crew began building the fissure containment structure and as of May 19, 2014, construction was ongoing. The final design of the access pad was still in discussion.

3.6 Wildlife Management

Wildlife management activities between April 22 and May 19, 2014 included maintaining perimeter fencing; installing, maintaining, and frequently relocating up to four wildlife scare cannons (Zon Guns); and conducting daily inspections.

Current wildlife management plans appear to be working and there have been no reported impacts to wildlife during the reporting period.

3.7 Waste Management

Materials temporarily stored in lined containment Cells C and D will be transported to the landfill for disposal in 2014, after the material is thawed and dewatered to meet landfill criteria.

4 Conclusions

The work conducted at the 9-21 FTS site from April 22 to May 19, 2014 included:

- completing refilling of Basins 1 and 3 from the storage area of Basin 4
- operating a PIW treatment system at containment Cell D
- dewatering from within the containment area
- continuing initial work on construction of the 9-21 fissure containment structure
- ongoing monitoring of water quality, pumped quantity, discharge point erosion and sedimentation during refilling, and remediation activities
- monitoring wildlife activity near the water body

Refilling of Basins 1 and 3 by pumping water stored in Basin 4 is progressing as planned. Monitoring of the pumping operations has indicated that Basins 1 and 3 have not been adversely impacted by the bitumen emulsion release or by refilling activities. There have been no reported impacts to wildlife during the reporting period.

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

5 References

Alberta Environment and Sustainable Resource Development (ESRD). 2014a. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*. Final Draft. Land and Forestry Policy Branch, Policy Division. Edmonton, Alberta. March 18, 2014. http://esrd.alberta.ca/lands-forests/land-industrial/inspections-and-compliance/documents/AlbertaTier1Guidelines-Mar18-2014.pdf

Alberta Environment and Sustainable Resource Development (ESRD). 2014b. *Environmental Quality Guidelines for Alberta Surface Waters.* Water Policy Branch, Policy Division. Edmonton, Alberta. April 1, 2014. http://esrd.alberta.ca/water/education-guidelines/documents/EnvironmentalQualitySurfaceWaters-Apr2014.pdf

I:\CanadianNatural\8881\FiguresAndTables\SPL\2013\Report_MonthlySummary\May\Public_9_21\Figure-1-9_21_Water_Body_Divisions.mxd

Easting (m)

529000 529500 530000

Northing (m)

6075000 6074500 6074000

N

Basin 4

Basin 3

Basin 1

Basin 2

Basin Boundary
Watercourse
Road
Cut Line
Pipeline
Direction of Flow

1:5,000 m
50 0 50 100
NAD 1983 UTM Zone 12N

Reference: Data obtained from AltaLIS © Government of Alberta and GeoBase® used under license. GDM midstream and transportation infrastructure data provided by IHS © 2014 used under license. Site features provided through Matrix Solutions Inc. field efforts. Imagery (September 2013) obtained from Canadian Natural Resources Limited used under license.

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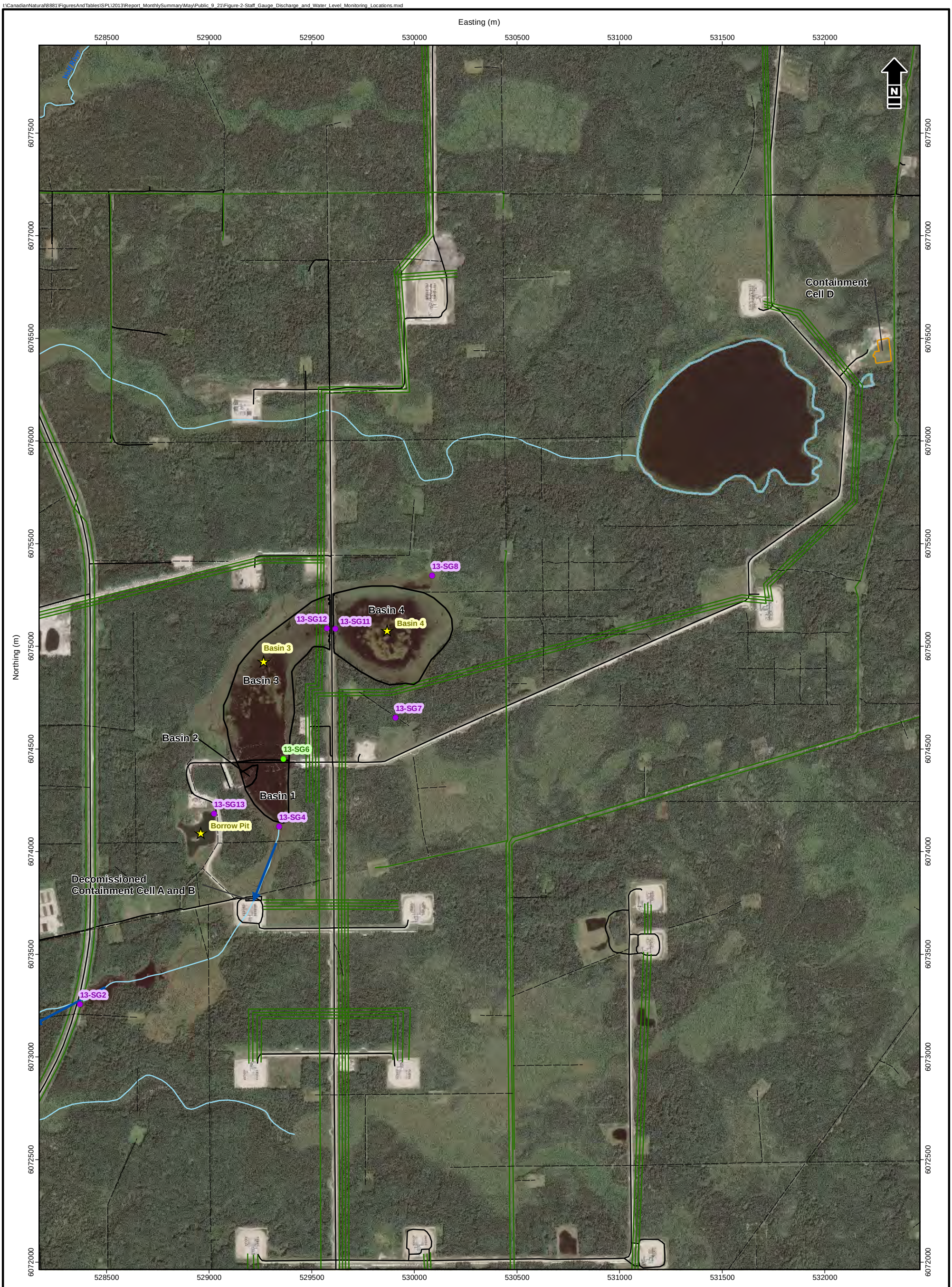
Primrose 09-21-067-04 W4M

9-21 Water Body Divisions

Date:	Project:	Technical:	Reviewer:	Drawn:
29 May 2014	8881-523	B. Ethier	H. de Pennart	R. Keller

Figure 1

I:\CanadianNatural\8881\FiguresAndTables\SPL\2013\Report_MonthlySummary\May\Public_9_21\Figure-2-Staff_Gauge_Discharge_and_Water_Level_Monitoring_Locations.mxd



- Basin Boundary
- Containment Cell D
- Decommisioned Containment Cell
- Water Body
- Watercourse
- Road
- Cut Line
- Pipeline
- Direction of Flow
- Staff Gauge Location
- Staff Gauge Location - moved on May 15
- Water Level Monitoring Location

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

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Staff Gauge, Discharge, and Water Level Monitoring Locations

Date:	Project:	Technical:	Reviewer:	Drawn:
11 Jun 2014	8881-523	B. Ethier	H. de Pennart	R. Keller

Figure 2

I:\CanadianNatural\8881\FiguresAndTables\SPL\2013\Report_MonthlySummary\May\Public_9_21\Figure-3-Containment_Structure_Pump_Locations.mxd

Easting (m)

529050 529100 529150 529200 529250 529300

Northing (m)

6074550 6074500 6074450 6074400 6074350 6074300 6074250 6074200 6074150

N

Basin 3

discharge #112

4 inch pump #112

Swale 2

discharge #077
discharge #730
discharge #731
discharge #063

V-trench Weir

Swale 1

6 inch pump #730

6 inch pump #731

4 inch pump #077

4 inch pump #063

Swale 3

Basin 2

Basin 1

Fissure 2

Fissure 1

- Access
- Rig Matting
- Sand Bag Wall
- Swale
- Berm
- Containment Structure
- Exposed fissure
- Discharge Line
- V-trench Weir
- Discharge Location
- Pump

1:1,250 m

10 0 10 20

NAD 1983 UTM Zone 12N

Reference: Site features provided through Matrix Solutions Inc. field efforts. Imagery (September 2013) obtained from Canadian Natural Resources Limited used under license.

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Containment Structure Pump Locations

Date:	Project:	Technical:	Reviewer:	Drawn:
11 Jun 2014	8881-523	B. Ethier	H. de Pennart	R. Keller

Figure 3

I:\CanadianNatural\8881\FiguresAndTables\SPL\2013\Report_MonthlySummary\May\Public_9_21\Figure-4-2014_Re-watering_and_Monitoring_Plan_Overview.mxd

Easting (m)

528500 529000 529500 530000 530500 531000 531500 532000

Northing (m)

6077500 6077000 6076500 6076000 6075500 6075000 6074500 6074000 6073500 6073000 6072500 6072000

N

Containment Cell D
PIW System
14-SW2
Re-Watering System
13-DP4
Basin 4
13-SW12
13-DP3
Basin 3
13-SW31
Re-Watering System
13-DP7
14-SW3
Containment Cell C
14-SW1-P1
13-DP5
14-SW1-P2
13-SW22
Former Borrow Pit
14-SW1
Basin 1
13-SW46
Basin 2
13-DP6
Downstream Fen
Decomissioned Containment Cell A and B
13-SW26
13-DP1
13-SW27
Pad AC-21
13-SW16

Basin Boundary
Old Borrow Area
Containment Cell
Decommisioned Containment Cell
Access
Rig Matting
Containment Structure
Potentially Impacted Water System
Re-Watering System
Watercourse
Road
Cut Line
Pipeline
Production Well
Surface Water Sample Location
Drivepoint Piezometer Sample Location

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

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Primrose 09-21-067-04 W4M

2014 Re-watering and Monitoring Plan Overview

Date:	Project:	Technical:	Reviewer:	Drawn:
11 Jun 2014	8881-523	B. Ethier	H. de Pennart	R. Keller

Figure 4

I:\CanadianNatural\8881\FiguresAndTables\SPL\2013\Report_MonthlySummary\May\Public_9_21\Figure-5-Aquatic_Surveillance_Site_Plan.mxd

Easting (m)

529100 529200 529300 529400 529500

Northing (m)

6074700 6074600 6074500 6074400 6074300 6074200 6074100

N

3.6

Basin 3

50 62 100 150 200 250 300 350 400 450 500

Swale 2

Swale 1

Swale 3

Basin 2

Fissure 2

Fissure 1

3.5

2.3 2.2 2.1 1.1 1.2 1.3a 1.3b 1.3c

Basin 1

1.7 1.6 1.5a 1.5b 1.4a 1.4b

Access
Rig Matting
Water Body
Sand Bag Wall
Swale
Berm
Containment Structure
Exposed fissure
V-trench Weir

Existing Silt Boom
Existing Sorb Boom
Zone
Bitumen Sheen Detected
Bitumen Pellets Detected
Containment Structure Station Location

Reference: Site features provided through Matrix Solutions Inc. field efforts. Imagery (September 2013) obtained from Canadian Natural Resources Limited used under license.

1:2,000

m

20 0 20 40

NAD 1983 UTM Zone 12N

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Aquatic Surveillance Site Plan

Date:	Project:	Technical:	Reviewer:	Drawn:
11 Jun 2014	8881-523	B. Ethier	H. de Pennart	R. Keller

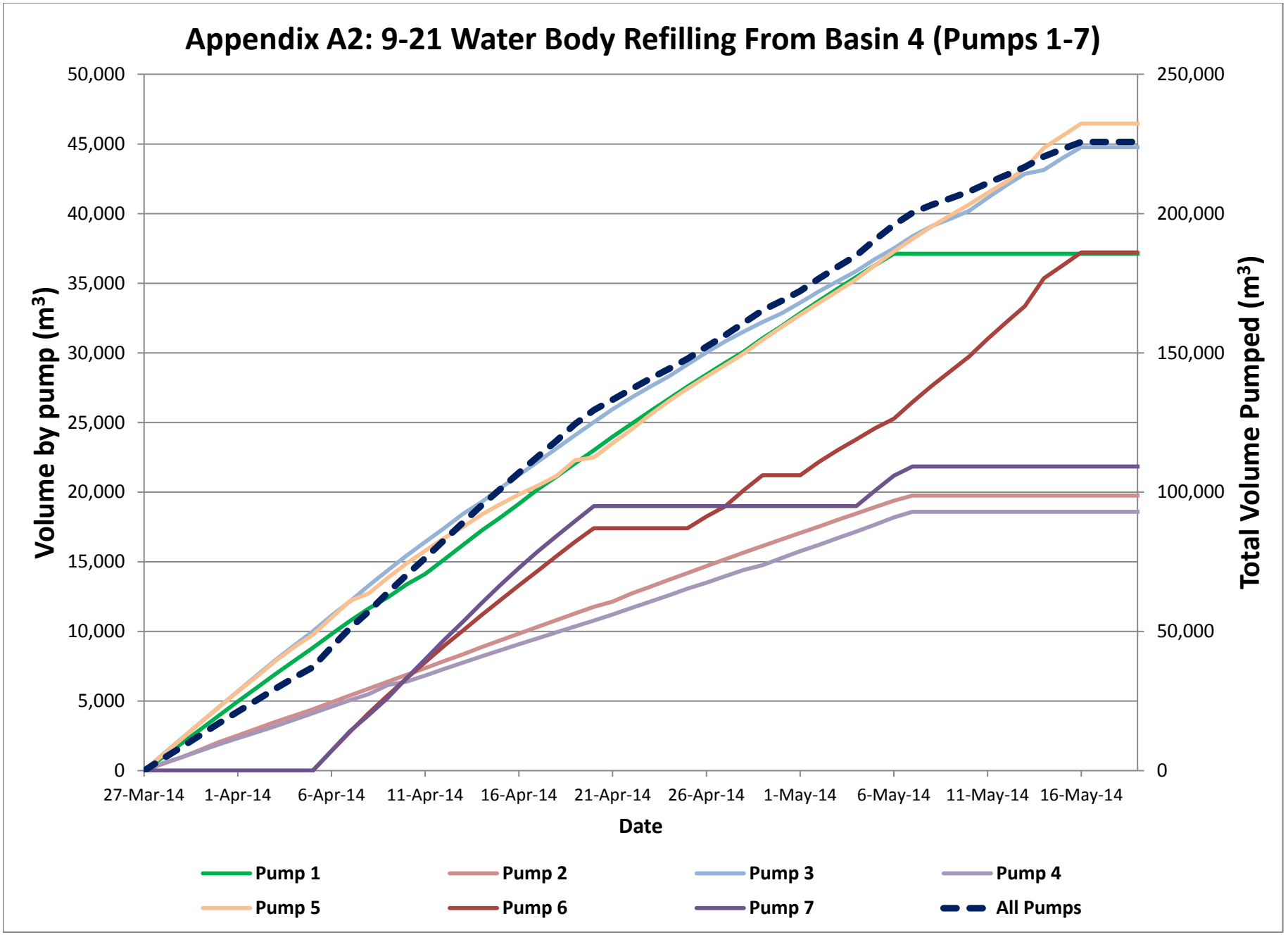
Figure 5

APPENDIX A
DEWATERING DATA

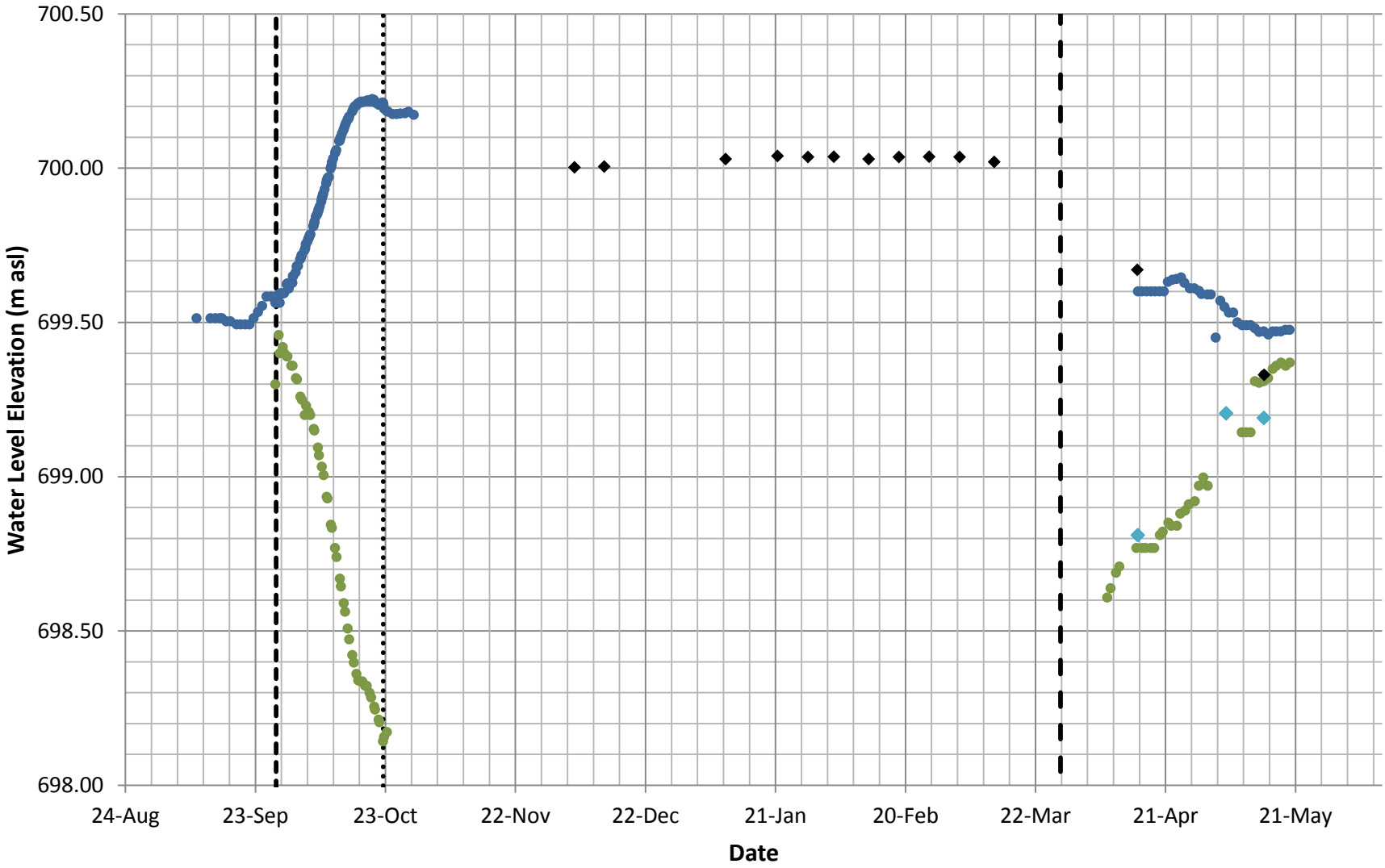
Appendix A1: Daily Flow Volumes from Basin 4 to Basin 3

CNRL Primrose 09-21 Water Body: Refilling Phase (Pumps 1-7)

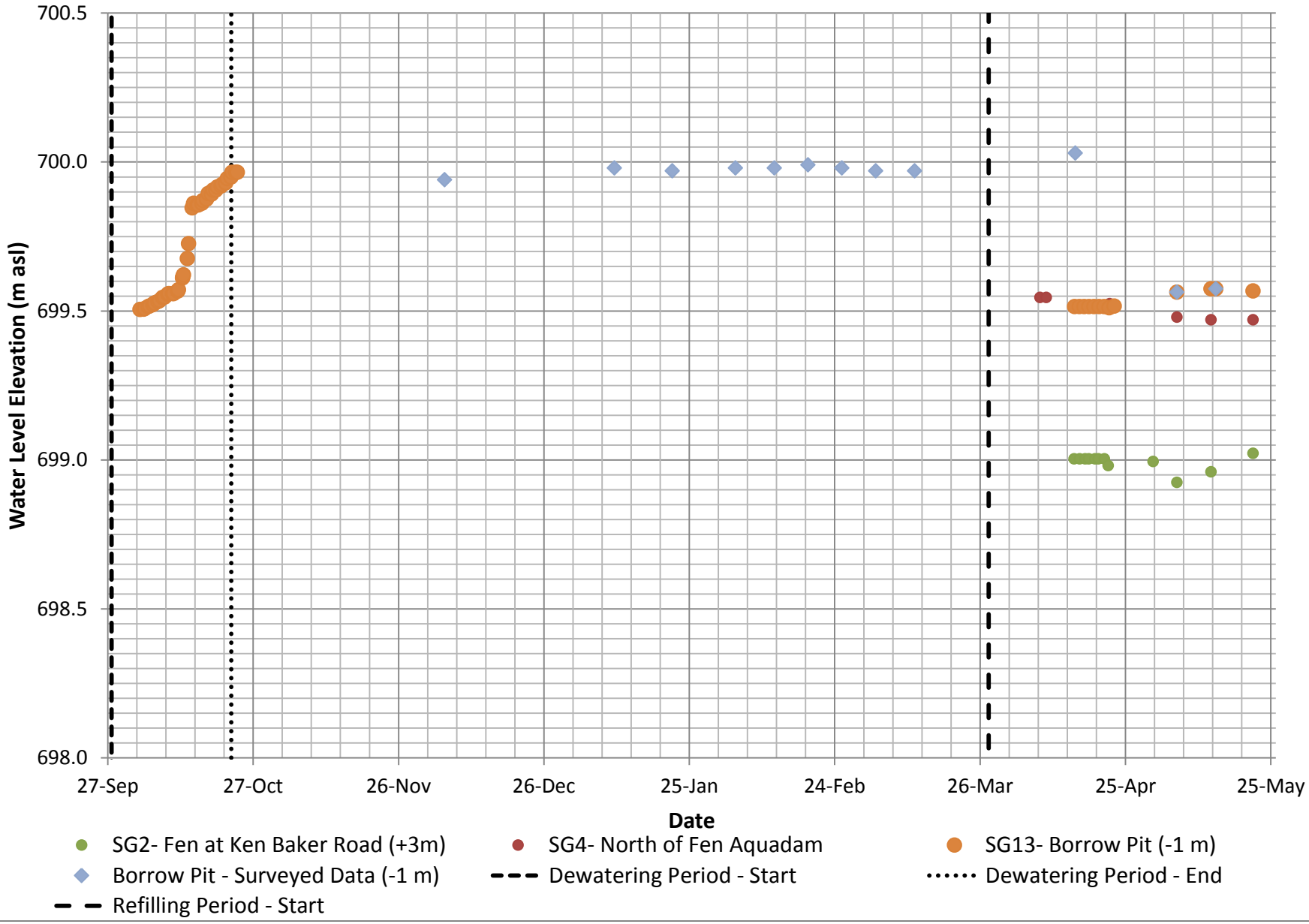
Date	Rewatering Volume (m^3/day)	Cumulative Pumped (m^3)	Rewatering Volume (m^3/day)	Cumulative Pumped (m^3)	Rewatering Volume (m^3/day)	Cumulative Pumped (m^3)	Rewatering Volume (m^3/day)	Cumulative Pumped (m^3)	Rewatering Volume (m^3/day)	Cumulative Pumped (m^3)	Rewatering Volume m^3/day	Cumulative Pumped (m^3)	Rewatering Volume m^3/day	Cumulative Pumped (m^3)	Daily Volume to Water Body from Pumps 1-7 (m^3/day)	Cumulative Total to Water Body from Pumps 1-7 (m^3)
	Basin 4															
	Pump 1		Pump 2		Pump 3		Pump 4		Pump 5		Pump 6		Pump 7			
27-Mar-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28-Mar-14	958	958	493	493	1,168	1,168	534	534	1,129	1,129	-	-	-	-	4,283	4,283
29-Mar-14	993	1,951	466	959	1,130	2,298	428	962	1,145	2,274	-	-	-	-	4,162	8,445
30-Mar-14	993	2,944	528	1,487	1,140	3,438	462	1,425	1,155	3,429	-	-	-	-	4,277	12,722
31-Mar-14	1,030	3,973	564	2,051	1,137	4,575	478	1,902	1,136	4,565	-	-	-	-	4,344	17,067
1-Apr-14	995	4,969	474	2,525	1,129	5,704	424	2,327	1,110	5,676	-	-	-	-	4,134	21,200
2-Apr-14	973	5,942	492	3,017	1,117	6,821	423	2,750	1,062	6,738	-	-	-	-	4,068	25,268
3-Apr-14	988	6,930	473	3,491	1,104	7,925	449	3,199	1,123	7,861	-	-	-	-	4,138	29,406
4-Apr-14	952	7,882	468	3,959	1,065	8,990	460	3,658	1,008	8,869	-	-	-	-	3,953	33,359
5-Apr-14	941	8,822	447	4,407	1,004	9,994	468	4,127	887	9,756	-	-	-	-	3,747	37,105
6-Apr-14	982	9,804	500	4,906	1,146	11,139	471	4,598	1,225	10,981	1,413	1,413	1,431	1,431	7,166	44,272
7-Apr-14	954	10,758	498	5,404	1,034	12,173	464	5,062	1,215	12,196	1,392	2,804	1,415	2,845	6,972	51,243
8-Apr-14	898	11,656	495	5,899	1,127	13,300	448	5,510	542	12,738	1,342	4,146	1,147	3,993	5,999	57,243
9-Apr-14	787	12,443	494	6,392	1,080	14,381	639	6,149	1,111	13,849	1,262	5,408	1,237	5,230	6,610	63,852
10-Apr-14	929	13,371	493	6,886	1,053	15,434	247	6,396	1,021	14,869	1,216	6,625	1,404	6,634	6,363	70,215
11-Apr-14	757	14,129	474	7,359	984	16,417	442	6,838	930	15,799	1,165	7,790	1,365	8,000	6,117	76,332
12-Apr-14	1,022	15,151	499	7,858	977	17,394	467	7,305	876	16,675	1,155	8,945	1,370	9,370	6,366	82,698
13-Apr-14	1,046	16,197	496	8,355	1,032	18,426	448	7,753	818	17,494	1,107	10,052	1,309	10,679	6,257	88,955
14-Apr-14	1,038	17,235	515	8,869	856	19,282	453	8,206	880	18,374	1,110	11,162	1,352	12,031	6,203	95,158
15-Apr-14	937	18,171	484	9,353	986	20,268	432	8,638	758	19,132	1,075	12,236	1,281	13,312	5,952	101,110
16-Apr-14	990	19,161	491	9,843	961	21,229	433	9,071	711	19,843	1,065	13,301	1,242	14,554	5,893	107,003
17-Apr-14	1,032	20,194	488	10,331	943	22,173	431	9,502	614	20,457	1,042	14,344	1,178	15,732	5,729	112,732
18-Apr-14	923	21,117	479	10,810	964	23,136	429	9,931	706	21,163	1,067	15,411	1,110	16,842	5,678	118,409
19-Apr-14	945	22,062	482	11,292	953	24,089	424	10,355	1,130	22,293	1,024	16,435	1,083	17,925	6,040	124,450
20-Apr-14	938	23,000	479	11,771	940	25,030	424	10,779	193	22,486	981	17,415	1,073	18,998	5,028	129,478
21-Apr-14	980	23,979	361	12,132	920	25,949	438	11,217	1,027	23,513	0	17,415	0	18,998	3,725	133,203
22-Apr-14	922	24,901	588	12,720	842	26,791	464	11,682	987	24,499	0	17,415	0	18,998	3,803	137,006
23-Apr-14	898	25,799	488	13,208	772	27,563	456	12,138	1,059	25,558	0	17,415	0	18,998	3,673	140,679
24-Apr-14	892	26,691	491	13,699	757	28,320	450	12,588	983	26,541	0	17,415	0	18,998	3,573	144,252
25-Apr-14	902	27,593	493	14,191	858	29,179	490	13,078	896	27,437	0	17,415	0	18,998	3,638	147,891
26-Apr-14	857	28,450	494	14,686	853	30,031	416	13,494	862	28,299	837	18,252	0	18,998	4,319	152,210
27-Apr-14	831	29,280	488	15,174	787	30,818	473	13,967	818	29,117	733	18,985	0	18,998	4,131	156,340
28-Apr-14	818	30,099	482	15,656	715	31,533	450	14,417	840	29,957	1,154	20,140	0	18,998	4,460	160,800
29-Apr-14	942	31,040	476	16,132	674	32,207	337	14,754	975	30,932	1,080	21,220	0	18,998	4,484	165,284
30-Apr-14	866	31,906	469	16,601	613	32,820	502	15,255	911	31,843	0	21,220	0	18,998	3,361	168,644
1-May-14	935	32,841	462	17,063	786	33,607	499	15,754	882	32,725	0	21,220	0	18,998	3,564	172,208
2-May-14	888	33,728	465	17,528	801	34,408	464	16,219	863	33,589	943	22,163	0	18,998	4,424	176,633
3-May-14	884	34,613	479	18,007	735	35,142	480	16,699	847	34,436	843	23,006	0	18,998	4,268	180,901
4-May-14	833	35,446	455	18,462	728	35,870	462	17,161	848	35,284	770	23,776	0	18,998	4,097	184,997
5-May-14	857	36,303	465	18,927	867	36,737	515	17,676	1,016	36,300	812	24,588	1,118	20,116	5,650	190,648
6-May-14	807	37,110	462	19,389	761	37,498	506	18,182	973	37,273	690	25,278	1,058	21,174	5,257	195,905
7-May-14	0	37,110	370	19,760	875	38,373	412	18,595	914	38,187	1,185	26,463	663	21,838	4,419	200,325
8-May-14	0	37,110	0	19,760	720	39,093	0	18,595	869	39,055	1,144	27,606	0	21,838	2,732	203,057
9-May-14	0	37,110	0	19,760	536	39,629	0	18,595	805	39,860	1,064	28,670	0	21,838	2,404	205,461
10-May-14	0	37,110	0	19,760	565	40,193	0	18,595	782	40,642	1,043	29,713	0	21,838	2,389	207,850
11-May-14	0	37,110	0	19,760	934	41,127	0	18,595	847	41,488	1,279	30,992	0	21,838	3,060	210,910
12-May-14	0	37,110	0	19,760	900	42,027	0	18,595	799	42,287	1,210	32,202	0	21,838	2,908	213,818
13-May-14	0	37,110	0	19,760	832	42,859	0	18,595	960	43,247	1,167	33,369	0	21,838	2,959	216,777
14-May-14	0	37,110	0	19,760	267	43,127	0	18,595	1,472	44,718	1,985	35,354	0	21,838	3,724	220,501
15-May-14	0	37,110	0	19,760	864	43,990	0	18,595	876	45,594	925	36,279	0	21,838	2,665	223,166
16-May-14	0	37,110	0	19,760	1,644	45,635	0	18,595	876	46471	925	37,204	0	21,838	3,446	226,612
17-May-14	0	37110	0	19760	0	45635	0	18595	0	46471	0	37204	0	21838	0	226612
18-May-14	0	37110	0	19760	0	45635	0	18595	0	46471	0	37204	0	21838	0	226612
19-May-14	0	37110	0	19760	0	45635	0	18595	0	46471	0	37204	0	21838	0	226612


Appendix A2: 9-21 Water Body Refilling From Basin 4 (Pumps 1-7)
Volume by pump (m³)
Total Volume Pumped (m³)
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
250,000
200,000
150,000
100,000
50,000
0
27-Mar-14
1-Apr-14
6-Apr-14
11-Apr-14
16-Apr-14
21-Apr-14
26-Apr-14
1-May-14
6-May-14
11-May-14
16-May-14
Date
Pump 1
Pump 2
Pump 3
Pump 4
Pump 5
Pump 6
Pump 7
All Pumps

Appendix A3: Water Levels at 9-21 Water Body



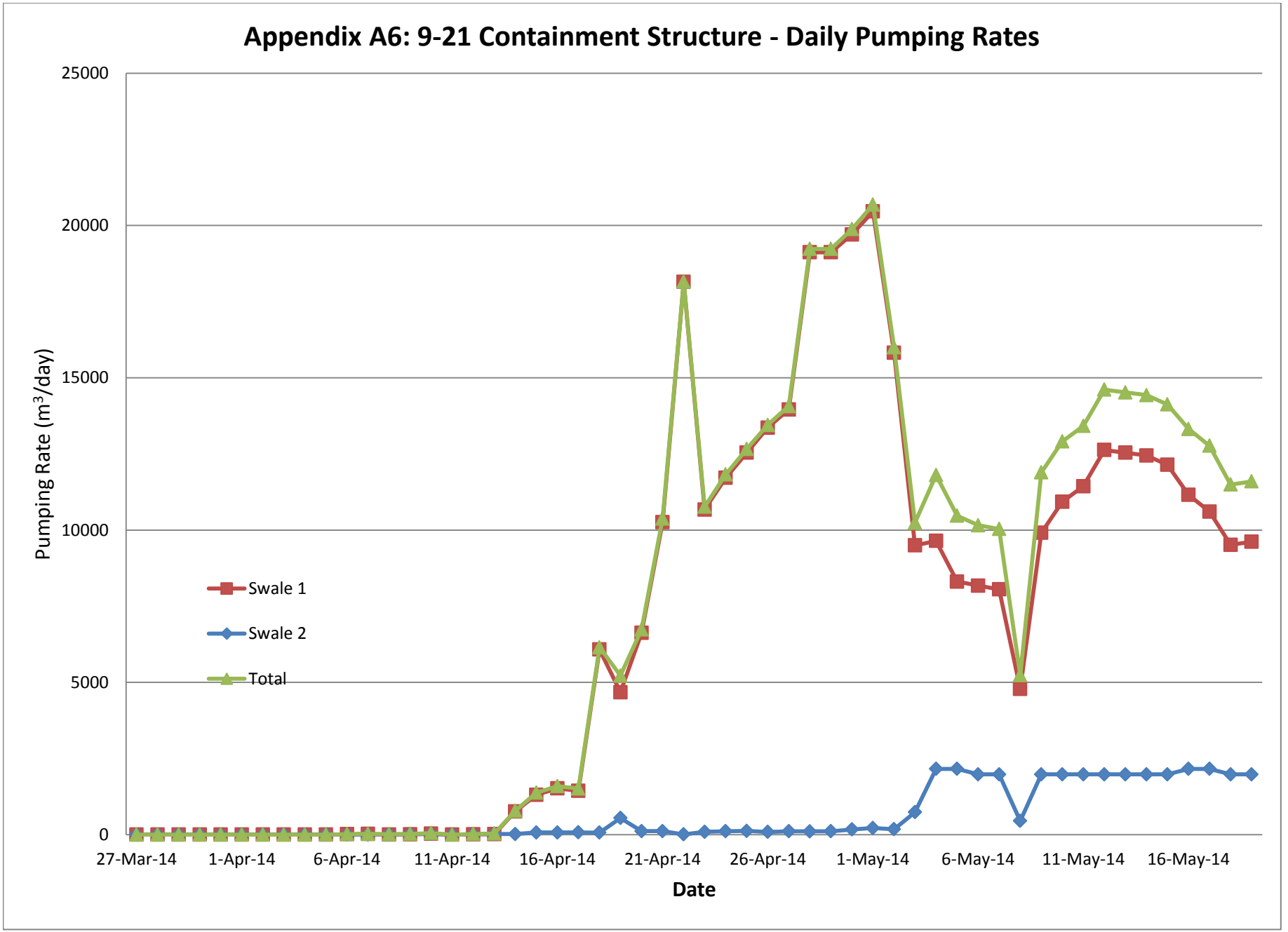
Appendix A4: Water Levels in the Downstream Fen and Borrow Pit



Appendix A5: Daily Pump Volumes from Containment Structure

CNRL Primrose 09-21 Water Body: Refilling Phase

Date	Containment Structure						Containment Structure Total	
	14-SW1-P1		14-SW1-P2		South Wall			
	Rewatering Volume (m^3/day)	Cumulative Pumped (m^3)	Rewatering Volume (m^3/day)	Cumulative Pumped (m^3)	Rewatering Volume (m^3/day)	Cumulative Pumped (m^3)	Daily Volume to Water Body from Containment Structure (m^3/day)	Cumulative Total to Water Body from Containment Structure (m^3)
27-Mar-14	-	-	-	-	-	-	-	-
28-Mar-14	-	-	-	-	-	-	-	-
29-Mar-14	-	-	-	-	-	-	-	-
30-Mar-14	-	-	-	-	-	-	-	-
31-Mar-14	-	-	-	-	-	-	-	-
1-Apr-14	-	-	-	-	-	-	-	-
2-Apr-14	-	-	-	-	-	-	-	-
3-Apr-14	-	-	-	-	-	-	-	-
4-Apr-14	-	-	-	-	-	-	-	-
5-Apr-14	-	-	-	-	-	-	-	-
6-Apr-14	15	15	-	-	-	-	15	15
7-Apr-14	23	38	4	4	-	-	28	42
8-Apr-14	0	38	11	15	-	-	11	53
9-Apr-14	11	49	14	30	-	-	25	79
10-Apr-14	31	80	23	53	-	-	54	133
11-Apr-14	0	80	0	53	-	-	0	133
12-Apr-14	11	91	13	66	-	-	24	157
13-Apr-14	15	106	25	91	-	-	40	197
14-Apr-14	765	871	20	111	-	-	785	982
15-Apr-14	1,308	2,179	73	184	-	-	1,381	2,363
16-Apr-14	1,521	3,700	70	254	-	-	1,591	3,954
17-Apr-14	1,442	5,142	75	329	-	-	1,517	5,471
18-Apr-14	6,081	11,223	70	399	-	-	6,151	11,621
19-Apr-14	4,675	15,898	545	944	-	-	5,220	16,841
20-Apr-14	6,623	22,521	114	1,058	-	-	6,737	23,578
21-Apr-14	10,261	32,782	116	1,173	-	-	10,377	33,955
22-Apr-14	18,147	50,929	7	1,181	-	-	18,154	52,110
23-Apr-14	10,673	61,602	93	1,274	-	-	10,766	62,876
24-Apr-14	11,714	73,316	113	1,387	-	-	11,827	74,703
25-Apr-14	12,539	85,856	123	1,510	-	-	12,662	87,366
26-Apr-14	13,361	99,217	89	1,599	-	-	13,450	100,816
27-Apr-14	13,959	113,176	111	1,709	-	-	14,070	114,886
28-Apr-14	19,120	132,296	110	1,819	-	-	19,230	134,116
29-Apr-14	19,121	151,417	111	1,930	-	-	19,232	153,348
30-Apr-14	19,707	171,124	170	2,100	-	-	19,877	173,225
1-May-14	20,462	191,586	219	2,319	-	-	20,681	193,906
2-May-14	15,820	207,406	178	2,497	-	-	15,998	209,904
3-May-14	9,497	216,903	740	3,237	-	-	10,237	220,141
4-May-14	9,646	226,549	2,160	5,397	-	-	11,806	231,947
5-May-14	8,309	234,858	2,160	7,557	-	-	10,469	242,416
6-May-14	8,176	243,034	1,980	9,537	-	-	10,156	252,572
7-May-14	8,055	251,089	1,980	11,517	-	-	10,035	262,607
8-May-14	4,783	255,872	450	11,967	-	-	5,233	267,840
9-May-14	9,911	265,783	1,980	13,947	-	-	11,891	279,731
10-May-14	10,928	276,711	1,980	15,927	-	-	12,908	292,639
11-May-14	11,439	288,150	1,980	17,907	-	-	13,419	306,058
12-May-14	12,630	300,780	1,980	19,887	-	-	14,610	320,668
13-May-14	12,539	313,319	1,980	21,867	-	-	14,519	335,187
14-May-14	12,450	325,769	1,980	23,847	-	-	14,430	349,616
15-May-14	12,143	337,912	1,980	25,827	-	-	14,123	363,740
16-May-14	11,157	349,069	2,160	27,987	-	-	13,317	377,057
17-May-14	10,608	359,677	2,160	30,147	-	-	12,768	389,825
18-May-14	9,515	369,192	1,980	32,127	-	-	11,495	401,320
19-May-14	9,616	378,808	1,980	34,107	-	-	11,596	412,916


Appendix A6: 9-21 Containment Structure - Daily Pumping Rates
25000
20000
15000
10000
5000
0
Pumping Rate (m3/day)
Swale 1
Swale 2
Total
27-Mar-14
1-Apr-14
6-Apr-14
11-Apr-14
16-Apr-14
21-Apr-14
26-Apr-14
1-May-14
6-May-14
11-May-14
16-May-14
Date

APPENDIX B

WATER QUALITY DATA – WATER BODIES AND WATERCOURSES

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-064-04 W4M

Sample Point	Sample Date	MSI Sample Number	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-SW12	19-Mar-14	08881140319312	<0.0004	***0.0044***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	27-Mar-14	08881140327003	<0.0004	***0.0085***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	01-Apr-14	08881140401001	<0.0004	***0.0006***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	08-Apr-14	08881140408312	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	15-Apr-14	08881140415312	<0.0004	***0.0180***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	22-Apr-14	08881140422312	<0.0004	***0.0040***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	29-Apr-14	08881140429312	<0.0004	***0.0140***	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW12	06-May-14	08881140506312	<0.0004	***0.0060***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	06-May-14	08881140506346	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW12	13-May-14	08881140513312	<0.00040	***0.00120***	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW12	13-May-14	08881140513313	<0.00040	***0.00096***	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW16	13-May-14	08881140513316	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW22	01-Apr-14	08881140401002	<0.0004	***0.00230***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	08-Apr-14	08881140408322	<0.0004	***0.00084***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	15-Apr-14	08881140415322	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	22-Apr-14	08881140422322	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	29-Apr-14	08881140429322	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW22	06-May-14	08881140506322	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW22	13-May-14	08881140513322	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW26	13-May-14	08881140513326	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	0.23	<0.20
13-SW27	13-May-14	08881140513327	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31	08-Apr-14	08881140408331	<0.0004	***0.0011***	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	15-Apr-14	08881140415331	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31 dup	15-Apr-14	08881140415531	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	22-Apr-14	08881140422331	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31 dup	22-Apr-14	08881140422531	<0.0004	0.00043	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	29-Apr-14	08881140429331	<0.0004	***0.0017***	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW31 dup	29-Apr-14	08881140429531	<0.0004	***0.0150***	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW31	06-May-14	08881140506331	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	06-May-14	08881140506531	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	0.11	<0.20	<0.20
13-SW31	13-May-14	08881140513331	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	13-May-14	08881140513531	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
ESRD Freshwater Aquatic Life*			**0.04**	**0.0005**	**0.09**	**0.03**	**NS^{ST}**	**NS^{ST}**	**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

09-21-064-04 W4M

Sample Point	Sample Date	MSI Sample Number	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
PIW Samples										
15-26 14-PIW	30-Apr-14	08881140430003	<0.0004	***0.0020***	0.00046	0.0023	<0.1	0.24	---	---
9-21 14-PIW	28-Apr-14	08881140428001	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
9-21 Generator	28-Apr-14	08881140428002	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
15-26 PIW	08-May-14	08881140508001	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	0.13	---	---
15-26 PIW-2	08-May-14	08881140508002	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
Containment Structure Samples										
14-SW1-P1	01-Apr-14	08881140401003	<0.0004	0.00046	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
14-SW1-P1	22-Apr-14	08881140422381	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
14-SW1-P1	29-Apr-14	08881140429001	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	---	---
14-SW1-P1	06-May-14	08881140506381	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
14-SW1-P1	13-May-14	08881140513381	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
14-SW1-P2	05-Apr-14	08881140405001	<0.0004	0.00050	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
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

09-21-064-04 W4M

Sample Point	Date	MSI Sample Number	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[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
Surface Water Samples																									
13-SW12	19-Mar-14	08881140319312	<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-SW12	27-Mar-14	08881140327003	<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-SW12	01-Apr-14	08881140401001	<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-SW12	08-Apr-14	08881140408312	<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-SW12	15-Apr-14	08881140415312	<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	***0.065***	<0.20	0.065
13-SW12	22-Apr-14	08881140422312	<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-SW12	29-Apr-14	08881140429312	<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	0.19	<0.050	<0.050	<0.020	<0.20	0.19
13-SW12	06-May-14	08881140506312	<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	***0.035***	<0.20	0.035
13-SW12	06-May-14	08881140506346	<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	***0.033***	<0.20	0.033
13-SW12	13-May-14	08881140513312	<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-SW12	13-May-14	08881140513313	<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-SW16	13-May-14	08881140513316	<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-SW22	01-Apr-14	08881140401002	<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-SW22	08-Apr-14	08881140408322	<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-SW22	15-Apr-14	08881140415322	<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-SW22	22-Apr-14	08881140422322	<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-SW22	29-Apr-14	08881140429322	<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-SW22	06-May-14	08881140506322	<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	***0.038***	<0.20	0.038
13-SW22	13-May-14	08881140513322	<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-SW26	13-May-14	08881140513326	<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-SW27	13-May-14	08881140513327	<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-SW31	08-Apr-14	08881140408331	<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-SW31	15-Apr-14	08881140415331	<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-SW31 dup	15-Apr-14	08881140415531	<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-SW31	22-Apr-14	08881140422331	<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-SW31 dup	22-Apr-14	08881140422531	<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-SW31	29-Apr-14	08881140429331	<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-SW31 dup	29-Apr-14	08881140429531	<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-SW31	06-May-14	08881140506331	<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	***0.038***	<0.20	0.038
13-SW31 dup	06-May-14	08881140506531	<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	***0.033***	<0.20	0.033
13-SW31	13-May-14	08881140513331	<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-SW31 dup	13-May-14	08881140513531	<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
PIW Samples																									
15-26 14-PIW	30-Apr-14	08881140430003	<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	***59***	0.86	<0.050	<0.050	<0.020	<0.20	59.86
9-21 14-PIW	28-Apr-14	08881140428001	<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	0.51	<0.10	<0.050	<0.050	<0.020	<0.20	0.51
9-21 Generator	28-Apr-14	08881140428002	<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	0.31	0.46	<0.050	<0.050	<0.020	<0.20	0.77
15-26 PIW	08-May-14	08881140508001	<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	0.012	0.061	<0.0085	0.57	1.5	<0.050	0.1	***0.046***	<0.68	2.289
15-26 PIW-2	08-May-14	08881140508002	<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	***0.034***	<0.20	0.034
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**

APPENDIX B2.

WATER QUALITY RESULTS - POLYCYCLIC AROMATIC HYDROCARBONS

Canadian Natural Resources Limited

09-21-064-04 W4M

Sample Point	Date	MSI Sample Number	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[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-SW1-P1	01-Apr-14	08881140401003	<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-SW1-P1	22-Apr-14	08881140422381	<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-SW1-P1	29-Apr-14	08881140429001	<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-SW1-P1	06-May-14	08881140506381	<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	***0.033***	<0.20	0.033
14-SW1-P1	13-May-14	08881140513381	<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-SW1-P2	05-Apr-14	08881140405001	<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 - ROUTINE WATER CHEMISTRY

Canadian Natural Resources Limited

09-21-064-04 W4M

Sample Point	Sample Date	Matrix Sample Number	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
Surface Water Samples																			
13-SW12	19-Mar-14	08881140319312	7.56	90	12	3	0.98	2.6	1.2	<1	<0.01	<0.01	<0.001	43	52	42	46	24	10
13-SW12	27-Mar-14	08881140327003	---	---	---	---	---	---	1.3	---	---	---	---	---	---	---	---	6.7	3.1
13-SW12	01-Apr-14	08881140401001	---	---	---	---	---	---	1.5	---	---	---	---	---	---	---	---	4	---
13-SW12	08-Apr-14	08881140408312	---	---	---	---	---	---	<1	---	---	---	---	---	---	---	---	37	27
13-SW12	15-Apr-14	08881140415312	---	---	---	---	---	---	2.3	---	---	---	---	---	---	---	---	40	14
13-SW12	22-Apr-14	08881140422312	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	37	15
13-SW12	29-Apr-14	08881140429312	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	7.3	1.8
13-SW12	06-May-14	08881140506312	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	20	5.7
13-SW12	06-May-14	08881140506346	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	59	19
13-SW12	13-May-14	08881140513312	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	1.3	0.88
13-SW12	13-May-14	08881140513313	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	170	9.5
13-SW16	13-May-14	08881140513316	---	---	---	---	---	---	6	---	---	---	---	---	---	---	---	10	11
13-SW22	01-Apr-14	08881140401002	---	---	---	---	---	---	2.1	---	---	---	---	---	---	---	---	3.3	---
13-SW22	08-Apr-14	08881140408322	---	---	---	---	---	---	1.5	---	---	---	---	---	---	---	---	7.3	6.1
13-SW22	15-Apr-14	08881140415322	---	---	---	---	---	---	1.4	---	---	---	---	---	---	---	---	220	120
13-SW22	22-Apr-14	08881140422322	---	---	---	---	---	---	1.6	---	---	---	---	---	---	---	---	33	8.8
13-SW22	29-Apr-14	08881140429322	---	---	---	---	---	---	3.5	---	---	---	---	---	---	---	---	130	100
13-SW22	06-May-14	08881140506322	---	---	---	---	---	---	1.7	---	---	---	---	---	---	---	---	130	170
13-SW22	13-May-14	08881140513322	---	---	---	---	---	---	2.6	---	---	---	---	---	---	---	---	150	200
13-SW26	13-May-14	08881140513326	---	---	---	---	---	---	8	---	---	---	---	---	---	---	---	6	4.4
13-SW27	13-May-14	08881140513327	---	---	---	---	---	---	3.9	---	---	---	---	---	---	---	---	1.3	1.7
13-SW31	08-Apr-14	08881140408331	---	---	---	---	---	---	1.3	---	---	---	---	---	---	---	---	4.7	3.6
13-SW31	15-Apr-14	08881140415331	---	---	---	---	---	---	1.1	---	---	---	---	---	---	---	---	170	54
13-SW31 dup	15-Apr-14	08881140415531	---	---	---	---	---	---	1.1	---	---	---	---	---	---	---	---	420	130
13-SW31	22-Apr-14	08881140422331	---	---	---	---	---	---	3.3	---	---	---	---	---	---	---	---	100	34
13-SW31 dup	22-Apr-14	08881140422531	---	---	---	---	---	---	1.9	---	---	---	---	---	---	---	---	37	7.2
13-SW31	29-Apr-14	08881140429331	---	---	---	---	---	---	1.8	---	---	---	---	---	---	---	---	4.7	2.1
13-SW31 dup	29-Apr-14	08881140429531	---	---	---	---	---	---	1.1	---	---	---	---	---	---	---	---	6.0	1.4
13-SW31	06-May-14	08881140506331	---	---	---	---	---	---	1.9	---	---	---	---	---	---	---	---	140	180
13-SW31 dup	06-May-14	08881140506531	---	---	---	---	---	---	<1.0	---	---	---	---	---	---	---	---	80	17
13-SW31	13-May-14	08881140513331	---	---	---	---	---	---	2.1	---	---	---	---	---	---	---	---	20	24
13-SW31 dup	13-May-14	08881140513531	---	---	---	---	---	---	7.9	---	---	---	---	---	---	---	---	25	13
ESRD Freshwater Aquatic Life*			**6.5-9.0^{pH}**	**NS**	**NS**	**NS**	**NS**	**NS**	**120^{LT}**	**H^{SO4}**	**Cl^{LT}**	**3^{LT}**	**NS**	**20^{Alk}**	**NS**	**NS**	**NS**	**narrative**	**narrative**
ESRD Agriculture - Irrigation*			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**100^{crop}**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**500^{crop}**	**NS**	**NS**
ESRD Agriculture - Livestock*			**NS**	**NS**	**1000**	**NS**	**NS**	**NS**	**NS**	**1000**	**10**	**NS**	**100**	**NS**	**NS**	**NS**	**3000**	**NS**	**NS**

APPENDIX B3.

WATER QUALITY RESULTS - ROUTINE WATER CHEMISTRY

Canadian Natural Resources Limited

09-21-064-04 W4M

Sample Point	Sample Date	Matrix Sample Number	Lab pH	Lab EC µS/cm	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Cl mg/L	SO_4 mg/L	NO_2-N mg/L	NO_3-N mg/L	NO_3+NO_2-N mg/L	Total Alkalinity^ mg/L	HCO_3 mg/L	Hardness^ mg/L	TDS mg/L	TSS mg/L	Turbidity NTU
PIW Samples																			
15-26 14-PIW	30-Apr-14	08881140430003	---	---	---	---	---	---	43	---	---	---	---	---	---	---	---	7.3	100
9-21 14-PIW	28-Apr-14	08881140428001	---	---	---	---	---	---	52	---	---	---	---	---	---	---	---	260	460
9-21 Generator	28-Apr-14	08881140428002	---	---	---	---	---	---	--	---	---	---	---	---	---	---	---	---	--
15-26 PIW	08-May-14	08881140508001	---	---	---	---	---	---	24	---	---	---	---	---	---	---	---	92	170
15-26 PIW-2	08-May-14	08881140508002	---	---	---	---	---	---	30	---	---	---	---	---	---	---	---	100	170
Containment Structure Samples																			
14-SW1-P1	01-Apr-14	08881140401003	---	---	---	---	---	---	46	---	---	---	---	---	---	---	---	21	---
14-SW1-P1	01-Apr-14	08881140422381	---	---	---	---	---	---	3.0	---	---	---	---	---	---	---	---	400	360
14-SW1-P1	29-Apr-14	08881140429001	---	---	---	---	---	---	3.2	---	---	---	---	---	---	---	---	350	510
14-SW1-P1	06-May-14	08881140506381	---	---	---	---	---	---	16	---	---	---	---	---	---	---	---	320	400
14-SW1-P1	13-May-14	08881140513381	---	---	---	---	---	---	1.3	---	---	---	---	---	---	---	---	54	82
14-SW1-P2	05-Apr-14	08881140405001	---	---	---	---	---	---	22	---	---	---	---	---	---	---	---	130	---
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**
ESRD Freshwater Aquatic Life*			**6.5-9.0^{pH}**	**NS**	**NS**	**NS**	**NS**	**NS**	**120^{LT}**	**H^{SO4}**	**Cl^{LT}**	**3^{LT}**	**NS**	**20^{Alk}**	**NS**	**NS**	**NS**	**narrative**	**narrative**
ESRD Agriculture - Irrigation*			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**100^{crop}**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**500^{crop}**	**NS**	**NS**
ESRD 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

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

H - dependent on hardness value

Cl - dependent on chloride value

^{pH} - not to be altered by more than 0.5 units from background

^{LT} - long-term exposure guideline; see applicable guidelines for further details

^{Alk} - minimum value, unless natural conditions are less

^{SO4} - guideline level is hardness dependent; hardness values greater than 250 mg/L need to be determined based on site water

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

Italics - values do not meet applicable guidelines