

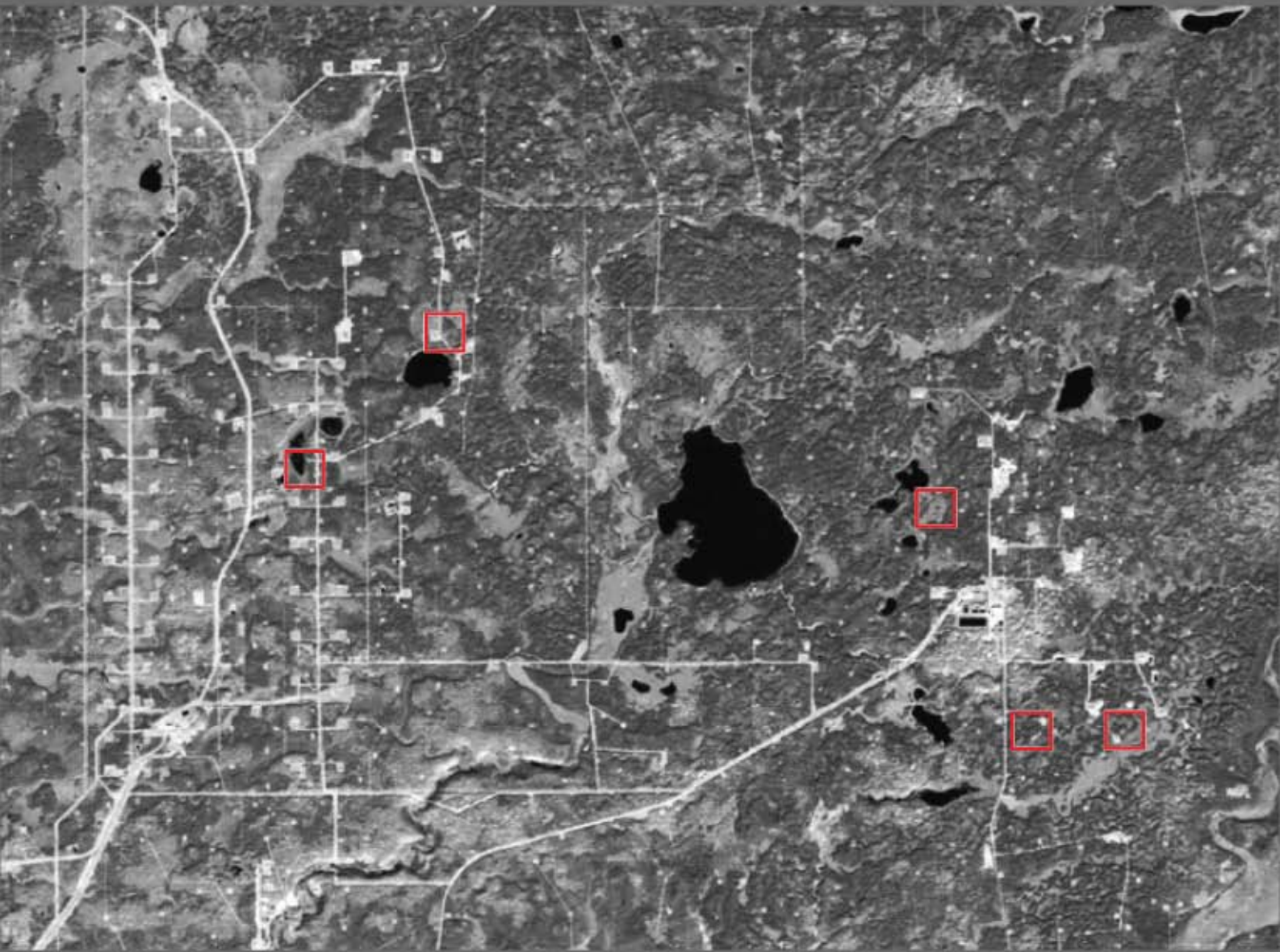
CNRL's Persistent 2013-2014 Bitumen Releases near Cold Lake, Alberta: Facts, Unanswered Questions, and Implications

Final Report (February 2014)

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Note to reader: The authors would be grateful to be made aware by email of any errors of fact found in the document.

Summary

Throughout 2013 and extending into early 2014, four uncontrolled releases of bitumen have been occurring at Canadian Natural Resources Limited's (CNRL's) high pressure cyclic steam stimulation (HPCSS) Primrose operations near Cold Lake, Alberta. Similar large and uncontrolled releases occurred in 2006 and 2009. The HPCSS method (also referred to as "huff and puff") involves repeated cycles of steam injection, followed by "soaking" of the steam and bitumen, and then extraction of the bitumen emulsion to the surface via a single well bore. In addition to reducing the viscosity of the bitumen, the method results in deformation, fracturing of bedrock, and vertical heave.

In this bulletin we summarize known facts; identify unknowns; evaluate the accuracy, completeness, and timeliness of the information provided to the public; and discuss the significance and implications of the incidents.

Quantification

The reported bitumen volume recovered makes this event the fourth largest bitumen release on record in Alberta. Of the 856 bitumen release incidents on record for which a recovered volume is provided, only three incidents have involved larger volumes of bitumen. This places the CNRL 2013 Primrose event at the 99.65 percentile for bitumen volume released.

Other than the ongoing CNRL incident at Primrose, the three largest bitumen release incidents known in Alberta are: 2,500 m³ bitumen released after a CNRL well incident on 3 January 2009 at 14-01-67-03W4 (this is the CNRL Pad 74 event); 2,522 m³ bitumen released after a CNRL "crude oil" incident on 27 May 2004 at 02-12-82-23W4; and 3,000 m³ bitumen released attributed to an "unknown" company and an "unknown" cause on 3 April 2006 at 01-24-92-10W4. It is unclear why the AER did not identify the company responsible for the largest known bitumen incident on record in Alberta given that the location (Suncor's Tar Island Pond One) and date of the incident are known and the incident (number 221357) was recorded by Alberta Environment.

Over the period late-September to mid-November 2013, the daily volume of bitumen recovered varied from 29.1 (28 September), 54.0 (3 October), 17.7 (10 October), 31.4 (17 October), 28.7 (31 October), to 13.3 (14 November) barrels/day. The data indicate that CNRL's statement (31 July 2013) that the daily release of bitumen had fallen to a total of "less than 20 barrels per day" was inaccurate.

Bitumen recovery data released by CNRL and AER in mid-January 2014 call into question the accuracy of previously reported data. As of 14 November 2013, AER and CNRL reported a total of 1,878.62 m³ recovered. As of 10 January 2014, CNRL reported to the authors that the total volume recovered had been revised to 1,864.21 m³. In contrast, as of ~ 19 January 2014, AER posted a total volume recovered of 1,177.14 m³. No explanation for these downward revisions and discrepancies has been provided by industry or AER. Nor do these values make sense in light of CNRL President Laut's statement of 14 January 2014 in which he was quoted that the field was seeping at about "one cubic metre squared per day" [*sic*, m³/day] (or 6.3 barrels/day).

If the total release and daily release values provided by CNRL were accurate, then the total volume released as of 14 January 2014 at the four CNRL sites should be roughly 1,939.6 m³ (12,185 barrels).

The total mass of bitumen-impacted soils removed to date has been estimated at roughly 70,000 metric tonnes. To place that amount of impacted soils in perspective, Enbridge removed about 190,000 cubic yards of contaminated sediment from the Kalamazoo River in Michigan over a three year period in response to its 2010 pipeline spill. Although metric tonnes and cubic yards cannot be compared directly because mass depends upon the proportions of sediment, water, and organic matter, the amounts of contaminated soil and sediment removed in response to both the Enbridge and CNRL incidents suggest significant ecosystem impacts.

As of late summer 2013, bitumen production at a minimum of three of the four locations continued throughout the ongoing incidents (production data for the 09-21 lake site were not provided). Assuming a January-August 2013 value of \$67.53 per barrel of bitumen, revenue from the three legal locations (10-01, 10-02, and 02-22) for the first eight months of 2013 is estimated at roughly 64 million dollars.

For CNRL's operations in Townships 65 to 68, Ranges 1 to 7, W4, which encompass a portion of CNRL's operations northwest of Cold Lake, AER records indicate 32 primary releases of crude bitumen (over the period 2003 to early 2013), 44 primary releases of crude oil (1985 to 2008), 34 primary releases of process water (1999 to early 2013), 121 primary releases of salt/produced water (1985 to 2012), and 15 primary releases of waste (2008 to 2012). These releases may be resulting in environmental impacts that are not being documented with sufficient scientific rigor.

Communications, Reliability, and Transparency

Although information about these incidents was first released to the public on 24 June 2013, the first two bitumen incidents were reported to the regulator on 21 May 2013 (sites 10-01 and 10-02), the third was reported on 8 June 2013 (site 02-22), and the fourth was reported on 24 June 2013 (site 09-21). It is not clear why the Alberta Energy Regulator (AER) did not issue a press release until 24 June 2013, nor is it known with certainty when the bitumen releases began. It is suspected that the releases began as early as winter 2012-2013. It is unknown when the bitumen releases may cease.

On 24 September 2013, three months after reporting the bitumen release at the 09-21 lake site, the Alberta government issued an Environmental Protection Order to CNRL to drain the lake in an effort to mitigate the bitumen release. On 21 October 2013, the Alberta government issued an Enforcement Order to CNRL to minimize and contain impacts to surface and groundwater and prepare a comprehensive plan to manage, monitor, and remediate the impacts at the three "terrestrial release sites" (10-01, 10-02, and 02-22).

Data released in response to the Environmental Protection Order for the 09-21 lake site revealed significant levels of toluene, frequent detections of hydrocarbons, and unacceptably high laboratory detection limits. Additionally, the wetland impact summary report submitted to government for the 09-21 site would not have passed peer review in its documentation of vegetation, flora, and fauna.

In most of its media releases, CNRL has indicated that the cause of the releases is either a single defective well bore or multiple defective well bores. Yet in an August 2013 statement, the President of CNRL was of the view that the incidents resulted from well bore failure that permitted release of bitumen into fissures in bedrock followed by migration of bitumen. The admission that migration of bitumen through fractured bedrock could follow well bore failure is significant and consistent with the known science. Yet as of early February 2014, CNRL media releases still claimed that only faulty well bore(s) were involved.

Both AER and CNRL fail to provide accurate, complete, and timely information to the public. In response to questions, misleading or incomplete information was often supplied, or, in some cases, no response was provided. Problems and errors were noted in reporting of the sequence of events and the locations of the incidents; of understating impacts to wildlife and wetlands; in provision of ambiguous, unverified, or incorrect values for volumes of bitumen released or recovered and tonnage of soil removed; in making claims that lack or contradict evidence; in misdirecting the investigators to web links that did not contain the information requested; and in failing to answer questions. Despite repeated requests, a set of questions posed to AER pertaining to the accuracy and reliability of their incident data, posed in mid-June 2013, remained unanswered for six months. [Following a complaint to AER, the regulator provided responses to those questions in mid-December 2013, the content of which will form the basis for an upcoming bulletin.]

Correspondence with CNRL and AER indicates that data on bitumen recovery may be suspect for the following reasons: (1) AER does not verify volumes released or recovered; instead, it relies upon industry for those numbers. (2) AER and CNRL bitumen recovered values should agree. The fact that the AER and CNRL bitumen recovery data differ suggests editing of the numbers by one or both parties without that party informing the other. (3) Because bitumen releases have continued at the sites over the two-month period 14 November 2013 to 15 January 2014, if the previous data reported by the regulator were accurate, it would be numerically impossible for the recovered volume of 10 January 2014 to be lower than the recovered volume of 14 November 2013. Without independent oversight of reported hydrocarbon release and recovery volumes, the public may never know the true volumes spilled or recovered.

The 3 January 2014 bitumen release incident, the fifth AER-reported incident at the legal location at CNRL Primrose Pad 30, is instructive. It demonstrates that, despite assurances that CNRL would prevent future releases of bitumen, industry cannot prevent these incidents under a high pressure steaming regime. CNRL objected to AER categorizing the incident as a release because bitumen did not reach the surface. That objection suggests that sub-surface releases are more common than release data indicate and therefore that the extent of sub-surface contamination is poorly documented. And, there was a three-day delay between occurrence of the incident and its being reported to the regulator.

Although improvements in communication and transparency were made in mid-2013 when AER replaced the ERCB, those improvements were eroded in late-2013. Since that time, AER has imposed a “single point of contact” communication rule that inhibits exchange of information between AER staff and the public. Similarly, its incident reporting has been degraded through removal of pre-2014 incident data and the decision to withhold precise location data for incidents. Also in late-2013, the Alberta government began transfer of its responsibility for enforcement of the Water Act, the Public Lands Act, and the Environmental Protection and Enhancement Act as they pertain to energy company activities.

The systematic deficiencies documented in the AER's provision of accurate, timely, and complete information to the public may be the result of its conflicted mandate to both promote and regulate the energy industry.

Causality and Unknowns

Uncontrolled *in situ* bitumen releases differ from typical spills in that: (1) the cause(s) of the releases are either uncertain or difficult to determine; (2) they occur underground and are not confined to a pipe or a well bore and therefore are difficult to study and difficult to stop; (3) they are three-dimensional; (4) the bitumen is conducted under pressure through bedrock fissures; (5) the incidents present unquantified risks to the integrity of the bitumen reservoir, to the quality of groundwater; and to the quality of the near-surface and surface environment.

If defective well bore(s) are the sole explanation for the four ongoing CNRL Primrose releases, there is a problem of statistical improbability. If a single defective well bore is the explanation, it raises the question of how the bitumen releases could be spread over an extent of about 14.6 km east-west and 4 km north-south. In order for that to happen, there would need to be an extensive network of vertical and horizontal fractures that could convey bitumen over large distances. Both scenarios present problems for CNRL and the regulator. Fracture of the cap rock need not be involved for the current incidents at CNRL Primrose to be causally-linked.

Although more than four years have passed since the 2009 incident at CNRL Primrose, the causality for the five CNRL incidents remains unclear but they are known to involve migration of bitumen emulsion through a network of vertical and horizontal fissures. Similarly, the causality of the 2006 cap rock failure at Total's Joslyn operation remains uncertain. Although the regulator was unable to determine the causes of previous cap rock failures, it allowed HPCSS operations to both continue and expand which has imposed unquantified risks to bitumen resources, groundwater, and adjacent ecosystems.

As of 2001, more than 250 wells had failed in the Cold Lake area. About 85-90% of the well failures were the result of geologic shear stresses generated by steaming operations. Given the documented geologic hazards and well failures associated with HPCSS, the demonstrated inability to prevent well failures in areas subjected to high pressure steaming, and previous large and uncontrolled releases of bitumen, the decision by AER to allow CNRL to continue HPCSS operations in the Cold Lake area illustrates failure of the regulator to protect the public interest and the environment.

Questions and issues remain, such as: (1) What is the total volume of bitumen released below-ground and the spatial extent of the below-ground migration of bitumen at the four release sites? (2) Why did the regulator allow HPCSS operations to continue in the absence of sufficient knowledge about the potential impacts and the causality of recent bitumen incidents? (3) Why do both the regulator and industry continue to fail to provide timely access to accurate or complete information? (4) How many covert underground releases of hydrocarbons and other energy industry chemicals have occurred in the past and are they occurring presently elsewhere in Alberta? (5) What are the effects of HPCSS and other *in situ* methods on groundwater and the formational integrity of bedrock?

Given the thousands of abandoned wells and the high pressure cyclic steaming methods used, future bitumen releases may be expected. Alternatively, the regulator may take pro-active steps to avoid juxtaposing geologic hazards, abandoned wells, and high pressure steaming operations.

Expansion of *in situ* methods of bitumen exploitation across Alberta is outpacing the increase in knowledge of the potential below-ground and surface impacts of these methods. By the time the effects of these methods are sufficiently understood, it may be too late to remediate. High pressure cyclic steam stimulation methods may be leading to degradative changes in the quality of groundwater and the integrity and containment capability of bitumen reservoirs and may be placing adjacent ecosystems at risk of bitumen releases that are difficult to control.

1. Introduction

Early in 2013, bitumen extraction by Canadian Natural Resources Limited (CNRL) in its Primrose East operations near Cold Lake, Alberta (Figure 1) resulted in three releases of bitumen emulsion to the surface (AER 2013a). On 24 June 2013, CNRL reported a fourth release of bitumen, this one into an unnamed waterbody in CNRL's Primrose operations. These surface releases of bitumen at four geographically-separated locations are the subject of this bulletin, (Figure 2). Three sites are located in Primrose East and one site is located in Primrose South. For brevity, the four releases (assigned AER reference numbers 20131458, 20131016, 20131126, and 20131243) are referred to as the "winter-summer 2013 incidents". In 2009, a similar surface release of bitumen in the same geographic area occurred at CNRL's Pad 74 (ERCB 2011) and in 2006 a similar release occurred at Total's Joslyn Creek SAGD operations (Roche 2010).

These six occurrences are significant in that they represent a new type of industrial incident that differs fundamentally from a typical "spill" (Table 1a) in the following ways: (1) the cause(s) of the releases are either uncertain or still under investigation; (2) they occur underground and are not confined to a pipeline conduit and are therefore difficult to study and difficult to stop; (3) the releases are three-dimensional as opposed to a typical surface spill which is essentially two-dimensional; (4) the bitumen is conducted under pressure through bedrock fissures; (5) the incidents present unquantified risks to the integrity of the bitumen reservoir, to the quality of groundwater; and to the quality of the near-surface and surface environment.

The objectives of this bulletin are to: (a) summarize the known facts; (b) identify the unknowns; (c) evaluate the accuracy, completeness, and timeliness of the information provided by AER and CNRL; and (d) discuss the significance and implications of the incidents.

Section 2 documents the locations of the release sites. Section 3 presents the events as related by AER and CNRL press releases and correspondence and then in media accounts. Where comments by the investigators are inserted in Section 3, they are set in square brackets. Material in later press releases that was published verbatim from earlier press releases has been deleted to minimize repetition. Section 3 is presented in chronological order because the ongoing nature of the incidents and the failure by the regulator and CNRL to provide accurate and timely information are best understood within a chronological narrative. Section 4 presents the CNRL Pad 74 incident as context for the current ongoing events, documents failures to inform the public, discusses unanswered questions and concerns, and concludes with the significance and implications of these events and provides recommendations to serve the public interest and minimize the risk of future uncontrolled bitumen releases.

Although the 2013 CNRL Primrose incidents continue as of early February 2014, we make this report available so that the public may be better informed about these important ongoing incidents.

2. Location of the Bitumen Release Sites

The four bitumen release sites are located in:

- (1) LSD 10, Section 01, Township 67, Range 03, W4 (the "10-01" site);
- (2) LSD 10, Section 02, Township 67, Range 03, W4 (the "10-02" site);
- (3) LSD 02, Section 22, Township 67, Range 03, W4 (the "02-22" site); and
- (4) LSD 09, Section 21, Township 67, Range 04, W4 (the "09-21" site) (Figures 2 and 3).

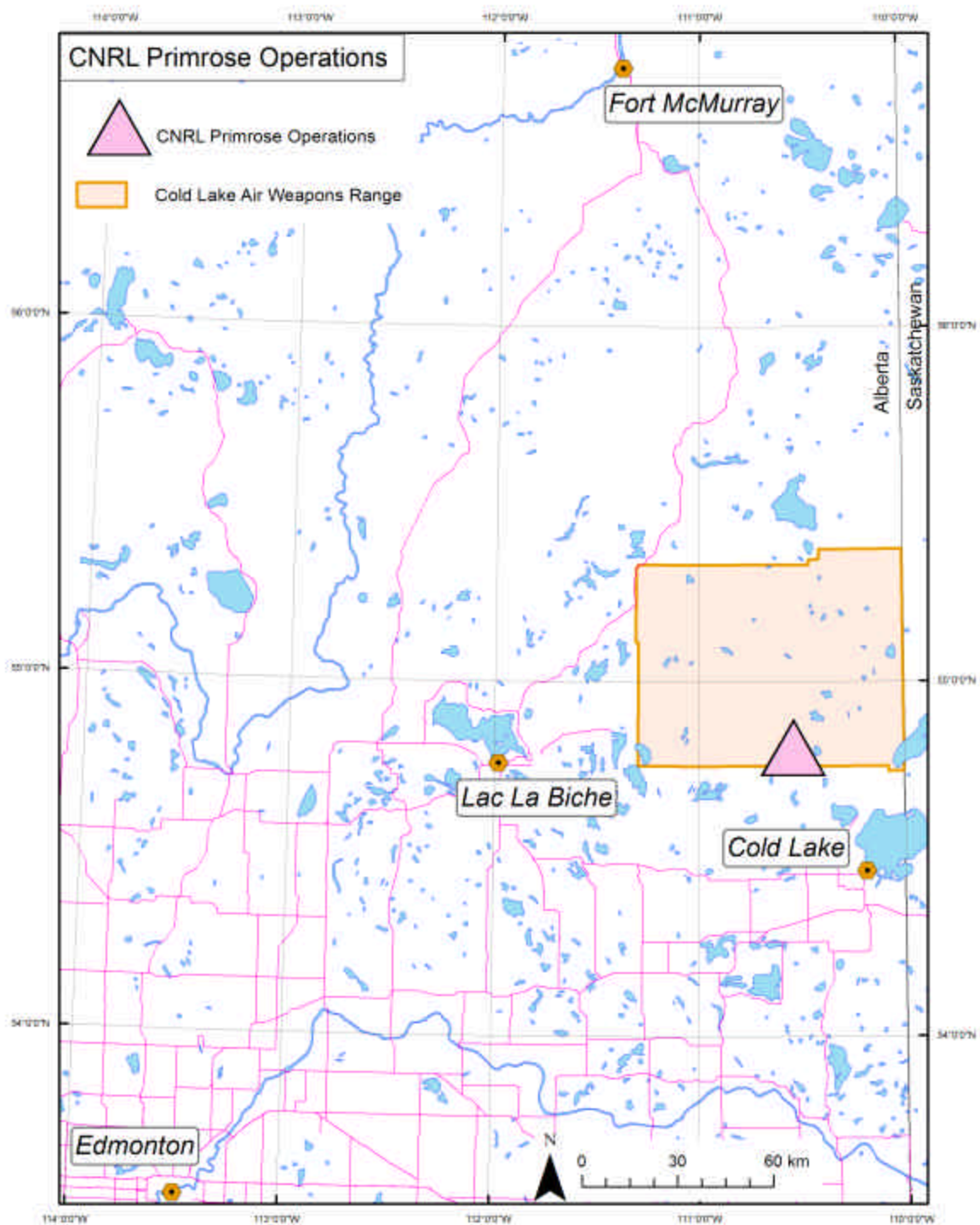


Figure 1. The CNRL study area lies northwest of Cold Lake near the southern margin of the Cold Lake Air Weapons Range in eastern Alberta.

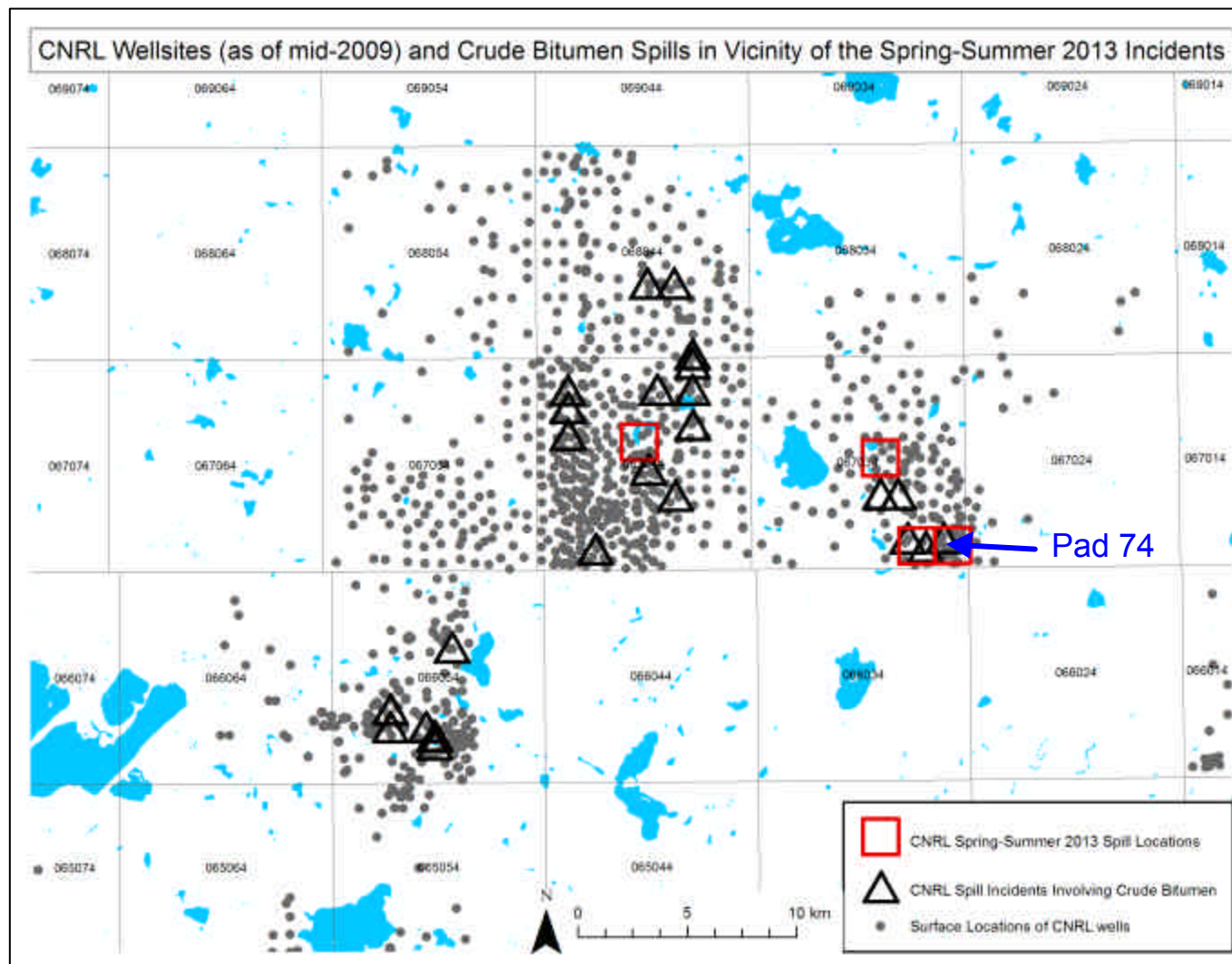


Figure 2. Locations of the four CNRL 2013-2014 ongoing bitumen releases, location of other CNRL spills from the ERCB (AER) spills database that occurred between 2003 and 2013, and the surface locations of CNRL wells in the Primrose study region. The six digit number in each box provides the Township, Range, and Meridian (for example, 067024 indicates Township 67, Range 2, W4). The location of the 2009 CNRL bitumen release at Pad 74 (ERCB 2011) is indicated.

3. Results: Chronology of Events and Information Exchanges

The sequence of events that occurred at the four bitumen release sites is described below based on AER press releases, CNRL press releases, and correspondence between the investigators and both AER and CNRL. Quotations are set in blue font.

3.1 Information Provided by AER (excerpted from AER 2013a)

Reference number: 20131243
Date of incident: June 24, 2013
Date of notification: June 24, 2013, 20:18
[Although the date of the incident and the date of notification of the incident as provided by CNRL are both given as 24 June 2013, no evidence was provided by CNRL that the releases of bitumen did not begin prior to 24 June 2013. For a more accurate chronology, see the note under 27 June 2013 (below) and Correspondence Section 3.3.]
Company: Canadian Natural Resources Limited
Location: 09-21-067-03W4, 10-01-067-03W4, 10-02-067-03W4 and 02-22-067-04W4 ~45 km NW of Cold Lake
[As initially provided by AER in its incident report, three of the four locations were incorrect. In this press release, the two underlined locations are incorrect. See Correspondence, Section 3.3.]
Type of facility: Facility
Product reported: Bitumen

24 June 2013 Unnamed standing body of water impacted by bitumen coming to surface from underground source. AER working with company to determine cause, control the release, and establish containment. Some wildlife impacts reported—ESRD working with company on wildlife mitigation and clean up.

27 June 2013, Press Release (AER 2013b)

The Alberta Energy Regulator (AER) is responding to a release of bitumen emulsion to surface at a high pressure cyclic steam project on the Cold Lake Air Weapons Range. The project, known as Primrose, is operated by Canadian Natural Resources Limited. The affected area is off lease and has impacted a nearby slough. The company has begun clean-up operations. There were no injuries as a result of the release. The volume of emulsion released has not been confirmed at this time.

[The preceding information is misleading. The press release refers to only one of the four incidents; there are four affected areas, not one; and the affected water body at the 09-21 site is a 50.3 ha lake, not a slough, and is discussed in a later press release.

The sequence of events indicated in the press releases is also misleading in that the reader is given the impression that the incidents began on 24 June 2013. The reality is that the first two bitumen incidents were reported to the regulator on 21 May 2013 (sites 10-01 and 10-02), the third on 8 June 2013 (site 02-22), and the fourth on 24 June 2013 (site 09-21). It is not known when the releases began. (For incident dates, see AESRD (2013b); correspondence between the investigators and AER indicates that the 10-01 and 10-02 incidents were reported on 20 May

2013).)]

The AER is onsite and will continue to work with the company, Alberta Environment and Sustainable Resource Development and other agencies to ensure that the incident is controlled, contained, and all appropriate clean up and mitigation measures take place. The AER is conducting an investigation into the cause of the incident. All information is preliminary and may be changed as updates are available.

During an incident, the AER works with the company, local authority, and other provincial agencies to coordinate efficient and effective response by all parties involved. The AER expects the responsible party to respond immediately and effectively to all energy incidents and to limit impacts to the public, property, and the environment. The AER will hold the responsible party accountable for the incident and its impacts.

The Alberta Energy Regulator ensures the safe, efficient, orderly, and environmentally responsible development of hydrocarbon resources over their entire life cycle. This includes allocating and conserving water resources, managing public lands, and protecting the environment while providing economic benefits for all Albertans.

[Has the response been efficient and effective? Do AER's repeated remonstrations to CNRL to accelerate the response indicate otherwise? Given its previous record following the 2009 CNRL bitumen release (ERCB 2011), after which no holding to account was in evidence, will AER hold CNRL responsible for the four 2013 incidents?]

AER (2013a), continued—

17 July 2013 Updated volumes. Impacted vegetation continues to be cleaned up. Bitumen releasing from fissure underground contained within double lined control curtain. Wildlife impacts reported. ESRD and AER continue to monitor the site. AER ordered CNRL to suspend steaming operations and accelerate clean up.

[The preceding information is vague and raises questions. What is meant by a fissure? Does AER mean a fissure in a well bore, a fissure in bedrock, or both? Does AER mean a single fissure or are there multiple fissures given the geographic extent of the bitumen releases?]

18 July 2013, Press Release (AER 2013c)

The Alberta Energy Regulator (AER) has ordered Canadian Natural Resources Limited (CNRL) to restrict steam injection, enhance monitoring, and continue to accelerate cleanup efforts at its Primrose and Wolf Lake high pressure cyclic steam stimulation (HPCSS) project following incidents involving the release of bitumen emulsion to surface within the project area located in the Cold Lake region.

Earlier this year, as a result of three releases of bitumen emulsion to surface, the AER ordered the suspension of steaming operations within the Primrose East section of the project area. On June 24, 2013, the company reported a fourth release, this time into an unnamed water body on the Cold Lake Air Weapons Range, at Primrose South. In response to the issues in this area, the AER has ordered that CNRL take further measures, including suspending steaming operations within one kilometre of the Primrose South incident and restricting steam operations throughout Primrose North and South.

“The Alberta Energy Regulator is investigating all instances of bitumen release to surface in relation to this project,” said CEO Jim Ellis. “Although there have been no risks to public safety,

until we investigate these incidents, better understand the cause of these releases, and what steps CNRL will take to prevent them, we are taking these measures as a precaution.”

[AER is using “public relations speak” when referring to steps that CNRL will take to prevent future bitumen releases. Although industry often uses such phrases, there are no known methods that can assure that such incidents do not take place. Application of best practices can serve to minimize the probability of adverse outcomes, but it cannot prevent them. Promising that these or other industrial incidents will not happen again may sound good, but it is not a promise that can be assured of delivery. AER’s claim that “there have been no risks to public safety” is premature. Investigation of the 2009 bitumen release observed contamination of the aquifer with bitumen-related chemicals, which it could be argued presents an unquantified risk to public safety. Is there any reason to believe, in advance of investigation, that bitumen-related chemicals did not enter the aquifer as a result of the four new releases?]

HPCSS has been used in oil recovery in Alberta for more than 30 years. The method involves injecting high-pressure steam into a reservoir over a prolonged period of time. As heat softens the bitumen and water dilutes and separates the bitumen from the sand, the pressure creates cracks and openings through which the bitumen can flow back into the steam-injector wells.

[AER is indicating the HPCSS method results in subsurface cracks through which the heated bitumen then flows under pressure.]

HPCSS differs from steam assisted gravity drainage (SAGD) operations where steam is injected at lower pressures without fracturing the reservoir and uses gravity drainage as the primary recovery mechanism.

The AER is investigating these incidents and will issue a public report once the investigation is complete. Regular incident updates are available at www.aer.ca.

AER (2013a), continued—

26 July 2013 Due to the ongoing nature of the four related incidents on CNRL's Primrose project area, future updates to this incident report will include information on all four incidents.

[The preceding indicates that AER views the June-July-August (to date) releases as four related incidents.]

Clean up continues on all sites. Impacted lake area has been reduced to 12 hectares as skimming and vegetation cutting progresses. CNRL has reported the following wildlife impacts: 2 beavers, 12 migratory birds, 23 amphibians, and 5 small mammals deceased. Wildlife fencing and deterrents have been installed at all sites. Recovered bitumen is being recycled. Both AER and ESRD continue to monitor these sites on a regular basis.

[The information on wildlife impacts is misleading in that it is a tally of wildlife reported as found. The number of animals found is a fraction of the number of animals impacted. Without scientifically-credible study, it is not possible to state that x number of animals have died.]

The Alberta Energy Regulator (AER) has directed Canadian Natural Resources Limited (CNRL) to undertake the following actions: 1) CNRL must continue to accelerate efforts to contain and clean up the bitumen-emulsion release and submit detailed containment, cleanup, and remediation plans to the AER and Alberta Environment and Sustainable Resource Development

(ESRD) by July 29, 2013, and 2) develop and implement a plan, subject to AER approval, to ensure all bitumen emulsion releases to surface within the project area have been identified and, if identified, appropriately addressed to the AER's satisfaction.

[The direction to “accelerate efforts to contain and clean up” made here, made previously, and made in later report updates suggests that the efforts by CNRL have been insufficient.]

Earlier this year, as a result of three releases of bitumen emulsion to surface, the AER ordered the suspension of CNRL's high pressure cyclic steam stimulation (HPCSS) operations within the Primrose East section of the project area. In response to the most recent incident at Primrose South, the AER has ordered that CNRL take further measures, including suspending the steaming operations within one kilometre of the Primrose South incident and restricting steam operations throughout Primrose North and South. These restrictions will remain in place until the cause of the releases has been confirmed, CNRL can introduce operating practices to minimize the risk of similar events occurring, and full approval has been granted by the AER.

[Here AER admits to three earlier incidents in 2013 of the same nature but it allowed high pressure steaming to continue outside of Primrose East. The continued permitting of steaming operations is difficult to justify given the 2009 major bitumen release at CNRL's Pad 74 (ERCB 2011) which is described in the Discussion.]

The AER will continue to work closely with CNRL to investigate the incident, monitor cleanup efforts and provide advice to ensure any future applications to resume steam injection fully meet the technical expectations of the AER. The AER will review these restrictions on a regular basis and will only allow further steaming operations once it is assured that CNRL can develop the resources in a safe and responsible manner in accordance with all regulatory requirements....

27 July 2013 'Location' has been updated (originally 09-21-067-04W4, 45 km NW of Cold Lake). 'Volume reported' has been updated (originally 28 m3 bitumen and 127 m3 of oily vegetation. 40 hectares reported to have been impacted.). 'Status' has been updated (originally Over. Emergency phase over July 17, 2013.).

[This is confusing: the site 09-21-067-04W4 is correct; it was earlier reported incorrectly as 09-21-067-03W4; it was not “09-21-067-04W4”.]

2 August 2013 'Location' has been updated (originally 09-21-067-04W4, 10-01-067-04W4, 10-02-067-04W4, and 2-22-067-04W4 ~45 km NW of Cold Lake).

[This is confusing: the site 09-21-067-04W4 is correct; it was earlier reported incorrectly as 09-21-067-03W4; it was not “originally 09-21-067-04W4”. Conversely, sites 10-01-067-04W4, 10-02-067-04W4, and 2-22-067-04W4 are all incorrect; they are all in Range 3, not 4. The AER's difficulty with providing correct legal locations is not an isolated instance. In June 2013, the investigators informed AER (then ERCB) that the location provided for the June 2013 Apache Corporation pipeline spill near Zama city was incorrect (it was off by about 40 km; Timoney and Lee 2013). If the regulator has difficulty providing correct location data for the incidents, it calls into question all information provided by AER.]

'Volume reported' has been updated (originally 950 m3 bitumen. 20.7 hectares reported to be impacted by bitumen to date. These numbers reflect totals from all 4 sites.).

Volume reported (on 2 Aug 2013): 1060 m3 bitumen released and 20.7 hectares impacted. 344 m3 of oily vegetation recovered from the 09-21 site.
[How can 40 ha impacted by 27 July be revised downward to 20.7 ha as of 2 August 2013? Which number is accurate? A later update indicates that 20.7 ha figure refers to all four sites. Was the 40 ha impacted as of 27 July an overestimate? The use of the term “oily vegetation recovered” is misleading. AER means that oily vegetation has been collected for disposal at a landfill. It does not mean that there has been recovery of oily vegetation.]

10-01, 10-02 locations: Clean up continues. 8.5 m3 of bitumen recovered on July 28 from both sites. Impacted areas are still secured; wildlife deterrents remain in place and are monitored daily. The AER and ESRD continue to work with CNRL.

02-22 location: Clean up continues. 7.4 m3 of bitumen is reported to have been removed on July 28. Impacted areas are still secured; wildlife deterrents remain in place and are monitored daily. The AER and ESRD continue to work with CNRL.

09-21 location: Clean up continues. Additional wildlife deterrents have been deployed on the water body. Impacted areas are still secured; wildlife deterrents remain in place and are monitored daily. The AER’s investigation is ongoing. The AER and ESRD continue to work with CNRL.

2 August 2013, Press Release (AER 2013d)

Response efforts at the bitumen emulsion releases on Canadian Natural Resource Limited’s (CNRL) Primrose East and South locations continue. The Alberta Energy Regulator (AER) remains on site and is working with the company and other regulators to control the release, contain and clean up the surface impact, and investigate the circumstances that lead [*sic*, led] to the cause of the bitumen releases.

“AER staff have been working with the company to control these releases and understand why they happened in the first place,” said AER CEO Jim Ellis. “The AER’s formal investigation into the cause of these incidents is actively underway. We do not currently have the evidence or data to support any conclusions as to the cause of the incident and look forward to reviewing CNRL’s information supporting their conclusions on the root cause of the releases.”

[A press release by CNRL states the company believes that the releases of bitumen are due to essentially simultaneous failures of four well bores. See the following CNRL press release section.]

The AER’s direction to suspend and restrict steaming operations at the Primrose sites will remain in place until the regulator is satisfied that CNRL has provided factual technical information identifying the cause of the releases, has determined what is necessary to prevent future occurrences, and has demonstrated that measures are in place to prevent a similar incident from occurring in the future.

As of August 2, the combined volume of bitumen released from the four sites is 1060 cubic metres (m3), which has impacted 20.7 hectares of land. The impacted area has been delineated, wildlife deterrents are monitored daily, and cleanup continues. The AER is working closely with Alberta Environment and Sustainable Resource Development and other agencies to ensure all regulatory requirements are met.

[Does the 20.7 ha (or 40 ha) of land include impacted water bodies?]

The AER continues to provide updates through the incident reporting tool, which includes incidents reported to the regulator since the AER's launch on June 17, 2013. The web tool provides enhanced transparency about energy incidents that occur in the province and was developed in response to Albertans' request for more information. The tool can be found at www.aer.ca by clicking on Compliance and Enforcement then Incident Reporting.

The Alberta Energy Regulator ensures the safe, efficient, orderly, and environmentally responsible development of hydrocarbon resources over their entire life cycle. This includes allocating and conserving water resources, managing public lands, and protecting the environment while providing economic benefits for all Albertans.

AER (2013a), continued—

16 August 2013 'Location' has been updated (originally 09-21-067-03W4, 10-01-067-03W4, 10-02-067-03W4 and 02-22-067-04W4 ~45 km NW of Cold Lake).

'Status' has been updated (originally Ongoing. Response continues; emergency phase over July 17, 2013.).

'Volume reported' has been updated (originally 1060 m3 bitumen released and 20.7 hectares impacted. 344 m3 of oily vegetation recovered from the 09-21 site.).

Clean up continues on all four sites. Bitumen recovery at the source, skimming of other areas within water body and vegetation cutting continues at the 09-21 site. Bitumen recovery, impacted soil removal, fissure exposure, surface water management and containment efforts continue at the 10-01, 10-02 and 02-22 sites. To date the total wildlife impacts between all four sites have been reported with 2 beavers, 31 birds, 82 amphibians, and 31 small mammals deceased. Wildlife fencing and deterrents are installed and CNRL continues to monitor all four sites for wildlife and impacted wildlife. Subsurface investigation has been initiated and is ongoing. AER and ESRD continue to monitor sites on a regular basis.

[Because bitumen floats for a short time, then sinks, it is unclear how successful skimming and vegetation cutting might be for bitumen recovery. No independent scientists have been allowed on site; therefore, claims as to amount of bitumen recovered and amount of bitumen remaining in the substrate cannot be verified. Excavation to expose fissures at the 10-01, 10-02, and 02-22 sites indicates leakage from bedrock fissures. The list of dead animals found underestimates “total wildlife impacts”.]

The following reference numbers have been added to this incident: 20131458, 20131016, 20131126.

Volume reported: 1275.7 m3 total bitumen emulsion recovered between all four sites. 397 m3 of oily vegetation has been removed from the 09-21-067-4W4 (09-21) site. 5096.66 metric tonnes of impacted soils have been removed from the 10-01-067-3W4 (10-01), 10-02-067-03W4 (10-02) and 02-22-067-03W4 (02-22) sites. 20.7 hectares total is reported to have been impacted by all four sites.

[The removal of 5.1 kilotonnes of soil suggest extensive impacts to the surface. After saline pipeline spills in Alberta peatlands, reclamation that involves significant soil disturbance has been shown to be detrimental to the peatlands (Bright and Wood 2012).]

Status: Ongoing. Emergency phase over July 17, 2013.

29 August 2013 Clean up continues on all four sites. Bitumen recovery at the source, agitation and skimming of other areas within water body and vegetation cutting continues at the 09-21 site. Bitumen recovery, impacted soil removal, fissure exposure, surface water management and containment efforts continue at the 10-01, 10-02 and 02-22 sites. To date the total wildlife impacts between all four sites have been reported with 2 beavers, 40 birds, 101 amphibians, and 33 small mammals deceased. Wildlife fencing and deterrents are installed and CNRL continues to monitor all four sites for wildlife sightings and impacted wildlife. Early stages of the subsurface investigation continues and is ongoing. AER and ESRD continue to monitor sites on a regular basis.

[Although bitumen recovery reportedly continues, no updated figure on volume recovered was provided by AER. It bears repetition that the list of dead animals found underestimates “total wildlife impacts”.]

5 September 2013 Summary: Clean up continues on all four sites. Bitumen recovery at the source, agitation and skimming of other areas within water body and vegetation cutting continues at the 09-21 site. Bitumen recovery, impacted soil removal, fissure exposure, surface water management and containment efforts continue at the 10-01, 10-02 and 02-22 sites. To date the total wildlife impacts between all four sites have been reported with 2 beavers, 43 birds, 104 amphibians, and 40 small mammals deceased. Wildlife fencing and deterrents are installed and CNRL continues to monitor all four sites for wildlife sightings and impacted wildlife. Early stages of the subsurface investigation continues and is ongoing. AER and ESRD continue to monitor sites on a regular basis.

[Although bitumen recovery reportedly continues, no updated figure on volume recovered was provided by AER. It was reported that bitumen release had decreased to less than 20 barrels per day as of 31 July 2013 (CNRL 2013a). If such is true, and the volume recovered on 16 August 2013 was 1275.7 m³, and bitumen recovery continues as of 5 September 2013, why did the volume recovered not change between 16 August and 5 September 2013? It bears repetition that the list of dead animals found underestimates “total wildlife impacts”.]

The fact that AER stated the monitoring for impacted wildlife is being conducted by the company suggests no independent monitoring by government. The volumes of bitumen recovered (characterized by infrequent updates), contaminated soil removed, and other activities are apparently reported by AER verbatim from CNRL communications which suggests that AER is conducting no independent data gathering on these post-release actions.

Because no updates on volumes of bitumen recovered had been provided since 16 August 2013, the authors sent an email to Bob Curran at AER on 5 September 2013 in which they wrote: “Although bitumen release and recovery reportedly continues, no updated figure on volumes have been provided by AER. It was reported that bitumen release had decreased to less than 20 barrels per day as of 31 July 2013 (CNRL 2013a). If such is true, and the volume recovered on 16 August 2013 was 1275.7 m³, and bitumen recovery continues, why did the volume recovered not change between 16 and 29 August 2013?”

To that question, Mr. Curran replied (5 September 2013): “The incident reporting website is updated with new incidents every 24 hours and ongoing incidents are updated with new

information as it becomes available. We endeavour to update the CNRL posting on a weekly basis, regardless of whether there is new information.”

Perhaps as a result of either the foregoing correspondence or a coincidental provision of updated information from CNRL, AER provided a “weekly update” one day after the 5 September 2013 update, as follows:]

6 September 2013

Volume reported: 1444.4 m³ total bitumen emulsion recovered between all four sites. 494 m³ of oily vegetation has been removed from the 09-21-067-4W4 (09-21) site. 1049.62 metric tonnes of impacted soils have been removed from the 10-01-067-3W4 (10-01), 10-02-067-03W4 (10-02), and 02-22-067-03W4 (02-22) sites. 20.7 ha total is reported to have been impacted by all four sites

Status: Ongoing. Emergency phase over July 17, 2013.

'Location' has been updated (originally 09-21-067-04W4, 10-01-067-03W4, 10-02-067-03W4 and 2-22-067-3W4. Incident site locations are approximately 45 km NW of Cold Lake.).

'Volume reported' has been updated (originally 1275.7 m³ total bitumen emulsion recovered between all four sites. 397 m³ of oily vegetation has been removed from the 09-21-067-4W4 (09-21) site. 5096.66 metric tonnes of impacted soils have been removed from the 10-01-067-3W4 (10-01), 10-02-067-03W4 (10-02) and 02-22-067-03W4 (02-22) sites. 20.7 hectares total is reported to have been impacted by all four sites.).

[The 6 September 2013 update is misleading on two counts.

(1) As of 5 September 2013, the total impacted soils removed from the 10-01, 10-02, and 02-22 sites was given as 5,096.66 tonnes. On 6 September 2013, the value was changed to 1049.62 tonnes impacted soils removed from the three sites. As written, the 6 September 2013 value implies that a total of 1,049.62 tonnes impacted soils had been removed, which would mean that previous press releases which specified 5,096.66 tonnes removed were all in error. It is more likely that the 6 September 2013 AER press release meant either (a) that an additional 1,049.62 tonnes of impacted soils had been removed, over and above the previous 5,096.66 metric tonnes, or (b) that a decimal was misplaced and AER meant 10,496.2 metric tonnes of impacted soils were removed. Given the later 11 September 2013 press release, the latter possibility is more likely. In either case, the reporting of the tonnage is either confused and ambiguous or it is in error.

(2) Although the update states: “'Location' has been updated (originally 09-21-067-04W4, 10-01-067-03W4, 10-02-067-03W4 and 2-22-067-3W4,” this is incorrect. The location information was not updated, nor was it originally at the locations listed in that statement. Given that two and one-half months have elapsed since AER first began to post information about the CNRL Primrose incidents, and the investigators have communicated with AER in reference to inaccurate location data, it is difficult to understand how AER can continue to have difficulty communicating correct location information to the public.]

11 September 2013

Volume reported: 1529 m³ total bitumen emulsion recovered between all four sites. 515 m³ of oily vegetation has been removed from the 09-21-067-4W4 (09-21) site. 14 491 metric tonnes of impacted soils have been removed from the 10-01-067-3W4 (10-01), 10-02-067-03W4 (10-02)

and 02-22-067-03W4 (02-22) sites. 20.7 hectares total is reported to have been impacted by all four sites. Clean up continues on all four sites. Bitumen recovery at the source, agitation and skimming of other areas within water body and vegetation cutting continues at the 09-21 site. Bitumen recovery, impacted soil removal, fissure exposure, surface water management and containment efforts continue at the 10-01, 10-02 and 02-22 sites. To date the total wildlife impacts [= animals found dead] between all four sites have been reported with 2 beavers, 49 birds, 105 amphibians, and 46 small mammals deceased. Wildlife fencing and deterrents are installed and CNRL continues to monitor all four sites for wildlife sightings and impacted wildlife. At the 09-21 site CNRL has implemented additional monitoring and deterrents to prevent impacts to migratory birds attempting to land. Early stages of the subsurface investigation continues and is ongoing. AER and ESRD continue to monitor sites on a regular basis...

Volume updated: reported: was 1444.4 m³ total bitumen emulsion recovered between all four sites. 494 m³ of oily vegetation has been removed from the 09-21-067-4W4 (09-21) site. 1049.62 metric tonnes of impacted soils have been removed from the 10-01-067-3W4 (10-01), 10-02-067-03W4 (10-02), and 02-22-067-03W4 (02-22) sites.

[There are three updates of note. The removal of 14,491 tonnes of contaminated soils is striking and is evidence of a major ecological impact to the area and its wetlands. Secondly, the volume of bitumen recovered increased from 1444.4 m³ on 6 September to 1529 m³ on 11 September 2013, an increase of 84.6 m³ in five days or 16.92 m³/day (106.3 barrels/day). The volume update for removal of impacted soils in the second paragraph (1,049.62 metric tonnes) is a small fraction of the volume reported in the first paragraph (14,491 metric tonnes) for the same date (11 September 2013), which suggests that AER continues to experience difficulty reporting accurate, consistent information.]

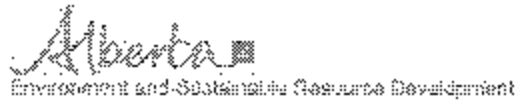
19 September 2013

Volume Reported: 1645.65 m³ total bitumen emulsion recovered between all four sites. 542 m³ of oily vegetation has been removed from the 09-21-067-4W4 (09-21) site. 15047.10 metric tonnes of impacted soils have been removed from the 10-01-067-3W4 (10-01), 10-02-067-03W4 (10-02) and 02-22-067-03W4 (02-22) sites. 20.7 hectares total is reported to have been impacted by all four sites.

[There are two updates of note. The removal of contaminated soil, totaling 15,047 tonnes as of 19 September 2013, continues to rise in volume and provides further evidence of ecological impacts that have received little attention in the press releases by the regulator and industry. This surmise is supported by the issuance of an Environmental Protection Order by Alberta Environment and Sustainable Resource Development (AESRD; see 24 September 2013 entry; Appendix). Secondly, the volume of bitumen recovered has continued to increase and was estimated to be 91.6 barrels/day over the 11-19 September 2013 period. See Section 3.4 and Table 2 for a discussion of bitumen release and recovery rates at the four sites.]

24 September 2013

[On 24 September 2013, AESRD issued an Environmental Protection Order (EPO) to CNRL (AESRD 2013a) in relation to the 09-21 bitumen release site. An excerpt from the EPO is provided below and the full EPO is provided in the Appendix.]



ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT

BEING CHAPTER E-12 R.S.A. 2000 (the "Act")

ENVIRONMENTAL PROTECTION ORDER NO. EPO-2013-33/NR.

Canadian Natural Resources Limited
Suite 2500
855 – 2nd Street SW
Calgary, Alberta
T2P 4J6

WHEREAS Canadian Natural Resources Limited (CNRL) holds *Environmental Protection and Enhancement Act* (EPEA) Approval No. 0011115-03-00, as amended, to operate the Primrose-Wolf Lake enhanced recovery in-situ oil sands and heavy oil processing plant and oil production site (the "Primrose-Wolf Lake Plant") within the Cold Lake Air Weapons Range at 65 & 66 - 5 & 6 - W4M, 67 - 3, 4 & 5 - W4M, and 68 - 4 & 5 - W4M, in the Province of Alberta;

WHEREAS On June 24, 2013, CNRL discovered and reported to Alberta Environment and Sustainable Resource Development (ESRD) a release of a substance, namely a bitumen emulsion (the "Substance"), within an unnamed permanent water body (the "Water Body"), which Water Body covers portions of NE21-67-4-W4M, SE21-67-4-W4M, NW22-67-4-W4M, SW27-67-4-W4M, and SE28-67-4-W4M at 09-21-067-04 W4M, all of which are hereinafter referred to as the "Aquatic Release Site", on the Primrose-Wolf Lake Plant site;

WHEREAS it is unknown how long the release had been occurring prior to June 24, 2013;

WHEREAS the bitumen emulsion consists of a mixture of hydrocarbons and water;

WHEREAS the cause of the release of the bitumen emulsion within the Water Body is unknown;

WHEREAS although CNRL has initiated some temporary containment measures, the bitumen emulsion release into the Water Body is on-going, and CNRL has been unable to determine the exact location and the subsurface conditions under which the release is continuing;

WHEREAS CNRL has advised ESRD that in order for CNRL to assess these underlying conditions of the Substance release into the Water Body and eventually contain the release, stop the release and carry out remedial action, CNRL must dewater a portion of the Water Body;

WHEREAS on September 20, 2013, CNRL submitted to ESRD a Revised Dewatering Feasibility Assessment and Water Management Plan (the "Dewatering Plan"), which proposes that CNRL be

permitted to dewater approximately two thirds of the Water Body and divert that water to a local borrow pit and the remaining one third of the Water Body;

WHEREAS the bitumen emulsion is a "substance" pursuant to section 1(mmm) of EPEA;

WHEREAS pursuant to section 1(tt) of EPEA, CNRL is a 'person responsible' for the Substance;

WHEREAS the Substance may cause and is causing an adverse effect on the environment, including the death of and damage to aquatic and terrestrial vegetation, aquatic and terrestrial invertebrates, aquatic life, amphibians, mammals and birds, and the degradation of water quality;

WHEREAS pursuant to section 112 of EPEA, CNRL has a duty to take all reasonable measures to:

- Repair, remedy and confine the effects of the substance;
- Remediate, manage, remove or otherwise dispose of the substance in such a manner as to prevent an adverse effect or further adverse effect; and
- Restore the environment to a condition satisfactory to the Director;

WHEREAS Michael Aiton, Regional Compliance Manager, [the "Director"], has been designated a Director for the purposes of issuing environmental protection orders under the Act

WHEREAS the Director is of the opinion that a release or a substance into the environment has occurred and is occurring and the release may cause or is causing an immediate and significant adverse effect;

THEREFORE, I, Michael Aiton, Regional Compliance Manager, pursuant to sections 113 and 114 of the *Environmental Protection and Enhancement Act*, DO HEREBY ORDER:

The Comprehensive Plan

1. CNRL shall prepare, in writing for the Director's approval, a Comprehensive Remedial Plan, the constituents of which have due dates set out herein.
2. In the Comprehensive Remedial Plan, CNRL shall include, at a minimum, each of the following:
 - a. Water Management Plan for Dewatering ;
 - b. Water Body Monitoring Plan;
 - c. Erosion and Sedimentation Prevention Plan;
 - d. Phase 2 Environmental Site Assessment Plan
 - e. Bitumen Emulsion Delineation and Containment Plan;
 - f. Amphibian Salvage Plan
 - g. Fish and Fish Habitat Assessment Plan;
 - h. Wetlands Impact Assessment Plan;
 - i. Water Body Restoration Plan.
 - j. Wildlife Management Plan, and
 - k. Waste Management Plan
3. CNRL shall implement of each and every part of the Comprehensive Plan under the direct supervision of a Qualified Aquatic Environmental Specialist, currently registered as a Professional Biologist with the Alberta Society of Professional Biologists.

[Key points in the excerpt include the facts: (1) it is unknown how long the release had been occurring prior to CNRL's notification of release on 24 June 2013; (2) that the cause of the release is unknown; (3) that the bitumen emulsion is causing an adverse effect on the environment, including the death of and damage to aquatic and terrestrial vegetation, aquatic and terrestrial invertebrates, aquatic life, amphibians, mammals, and birds, and the degradation of water quality.

It is interesting to note that the EPO (see Appendix) directs CNRL to carry out a Fish and Fish Habitat Assessment Plan on the 09-21 water body whereas the information provided by CNRL (below) indicates that the lake is "a 1.5 meter deep, non-fish bearing, shallow slough" which suggests that the Alberta government disagrees with CNRL's assessment.]

3 October 2013

Volume 1730.28 m³ [10,870 barrels recovered, see Table 2]

Bitumen recovery at the source, agitation and sheen management continues at the 09-21 water body. As a result of the Environmental Protection Order (EPO) issued by ESRD to CNRL, temporary removal of water from a portion of the waterbody is currently underway. (See following link for details and ESRD contact for any inquiries relating to the EPO <http://alberta.ca/release.cfm?xID=3503628AD742B-92C5-E54E-31B3D003B72A0792>)

Bitumen recovery, impacted soil removal, fissure exposure and surface water management continue at the 10-01, 10-02 and 02-22 sites. Excavation at the 10-1 and 2-22 sites are near complete while 10-2 excavation is still ongoing.

To date the total wildlife impacts between all four sites have been reported with 2 beavers, 50 birds, 105 amphibians, and 57 small mammals deceased... Wildlife fencing and deterrents are installed and third party consultants continue to monitor all four sites for wildlife sightings and impacted wildlife. At the 9-21 site CNRL has implemented additional monitoring and deterrents to prevent impacts to migratory birds attempting to land. Subsurface investigation continues and is ongoing. AER and ESRD continue to monitor sites on a regular basis.

[As of 3 October 2013, AER tallied a total 214 "wildlife impacts", i.e., animals found dead. Neither AER nor CNRL have discussed the fact that the number of animals found dead is an undefined subset of the total wildlife mortalities, nor that the habitat loss and contamination resulting from the four incidents will result in larger wildlife losses. The fact that the public and independent observers are not allowed on site renders unverified all statements made by the regulator and CNRL.]

10 October 2013

Volume 1750 m³ [10,994 barrels recovered, see Table 2]

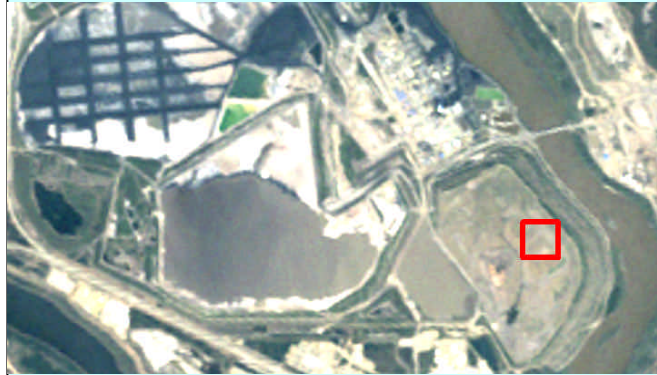
... As a result of the Environmental Protection Order (EPO) issued by ESRD to CNRL on September 24, 2013, temporary removal of water from a portion of the waterbody is ongoing... Excavation is complete at the 2-22 site while bitumen recovery at the exposed fissure, impacted soil removal from site and surface water management continues. Excavation at the 10-1 is near complete while excavation at the 10-2 site is ongoing. Bitumen recovery at the source, impacted soil removal, fissure exposure and surface water management continue at the 10-1 and 10-2 sites...

[The current volume recovered, when compared with the regulator's database of spills, makes this event the fourth largest bitumen release on record in Alberta. Of the 856 bitumen release incidents on record for which a recovered volume is provided, only three incidents have involved larger volumes of bitumen. This places the CNRL 2013 Primrose event at the 99.65 percentile

for bitumen volume released (data provided by Leslie Young (pers. comm., June 2013); Global News (2013)). The three largest bitumen release incidents were as follows: 2,500 m³ bitumen released after a CNRL well incident on 3 January 2009 at 14-01-67-03W4 (this is the CNRL Pad 74 event); 2,522 m³ bitumen released after a CNRL “crude oil” incident on 27 May 2004 at 02-12-82-23W4; and 3,000 m³ bitumen released attributed to an “unknown” company and an “unknown” cause on 3 April 2006 at 01-24-92-10W4 (Box 1). It is unclear why the regulator has been unable to identify the company responsible for the largest known bitumen incident on record in Alberta given that the location and date of the incident are known. It suggests that the regulator is lax in its data gathering, record keeping, and enforcement.

In some previous updates, AER provided information on the volume of impacted soil and vegetation removed. If, as of 10 October 2013, excavations continue at three of the four sites, presumably the volume of impacted soils and vegetation removed during excavation continues to increase. As of 19 September 2013, AER stated that: “542 m³ of oily vegetation has been removed from the 09-21-067-4W4 (09-21) site. 15 047.10 metric tonnes of impacted soils have been removed” from all sites. It is unclear why AER has not provided an updated volume for impacted soils and vegetation since 19 September. Because the regulator relies upon the company to report volumes of hydrocarbons spilled or recovered or impacted soils and vegetation removed, AER’s failure to update volumes may simply mean that the company did not update the regulator. In response to incidents, leaving what and when to report to the discretion of the company is a weakness of the regulator’s procedures.]

Box 1. Plotting of the largest reported bitumen release incident on record indicates that it occurred on the east side of Suncor’s Tar Island Pond One (location shown as the red box in the image below).



Reference to the incident database compiled for the region (Timoney and Lee 2013) reveals a Suncor spill on that date that may correspond to the AER incident: “Spill of pond effluent water into pond and sump; probably not into the Athabasca River. Cause is due to pressure safety valve lifted” (AESRD incident number 221357). No evidence of enforcement action was found in relation to this largest of known bitumen releases. Incidentally, the location and date of the 3,000 m³ 2006 bitumen release were near and occurred just prior to Total’s Joslyn project catastrophic blowout/cap rock failure which took place on 18 May 2006 at 15-33-95-12-W4 which was recorded by AER as the release of 5,000 m³ of process water.

17 October 2013

Volume 1785.1 m³ [11,214 barrels recovered, see Table 2]

Bitumen recovery at the source and removal of impacted vegetation continues at the 09-21 water body. As a result of the Environmental Protection Order (EPO) issued by AESRD to CNRL on September 24, 2013, temporary removal of water from a portion of the waterbody is ongoing. (See following link for details and AESRD contact for any inquiries relating to the EPO; <http://alberta.ca/release.cfm?xID=3503628AD742B-92C5-E54E-31B3D003B72A0792>)... To date the total wildlife impacts between all four sites have been reported with 2 beavers, 51 birds, 106 amphibians, and 57 small mammals deceased.

[It bears reiteration that the updated volume of bitumen recovered does not provide information on the volume of bitumen lost from containment underground. Over the past month, the daily volume of bitumen recovered has varied from 29.1 (28 September), 54.0 (3 October), 17.7 (10 October), to 31.4 barrels/day (17 October). Given the asymptotic trend in the number of barrels recovered per day over the past month, it is difficult to predict when the bitumen releases will cease. Similarly, the “total wildlife impacts” are underestimated by issuing of list of dead animals that have been found and reported. The impacts to wildlife extend to animals killed but not found or reported; animals that have left the area after exposure to contaminants; animals whose habitat has been disturbed or destroyed; and animals whose activities have been disrupted by excessive noise and other human disturbances associated with the incidents.]

21 October 2013

[On 21 October 2013, AESRD issued a second order to CNRL, this one an Enforcement Order (AESRD 2013b). The order stated that the “Director is of the opinion that a release of a substance into the environment has occurred and is occurring and the release may cause or is causing an immediate and significant adverse effect.” In brief, the order directed CNRL to (1) Contain all of the releases of the “Substance” and prevent the migration of the “Substance” to all currently unaffected areas; (2) Minimize and mitigate the migration of the “Substance” to all subsurface material; (3) Prepare a Comprehensive Plan with fixed reporting dates, including plans for subsurface site containment, delineation, and remediation for terrestrial release sites (10-01, 10-02, and 02-22); geology and regional groundwater delineation, monitoring, and remediation; source/flow pathways investigation; surface water management and monitoring; wildlife management; waste management; reclamation, and communications.]

19 January 2014 (AER online update was posted sometime between Friday night 17 January and Sunday 19 January 2014; downloaded on Sunday 19 January 2014)

From AER

Volume reported: Bitumen emulsion totals to date have been reviewed and revised to 1177.14 m³ recovered between all four sites. 557 m³ of oily vegetation has been recovered from the 09-21-067-4W4 (09-21) site. 69 698.73 metric tonnes of impacted solids have been recovered between all four sites. 20.7 hectares total is reported to have been impacted by all four sites. As a result of the Environmental Protection Order (EPO) issued by Alberta Environment and Sustainable Resource Development (AESRD) to CNRL on September 24, 2013, temporary removal of water from a portion of the waterbody is complete at the 09-21 location. The following link includes details and an AESRD contact for any inquiries relating to the EPO; <http://alberta.ca/release.cfm?xID=3503628AD742B-92C5-E54E-31B3D003B72A0792>. In addition to the EPO, an Enforcement Order (EO) was issued by AESRD to CNRL on October 21, 2013. The following link includes details and an AESRD contact for any inquiries relating to the EO; <http://alberta.ca/release.cfm?xID=35203A39DF085-0B3E-A27B-FDE1ED37CF2D3535>. Excavation to expose the fissure and removal of impacted solids

continues at the 9-21 site. Minimal bitumen and water volumes continue to be collected at the source. CNRL continues with the surface clean up and subsurface investigation at this release site.

[The foregoing update is significant for the following reasons. (1) For several months the authors have corresponded with AER in relation to the accuracy of the spill release and recovery data. That correspondence will be detailed and placed within a scientific context in an upcoming bulletin. In the meantime, it is noteworthy that as of ~ 19 January 2014, AER online incident data no longer reported “volume released” and “volume recovered”. Those data fields were replaced by a field entitled “volume”. (2) In the summary provided by AER, the regulator uses the term “volume reported”, which confirms the surmise that AER depends upon the company to report volumes released and recovered and that AER does not gather independent data nor does it verify company-reported incident data before posting. (3) In Sections 3.3 and 3.4 of this report, correspondence with AER and CNRL documents discrepancies and inconsistencies in the incident data.]

[On 11 and 19 September 2013, AER reported total volumes of 14,491 metric tonnes and 15,047 metric tonnes, respectively, of impacted soils removed. In the 19 January 2014 AER update, the regulator stated that 69,698.73 metric tonnes of impacted soils removed. To place that amount of impacted soils in perspective, consider that Enbridge removed about 190,000 cubic yards of contaminated sediment from the Kalamazoo River in Michigan over a three year period in response to its 2010 oil pipeline spill (US EPA 2013). Although metric tonnes and cubic yards cannot be compared directly because mass depends upon the proportions of sediment, water, and organic matter, the amounts of contaminated soil and sediment removed in response to both the Enbridge and CNRL incidents suggest significant ecosystem impacts.]

Maintenance and monitoring of the exposed fissures and containment continue at 2-22, 10-01, and 10-02 sites. CNRL has commenced lease construction operations at the three release sites and other approved surface locations in preparation for planned drilling operations as a part of the on going [*sic*] sub-surface investigation.

No new impacts to wildlife have been identified. Wildlife fencing and deterrents are installed at all four sites. Sites continue to be monitored for wildlife sightings and impacted wildlife.

For more information and pictures relating to the releases, please see the following link from CNRL’s website (<http://www.cnrl.com/corporate-responsibility/public-statement--primrose-update.html>).

Please note on a go forward [*sic*] that due to the freeze up during winter months, there will be reduced activity at these sites. As a result, the information on the Incident Reporting page will be updated monthly. Both the AER and ESRD continue to monitor the site, and if necessary, will reinstate more frequent reporting. For further information, please contact CNRL directly. Alternatively, please contact the AER’s Office of Public Affairs.

28 January 2014 (AER 2014)
From AER

[In late January 2014, AER issued a regulatory bulletin that applies to shallow thermal *in situ* bitumen applications in the region of the Wabiskaw-McMurray bitumen deposit in northeastern Alberta. It stated:]

The Alberta Energy Regulator (AER) is currently completing a thorough technical review of the factors that affect reservoir containment of steam-assisted gravity drainage (SAGD) projects and

will be consulting with stakeholders to develop formal regulatory requirements. Until those requirements are issued, the AER will defer decisions on applications for thermal oil sands projects that meet the following criteria:

1) Fall within a designated shallow thermal area of the Wabiskaw-McMurray Deposit in the Athabasca Oil Sands Area (see attached map).

The AER believes that the risk of steam and reservoir fluids being released at surface is greater if reservoir containment is compromised in this area due to the shallow nature of the resource.

2) Address reservoir containment in a manner that is different from the approach the AER currently uses.

Currently, the AER assesses reservoir containment for SAGD projects by establishing caprock integrity and determining the maximum operating pressure (MOP). A caprock must have sufficient thickness and competency and be continuous across the project area to contain steam and heated reservoir fluids. In the shallow thermal area, the Clearwater shale is the interval currently accepted as a caprock. The integrity of the Clearwater shale is established, in part, by acquiring 3-D seismic over the entire development area.

The MOP is calculated by applying the following formula:

$$\text{MOP} = 0.8 \times \text{caprock fracture closure gradient} \times \text{depth to base of caprock}$$

where 0.8 is a safety factor

The AER is satisfied that deferring decisions on applications under these circumstances supports safe and responsible development at these projects and will ensure the consistency of regulatory decisions until new fully consulted and technically supported requirements are in place.

[Although the AER bulletin may not relate directly to the CNRL Primrose incidents, it suggests that the regulator has concerns that the safety of *in situ* steaming operations may have been overestimated in the past. In retrospect, had the directive been issued earlier, it would have prevented the 2006 Total Joslyn incident and the 2010 Devon Canada Jackfish incident in northeastern Alberta. A similar directive issued by the regulator for the Primrose area would have prevented CNRL's Pad 74 incident in 2009 and the ongoing bitumen releases at CNRL Primrose.]

3.2 Information Provided by CNRL

31 July 2013 (CNRL 2013a) Canadian Natural Resources Limited (“Canadian Natural” or the “Company”) would like to provide an update to an incident at the Company’s Primrose development area in which bitumen emulsion was discovered at surface at four separate locations. The discoveries were immediately reported to the Alberta Energy Regulator (“AER”) and concurrently crews were dispatched to initiate necessary action. Each location has been secured and clean-up, recovery and reclamation activities are well underway. The bitumen emulsion does not pose a risk to health or human safety. The Company is working diligently with the AER and Alberta Environment and Sustainable Resource Development to investigate and remediate the affected locations. Canadian Natural is committed to ensuring the cleanup and reclamation work is done right, while minimizing impacts to the environment. Canadian Natural is also taking proactive measures to prevent this type of incident in the future.

[From the standpoint of statistical probability, the near-simultaneous occurrence of four incidents at four separate locations appears unlikely. Such simultaneity of incidents appears even less likely if the view espoused by both CNRL and AER is valid that high pressure cyclic steam stimulation has been conducted for decades without incident. Finally, as the recently released ERCB (AER) spills database demonstrates, the prevention of spills and releases is not possible. It is feasible to lower the probability of spills and releases, but it is not possible to prevent them.]

The four locations initially impacted at Primrose covered an area of 20.7 hectares. The bitumen emulsion seepage is now controlled to specific containment areas where it is effectively recovered as it reaches the surface. As a result of the Company’s successful active clean-up efforts, approximately 6,300 barrels of bitumen emulsion has been collected to date, with the Company now focusing on a reduced impact area of 13.5 hectares. The rate of bitumen emulsion seepage in all four locations has declined as expected and now totals less than 20 barrels per day.

[The decline in the rate of release to “less than 20 barrels per day” is probably inaccurate (see Section 3.4 and Table 2). No evidence has been presented to indicate how much bitumen is being lost from containment below-ground but is not reaching surface. The total volume of such escaped sub-surface bitumen may be greater than that released to the surface. The view that the clean-up has been successful has not been verified. Accepting the unverified statement that 6,300 barrels of bitumen emulsion have been collected to date, the question arises: How much bitumen has been released and not collected? Does CNRL’s focus on a “reduced impact area of 13.5 hectares” mean (a) that the company is focusing its efforts on an area that has been less impacted than a more impacted area? or (b) that reclamation is complete in all but 13.5 ha? By lowering the impact area to 13.5 ha, is CNRL implying that the initial impact area of 40 ha, later lowered to 20.7 ha, is reduced still further to 13.5 ha? Is this implying that removal of bitumen, bitumen-coated vegetation, and contaminated soils convert an area from impacted to non-impacted? CNRL expected that the volume of bitumen released per day would decline over time with the cessation of steaming. This expectation reveals an admission that the bitumen release was the result of high pressure steaming.]

One affected location, which is now contained, is a 1.5 meter deep, non-fish bearing, shallow slough that does not flow in or interact with other water bodies. Canadian Natural is conducting groundwater monitoring activities in the vicinity of all locations and is undertaking aquatic and sediment sampling to monitor and mitigate any potential impacts.

[There are four affected areas, not one, and at each site, water would have been affected because all four sites are located within wetland complexes (Figures 3 and 4). Secondly, the affected waterbody at release site 09-21-67-04W4 is a 50.3 ha lake, not a slough (Figure 4, panels d, e). The 31 July 2013 CNRL press release states that this lake is a “shallow slough that does not flow in or interact with other water bodies”. Detailed aerial imagery released in December 2013 (CNRL 2013i) indicates that water flow in the spill site 4 peatland complex is towards the south then west into the Wolf River (see Figure 3, upper left corner).]

The Company has implemented aerial and ground surveillance across its Primrose operations area and has not identified any additional bitumen emulsion seepages outside of the four identified locations. The ongoing efforts of over 120 employees and contractors on site will continue to reduce the impacts of these bitumen emulsion seepages until the locations are fully remediated.

Unfortunately some animal fatalities have occurred including 16 birds, 7 small mammals and 38 amphibians. Two beavers, two birds and two muskrats are currently being cared for prior to being returned to their natural environment.

[Although this CNRL press release is dated 31 July 2013, an incident status report (AER 2013a) dated 26 July 2013 indicated that the two beavers had died. By 16 August the animals found dead had reached 2 beavers, 31 birds, 82 amphibians, and 31 small mammals (AER 2013a).]

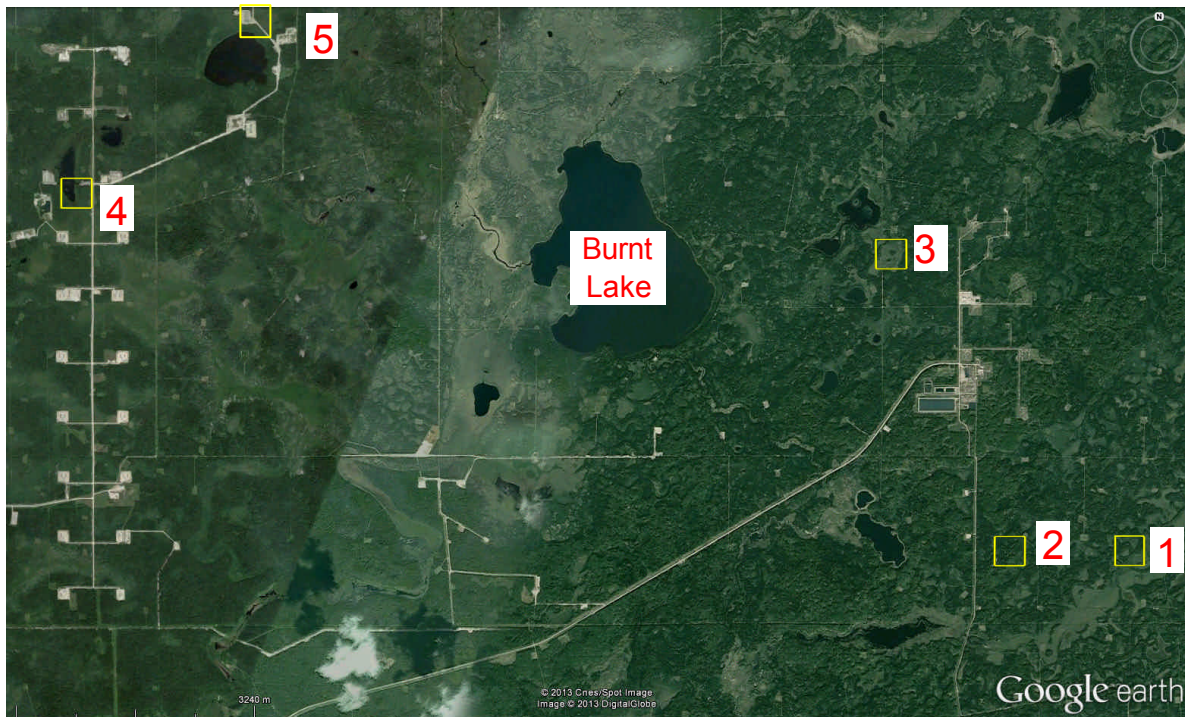


Figure 3. Locations of the 2013-2014 CNRL bitumen release sites within the context of the local landscape, which is predominantly a bog and fen peatland complex, as plotted on a Google Earth mosaic constructed from images taken on 19 June 2005 and 7 July 2005. 2013 Locations: (1) LSD 10, Sect. 01, Twp 67, Rge 03, W4; (2) LSD 10, Sect. 02, Twp 67, Rge 03, W4; (3) LSD 02, Sect. 22, Twp 67, Rge 03, W4; and (4) LSD 09, Section 21, Township 67, Range 04, W4. (5) LSD 03, Sect. 35, Twp 67, Rge 4, W4; this is the January 2014 CRNL bitumen release, AER incident number 20140048 (location provided by M. Darwent, AER, 28 January 2014). Pad 74, the site of the 2009 bitumen release, did not exist in 2005; it is located in LSD 14, Sect. 01, Twp 67, Rge 03, W4, ~ 700 m northwest of site (1); for the location of Pad 74, see Figure 4.

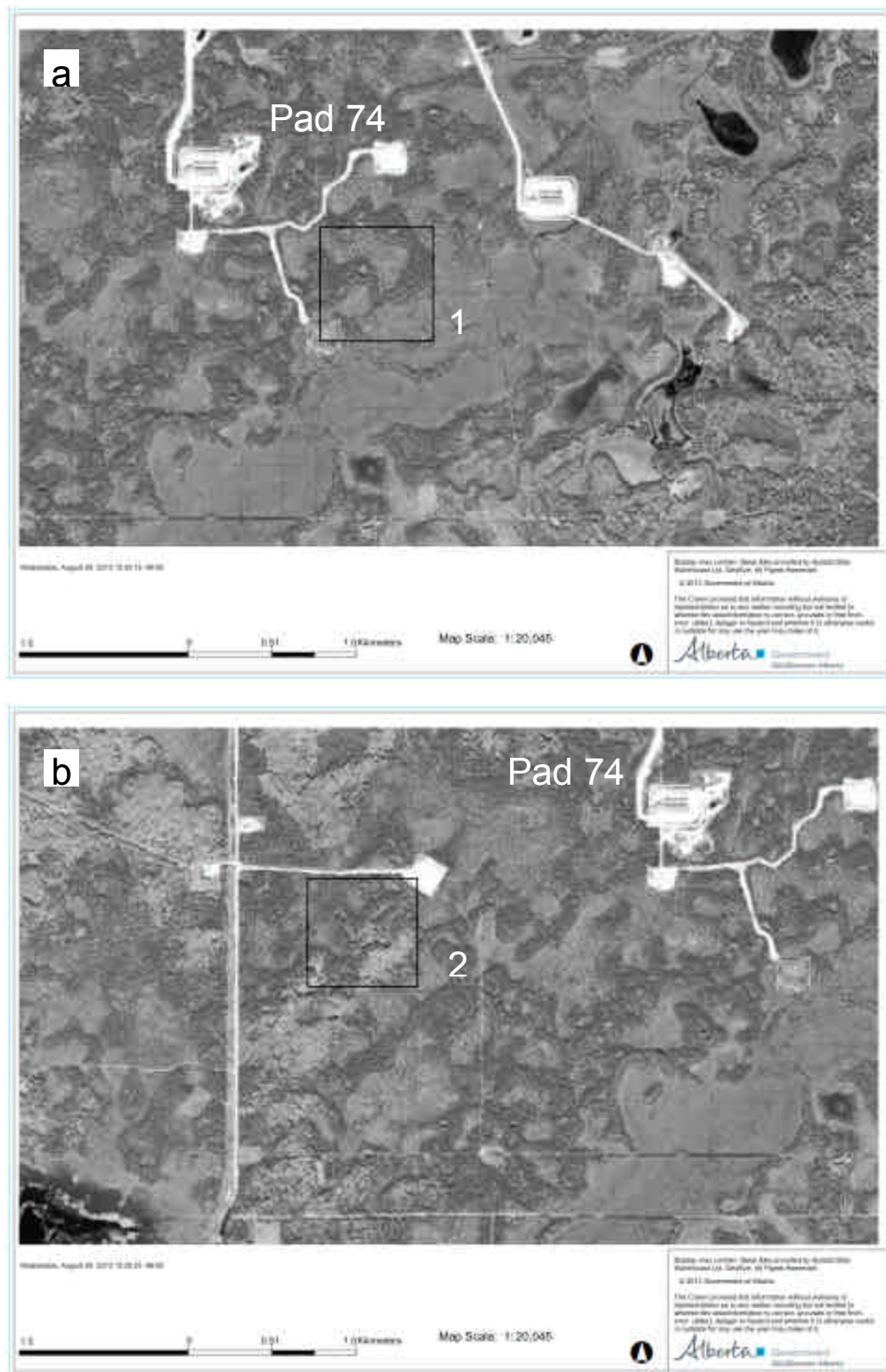


Figure 4. (a) CNRL spill site 1 (10-01) and (b) spill site 2 (10-02), delimited by black squares. Positions are based on legal locations provided by AER . Note the proximity of CNRL Pad 74.

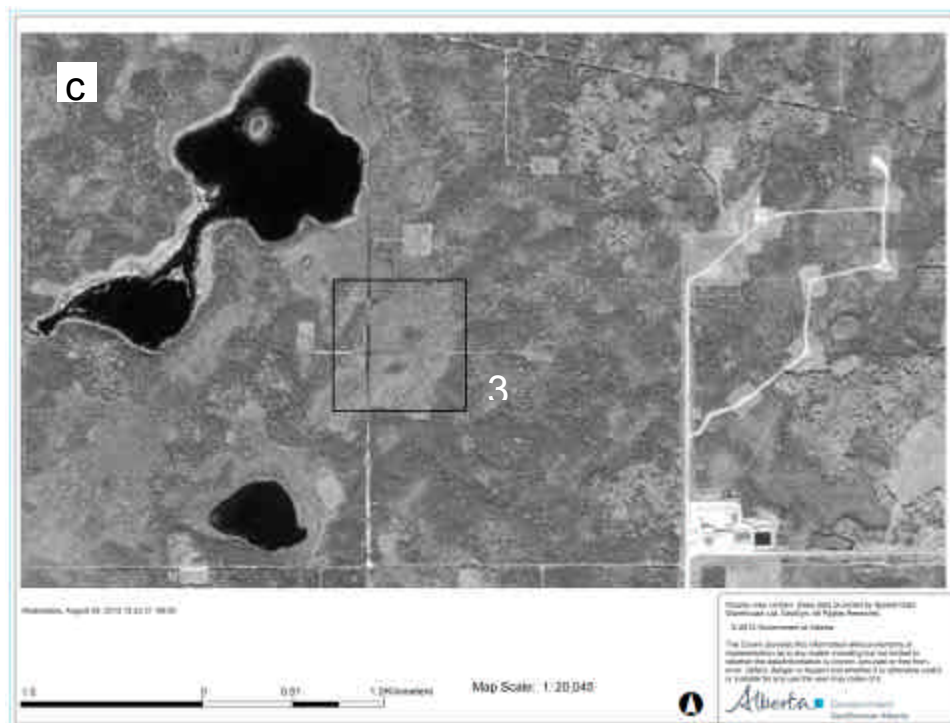


Figure 4, continued. (c) CNRL spill site 3 (02-22) and (d) spill site 4 (09-21), delimited by black squares. Positions are based on legal locations provided by AER.

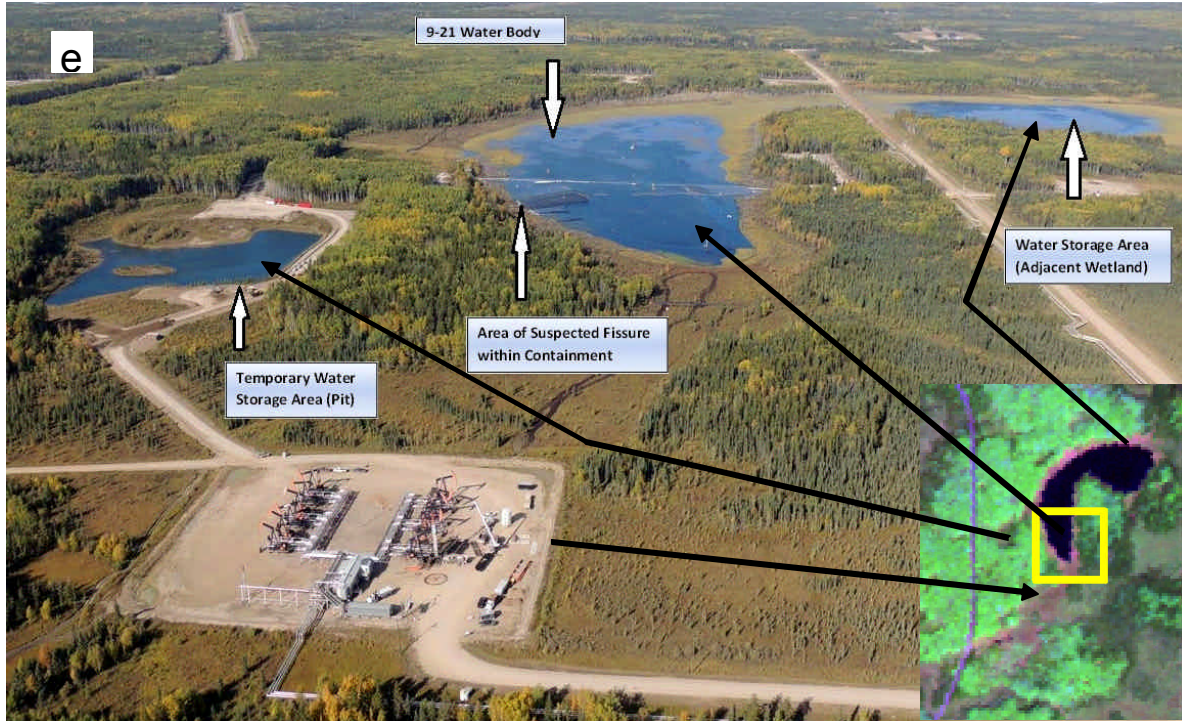


Figure 4, continued. (e) Oblique aerial view of spill site 4 (the 09-21 site). Image modified from CNRL (2013e); image date was not provided. The inset in the lower right is from a September 1987 false colour Landsat image (the yellow box indicates the legal location of the 09-21 spill site). Desiccation of the 09-21 lake post-1987 is evident as is the increase in landscape disturbance over the period. The placement of the well pad directly within the wetland drainage channel would have modified the local hydrology. The “storage area (pit)” was formerly a natural wetland. According to AER correspondence (4 October 2013), there is no well associated with the 09-21 bitumen release site.

As part of the Company's wildlife mitigation program, fencing and deterrents have been deployed in the area. Canadian Natural believes the cause of the bitumen emulsion seepage is mechanical failures of wellbores in the vicinity of the impacted locations. In over 30 years of using the current steaming and extraction method in the Primrose area, there have been few bitumen emulsion seepages to surface. This is due to the fact that most potential wellbore failures are corrected before steaming. In cases where potential wellbore failures are not repairable, steaming strategies can be modified, to prevent these types of incidents from occurring in the future. A complete review is ongoing and Canadian Natural has a specialized team focused on investigating wells in the impacted areas for any potential required remediation work.

[The statement that there have been few releases of bitumen emulsion to the surface merits scrutiny. Examination of the regulator's spill database for the CNRL operations in the Primrose area documented 36 releases of bitumen between April 2003 and January 2013 (Table 1a, Figure 5). That list does not include the four recent releases of bitumen in 2013 that are the focus of this bulletin.

Setting aside those four incidents for the moment, the regulator's data indicate that the cause of the remaining 36 incidents were as follows: blowout (n = 3), internal corrosion (1), equipment failure (10), flare stack (1), fracturing operation (1), high level switch (1), high pressure switch (1), line failure (1), metal fatigue (1), cause field left blank (1), operator error (5), power failure (1), separator (1), tank overflow (1), unknown (1), valve failure (1), valve leak (2), valve or fitting failure (3). The largest of the 36 releases reportedly occurred on 3 January 2009 during which 2500 m³ of crude bitumen were reportedly released; the cause of this incident was left blank in the ERCB database. This incident, which involved a major release of bitumen to surface at CNRL's Pad 74 (ERCB 2011), is described in Section 4.1.

Other noteworthy incidents included a blowout release of 390.5 m³, an equipment failure release of 346 m³, and another well blowout of 50 m³.

Examination of the CNRL bitumen release data (Table 1a) reveals a nearly perfect recovery of bitumen. The correlation between bitumen volume released and recovered was 0.84, (df = 34, p < 0.0001). In 29 out of 35 incidents, the volume recovered exactly equaled the volume released (one incident did not provide a recovered volume); the only notable exceptions occurred after an equipment failure and after an incident of unspecified cause. Examination of bitumen release and recovery data for the entire province provides evidence that the reported post-spill recovery of bitumen may not be based on empirical data (Table 1b, Figure 6). The bitumen recovery rates are sufficiently high to call into question the validity of the data. For example, the correlation between the volume released and the volume recovered for the full dataset was $r = 0.961$ (df = 855, $p < 0.0001$) and for the subset of spills of ≥ 1 m³, $r = 0.966$ (df = 531, $p < 0.0001$). Indeed, for the full dataset, the volume recovered was equal to or greater than the volume released in 85.4 % of incidents. For the dataset of spills ≥ 1 m³, the volume recovered was equal to or greater than the volume released in 86.5 % of incidents. For both datasets, the median rate of bitumen recovery equaled 1.00 (i.e., 100 % recovery of spilled volumes).

The admission that most potential well bore failures are corrected before steaming raises the question as to why all potential well bore failures are not corrected before steaming? Secondly, the admission that where potential well bore failures are not repairable steaming strategies can be modified raises the question why would steaming be allowed by the regulator when there is a significant probability of an incident. Finally, it is misleading for CNRL to state that these incidents can be prevented.]

As a result of the bitumen emulsion seepages, the Company's near term steaming plan at Primrose has been modified, with restrictions on steaming in some areas until the investigation

with the AER is complete. With these steaming restrictions Canadian Natural has begun the production cycle in some areas earlier than would normally have been the case. Canadian Natural's July production was approximately 120,000 bbl/d with an additional 20,000 bbl/d of production capacity in such month restricted due to available plant capacity. The Company believes that it will achieve its 2013 Thermal production guidance of 100,000 – 107,000 bbl/d. For 2014, even with these modified steaming strategies, the Company anticipates Thermal production, excluding Kirby South, to be 100,000 to 110,000 bbl/d range, in line with expected 2013 Thermal production levels and approximately 10,000 bbl/d less than originally targeted for 2014. The Company is of the view that reserves recovered from the Primrose area over its life cycle will be substantially unchanged.

[As a result of the four current incidents, CNRL has accelerated production elsewhere. The imperative to reach production targets reveals that the possibility that the HPCSS process may lead to groundwater and ecological damage is not a serious concern for the company.]

Canadian Natural is committed to conducting all of its operations in a way that strives to identify, minimize and mitigate harm to the health and safety of employees, contractors, the public, animals and the environment. Canadian Natural will continue to make available any necessary resources for investigation, clean-up and safeguards to ensure events such as these do not happen again.

[It bears reiteration that CNRL cannot prevent these and other similar releases from occurring in the future. The statement that CNRL will continue to make available any necessary resources for investigation is considered in Section 3.4 of this bulletin.]

CNRL Update (Reporting Period 25-31 August 2013)
[CNRL (2013b) excerpts that contain new information]

Operations Update

As a result of our active clean-up efforts approximately 9,000 barrels of bitumen emulsion have been recovered to date, and we are focusing on a reduced impact area of 13.5 hectares, a 35% reduction since our original report. The rate of bitumen emulsion seepage in all four locations now totals less than 20 barrels per day.

[See Section 3.4 and Table 2 for a discussion of bitumen release and recovery rates at the four sites.]

As we clean up each site, we are focused on minimizing the environmental impact on the surrounding areas. We have designated decontamination areas and dispose of all used personal protection equipment, absorbent materials, vegetation and soil off-site at specially designed waste management facilities.

[In Pratt (2013), contaminated soil is noted as being disposed at a landfill site, which connotes something different than “specially designed waste management facilities.”]

Environmental Update

We are on the lookout for migrating birds at this time of year, and are pleased to observe birds altering their course as they near our bird deterrent systems. We built an aluminum scaffold structure over the fissure at the water body site so birds cannot land. In addition to the wildlife

monitoring sweeps, we have trail cameras with remote and infrared motion sensors, in order to detect any animal activity.

Unfortunately some animal fatalities have occurred and three beavers, seventeen birds and two small mammals are being cared for at a Wildlife Rehabilitation Centre, prior to being returned to their natural environment.

[This statement lists animals that are being cared for at a wildlife rehabilitation; it does not disclose the numbers and kinds of animals that have been found dead, nor does it address the fact that animals found dead represent a subset of the total animals that have died. That total is the sum of dead animals not found + dead animals found. Finally, the statement does not indicate what proportion of the animals that have been removed to the rehabilitation centre have later died.]

Investigation

We are working diligently with the Alberta Energy Regulator and Alberta Environment and Sustainable Resource Development to investigate and remediate the affected locations and investigate the cause.

Canadian Natural believes the cause of the bitumen emulsion seepage is mechanical failures of wellbores in the vicinity of the controlled areas. We are in the process of identifying and investigating these wellbores. We are drilling hydrogeological and delineation wells adjacent to the affected locations to aid in the investigation.

[CNRL here restates its view that the cause of the incidents is the simultaneous failure of multiple well bores. The simultaneous failure view is discussed in Section 4.3.]

For More Information, please:

Visit our website at www.CNRL.com

For media, contact 403-514-7777 or IR@cnrl.com

[This is the CNRL investor relations office. Why is a contact provided for media and not for the public?]

[The update provided a photograph of an excavation of a surface fissure at site “02-22”.
The caption read:]

[Exposed Fissure at 2-22](#)



[Notes to accompany the image. This view of part of the excavation at the “02-22” release site reveals two bitumen-releasing fissures that converge near photo center (red arrows). The excavation trench cuts through an imperfectly-drained black spruce forest. The bitumen here is being released from a three-dimensional network of fissures, not from a single well bore. The three-dimensional spatial extent and volume of the bitumen releases below-ground have not been ascertained. Image modified after CNRL (2013 b).]

Table 1a. Releases of bitumen at CNRL sites in the Primrose area from April 2003 to January 2013 as recorded in the ERCB releases database. Apparently the three incidents noted in the press releases that occurred early in 2013 are not included in these data, nor are the four incidents that are the subject of this bulletin.* Of the 36 release incidents of crude bitumen, 32 incidents specified crude bitumen as the primary substance released and four incidents (beneath the bold line in the table) specified crude bitumen as the secondary substance released.

Incident	LSD	Sect	Twp	Rge	Incident MoDayYR	Cause	Bitumen Released m ³	Bitumen Recovered m ³	Bitumen Residual m ³
20030991	10	8	66	5	4/19/2003	Hi Level Switch	15	15	0
20031109	10	8	66	5	5/3/2003	Valve Leak	0.1	0.1	0
20042260	8	9	66	5	9/21/2004	Unknown	1	1	0
20050766	2	17	66	5	3/29/2005	Valve Or Fitting Failure	3	3	0
20060414	14	22	66	5	2/11/2006	Separator	3	3	0
20060915	1	9	66	5	4/10/2006	Equipment Failure	0.5	0.5	0
20061088	10	8	66	5	4/29/2006	Operator Error	7	7	0
20082582	10	8	66	5	10/27/2008	Equipment Failure	10	10	0
20082645	10	8	66	5	11/1/2008	Equipment Failure	6	6	0
20090757	10	8	66	5	4/10/2009	Equipment Failure	15	15	0
20111055	10	8	66	5	5/18/2011	Operator Error	7	7	0
20121102	10	9	66	5	5/14/2012	Line Failure	1.5	1.5	0
20121389	10	8	66	5	7/3/2012	Operator Error	1	1	0
20090005	14	1	67	3	1/3/2009	Left blank (see ERCB 2011)	2500	2400	100
20111111	9	2	67	3	5/24/2011	Hi Pressure Switch	1	0	1
20111114	14	2	67	3	5/24/2011	Fracturing Operation	1	0	1
20121757	2	15	67	3	8/24/2012	Valve Or Fitting Failure	2	2	0
20121960	4	14	67	3	9/23/2012	Power Failure	75	75	0
20042185	9	30	67	4	9/15/2004	Equipment Failure	10	10	0
20052167	14	35	67	4	9/11/2005	Equipment Failure	25	25	0
20070035	3	35	67	4	12/30/2006	Blowout	390.5	390.5	0
20070556	3	35	67	4	2/25/2007	Equipment Failure	2	2	0
20070893	1	15	67	4	4/4/2007	Equipment Failure	3	3	0
20071146	3	35	67	4	5/7/2007	Equipment Failure	2	2	0
20090437	13	15	67	4	2/27/2009	Tank Overflow	1	1	0
20092169	3	26	67	4	11/12/2009	Equipment Failure	346	0	346
20110383	3	34	67	4	2/9/2011	Blowout	15	15	0
20121718	16	19	67	4	8/21/2012	Corrosion Internal	0.2	0.2	0
20110092	3	2	68	4	12/29/2010	Metal Fatigue	0.1	0	0.1
20110591	4	15	68	4	3/10/2011	Blowout	50	Left blank	50
20111671	1	15	68	4	7/13/2011	Operator Error	0.4	0.4	0
20130060	1	15	68	4	1/9/2013	Operator Error	0.1	0.1	0
20032163	10	8	66	5	9/6/2003	Valve Leak	2	2	0
20112068	10	8	66	5	10/12/2011	Valve Failure	1	1	0
20111821	1	31	67	4	9/14/2011	Valve Or Fitting Failure	0.1	0.1	0
20122623	10	5	67	4	12/29/2012	Flare Stack	1.5	1	0.5

* Crude bitumen release incidents are limited to those in Twp 66, Range 5, Twp 67, Ranges 3, 4, 5, and Twp 68, Ranges 3, 4, 5, all W4 meridian.

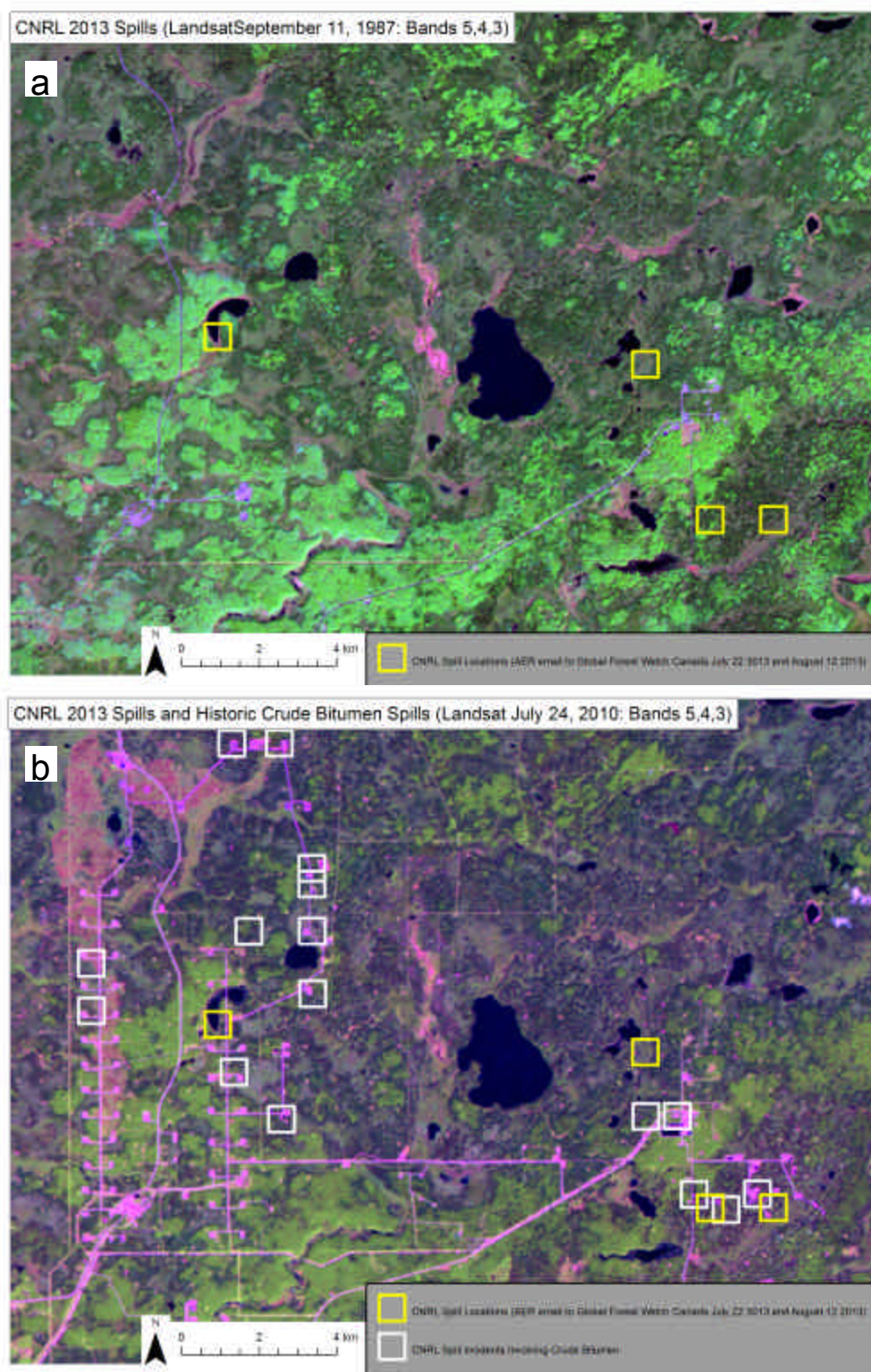


Figure 5. False-color infra-red satellite images of (a) the area of the four 2013 bitumen releases (yellow boxes) in September 1987 and (b) the area in July 2010. Other bitumen releases attributed to CNRL in the area near the 2013 releases are plotted (white boxes) based on the ERCB spills database. The increase in landscape disturbance over the 26-year period is significant.

Table 1b. Statistics and Spearman correlations for released and recovered volumes of crude bitumen release incidents in Alberta based on ERCB (AER) data.

	Dataset: All crude bitumen releases		
Statistic	Variables		
	Volume Released (m ³)	Volume Recovered (m ³)	Volume Recovered/ Volume Released
N	945	856	855
Minimum	0	0	0
Maximum	3000	3000	290
Range	3000	3000	290
Median	2.00	2.85	1.00
Mean	20.23	21.45	1.31
Correlation	r = 0.961, df = 855, p << 0.0001		
	Dataset: Volume released >0.999 m ³		
	Volume Released (m ³)	Volume Recovered (m ³)	Volume Recovered/ Volume Released
N	553	532	532
Minimum	1	0	0
Maximum	3000	3000	21
Range	2999	3000	21
Median	5.00	5.00	1.00
Mean	34.45	34.34	1.00
Correlation	r = 0.966, df = 531, p << 0.0001		

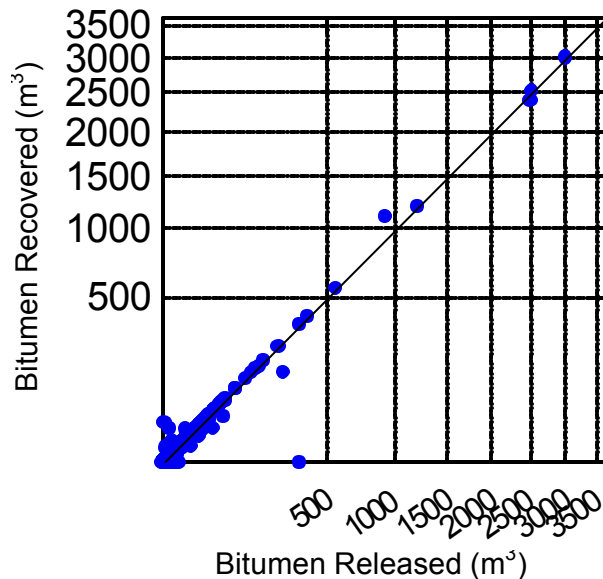


Figure 6. Relationship between crude bitumen released and recovered based on ERCB release data. The diagonal line depicts a perfect 1:1 relationship between volume released and volume recovered. Points above the line indicate that more bitumen was recovered than was released. Both the x and y-axes are power-transformed (power = 0.5) to better depict the lower values. There are 856 data points; hundreds of data points overlap.

CNRL Update (Reporting Period 1-7 September 2013)
[CNRL (2013c) excerpts that contain new information]

Operations Update

As a result of our active clean-up efforts approximately 9,400 barrels of bitumen emulsion have been recovered to-date... Currently there are approximately 200 workers on all sites involved with clean-up activities...

[The volume of bitumen recovered continues to increase. AER data indicate a recent increase in the volume of bitumen recovered per day. It is noteworthy that the sentence “The rate of bitumen emulsion seepage in all four locations now totals less than 20 barrels per day” that was provided in the previous CNRL update has been deleted from this update. Taken together, the information suggests that CNRL has retreated from its view that “less than 20 barrels per day” are being released and further that there is no immediate end in sight to the bitumen releases. The fact that 200 workers are being employed to deal with the bitumen releases indicates the large scale of the incidents.]

Environmental Update

Our current regional groundwater monitoring network in the Primrose area includes 229 wells and identifies contaminants, if any, in the shallow groundwater and aquifers, at each of our sites. We are planning an additional 80 wells as part of our enhanced monitoring program.

In addition to our regional ground water monitoring, we have a surface water and sediment sampling program for monitoring the level of hydrocarbons, if any, around each site.

[It would be informative for CNRL to release the data derived from these monitoring wells and sampling programs. Data released as part of the ERCB (2011) investigation of the Pad 74 bitumen release documented groundwater contamination.]

Three beavers being cared for at a Wildlife Rehabilitation Centre are to be returned to their natural environment next week.

[The wildlife impacts information released by CNRL has been minimal to date and has been reduced in this update to a single sentence about three beavers that are to be reintroduced into natural habitat. Although this is positive news, the fact that no other information is supplied is significant. CNRL has not provided updated numbers and species of animals that have been found dead, nor does it address the fact that animals found dead represent a subset of the total animals that have died. Finally, the statement does not indicate what proportion of the animals that have been removed to the rehabilitation centre have later died.]

Investigation Update [not reproduced because it is verbatim from the 25-31 August update]

CNRL Update (Reporting Period 8-14 September 2013)

[CNRL (2013d) excerpts that contain new information]

Operations Update

As a result of our active clean-up efforts approximately 10,100 barrels of bitumen emulsion have been recovered to-date.

We have further reduced the bitumen impacted area from 13.5 hectares to 7.4 hectares, a 65% reduction since our original report...

[The previous statement is potentially misleading. CNRL appears to imply that once contaminated soils have been removed from an area, the area is no longer impacted.]

There have been no further discoveries of bitumen emulsion to surface or any other liquids to surface at our Primrose sites.

[The previous statement is potentially misleading. AER incident data indicate recent CNRL Primrose area incidents, but they are not the same kind of uncontrolled, fracture-related incidents as the four ongoing releases. On 31 August 2013, there was a pipeline release of crude bitumen, estimated volume of 4 m³, on a pipeline right-of-way 43 km northwest of Cold Lake (AER incident 20131701). On 20 August 2013, there was a bitumen release of unknown volume due to equipment failure at a CNRL multiphase pipeline 40 km northwest of Cold Lake (AER incident 20131596).]

Environmental Update

Three beavers and one muskrat were released on Sept 11, 2013, bringing the release rate of animals captured live to 77%.

The animals were released onto private property with a fenced-in area with brush and a pond, to encourage them to remain in this location for the winter. The site was prepared with fresh cuttings and a small den area to give the beavers a head-start on winter preparation of their new lodge. The beavers will continue to receive supplemental tree cuttings as they build up their winter food stockpile over the next 4 to 6 weeks.

After the beavers were released they were observed investigating their new home, playing and foraging for food. A joint post-release monitoring project will begin immediately to track the beavers' activity for the next 400 days.

[As with other CNRL statements, what is not stated may be more important than what is stated. The press release does not address key wildlife concerns, such as (1) how many animals remain in care?; (2) how many animals have died at the rehabilitation center?; (3) what are the species and total number of animals that have been found dead; (4) the fact that the number of found dead animals is a subset of the total number of dead animals; and (5) the contamination and loss of wildlife habitat that have resulted from the four incidents.]

Investigation Update [not reproduced because it is verbatim from the 25-31 August update]

CNRL Update 24 September 2013

[In response to the EPO issued by AESRD on 24 September 2013 in relation to the 09-21 release site, CNRL issued the following press release (CNRL 2013e).]

Canadian Natural Resources Limited would like to provide an update to the incident at the Primrose development area in which bitumen emulsion was discovered at surface at four

locations. Each location has been secured and clean-up, recovery and reclamation activities are progressing well.

[Given the fact that an EPO was required, and that bitumen continues to be released with no sign of abatement, it is difficult to understand how the “reclamation activities are progressing well”.]

We are working diligently with the Alberta Energy Regulator (AER) and Alberta Environment and Sustainable Resource Development (ESRD) to investigate and remediate the affected locations and investigate the cause. We are at a phase in our restoration plan for the 9-21 site where we require access to the fissure below the shallow water body. We have determined the best regulatory approach to manage this work is through the Environmental Protection Order process.

[The CNRL reference to its being in a phase in their “restoration plan” is interesting on two accounts: (1) That it refers to restoration rather than reclamation in that restoration connotes a higher level of ecological engineering (restoration to pre-disturbance conditions) than does reclamation. (2) That the EPO directs CNRL to prepare a “Comprehensive Remedial Plan”, components of which are to be submitted to AESRD for approval on 26 September, 30 September, 1 October, 6 October, 15 October, or 30 November 2013. In other words, an approved “restoration plan” does not yet exist.]

Canadian Natural requested and received an Environmental Protection Order for the 9-21 site from ESRD. This order will allow us to isolate, excavate and contain the fissure below the water body. To facilitate this work, the water from the area will be moved and stored near-by and returned the following year. We appreciate AER and ESRD ongoing support as we continue to manage these events.

Canadian Natural will continue to make available any necessary resources for investigation, clean-up and towards putting safeguards in place to ensure events such as these do not happen again. We will continue to provide regular updates on the progress of this remediation work at www.CNRL.com.

[As noted elsewhere, it is not within CNRL’s power to ensure that such events “do not happen again”. To make such assertions is misleading.]

CNRL Update (Reporting Period 22-28 September 2013) (CNRL 2013f) Operations Update

As a result of our active clean-up efforts approximately 10,600 barrels of bitumen emulsion have been recovered to-date and daily we are seeing less than 15 barrels from all sites, coming to surface...

[It is difficult to place credence in the statement that “less than 15 barrels” per day are reaching the surface at the four sites. That value is far lower than the average recovery rate for bitumen (from AER data) for September 2013, which has ranged between 62.4 and 106.3 barrels/day. Similarly, from 31 July to 27 September 2013, CNRL maintained that the release rate was “less than 20 barrels” per day, but the bitumen recovery rate (from AER data) ranged between 62.4 and 213.7 barrels/day during that period.

If the CNRL value for total recovered volume is accurate for the date reported (28 September 2013), the recovery rate would be 29.1 barrels/day, about twice their stated release rate. A more

recent update made by AER on barrels recovered, yielded a bitumen recovery rate of 54.0 barrels/day as of 3 October 2013), about 3.6 times greater than the CNRL release rate.]

Environmental Update

On September 3, 2013 Canadian Natural requested, and received on September 24, 2013 an Environmental Protection Order for the 9-21 site from Alberta Environment and Sustainable Resource Development (ESRD). This order will allow us to isolate, excavate and contain the fissure that is below the water body. To facilitate this work, the water from the area will be moved and stored near-by [sic] and returned the following year. On September 27, 2013 we commenced de-watering. We appreciate the ongoing support from the Alberta Energy Regulator and ESRD as we continue to manage these events.

Moving the water will remove the risk of impacting migrating birds. Frogs from the area have either been relocated or have moved out of the area in preparation for hibernating. We will continue to monitor wildlife throughout the winter.

[Removing the water from 09-21 lake does not “remove the risk of impacting migrating birds.” The contaminated water has been relocated as per the environmental protection order, but relocation does not remove the risk of impacting migrating birds. Secondly, relocating frogs from their home range may simply delay their mortality. Thirdly, it is unlikely that frogs “have moved out of the area” given their limited dispersal powers. It is more likely that CNRL staff are failing to find the frogs.]

Investigation Update

...

Canadian Natural believes the cause of the bitumen emulsion seepage is mechanical failures of wellbores in the vicinity of the controlled areas. We are in the process of identifying and investigating these wellbores. We are drilling hydrogeological and delineation wells adjacent to the affected locations to aid in the investigation.

[CNRL has been steadfast in its view that the cause of the uncontrolled bitumen releases is the simultaneous failure of four wellbores. In light of the available evidence, this view is unlikely; see Section 4.3.]

CNRL Update (Monthly Update Report, 09-21-067-04 W4M, 7 October 2013) (CNRL 2013g) [This CNRL document provides preliminary results of the “Comprehensive Remedial Plan” required under the EPO issued to CNRL on 24 September 2013. The update provides a summary of activities undertaken in response to the EPO and provides data on water quantity and water quality. Of note are the high laboratory “reliable detection limits”, which range from 500 µg/L (for the F1 and F2 hydrocarbon fractions) to 1000 µg/L (for the F3 and F4 hydrocarbon fractions). Secondly, the testing is for dissolved hydrocarbons, which are hydrophobic and tend not to dissolve in water. Sampling for total hydrocarbons in water and in sediment would yield more relevant results. Therefore the water quality sampling will provide results that underestimate the contaminant loading to the system. Thirdly, the 29 and 30 September 2013 concentrations of toluene in “Basin 3” exceeded Alberta and federal guidelines for protection of aquatic life (Appendix D1 in CNRL 2013g). The preliminary results suggest that it is false economy to direct the company to investigate itself rather than require the company to provide funds to government to conduct a scientifically sound investigation.]

CNRL Update (21 October 2013) (CNRL 2013h)

Canadian Natural Resources Limited would like to provide an update to the incident at the Primrose development area in which bitumen emulsion was discovered at surface at four locations.

Our efforts to date have focused on ensuring each surface location is secured, and that recovery and reclamation activities progress. On August 15 we began applying for approvals to advance our investigation and requested an Enforcement Order. On October 21, 2013 we received the Order that will allow us to continue mitigation and investigation activities.

We will comply with all aspects of the Order and we look forward to the opportunity to further our investigation in a timely manner. Canadian Natural will continue to make available any necessary resources for investigation, clean-up and towards putting safeguards in place to ensure events such as these do not happen again.

We appreciate the ongoing support from the Alberta Energy Regulator and Alberta Environment and Sustainable Resources Development as we continue to manage these events. We will continue to provide regular updates on the progress of this work at www.CNRL.com.

[The foregoing is instructive in its: (1) failing to provide relevant information; (2) indication that the enforcement order of 21 October 2013 was made at the request of CNRL rather than at the discretion of the Alberta government; and (3) making promises that cannot be kept. These are noted as follows. (1) Although the bitumen releases were first reported on 21 May 2013 for sites 10-01 and 10-02, on 8 June 2013 for site 02-22, and on 24 June 2013 for site 09-21 (AESRD 2013b), it is not known when any of the releases began. The suspicion is that the releases began as early as winter 2012-13. Although the uncontrolled releases of bitumen continue as of this writing (late October 2013), CNRL indicates in this and previous press releases that the situation is under control, and that the locations are secured. (2) As far as can be ascertained, CNRL did not request the 21 October 2013 Enforcement Order. Reportedly, CNRL requested the 24 September Environmental Protection Order (which allowed the company to drain the lake), but no record has been found to indicate that the company requested the Enforcement Order. (3) It is not within the capability of CNRL to “ensure events such as these do not happen again”. The best that the company can accomplish is to lower the probability of such events.]

CNRL Update (2 December 2013) (CNRL 2013i)

Regarding the 09-21 site:

On November 6, a survey of surficial bitumen emulsion in the bed of the dewatered water body was completed. A bitumen delineation summary was submitted on November 15, 2013 as an extension to the existing EPO-approved Bitumen Emulsion Delineation and Containment Plan. The extension program outlined methods that can be used to remove the bitumen remaining on the surface of the sediments at the bottom of the water body after the dewatering. Canadian Natural is currently awaiting comments and/or approval from ESRD to proceed with the additional removal of bitumen within drained Basin 2 as per the bitumen delineation summary submitted... Preparation and excavation of bitumen emulsion impact in the area of the suspected fissure(s) began on November 14, 2013... Excavation was initiated on November 14, 2013 at the western shore of the water body, in the area of the suspected fissure(s). Excavation of impacted soil and sediment was ongoing as of November 22, 2013 and two fissures had been exposed in mineral soil ... [Figures 7, 8]. Excavated material was stockpiled in containment cells for temporary storage prior to trucking to landfill.

Due to frozen conditions, containment of bitumen emulsion is accomplished through management of impacted solids and a structure for temporary containment is not required. A plan for water management is in preparation; recovered water is currently collected in

depressions within the excavation, removed by vacuum truck, and disposed at the Tervita Lindbergh disposal facility.

... Wildlife Management

Wildlife management activities in the month of November included maintaining perimeter fencing, installing and maintaining and frequently relocating wildlife scare cannons, and conducting daily inspections. Large mammals are the main species of concern as most others are not found near the site due to winter conditions.

[No information is provided in the CNRL report as to what mammal species have been encountered or impacted in recent months.]

... Waste Management

Waste generated as part of the remediation program includes oily vegetation, oily absorbents, fluids and impacted soil and sediment. All waste is collected in bags, bins, barrels or is trucked to lined containment cells for temporary storage. Waste is tested to insure that it meets landfill requirements and is safe 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 prior to collection and will be assessed following completion of the remediation program.

- A total of 200, 1 m³ tote bags were filled with impacted vegetation and solidified bitumen emulsion. The bags will be transported to the lined Tervita bins located on Pad AC-21 ... for offsite disposal as per the Waste Management Plan. Tervita bins containing the totes were transported to Tervita Edmonton on November 20, 21 and 22, 2013.

- Two lined containment cells were constructed on Pad AC21 between October 27 and November 22, 2013. Soil beneath the cells was sampled prior to installation. Trucks began hauling impacted material to Tervita Bonnyville on November 20, 2013. To date a total of 1,993.2 tonnes of soil containing bitumen emulsion has been taken to Tervita Bonnyville.

[The removal of contaminated vegetation, soil, and subsoil from the 09-21 lake continues (CNRL 2013i and Figures 7, 8) and may result in long-term impacts to the biota. Vegetation and soil are closely-linked in ecosystems. Replacement of the living vegetation and soil layers with an abiotic mineral substrate or transplanted soil and vegetation will alter the aquatic and shore habitat in unpredictable ways. Because independent scientist are not allowed on site to document these ecosystem alterations and the responses to them, it may be some years before the full impacts of this bitumen release on the lake are known.

It is unclear whether placement of the contaminated materials within a landfill may pose risks to the subsurface at the landfill.]

... Conclusions

The data collected as of November 22, 2013 indicate that the dewatering of the water body took place as planned with no adverse effects on the hydrology and water quality in the surrounding environment. The toluene levels measured in previous months in the shallow groundwater and water within the fen south of Basin 1 were not associated with dewatering activities and did not persist in November 2013. A survey of surficial bitumen remaining on the water body substrate after dewatering was completed and a plan submitted for remediation. Preparation of containment cells and infrastructure associated with the remedial excavation were constructed. Excavation of impacted soil and sediment at the western shore of the water body was initiated on November 14, 2013 and is ongoing.

[Insufficient information is contained in the CNRL (2013i) report to support the conclusion that there have been no adverse effects on the ecosystem, as follows: (1) The elevated toluene is coming from an industrial source. What is the source? It is not enough to state that it is not derived from dewatering. (2) Bitumen was still leaking to the surface as of 15 January 2014 at all four CNRL Primrose bitumen release sites. Therefore, the incidents were ongoing. (3) Continued excavation of bitumen on the bottom of the 09-21 lake site will be required. (4) The water quality

results are not particularly informative because the organic contaminants sampled (BTEX, C1 to C4 fraction hydrocarbons, and PAHs) are hydrophobic and therefore do not reach high concentrations in water grab samples. A better approach to assess concentrations of organic hydrophobic contaminants would have involved the use of semi-permeable membrane devices (SPMDs) and the sampling of sediments. Without such data, it is premature to conclude that organic contaminants have not impacted the ecosystem.

Taken as a whole, the information provided by AER and CNRL and government over the period June 2013 to January 2014 demonstrates that uncontrolled releases to bitumen resulting from high pressure steaming operations represent a type of energy industry incident whose occurrence, duration, volume, and spatial extent cannot be predicted. Secondly the challenging clean-up operations may require months of concerted efforts and result in long-term impacts to affected areas.]

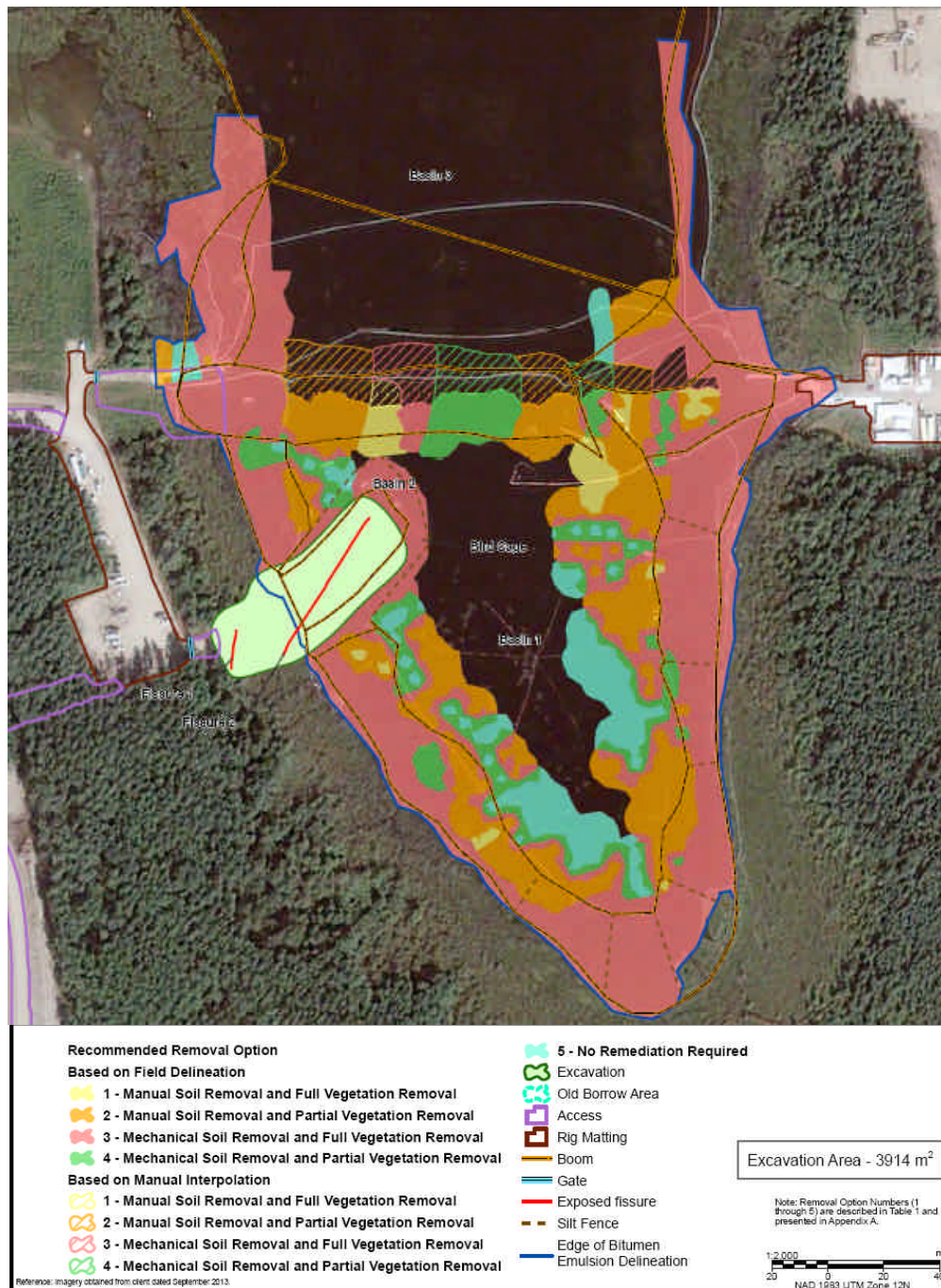


Figure 7. The south end of the 09-21 spill site. The blue line denotes the edge of the bitumen emulsion as delineated by CNRL. The yellow, orange, and green polygons denote the recommended removal options for contaminated soil and vegetation. The red lines on the west (left) of the 09-21 lake denote bitumen release fissures. Image modified from Figure 5 in CNRL (2013i).

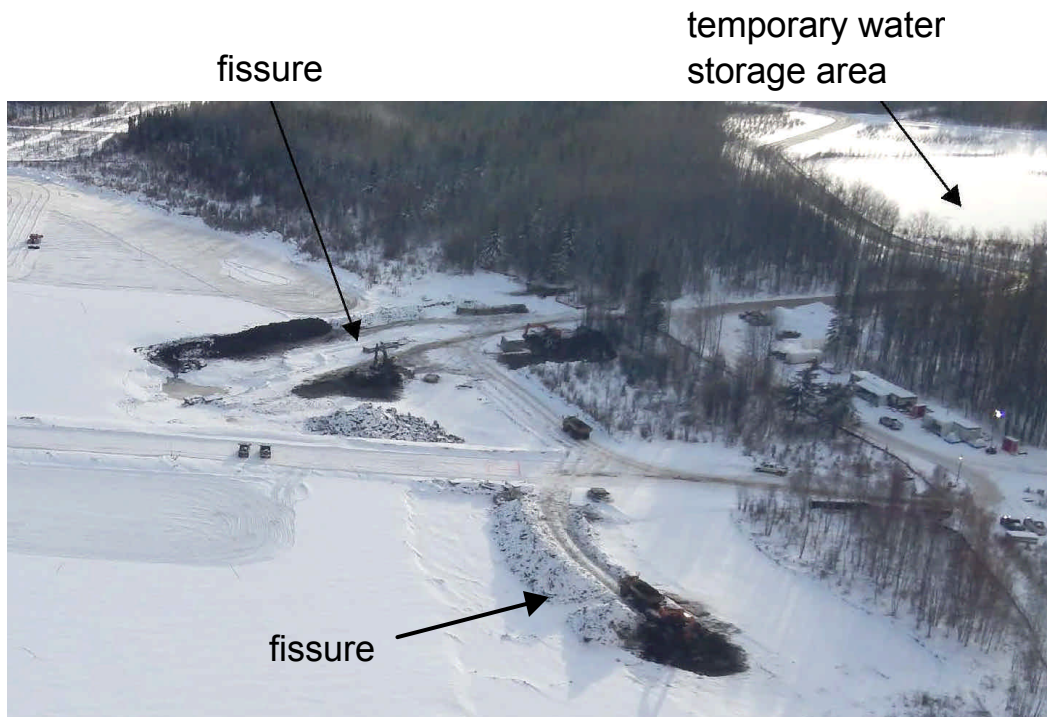


Figure 8. The two “suspected fissure” sites on the west side of 09-21 lake on 15 December 2013. Note the accumulations of black materials in the vicinity of the fissures. Image downloaded and modified from CNRL (<http://www.cnrl.com>; aerial-photograph-9-21-site-december-15-2013.jpg).

CNRL Update (13 January 2014, posted 23 January 2014) (CNRL 2014a)
 [Regarding the 09-21 site, CNRL released a report which was posted on 23 January 2014]:

Water Management for Dewatering

... Between November 22 and December 31, 2013, the total fluid volume (bitumen emulsion and surface water) recovered from the 9-21 FTS [= flow to surface] site and disposed of at the Tervita Corporation Lindbergh, Alberta, plant, was 334 m³; the volume of bitumen emulsion was 3 m³. The cumulative total fluid volume (bitumen emulsion and surface water) recovered at the 9-21 FTS site between July 15 and December 31, 2013 was 1,872 m³ and the cumulative volume of bitumen emulsion recovered was 308 m³. [The meaning of this text is unclear.]

Surface Water Quality

Water quality samples were collected weekly until November 5, 2013 from surface locations indicated on Figure 3. The samples were tested to ensure water quality in the receiving environment was not affected by the dewatering operations. Water quality results are presented in Appendix C.

Water quality from Basins 1, 2, 3 and 4 of the water body and the downstream fen south of Basin 1 were within freshwater aquatic life guidelines. Hydrocarbons were not detected in any sample collected in the water body or the fen.

[This statement is misleading. There are no data reported in Appendix C for November 2013. It may be true that no hydrocarbons were detected in the November samples, but no data are presented to support that statement. It is also important to remember that the hydrocarbons may not have disappeared from the surface water but may have simply migrated past the sampling points. Moreover, data in Appendix C indicate that seven surface water samples contained high concentrations of toluene (exceedances of the 2 µg/L guideline for protection of aquatic life). A maximum of toluene concentration of 7.9 µg /L was reported for Basin 1 on 1 October 2013). Finally, in addition to the samples indicating toluene exceedances, many other samples did detect hydrocarbons (e.g., downstream fen upstream of Ken Baker Road, 11 Oct 2013, 0.57 mg/L F1 hydrocarbons, 0.20 mg/L F2 hydrocarbons, 0.41 mg/l F3 hydrocarbons, and 0.24 mg/L F4 hydrocarbons).]

Shallow Groundwater

Shallow groundwater quality samples were collected from one shallow drive-point piezometer well (13-DP4) on November 27 and December 3, 4, 10, 11 and 17, 2013 (Figure 4). Sampling was carried out on two consecutive days on December 3 and 4 and December 10 and 11, 2013 to obtain enough water for analysis. Water quality results are presented in Appendix C. Water quality from the shallow groundwater locations was within freshwater aquatic life guidelines. Hydrocarbons were not detected in any sample collected in the shallow groundwater locations.

[This statement is misleading. There are no data reported in Appendix C for either November or December 2013. It may be true that no hydrocarbons were detected in the November and December samples, but no data are presented to support that statement.

Moreover, data in Appendix C indicate that nine groundwater samples contained high concentrations (exceedances of the 2 µg/L guideline) for toluene. A maximum of toluene concentration of 220 µg/L was reported for sample point 13-DP5 on the south side of Basin 3 on 29 September 2013).

In disagreement with the CNRL statement above, some samples did detect hydrocarbons in the groundwater. Moreover, some samples indicated poor detection levels (e.g., F3 and F4 hydrocarbons with detection limits of 1.4 mg/L (e.g., sample 13-DP1, drive point southwest of Pad 21)), which undermines confidence in the results.

One other note about the water quality sampling is relevant. The reliable detection limit for toluene was equal to the water quality guideline. Because of the high detection limit, non-exceedances would have been recorded as non-detects.]

Bitumen Emulsion Delineation and Containment

... Excavation at the western shore of the water body, in the area of the suspected fissures, continued to December 20, 2013, when activities were halted for the holiday season. Two fissures were exposed in mineral soil (Figure 5). Fissure 1 is 19 m long and located entirely on the shore area immediately west of Basin 2. Fissure 2 is 105 m long and located within Basin 2. Fissure 2 splits into three short branches at its northeastern end. Further excavation north and south of Fissure 1 has not identified the presence of additional fissures, suggesting that Fissure 1 has been fully exposed and delineated. The southwestern end of Fissure 2 was exposed and delineated; the northeastern end has not yet been fully delineated.

Waste Management

... During that time period, 17,482 tonnes of soil were transported to the landfill. To date, a cumulative total of 19,655 tonnes of soil containing bitumen emulsion has been taken to Tervita Bonnyville. Based on the bitumen content of the soil, a cumulative total of 70 tonnes of bitumen emulsion has been removed from the site with the impacted soils.

[The length of the fissures excavated in Basin 2 suggests significant fractures in the underlying bedrock.

In the 2 December 2013 update, CNRL reported “To date a total of 1,993.2 tonnes of soil containing bitumen emulsion has been taken to Tervita Bonnyville.” Did the total volume of contaminated soil increase by about a factor of ten in the eighteen days between 2 and 20 December 2013?]

CNRL Update 24 January 2014 (CNRL 2014b)

[The CNRL (2014a) report was available for less than a day. It was replaced on the website by a six page report that provided some summary statistics of the four incidents. The report was dated 10 January 2014.]

... 2-22 (Terrestrial Site)

Discovered June 8, 2013.

Clean up is complete and 7,384 tonnes of impacted material were removed for disposal at the Tervita Class II landfill in Bonnyville, Alberta.

Impacted area is 0.31 hectares.

Bitumen Emulsion recovered to date: 99m³ as of January 10, 2014.

There were no excavation activities during the reporting period.

We are inspecting all wildlife deterrents, wildlife fences and silt fences weekly.

Drill pad construction is scheduled for the winter of 2014.

Bitumen emulsion seepage from the fissure has slowed to less than 5 L per day.

Site is fully contained within berms, and has a double layer of wildlife fence in place

Reclamation will be initiated on a portion of the 2-22 site this winter

... 10-1 (Terrestrial Site)

Discovered May 20, 2013.

Clean up is complete and 25,367 tonnes of impacted material were removed for disposal at the Tervita Class II landfill in Bonnyville, Alberta.

Impacted area is 0.55 hectares.

Bitumen emulsion recovered to-date: 350m³ as of January 10, 2014

There were no excavation activities at this site during the reporting period.

We are inspecting all wildlife deterrents, wildlife fences and silt fences weekly.

Bitumen emulsion seepage from the fissures has slowed to an almost imperceptible rate and is contained within clay berms.

A containment structure will be built over the fissures in the winter of 2014 as part of a drilling pad used for bitumen delineation purposes in the bedrock.

... 10-2 (Terrestrial Site)

Discovered May 20, 2013.

Clean up is complete and 17,390 tonnes of impacted material were removed for disposal at the Tervita Class II landfill in Bonnyville, Alberta.

Impacted area is 0.57 hectares.

Bitumen emulsion recovered to-date: 558m³ as of January 10, 2014

There were no excavation activities during the reporting period.

We are inspecting all wildlife deterrents, wildlife fences and silt fences weekly

The rate of bitumen flow has slowed to an almost imperceptible rate and the fissures are contained within clay berms.

A containment structure will be built over the fissures in the winter of 2014 as part of a drilling pad used for bitumen delineation purposes in the bedrock.

... 9-21 (Water Body Site)

Discovered June 24, 2013.

The impacted area has been reduced from over 20 hectares to less than 6 hectares and cleanup is over 80% completed as of January 4, 2014.

Bitumen emulsion recovered to date: 170m³ as of January 10, 2014

On September 24, 2013 we received an Environmental Protection Order for the 9-21 site to allow us to isolate, excavate and contain the fissure below the water body.

To facilitate this work, the water from the area was removed and stored in two near-by, temporary storage areas.

Work is currently underway to remove impacted soil from beneath the water body.

The flow to surface will be contained within berms and a retaining wall.

The water will be returned to the water body in spring of 2014 as per Alberta Environment and Sustainable Resource Development's requirements.

From November 23 to December 31, 2013, the following activities were carried out as part of the plan to identify and characterize the bitumen emulsion release point:

A combination of ARGOs, snowmobiles and Sno-Cat® vehicles were used around Basins 1, 2 and 3 of the water body to compact the snow cover and drive frost deeper to increase ice thickness to allow access for larger equipment. Testing of ice thickness was undertaken daily in November and early December to confirm safe access for heavy equipment onto the excavation area.

Excavation at the western shore of the water body, in the area of the suspected fissures, continued to December 20, 2013, when activities were halted for approximately 2 weeks over the Holiday Season.

... Wildlife Management Plan

This plan addresses wildlife deterrents, capture and treatment of impacted wildlife and rehabilitation/release options.

Wildlife fencing, effigies and scare cannons will continue to be used as a means to deter wildlife from entering the areas. Exposed fissure areas will be covered by means of tarping and the areas will be surrounded by wildlife fences.

Perimeter fences are visited daily to ensure intactness.

Wildlife Activity in the vicinity of the FTS sites continues to be minimal due to the onset of freezing conditions and snow. Additionally, frozen conditions at each location have helped to minimize the risk of wildlife exposure to possible contamination.

Canadian Natural will comply with all federal and provincial legislation that apply to the conservation and management of wildlife.

During the month of December, there were no wildlife sightings, captures or impacts at the 3 terrestrial sites.

During the month of December, 3 birds, 1 squirrel and 1 coyote were sighted in vicinity of the 9-21 site but there were no captures or impacts.

[The extreme paucity of wildlife sightings suggests that wildlife monitoring has been cursory. More wildlife occurrences would have been recorded in the four areas if scientifically credible monitoring had been conducted. The failure to document wildlife also undermines the oft-repeated statements made by the regulator and CNRL about minimal total wildlife impacts as measured by dead wildlife found. Finding dead wildlife is more difficult than observing living, active wildlife. Therefore the tally of total dead animals found is probably a large underestimate

of the true wildlife mortality at the four sites. It also raises a question. Given that the wetland impact report for the 9-21 site released by CNRL (Matrix Solutions Inc. 2013) indicated the presence of 19 sensitive bird species, one sensitive mammal (Canada lynx), and one at risk mammal (woodland caribou), what is the cause of the paucity of birds and mammals reported in recent monitoring? Some of the sensitive and at risk animals are resident rather than migratory; therefore, seasonal migration cannot be the explanation.]

... Communications Plan

This plan summarizes our planned weekly and monthly communication with stakeholders, regulators, Government officials and the general public.

Canadian Natural's website information on the incident will be updated on a regular basis.

We will continue to address government and media and public inquiries through our Investor Relations or Public Affairs Departments.

We will provide written summaries and meet with affected stakeholders as needed to provide updates.

... Future Action

1. Locate and delineate the FTS [flow to surface] event subsurface flow paths
2. Identifying the root cause(s) of these events
3. Continue to monitor the surface and subsurface for effects of the FTS events and remediate if any effects as necessary
4. Review the integrity of legacy wells in the Primrose area to identify potential issues and repair any wells that pose a risk of future events
5. Reclaim all surface areas affected by the FTS events including any new disturbances required for investigative activities according to a Conservation and Reclamation Plan.

[According to the CNRL information reported in CNRL 2014a and 2014b, the total bitumen emulsion recovered at the four sites current to 10 January 2014 was $\sim 1,315 \text{ m}^3$ and the total tonnage of impacted soils removed was 70,246 metric tonnes. In comparison, the AER reported current to 19 January 2014 a total of $1,177.14 \text{ m}^3$ bitumen emulsion and a total tonnage of impacted soils removed is 69,698.73 metric tonnes. It is difficult to place much credence in the figures for volumes of bitumen recovered given that as of 14 November 2013, AER and CNRL reported a total of $1,878.62 \text{ m}^3$ recovered then CNRL reported to the authors on 10 January 2014, that the total volume recovered had been revised to $1,864.21 \text{ m}^3$. The fact that CNRL reported two different values for bitumen recovered current to 10 January 2014 ($1,864.21 \text{ m}^3$ and $\sim 1,315 \text{ m}^3$) suggests that the numbers are subject to different assumptions. Of the three values for total bitumen emulsion recovered ($1,177.14 \text{ m}^3$, $1,864.21 \text{ m}^3$, and $\sim 1,315 \text{ m}^3$), which estimate is correct? And to return to a previously asked but still unanswered question, what is the total volume of bitumen emulsion that has escaped containment underground?]

CNRL Website Postings Late January 2014

In late January 2014, an environmental impact report was posted on the CNRL website in response to the Environmental Protection EPO-2013-33/NR issued by AESRD.

The EPO required the submission of a "Wetlands Impact Assessment Plan"; see the Appendix for the details of the plan. Among the ordered submissions, the EPO required a "detailed description of all i. Flora species; ii. Fauna species; iii. Rare species; and iv. Endangered species present on the Aquatic Release Site." A "Summary Report on Wetlands Impacts" was also required, which is the report posted by CNRL in January 2014. The wetland impact report (Matrix Solutions Inc. 2013) is considered below.

- (1) A single nomenclatural source for vascular plants was not provided, even though this is standard practice in vegetation science. Instead, the report provided several plant guides, most of which are outdated, apply to other regions, or are non-standard for use in Alberta. No standard nomenclatural references were provided for bryophytes.
- (2) The vegetation plots do not provide a detailed description of the flora. The plot data do not list common and expected shallow aquatic wetland and poor fen plants such as *Drepanocladus aduncus* and *Smilacina trifolia* (yet list a look-alike non-wetland plant *Maianthemum canadense*). No data were provided for liverworts and lichens.
- (3) The species list provides taxa such as “*Salix* spp.” and “bryophyte sp.” which indicate a lack of familiarity with the flora.
- (4) Although the plant species list is depauperate in expected taxa, several of the taxa listed are uncommon to rare in Alberta such as *Sparganium fluctuans* (ranked S1, with 1-5 occurrences in Alberta). It is possible for common species to be absent and rare or uncommon species to be present, but such results are unlikely. When vegetation types are reportedly composed of species that are not characteristic of the type (e.g., *Maianthemum canadense*), are lacking in the common species characteristic of the types (e.g., *Drepanocladus aduncus*, *Salix candida*, *Smilacina trifolia*), and contain provincially rare species (e.g., *Sparganium fluctuans*), they are either never-before described rare communities or are mistakenly described.
- (5) The list of 122 bird taxa reported for the 9-21 bitumen release site includes 19 species classified as “sensitive” in Alberta and two species federally-listed under COSWEIC (barn swallow, rusty blackbird). If reliable, this would be a relatively high proportion of birds classified as sensitive and would therefore present potential conservation concerns given the ongoing bitumen releases and clean-up activities. However, the source for this list is cited as “Canadian Natural Resources Limited (2013)”, which is missing from the literature cited.
- (6) The bird list provides taxa such as “American pipet” [*sic*], “gull sp.” and “woodpecker sp.” which suggest unfamiliarity with the fauna.
- (7) The mammal list states that Canada lynx (sensitive in Alberta) and woodland caribou (at risk in Alberta, threatened under COSEWIC, and Schedule 1 species under SARA) were documented. Again, this would be significant, but the source for this list is cited as “Canadian Natural (2013)”, which is also missing from the literature cited.
- (8) The mammal list provides taxa such as “deer sp.”, “east chipmunk” [*sic*], and “vole sp.” which suggest unfamiliarity with the fauna.
- (9) Common and expected mammal species such as northern bog lemming, deer mouse, dusky shrew, and porcupine are missing from the list.

Because the wetland impact summary report would not pass peer review with regard to the flora and fauna, the acceptance and posting of the report by CNRL suggest that CNRL is not a credible source of ecological and biological information. Therefore, its statements about impacts to the ecosystem are not supported by reliable data. Whether the energy regulator and AESRD have the expertise or the inclination to reject the report as insufficient to meet the EPO is not known. For the Alberta government and AER to accept such a report as meeting the conditions of the EPO would reflect poorly on their capacity to provide oversight.

3.3 Correspondence with AER

As the bitumen release events unfolded during the summer of 2013, the investigators corresponded with AER and CNRL in an effort to remain informed. The next two sections document that correspondence. Comments are inserted in square brackets.

22 July 2013

To AER

1. What is the location of the four spills / bitumen emulsions (LSD, Section, Twnshp, Rnge) in the two CNRL project areas this year?
2. When did the spills start?
3. When does AER expect the investigations to be completed and a public report to be issued?

22 July 2013

From AER

The locations are:

10-01-067-03 W4 (reported May 20)

10-02-067-03 W4 (reported May 20)

02-22-067-03 W4 (reported June 8)

09-21-067-04 W4 (reported June 24)

I don't know when the investigation will be complete and the public report issued.

[Although there are three reporting dates given by AER in this email, the press releases issued by AER listed the events as being reported on 24 June.]

22 July 2013

To AER

Can you confirm the locations you sent me as they are quite scattered (one being ~ 8 km from the rest). See attached map. If accurate, does the AER treat all four as one investigation?

22 July 2013

From AER

The locations are correct.

[The locations provided by the AER contact proved to be correct. However, the locations provided by AER on its website were incorrect for three of the four incidents. The question as to whether the four incidents are treated as one investigation was not answered.]

9 August 2013

To AER

As part of our efforts to understand the four recent CNRL spills in Primrose / Cold Lake Area, please answer the following questions.

CNRL states that “Canadian Natural believes the cause of the bitumen emulsion seepage is mechanical failures of wellbores in the vicinity of the impacted locations.” (http://www.cnrl.com/upload/media_element/648/03/0731_primrose-operations.pdf), that “...the problem is that old, vertical wells, thought to be sealed up, came unsealed and allowed bitumen to escape.” (<http://globalnews.ca/news/768386/months-after-primrose-spill-began-cnrl-doesnt-know-when-bitumen-flow-will-stop/>), and that “The company knows which wellbores are problematic, she said...” (<http://globalnews.ca/news/768386/months-after-primrose-spill-began-cnrl-doesnt-know-when-bitumen-flow-will-stop/>).

1. Since CNRL know which wellbores are problematic, have they informed you of their locations? If so, are they Abandoned Wells, Reclamation Certified Wells or Reclamation Exempt wells? Or are they presently operating wells? What are the failed wellbores identification numbers and geographic coordinates of their locations?

Attached is a map showing the locations of the 4 spills/leaks, along with locations of PNG wells in the area. The location information is from the Alberta Energy Regulator (<http://www.aer.ca/compliance-and-enforcement/incident-reporting-current-and-archive>):

2. Given that these 4 spill locations are > 6 km [*sic*, 6 miles] apart, is it not likely that the spills are a result in [of] fractures in the geologic formation rather than failures in wellbores, as claimed by CNRL?

9 August 2013

From AER

[The AER is conducting a full investigation. Once our investigation is concluded, we will issue a public report.](#)

[The AER response did not address the questions.]

9 August 2013

To AER

Bob, there is a discrepancy in the location information you provided to me for the four CNRL Primrose/Cold Lake spills versus the locations provided on AER's website.

On July 22 you responded with these locations:

- 10-01-067-03 W4
- 10-02-067-03 W4
- 02-22-067-03 W4
- 09-21-067-04 W4

In response to my request for confirmation of these locations are correct, due to them being so far apart, you responded on July 22 that "these locations are correct."

However, AER's website (<http://www.aer.ca/compliance-and-enforcement/incident-reporting-current-and-archive>) reports the locations as:

- 10-01-067-04 W4 [incorrect]
- 10-02-067-04 W4 [incorrect]
- 02-22-067-04 W4 [incorrect]
- 09-21-067-04 W4

The discrepancy in terms of distance is significant.

Please confirm the correct locations of the 4 spills or direct me to someone in AER who can confirm the locations.

9 August 2013

From AER

[I will be out of the office until Tuesday, August 13. From July 25 - 31, please contact Cara Tobin \(cara.tobin@aer.ca\). From Aug. 1 - 12, please contact John Ludwick \(john.ludwick@aer.ca\).](#)

9 August 2013
To AER
John, can you respond? Thanks

12 August 2013
From AER
Apologies for the confusion. These are the correct locations:

-
10-01-067-03 W4
10-02-067-03 W4
02-22-067-03 W4
09-21-067-04 W4

12 August 2013
To AER
Cara, are you aware that these locations are different (for 3 of the 4 locations) than the locations reported on the AER website (under Incidents Reporting / Ongoing Incidents)?

12 August 2013
From AER
Thanks for highlighting that. We'll have it changed today.

15 August 2013
To AER
Dear Bob Curran, my questions do not require a full investigation in order for the AER to provide timely answers.

Has CNRL informed the AER of the locations of the failed wellbores that they claim, on the public record, are the cause of the four Primrose leaks?

CNRL has also recently informed me that those failed wellbores are not from producing / operating wells.

Can the AER confirm to me whether the failed wellbore(s) for all 4 leaks, that CNRL claims are the cause of the four leaks, are any one or more of the following Abandoned wells:

- License Number 0184271 – Reclamation Certified. Licensee = CNRL (1996)
- License Number 0199303 – Reclamation Certified. Licensee = CNRL (1997)
- License Number 0194521 – Reclamation Exempt. Licensee = CNRL (1997)
- License Number 0208009 – Reclamation Exempt. Licensee = CNRL (1998)

Are there additional failed wellbores that CNRL has informed the AER as being the cause of one or more of the four leaks?

[No response to the question was received.]

19 August 2013
To AER
1. Please send me all documentation related to the following Incident Numbers referenced at:
<http://www.aer.ca/compliance-and-enforcement/incident-reporting-current-and-archive>:

20131243; 20131458; 20131016; 20131126.

2. Please send me all documentation related to the three releases of bitumen emulsion within the Primrose East section of the project area as referenced at: <http://www.aer.ca/compliance-and-enforcement/incident-reporting-current-and-archive> ("Earlier this year, as a result of three releases of bitumen emulsion to surface, the AER ordered the suspension of CNRL's high pressure cyclic steam stimulation (HPCSS) operations within the Primrose East section of the project area."). Are these the same incidents as referenced above (i.e., 20131458; 20131016; 20131126)?.

19 August 2013

From AER

"With regard to your questions below, I must reiterate that because the investigation is ongoing, we will not speculate on any information that is out there until the investigation is complete and we have issued a public report. Commenting on our investigation prior to that point could potentially jeopardize our ability to pursue enforcement if it was determined to be required"

19 August 2013

To AER

Earlier today Mr. Peter Lee emailed two information requests to you...

You responded:

"With regard to your questions below, I must reiterate that because the investigation is ongoing, we will not speculate on any information that is out there until the investigation is complete and we have issued a public report. Commenting on our investigation prior to that point could potentially jeopardize our ability to pursue enforcement if it was determined to be required."

With regard to question 1 and your response to it, should we conclude that AER declines to provide any further information that pertains to these incident numbers?

With regard to question 2, the request was for documentary information that pertains to three earlier releases that occurred in Primrose East, not in reference to the current incidents in Primrose South. Does this mean that AER declines to provide any information about these three earlier releases?

In neither case were we asking AER to speculate, but rather to provide timely, accurate, and relevant information.

19 August 2013

From AER

The four incidents are part of a single investigation. That investigation is ongoing. The AER will issue a public report once its investigation is complete, so the information you seek will be available at that time.

With regard to Peter Lee's request today... I received further information late this afternoon.

With inquiries of this nature, to ensure that we do not breach requirements within the FOIP Act, you will have to submit a FOIP request to us for the information you have requested. That request can be submitted to Reta McPhail (reta.mcphail@aer.ca) or Margaret Witt (Margaret.witt@aer.ca).

[It is difficult to over-stress the fact that the surface release of bitumen represents an undefined fraction of the total bitumen release. It is likely that the majority of the release is occurring

below-ground. In an effort to ascertain both the total volume of the bitumen release (below-ground release + surface release) and its spatial extent, the investigators submitted an information request to both CNRL and the AER. Because the volume of the daily bitumen release might be expected to be proportional to the daily bitumen production at the four locations prior to the incidents, we wrote:]

23 September 2013

To AER (Mr. Bob Curran)

Dear AER,

Will you provide me with the average annual or daily production volumes for the four ongoing incident wells at Primrose wells at: (1) LSD 10, Section 01, Township 67, Range 03, West4 (the "10-01" site); (2) LSD 10, Section 02, Township 67, Range 03, West4 (the "10-02" site); (3) LSD 02, Section 22, Township 67, Range 03, West4 (the "02-22" site); LSD 09, Section 21, Township 67, Range 04, West4 (the "09-21" site).

Thank you.

23 September 2013

From AER (Mr. Bob Curran)

Hello Mr. Lee.

Please direct your information request to: infoservices@aer.ca.

Thank you.

Bob Curran

[As a result, we sent the same information request to Information Services. We received the following reply.]

23 September 2013

From AER (Info Services)

Thank you for your email. Please be advised that for your protection, we do not accept credit card numbers through e-mail. If you wish to pay by credit card, once the order has been filled and processed, you will be contacted by a Customer Service Representative for payment. Processing time is estimated to be 3 to 5 business days after receipt and verification that your order contains all of the necessary information (proper "Product Name" and additional information identified in the "Product Request By" instruction, as specified in Guide 1). Incomplete orders will not be placed into the queue until such time as they are deemed complete. All orders are fulfilled on a first come first serve basis, regardless of the submission process (counter, fax, email, and phone). Please be aware that complex orders may take longer to complete.

For status updates of your order please call (403) 297-8311, Option 2.

[On 27 September 2013, the investigators were contacted by phone and were told that the information was available for purchase at a price of \$231. A payment was sent and the well production data were received. Unfortunately, production data for the most critical of the sites (the 09-21 site at the lake to be drained under the Environmental Protection Order) were not provided.

On the issue of actions taken by AER in response to the CNRL bitumen releases, the investigators wrote to AER for clarification.]

25 September 2013

To AER

Dear Mr. Curran:

Can you tell me the degree to which HPCSS operations have been suspended or restricted in the Primrose area? Is all HPCSS steaming suspended in Primrose? What about other HPCSS fields in Alberta? I am doing a radio interview this afternoon and the interviewer may ask me these questions.

25 September 2013

From AER

Hi Kevin.

Aside from our online incident alerts, the information you are asking for can be found in our news release of June 27: <http://www.aer.ca/about-aer/media-centre/news-releases/news-release-2013-06-27>.

25 September 2013

To AER

Hi Bob,

No it isn't. There is no information relevant to my request contained in the 27 June press release. Perhaps you meant the 18 July press release, but the information reported there is overly-general. It says:

“Earlier this year, as a result of three releases of bitumen emulsion to surface, the AER ordered the suspension of steaming operations within the Primrose East section of the project area. On June 24, 2013, the company reported a fourth release, this time into an unnamed water body on the Cold Lake Air Weapons Range, at Primrose South. In response to the issues in this area, the AER has ordered that CNRL take further measures, including suspending steaming operations within one kilometre of the Primrose South incident and restricting steam operations throughout Primrose North and South.”

What about other HPCSS areas in Alberta? Are you indicating that no other restrictions or suspensions were placed anywhere else in Alberta? How many wells would be unaffected in Primrose South (that lie beyond 1 km from the affected site)? What is it meant by "restricting" steam?

25 September 2013

From AER

I do not have those answers. I will forward your request.

[The preceding correspondence is characteristic: a question is posed; the enquirers are directed to a site that does not contain the information that is requested; this is pointed out, and the enquirers are then told that the question has been forwarded. The same process was followed when questions was sent to AER in June 2013 (see Section 4.3), the answers to which have not been supplied to date. A similar procedure has been used by CNRL (see 23, 24 September 2013 correspondence with CNRL, below).]

27 September 2013

[The investigators inspected the well production data and found two items of interest:

(1) Inspection of the 2013 well production data current through August for the three legal locations (10-01, 10-02, and 02-22) indicates that all three locations continued to produce bitumen throughout the incidents, as follows: 10-01: six wells, five of which produced January-August, one produced May-August; 10-02: three wells, all of which produced January-August; 02-22: eleven wells produced for various months January-August. A total of 20 producing wells are associated with the locations 10-01, 10-02, and 02-22. The total production from those 20

wells during the months January-August 2013 was estimated at 151,315.1 m³, or 950,591.1 barrels according to the AER production data. Bitumen production at three of the four locations has continued throughout the ongoing incidents. Assuming an average January-August 2013 value of \$67.53 per barrel of bitumen, the January-August 2013 revenue from the 20 wells associated with the three locations (10-01, 10-02, and 02-22) would total roughly 64 million dollars.

(2) No data for the 09-21 location were received. We queried AER and it responded (below).]

From AER

We did a search for production data for LSD 09, Section 21, Township 67 Range 04, W4, however we did not find any information on production in our systems. The Confirmation of Non Availability sheet that I had attached in the email sent to Peter shows **Well Not on Production**. If you need help interpreting data please do not hesitate to call our customer contact center at (403) 297-4788. In dissemination, we work at a clerk level and unfortunately, are not a knowledge index and we do not go through the data. [We later followed up to ask why there are no well production data for 2013.]

27 September 2013

Regarding the questions about changes in steaming practice, we received the following.

From AER

[A partial answer to the questions was provided.]

Regarding your questions concerning HPCSS:

The AER has imposed a no-steam-injection order for the entire Primrose East area, as well as 1 km around Primrose south release point. This means that no new steam injection operations are permitted in those areas.

For all CNRL's area wells not subject to this steam restriction, the AER has imposed a volume restriction. To explain: HPCSS operates at the fracture pressure of the reservoir. Once the fracture occurs, the pressure immediately levels out. The AER has required that the company reduce the volume of steam injected after fracture pressure has been reached [and?] closely monitor each well. Adjustments (further reductions) are required as the monitoring data indicates [sic].

[The foregoing indicates that after fracture of the bitumen reservoir has been accomplished, company procedure may include continuing to inject steam at high pressure.]

Other HPCSS fields continue to operate as per their approval. There is no evidence to suggest that the AER should require otherwise.

27 (in part) and 30 September 2013

To AER

Dear Mr. Curran,

We have received some information from AER and have asked follow up questions that have not been answered. Perhaps you can assist us in getting clarification, as follows:

(1) We asked the following questions [on 27 September]. What about other HPCSS areas in Alberta? Are you indicating that no other restrictions or suspensions were placed anywhere else in Alberta? How many wells would be unaffected in Primrose South (that lie beyond 1 km from the affected site)? ...

We received this answer: The AER has imposed a no-steam-injection order for the entire Primrose East area, as well as 1 km around Primrose south release point. This means that no new [underlining by the investigators] steam injection operations are permitted in those areas.

Does this mean that pre-existing steaming operations in the area can continue?

(2) We requested and purchased well production data for the four affected CNRL wells. We received no data for the 09-21 well. Regarding 09-21, we received an email from Kristie Bogle but it does not answer the question why there are no data. [We did a search for production data for LSD 09, Section 21, Township 67 Range 04, W4, however we did not find any information on production in our systems. The Confirmation of Non Availability sheet that I had attached in the email sent to Peter shows **Well Not on Production**. If you need help interpreting data please do not hesitate to call our customer contact center at (403) 297-4788. In dissemination, we work at a clerk level and unfortunately, are not a knowledge index and we do not go through the data.] Why were no data provided for that well?

(3) Inspection of the well production data for the three wells (10-01, 10-02, and 02-22) indicates that all three wells have continued to produce bitumen throughout the incidents [02-22 continued to produce April through August 2013; 10-01 continued to produce January through August 2013; 10-02 continued to produce January through August 2013]. Does this mean that production at the three well sites has continued throughout the release incidents?

4 October 2013

From AER

Thank you for your emails dated September 27 and September 30, 2013, regarding the bitumen to surface releases at the Canadian Natural Resources Limited (CNRL) operations on the Cold Lake Air Weapons Range. We are pleased to provide the following information.

As already described, the AER has imposed a no-steam-injection order for the entire Primrose East area, as well as 1 kilometre around the Primrose south release point. Since the order, no steam injection has been permitted in these areas.

[This response has been altered by AER from its original response which stated: “no new [underlining by the investigators] steam injection operations are permitted in those areas.”

...

LSD 09-21-67-04W4 refers to the surface location of one of the CNRL release sites. There is no wellbore associated with that surface location and, so, no well data to provide.

[This response is inscrutable. There are four sites associated with the four bitumen releases, each has been referred to by a legal location and each has been releasing bitumen, according to CNRL, due to faulty well bores. We queried AER for production data for the four sites and received well production data for three of the four, yet the most problematic of the sites, the 09-21 site for which AESRD issued an Environmental Protection Order, is not, according to AER, associated with a well. Secondly, a previous communication from AER indicated that the reason there were no data for 09-21 was given as “well not on production” (27 September 2013 email), which suggests that there is a well associated with the legal location.

Is the 09-21 release site not associated with a well? If so, this would be an admission that the bitumen release is unrelated to well bore failure. If it is associated with a well, AER would know which well, even it is not associated with the surface location LSD 09-21-67-04 W4, and AER

could have provided that information. The use of well identification numbers, rather than legal locations as a proxy for well numbers, would facilitate efficient and clear communication of information. It is disappointing that AER does not use well identification numbers in its communications.]

As part of the company's plan to depressurize the reservoir and slow the release of bitumen to surface, the AER has permitted CNRL to produce bitumen under modified conditions.

[This confirms that the three bitumen release sites (10-01, 10-02, and 02-22) have continued to produce bitumen throughout the incidents. It is unknown whether the 09-21 site has done so (see previous paragraph).]

...

15 January 2014

To AER

Dear Marta, could you please send me the detailed location Incident of # 20140048 in the form of Legal Subdivision, Section, Township, Range, Meridian or in Latitude/Longitude? Thanks

[From summer through late fall 2013, AER had been providing legal location data for incidents. It is unclear why the regulator has recently chosen to withhold location data for incidents.]

16 January 2014

To AER

AER no longer has 4 ongoing CNRL Primrose releases recorded on your online Incidents reports (<http://www.aer.ca/compliance-and-enforcement/incident-reporting>), yet CNRL has just informed me that they are indeed ongoing. AER had committed to providing monthly updates on releases yet the last update for these releases was November 22 2013.

- 1) Would you please provide the total volume released at the four sites as of the latest specified date known to the AER [e.g., x barrels released as of 16 January 2014]?
- 2) Why is the AER not following through on its commitment to publicly post monthly updates.
- 3) Why are these 4 ongoing releases not listed under the "Ongoing" category in the AER's Incidents XLS file?

20 January 2014

To AER

The AER incident data posted this past weekend in regard to the four CNRL ongoing bitumen releases at CNRL Primrose (reference number 20131243) are interesting.

Can you please explain the change in bitumen volume recovered at the four sites, as follows?

As of 14 November 2013, AER and CNRL reported a total of 1878.62 m³ recovered.

As of 10 January 2014, CNRL reported directly to me that the total volume recovered had been revised to 1864.21 m³.

Then, this past weekend AER posted a total volume recovered of 1177.14 m³.

Would you please explain how the volumes recovered have been revised downward since 14 November 2013 while the bitumen releases continue?

Secondly, would you please explain the difference between the current CNRL estimate of 1864.21 m³ and the current AER estimate of 1177.14 m³?

[No explanation about the changes and discrepancies in bitumen volumes was received from AER.]

28 January 2014

From AER

Good afternoon. The location of AER Incident # 20140048 is 03-35-067-4W4M. Sorry for the delay in response. [See Figure 3 for the location of the incident, which is about 2 km northeast of the 09-21 release site.]

3.4 Correspondence with CNRL

9 August 2013

To CNRL

As part of our efforts to understand the four recent CNRL spills in Primrose / Cold Lake Area, please answer the following seven questions.

CNRL states that “Canadian Natural believes the cause of the bitumen emulsion seepage is mechanical failures of wellbores in the vicinity of the impacted locations.” (http://www.cnrl.com/upload/media_element/648/03/0731_primrose-operations.pdf), that “...the problem is that old, vertical wells, thought to be sealed up, came unsealed and allowed bitumen to escape.” (<http://globalnews.ca/news/768386/months-after-primrose-spill-began-cnrl-doesnt-know-when-bitumen-flow-will-stop/>), and that “The company knows which wellbores are problematic, she said...” (<http://globalnews.ca/news/768386/months-after-primrose-spill-began-cnrl-doesnt-know-when-bitumen-flow-will-stop/>).

1. Since CNRL knows which wellbores are problematic, are they Abandoned Wells, Reclamation Certified Wells or Reclamation Exempt wells? Or are they presently operating wells?
2. What are the identification numbers and geographic coordinates of their location of the failed wellbores?

CNRL also states that “The company knows how to fix them using concrete and steel so the problem doesn’t recur.” (<http://globalnews.ca/news/768386/months-after-primrose-spill-began-cnrl-doesnt-know-when-bitumen-flow-will-stop/>) and that “We’ve learned from this and we know what steps to take to stop it from happening again,” said CNRL spokesperson Zoe Addington. (<http://globalnews.ca/news/768386/months-after-primrose-spill-began-cnrl-doesnt-know-when-bitumen-flow-will-stop/>)

3. If the company knows how to fix the leaking wells so the problem doesn’t recur, why did the problem recur given past similar problems CNRL experienced in the same area in 2009? Is it that, although you know how to fix them now, you did not know how to fix them before these recent 4 spills? If so, then why did you proceed with further operational activity following your 2009 spill?
4. Since you know what steps to take to stop it from happening again, what are these precise steps?

Attached [deleted in this report] is a map showing the locations of the 4 spills/leaks, along with location of wells in the area. The location information is from the Alberta Energy Regulator (<http://www.aer.ca/compliance-and-enforcement/incident-reporting-current-and-archive/>):

5. Given that the 4 spill locations are > 6 km [*sic*, 6 miles] apart, according to the Alberta Energy Regulator, is it CNRL's assertion that 4 wellbores at these disparate locations all failed at the same time?
6. Given that within 15 km of these 4 spill locations are thousands of existing PNG wells, both operating and abandoned, what are CNRL's plans to ensure that none of these wellbores will experience the same problem as these 4?
7. Given that these 4 spill locations are > 6 km [*sic*, 6 miles] apart, is it not much more likely that the spills are a result in fractures in the geologic formation cap rather than concurrent failures in wellbores?

13 August 2013

From CNRL

Hi Peter – thank you for your email. I will get back to you with answers to your questions. Is there any specific deadline you are working towards?

14 August 2013

To CNRL

Dear Zoe Addington, thank you committing to get back to me with answers to my questions in order to meet my deadlines.

In order to meet my deadlines, please send to me by end of today the answers to my first two questions:

1. Since CNRL knows which wellbores are problematic, are they Abandoned Wells, Reclamation Certified Wells or Reclamation Exempt wells? Or are they presently operating wells?
2. What are the identification numbers and geographic coordinates of their location of the failed wellbores?

Please send to me by Friday, August 16 the answers to the remainder of my questions (the last question is new to this email):

3. If the company knows how to fix the leaking wells so the problem doesn't recur, why did the problem recur given past similar problems CNRL experienced in the same area in 2009? Is it that, although you know how to fix them now, you did not know how to fix them before these recent 4 spills? If so, then why did you proceed with further operational activity following your 2009 spill?
4. Since you know what steps to take to stop it from happening again, what are these precise steps?
5. Given that the 4 spill locations are > 6 km [*sic*, 6 miles] apart, according to the Alberta Energy Regulator, is it CNRL's assertion that 4 wellbores at these disparate locations all failed at the same time? (Please note that since I sent you my initial email, the Alberta Energy Regulator has changed the location of three of the four spills on their website by approximately 10 km.)
6. Given that within 15 km of these 4 spill locations are thousands of existing PNG wells, both operating and abandoned, what are CNRL's plans to ensure that none of these wellbores will experience the same problem as these 4?
7. Given that these 4 spill locations are > 6 km [*sic*, 6 miles] apart, is it not much more likely that the spills are a result in fractures in the geologic formation cap rather than concurrent failures in wellbores?

8. Since bitumen has a specific gravity greater than that of water, how can CNRL claim the leaks/spills are contained if bitumen sinks in water? Would not the bitumen be spreading throughout the bottom of any waterbodies receiving the leaks/spills?

I also wish to view, on the ground, the 4 spill locations. When can this be arranged?

13 August 2013

From CNRL

Hi Peter - We are in the process of identifying and investigating the problematic wellbores. We believe the well bore failures are not producing / operating wells.

15 August 2013

To CNRL

Hi Zoe, but CNRL has already gone on the public record as knowing where these wellbores are (see “The company knows which wellbores are problematic, she said...”

(<http://globalnews.ca/news/768386/months-after-primrose-spill-began-cnrl-doesnt-know-when-bitumen-flow-will-stop/>).

It should be a simple matter to send me the identification numbers and geographic locations.

15 August 2013

To CNRL

Dear Zoe, CNRL has gone on the public record that “The company knows which wellbores are problematic...” (<http://globalnews.ca/news/768386/months-after-primrose-spill-began-cnrl-doesnt-know-when-bitumen-flow-will-stop/>).

You have recently told me in an email: “We believe the well bore failures are not producing / operating wells.”

Therefore, if CNRL knows which wellbores are problematic and they are not producing /operating wells, please immediately send me the geographic locations and well identification numbers of the wellbore(s) that have failed and are the cause of the 4 leaks.

And specifically confirm whether the failed wellbore(s) for all 4 leaks are any one or more of the following Abandoned wells:

- License Number 0184271 – Reclamation Certified. Licensee = CNRL (1996)
- License Number 0199303 – Reclamation Certified Licensee = CNRL (1997)
- License Number 0194521 – Reclamation Exempt. Licensee = CNRL (1997)
- License Number 0208009 – Reclamation Exempt. Licensee = CNRL (1998)

16 August 2013

From CNRL

Hi Peter – you asked what we have said on the record - please find attached our press release of July 31 and fact sheet that we have provided to media with our latest figures.

Canadian Natural believes the cause of the bitumen emulsion seepage is mechanical failures of wellbores in the vicinity of the impacted locations. In over 30 years of using the current steaming and extraction method in the Primrose area, there have been few bitumen emulsion seepages to

surface. This is due to the fact that most potential wellbore failures are corrected before steaming.

In cases where potential wellbore failures are not repairable, steaming strategies can be modified, to prevent these types of incidents from occurring in the future.

A complete review is ongoing and Canadian Natural has a specialized team focused on investigating wells in the impacted areas for any potential required remediation work.

One affected location, which is now contained, is a 1.5 meter deep, non-fish bearing, shallow slough that does not flow in or interact with other water bodies. Canadian Natural is conducting groundwater monitoring activities in the vicinity of all locations and is undertaking aquatic and sediment sampling to monitor and mitigate any potential impacts.

As a result of the bitumen emulsion seepages, our near term steaming plan at Primrose has been modified, with restrictions on steaming in some areas until the investigation with the AER is complete.

Canadian Natural will continue to make available any necessary resources for investigation, clean-up and safeguards to ensure events such as these do not happen again.

In 2009 the bitumen came to surface at a producing well. We have since increased our monitoring capabilities and improved our cementing and casing procedures.

Thanks,
Zoe

Fact Sheet

Dates / Timelines:

May 20, 2013: Discovered and reported bitumen emulsion to surface at 10-01 and 10-02

June 8, 2013: Discovered and reported bitumen emulsion to surface at 2-22

June 24, 2013: Discovered and reported bitumen emulsion to surface at 9-21

Bitumen Impacted area

Initial 20.7 hectares (all sites)

Current 13.5 hectares (all sites)

1.6 hectares at 10-01, 10-02 and 2-22 (initial and current)

11.9 hectares at 9-21 current

Our ongoing efforts will continue to reduce the impacts until the sites are fully remediated.

Volumes as of August 5, 2013

To date: 1158 m³ collected (all sites) 7300 barrels

Daily: less than 3 m³ / 20 barrels from all sites (less than 2m³ at 9-21 and 1m³ at 10-01, 10-02 and 2-22)

377m³ of oily vegetation recovered from 9-21 site

[Although CNRL stated on 31 July that the daily release of bitumen had fallen to a total of “less than 20 barrels per day”, the figure may be incorrect (Table 2). There are two inherent uncertainties in the data. The first is that CNRL and AER report volumes inconsistently by using

four different units interchangeably: “volume reported” (meaning released or recovered?), “released”, and “collected” (= “recovered”), which leads to unnecessary confusion. Secondly, AER depends upon industry for the reported volumes; there is no independent verification of both volumes released and volumes recovered. Although the ERCB spills data indicate a strong correlation between volumes released and recovered (see Table 1), those volumes are reported by industry and have not been verified. The use of the term “oily vegetation recovered” is misleading. CNRL means that oily vegetation has been collected for disposal at a landfill. It does not mean that there has been recovery of oily vegetation.

Whether the wide fluctuations in the rate of bitumen released or recovered are real or are the result of imprecise estimates of volumes should be examined. It is also interesting that as of 5 September 2013 (despite the statement that the volume released had fallen to “less than 20 barrels/day” as of 31 July), the volume reported had not changed since 16 August. In a 5 September 2013 email, the investigators asked AER why had the volume of bitumen released/recovered not changed since 16 August 2013.

On 6 September 2013, AER provided an updated volume on its website. The apparent increase in volume recovered from 0 barrels/day on 20 August to 62.4 barrels/day on 6 September 2013 is unlikely to be due to an actual increase in the bitumen recovery rate. It is more likely due to failure on the part of AER and CNRL to provide updated volume recovered data between 16 August and 6 September 2013 (Table 2). If it is assumed that the last valid volume recovered date prior to 6 September was 16 August, then the volume recovery rate over the period 16 August to 6 September was 1060 barrels/17 days or 50.5 barrels/day. Therefore the data as of 6 September 2013 neither supported nor refuted the CNRL statement that volume released has decreased to “less than 20 barrels/day”.

CNRL has explained a discrepancy in their estimate of bitumen release per day and the estimated bitumen recovered per day by stating that the company is “cleaning up more per day than is currently leaking”. If CNRL’s view is correct, it points to dysfunctional record keeping (interchangeable use of volumes released and volumes recovered) on the part of the company and the regulator. Conversely, if the bitumen release and recovery rates approach unity, it suggests that the bitumen release rate has not declined as rapidly as CNRL has indicated.

As of the 11 September 2013 update, the rate of bitumen recovery had increased to 106.3 barrels/day from its previous recovery rate of 62.4 barrels/day on 6 September 2013. The increased recovery rate for bitumen may indicate an increased collection effort by CNRL. Most importantly, the data indicate that the bitumen release shows little sign of abatement.

As of the 19 September 2013 update, the rate of bitumen recovery was 91.6 barrels/day over the period 11 to 19 September 2013. Although CNRL stated that the volume of bitumen released/day at the four sites had fallen to “less than 20 barrels/day” as of 31 July, the volume of bitumen recovered/day showed no clear downward trend until mid-September (Figure 9).

Over the period late-September to mid-November, the daily volume of bitumen recovered varied as follows: 29.1 (on 28 September), 54.0 (on 3 October), 17.7 (on 10 October), 31.4 (on 17 October), 28.7 (on 31 October), and 13.3 barrels/day (on 14 November). It is difficult to predict when the bitumen releases may cease (Figure 9).]

Table 2. Barrels of bitumen emulsion reported, collected, or released by date from sequential AER and CNRL press releases.*

Date	Barrels to Date	Barrels / Day	Source; Unit
27 July 2013	5,968	-----	AER; “volume reported”
31 July 2013	6,300	83.0	CNRL; “collected”
2 August 2013	6,659	179.5	AER; “released”
5 August 2013	7,300	213.7	CNRL; “collected”
16 August 2013	8,014	64.9	AER; “recovered”
20 August 2013	8,014 [no update?]	0? [no update?]	AER; “recovered”
6 September 2013	9,074	62.4	AER; “recovered”
11 September 2013	9,605	106.3	AER; “recovered”
19 September 2013	10,338	91.6	AER; “recovered”
28 September 2013	10,600	29.1	CNRL; “recovered”
3 October 2013	10,870	54.0	AER; “recovered”
10 October 2013	10,994	17.7	AER; “recovered”
17 October 2013	11,214	31.4	AER; “recovered”
31 October 2013	11,616	28.7	AER; “recovered”
14 November 2013	11,802	13.3	AER; “recovered”
14 January 2014	12,185^	6.3	CNRL^

* Barrels/day is calculated by determining the change in the number of barrels reported/released/collected/recovered between two dates and dividing that change in volume by the number of days between those dates

^ As of 14 November 2013, AER and CNRL reported a total of 1,878.62 m³ (11,802 barrels) recovered. As of 10 January 2014, CNRL reported to the authors that the total volume recovered had been revised to 1,864.21 m³. In contrast, as of ~ 19 January 2014, AER posted a total volume recovered, as reported by CNRL, of 1,177.14 m³. No explanation for these downward revisions and discrepancies has been provided by industry or AER. Nor do these values make sense in light of CNRL President Laut’s statement (Reuters 2014) of 14 January 2014 in which he was quoted that the field was seeping at about “one cubic metre squared per day” [*sic*, m³/day] (or 6.3 barrels/day). If the 14 November 2013 total release value was correct, and the daily release value provided by the CNRL President is accurate, then the total volume released as of 14 January 2014 at the four CNRL sites should be roughly 1,939.6 m³ (12,185 barrels), or if the CNRL 10 January 2014 update was correct, then perhaps 1,925.2 m³.

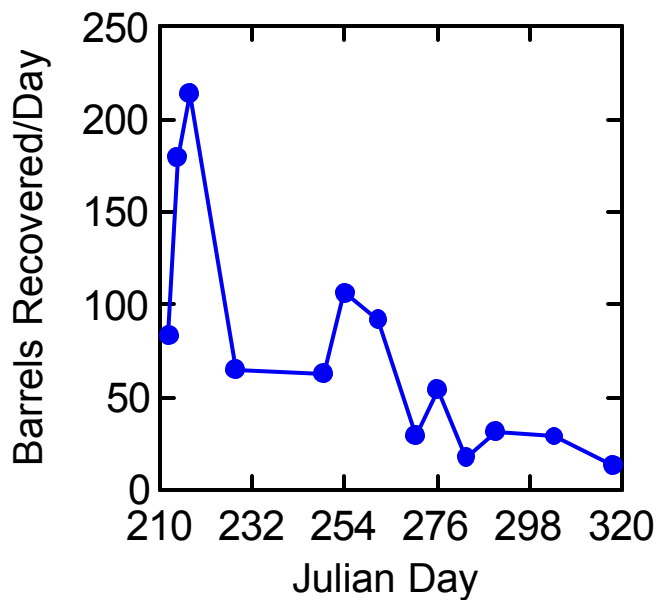


Figure 9. Barrels recovered per day at the four CNRL release sites over the period late-July through mid-November 2013. Due to discrepancies in the total barrels recovered as reported in January 2014, no data points after 14 November 2013 are plotted. Data are derived from Table 2.

Wildlife

Deceased as a result of impact (all sites): 27 birds, 23 small mammals and 71 frogs

Currently at Rehabilitation Center: 2 beavers, 5 birds and 2 muskrats

[Although the 5 August 2013 information from CNRL states that the two beavers are at a rehabilitation center, a 26 July 2013 press release from AER stated that the two beavers were dead.]

Over 2km of fencing, effigies, air horns and speakers, owl kites, wind socks and pennant flagging

Workforce

Approximately 200 on all sites involved with clean-up activities. An additional 180 involved in investigatory activities.

[The presence of 200 workers and 180 investigatory staff provide evidence of the magnitude of the four incidents.]

[It is difficult to over-stress the fact that the surface release of bitumen represents an undefined fraction of the total bitumen release. It is likely that the majority of the release is occurring below-ground. In an effort to ascertain both the total volume of the bitumen release (below-ground release + surface release) and its spatial extent, the investigators submitted an information request to both CNRL and the AER. Because the volume of the daily bitumen

release might be expected to be proportional to the daily bitumen production at the four wells prior to the incidents, we wrote:]

23 September 2013

To CNRL

Dear Zoe Addington,

Will you provide me with the average annual or daily production volumes for the four ongoing incident wells at Primrose wells at: (1) LSD 10, Section 01, Township 67, Range 03, West4 (the "10-01" site); (2) LSD 10, Section 02, Township 67, Range 03, West4 (the "10-02" site); (3) LSD 02, Section 22, Township 67, Range 03, West4 (the "02-22" site); LSD 09, Section 21, Township 67, Range 04, West4 (the "09-21" site).

Thank you

[The following reply was received.]

23 September 2013

From CNRL

Hi - Thank you for your email. You can find our regular updates on Primrose on our website at www.CNRL.com.

Thanks,

Zoe

[The direction to access this information from CNRL's Primrose incident website was problematic in that no such information is provided at that website. As a result, we wrote:]

24 September 2013

To CNRL

Are you aware that there are no production-related data on the Primrose updates website? If you are not aware of that, why are you misinformed? If you are aware of that, why would you direct me to a website that does not have the information that I requested?

[No reply in response to these questions was received from CNRL.]

8 January 2014

To CNRL

Dear Zoe, can you direct me to the latest information on bitumen release and recovery volumes for the CNRL Primrose release? The latest update we have was from the 2013 version of the Alberta Energy Regulator website on Incident Reporting ([\[aer.ca\]http://www.aer.ca/compliance-and-enforcement/incident-reporting\[aer.ca\]\[aer.ca\]](http://www.aer.ca/compliance-and-enforcement/incident-reporting)) [and] is 1,878.62 m³ from November 14 2013. The 2014 version of that website shows no "Ongoing" incidents. Is the CNRL Primrose release finished as of November 14 2013 or have there been further releases since that date?

15 January 2014

From CNRL

Hi Peter – I was away as I am sure you saw from my out of office reply. I understand you did not follow up with my identified colleagues in the meantime. You can find the latest update on our website at www.cnrl.com. The next monthly report should be available soon.

Clean up at 3 sites is complete and 80% at the fourth. There have been no further releases.

8, 15, and 16 January 2014 [repeated emails]

To CNRL

Dear Zoe, could you please respond to my January 8 2013 email in which I requested: "...please send me the detailed location of your January 3 2013 incident (AER's # 20140048) in the form of Legal Subdivision, Section, Township, Range, Meridian or in Latitude/Longitude."

[No information was provided about the location of the new January 2014 bitumen release by CNRL.]

15 January 2014

To CNRL

Hi Zoe,

In regard to your statement below that:

"Clean up at 3 sites is complete and 80% at the fourth. There have been no further releases", we request clarification.

Today is 15 January 2014. As of 14 November 2013, 11,802 barrels (1878.62 m^3) of bitumen emulsion had been recovered from the surface at the four locations in CNRL Primrose. An update on the AER site dated 22 November 2013 listed the same volume as that of 14 November 2013. Are you stating that there were no releases after 14 November 2013 and that the total volume of bitumen released is 11,802 barrels?

15 January 2014

From CNRL

Sorry - I thought you were asking if there had been any additional locations of flow to surface. Bitumen is still coming to surface in the 4 locations, but at a very low rate.

16 January 2014

To CNRL

Hi Zoe,

Thanks for your email.

Would you please provide the total volume released at the four sites as of a specified date (e.g., x barrels released as of 16 January 2014)?

16 January 2014

From CNRL

1,710 cubic meters as of Jan 10, 2014

16 January 2014

To CNRL

Hi Zoe,

Thanks for your email in re: 1,710 cubic meters as of Jan 10, 2014.

Sorry to trouble you, but the volume as of 10 January 2014 is less than the volume provided as of 14 November 2013, which was 1878.62 m^3 of bitumen emulsion.

Can you explain how the latter volume is less than the former volume?

16 January 2014

From CNRL

I appreciate you following up with me and not just re-printing my mistake. I was using formulas in excel and grabbed the wrong lines.

As of Jan 10, 2014 – 1864.21. I will follow up to see why AER's number is different than ours as I believe we report it to them, so it should be the same.

[The last several email exchanges suggest that both CNRL and AER data on bitumen recovery may be suspect for the following reasons: (1) AER does not verify volumes released or recovered; instead, it relies upon industry for those numbers. (2) Given point (1), AER and CNRL bitumen recovered values should agree (as noted by the CNRL spokesperson on 16

January 2014, above). The fact that the AER and CNRL numbers differ suggests editing of the numbers by one or both parties without that party informing the other. (3) Bitumen releases continued at the sites over the two-month period 14 November 2013 to 15 January 2014 (see Figure 8 and email of 15 January 2014 from CNRL). Therefore it is numerically impossible for the recovered volume of 10 January 2014 to be lower than the recovered volume of 14 November 2013 if the previous volume was accurate. Without independent oversight of reported hydrocarbon release and recovery volumes, the public may never have access to accurate incident data.]

22 January 2014

From CNRL

[In response to three previous emails sent to CNRL "...please send me the detailed location of your January 3 2013 incident (AER's # 20140048) in the form of Legal Subdivision, Section, Township, Range, Meridian or in Latitude/Longitude", CNRL responded]:

Hi Peter – the incident on Jan 3 is not related to the four bitumen emulsion to surface reported in May and June of 2013. I am not sure if you have seen it yet, but AER has updated their online incident reporting of this event.

22 January 2014

To CNRL

[Because CNRL did not provide the location of the 3 January 2014 bitumen release, we asked again]:

Hi Zoe, I know the January 3rd incident is not related to other four incidents under a different number, but I still need to know what the legal location of the January 3rd incident is. Thanks

24 January 2014

To CNRL

Dear Zoe, On the CNRL website a report was available titled "MONTHLY UPDATE REPORT - PRIMROSE SOUTH. 09-21-067-04 W4M. JANUARY 13, 2014". This report appears to no longer be available on your website, as of today, January 24, 2014. There is now on the CNRL website, however, a new report as of today titled "MONTHLY UPDATE. PRIMROSE OIL SANDS FLOW TO SURFACE. January 10, 2014". Was the report dated January 13 2014 removed from the CNRL website and if so, why? Is the January 10 2014 report intended to replace the January 13 2014 report and if so, why are the 71 pages of figures and tables related to water monitoring not included in the January 10 2014 report?

Also, could you please respond to my four emails in which I requested: "...please send me the detailed location of your January 3 2013 incident (AER's # 20140048) in the form of Legal Subdivision, Section, Township, Range, Meridian or in Latitude/Longitude."

[No reply was received.]

3.5 Media Coverage

In addition to press releases and correspondence, media coverage has supplied some insights into the winter-summer bitumen releases in Primrose. This section provides excerpts, in chronological order, of some of the media reports. The quoted excerpts, in blue font, have been edited for brevity. Comments are provided in square brackets.

3.5.1 18 July 2013 (Healing 2013)

... Chris Severson-Baker, managing director of the environmental Pembina Institute, said he's "shocked" that the project has had multiple failures and said the regulator should be shutting it down entirely. "The whole point of these types of operations is that the pressure is set at a level so that the steam stays in the formation," he said. "You should never get fluid and pressures building up to the point that they leak out. That's obviously what's happening here. These are worse than spills."

Greenpeace campaigner Mike Hudema said the lack of information about the June 24 spill from either the province or the company is "troubling." "The fact that we're just learning now that this is the fourth spill from this site, we still don't know what the damage is, if this spill is still happening or not, there are definitely a lot of unanswered questions," he said. "It raises concerns about how much we know about this kind of technology and are we doing everything we can to make sure it's being used safely." He said the fact that the spills are taking place on the weapons range makes it even harder for the public to learn what's happening and called on the government and the company to release detailed information, including site pictures.

[Escape of fluids from the bitumen reservoir, as Severson-Baker points out, is not supposed to occur. These underground escapes from containment may indeed be worse than spills because their volume and extent may be greater than above-ground releases and the ability to control or remediate them may be limited. Hudema raises the point that there are unanswered questions that deserve answers.]

3.5.2 19 July 2013 (Pullman and Lukacs 2013)

Oil spills at a major oil sands operation in Alberta have been ongoing for at least six weeks and have cast doubts on the safety of underground extraction methods, according to documents obtained by the Star and a government scientist who has been on site. Canadian Natural Resources Ltd. has been unable to stop an underground oil blowout that has killed numerous animals and contaminated a lake, forest, and muskeg at its operations in Cold Lake, Alta. The documents indicate that, since cleanup started in May, some 26,000 barrels of bitumen mixed with surface water have been removed, including more than 4,500 barrels of bitumen.

[It is not clear how the figure of 26,000 barrels of bitumen mixed with water was derived.]

The scientist said Canadian Natural Resources is not disclosing the scope of spills in four separate sites, which have been off bounds to media and the public because the operations are on the Cold Lake Air Weapons Range, where there is active weapons testing by the Canadian military. The scientist, who asked not to be named for fear of losing their job, said the operation was in chaos. "Everybody (at the company and in government) is freaking out about this," said the scientist. "We don't understand what happened. Nobody really understands how to stop it from leaking, or if they do they haven't put the measures into place." Canadian Natural Resources did not respond to the charge that they aren't disclosing the scope of the spills. ... "In the course of injecting steam they've created fractures from the reservoir to the surface that they

didn't expect," said the scientist, who is speaking out over concern that neither the company nor Alberta's regulatory bodies would properly address the situation.

"This is a new kind of oil spill and there is no 'off button,' " said Keith Stewart, an energy analyst with Greenpeace who teaches a course on energy policy and environment at the University of Toronto. "You can't cap it like a conventional oil well or turn off a valve on a pipeline. "You are pressurizing the oil bed so hard that it's no wonder that it blows out. This means that the oil will continue to leak until the well is no longer pressurized," which means the bitumen could be seeping from the ground for months.

The company said the process is sound and has a good track record over 30 years in Alberta. It said that nevertheless it is reviewing its wellbores "to enhance wellbore integrity and modify steaming strategies to prevent the remote possibility of these events in the future."

The Cold Lake operations are on the traditional territory of the Beaver Lake Cree First Nation, which is pursuing a constitutional challenge that argues the cumulative impacts of oil sands industrial development are infringing their treaty rights to hunt, fish and trap. As well, the First Nation says there are graves alongside the lake in the area affected by the spills, and that band members have been unable to access that area.

[The article points to the fact that the surface releases represent a new type of energy industry incident about which little is known; that CNRL failed to provide the public with timely access to facts; and that the Beaver Lake Cree are pursuing a constitutional challenge. Whether the process of HPCSS has a "good track record over 30 years" has not been established.]

3.5.3 31 July 2013 (Tait 2013)

Canadian Natural Resources Ltd. said faulty engineering on old wells is responsible for bitumen leaking to the surface of an oil-sands project, and the company did some of the work itself. CNRL believes bitumen made softer through steaming reached the surface unintentionally by travelling up old vertical wells and escaping when it hit defective spots in the casing or cement. Under pressure, the bitumen squirted into natural cracks in the rock layers and moved upward. Casing and cement are used to prevent hydrocarbons from spilling out of well bores. Bitumen is leaking at four sites on CNRL's Primrose project, and one leak has killed beavers, frogs, tadpoles, shrews and birds.

[It has not been established that the cracks in the bedrock are "natural" in origin.]

The leaks underscore how newer oil-sands technology, which the energy industry touts as key to carbon reduction and a smaller physical footprint in the oil patch, can cause unanticipated problems. While CNRL has collected 6,300 barrels of bitumen emulsion in its cleanup effort, the four leaks are still releasing a combined 20 barrels of oil per day.

Now experts are wondering whether Alberta's current extraction methods could lead to more leaks. "Throughout Alberta there are many old wells, which were drilled, which were not completed for thermal operation," said Ian Gates, a professor in the department of chemical and petroleum engineering at the Schulich School of Engineering at the University of Calgary. "That is – thermal cement was not used and thus, when an operation steams where these wells are located, there could be a failure of the non-thermally completed wells and thus flow to surface behind the casing of these wells."

[Professor Gates indicates that "thermal cement" formulated to withstand steaming operations is required in unused wells located in areas subjected to HPCSS. What proportion of wells in regions subjected to HPCSS contain thermal rather than standard cement?]

Steve Laut, CNRL's president, said while the investigation is ongoing, his Calgary-based company may have cemented and cased the wells that are now leaking. CNRL in investigating a handful of potentially problematic wells, including former gas and water-source wells, Mr. Laut said Wednesday. "We're pretty confident we know it is a well-bore failure, but just exactly what

the mechanism within that failure is, it is too early for me to give that detail,” he said. “Some of them will be our wells. Some of them will be other operators in the area before.” Amoco Corp. is one of the companies in the area prior to CNRL, Mr. Laut said. “In over 30 years of using the current steaming and extraction method in the Primrose area, there have been few bitumen emulsion seepages to surface,” the company said in a statement.

Two leaks started on May 20, one on June 8, and the final on June 24, according to Alberta Energy Regulator spokeswoman Cara Tobin. The regulator did not issue news releases on the first three spills because they were “small” and had “no public impact,” she said. They were disclosed on the incident reporting section of the regulator’s website. The fourth leak was announced in July in an AER press release because it involved water. The other three were mentioned in that statement because they were “related,” Ms. Tobin said, adding the AER encourages companies to inform the public. CNRL, which did not address the spills until after the AER issued its release in July, said it believed the regulator was keeping citizens informed. [Leaving whether the public is informed about industrial incidents to the discretion of the AER fails the test of transparency. What is the company’s responsibility to inform the public?]

“In hindsight, we should have come out with more information sooner, but we thought that the regulator was providing that information” Mr. Laut said.

[This comment illustrates a systemic dysfunction. If neither the company nor the regulator are legally bound to inform the public, there is insufficient transparency and accountability.]

3.5.4 31 July 2013 (Canadian Press 2013a)

There is little chance that the injected steam has damaged the cap rock over the deposit, he [Laut] said. That would require more steam pressure than the company uses. "We have magnitudes [?] of hard data showing the rock strength. It's impossible to frack through (the rock) with the pressures we're using."

[There is no scientific support for the statement that it is “impossible to frack through” the cap rock. The ERCB (2011) report did not rule out this possibility. Scientific and engineering studies indicate that subjecting bedrock to *in-situ* steam pressure can result in fracture of bedrock (see Section 4.3.4).]

3.5.5 1 August 2013 (Canadian Press 2013b)

"Canadian Natural is confident the cause of the seepage is due to the mechanical failure of well bores in the vicinity of impacted locations," president Steve Laut said in a conference call. "We have a pretty good idea of the likely well bores." Laut said an old well drilled in 1997 by a previous operator is the suspected culprit. The company will check records for all the wells on its lease to see if any of them might pose a future risk. "If we see wells that are flagged as having higher risk, we're going to go back and determine if there is a risk there. If there is a risk, we'll remediate it."

... If any wells aren't fixable, the company can adjust its steaming process to eliminate the risk, Laut said. There is little chance that the injected steam has damaged the cap rock over the deposit, he said. That would require more steam pressure than the company uses. "It's impossible to frack through (the rock) with the pressures we're using." However, Alberta's previous energy regulator said in its investigation into the 2009 spill that the cap rock could contain pre-existing faults or might have been recently cracked. The Energy Resources Conservation Board also blamed the high volumes of steam that CNRL injected. "The ERCB is of the view that this likely contributed to the bitumen emulsion surface release. CNRL acknowledged that the Cycle 1 injection volumes may have contributed to the release," said the board's report.

[According to the news story, Mr. Laut first stated that there is little chance that the injected steam has damaged the cap rock. Then he is quoted as stating “It’s impossible to frack through (the rock) with the pressures we’re using.” There is a large difference between little chance and impossible. What is the probability that is meant by “little chance”? In various accounts, the company indicates that the cause of the releases is either a single defective well bore or multiple defective well bores. If multiple defective well bores are the explanation, the problem of statistical improbability is raised (see Section 4.3). If a single defective well bore is the explanation, it would raise the question of how the bitumen releases could be spread over an extent of about 14.6 km east-west and 4 km north-south (see Section 4.1). In order for that to happen, there would need to be an extensive network of vertical and horizontal fractures that could convey bitumen over large distances. Both scenarios present problems for CNRL and the regulator. Finally, although CNRL attempts to deflect criticism of its operations onto a previous company, the 2009 major bitumen surface bitumen release was reportedly restricted to wells drilled by CNRL.]

3.5.6 9 August 2013 (Pratt 2013)

There is some urgency about cleaning the bitumen off the marshland [*sic*, peatland] and containing the leak in the bottom [of the lake], because migratory birds will be passing by in a few weeks and may try to land there, say officials with Canadian Natural Resources Ltd. The company wants to avoid more wildlife losses. In an effort to scare off birds, noise cannons are booming, flags flutter on the site, decoys of predators dot the lake and bizarre mannequins peek out of the trees. On the water, large booms contain the surface oil while crews collect bitumen. Under the water, a special fabric impervious to oil is wrapped over the fissure to contain the leaking bitumen.

CNRL president Steve Laut, who joined the first media tour of the site Thursday, said the company takes responsibility for the leaks. “We’re doing everything we can to see the site cleaned up,” he said. Laut said in retrospect the company should have been more open with the public about the spill, though every incident was quickly reported to the provincial regulator.

About 200 workers are spread across four sites on and near the lake. The company is confident the leaks have been “contained,” though they have not been stopped. It’s not clear how long the sites were leaking before the first problem one was discovered on May 20. It’s likely some bitumen was leaking in late winter and early spring, said company spokesperson Zoe Addington.

Cleanup is no easy task in the muskeg. Crews must clear the forests of black spruce and tamarack and lay down wooden mats so vehicles can get to the sites. The peat is removed and set aside to let the bitumen drain out, then sent to a landfill site.

...Laut said he’s confident the leaks were caused by the failure of an old well bore that allowed bitumen to flow into cracks in the rock and migrate horizontally, and not caused by weakness in the surrounding cap rock.

... The company and the provincial regulator disagree on the cause of the leak from the underground bitumen pool. CNRL says bitumen is leaking to the surface because of the mechanical failure of the cement casings in well bores.

...The question remains whether the regulator will allow CNRL to resume steam injection before the cause of the spill has been determined. That crucial question could take months to answer. The regulator’s report on the 2009 spill found no clear evidence the well bores were a factor in that leak. That report took two years and was not made public until January 2013. In that report, the regulator noted the steam volume used at Primrose East was significantly higher than normally used and “likely contributed” to the bitumen release.

... [Pembina Institute] Spokesperson Chris Severson-Baker also wondered how the company explains leaks in four different places, and what that says about the entire project.

“What do these releases mean for the structural integrity of the Clearwater formation?” he wrote on his organization’s blog, referring to the location of the Primrose site.

[Although the first bitumen release was reported in May 2013, a CNRL spokesperson acknowledges that at least one of the leaks may have started the previous winter. If such is the case, is there sufficient monitoring by the company and sufficient oversight by the regulator? The four-year delay between the 2009 bitumen release and public release of the report about the incident further indicates insufficient transparency on the part of the regulator.]

3.5.7 10 August 2013 (Thomson 2013)

When it comes to describing the accident at the Canadian Natural Resources' oilsands operation near Cold Lake, "leak" doesn't do it justice. Neither does "spill." A "leak" can be plugged. A "spill" implies a one-time event. What's happening at CNRL's project is neither. For the last three months, 7,300 barrels of bitumen have uncontrollably bubbled to the surface from deep underground and seeped into muskeg and water on four sites at the company's operations, creating an ecological mess, killing wildlife and damaging the reputation of CNRL in particular and the oilsands industry in general.

The company has cut down trees, hauled away tonnes of oily muskeg and put containment booms on a contaminated lake. But the bitumen keeps coming, seeping out of the ground through long, narrow fissures. Not only has CNRL been unable to stop it, the company doesn't know for sure why it keeps coming. ... in volume it's about one-third the size of the Enbridge accident that dumped more than 20,000 barrels of oil into Michigan's Kalamazoo River in 2010, causing the largest inland pipeline spill in United States history and creating an \$800-million cleanup job.

No matter the size or how you describe it, an oil spill is not a pretty sight - not that it's been easy to take a peek at the CNRL accident. The affected area is not only remote, it is on the Cold Lake Air Weapons range which means it is out of bounds to civilians. Its inaccessibility has made the story more intriguing to journalists in Canada but around the world.

... There remains the possibility the problem was the result of a crack in the overlying cap rock created by the high-pressure steaming process. That would be a much larger problem for CNRL. It's one thing for the company to plug up an old cracked well bore but quite another to deal with cracks in a geological formation.

It would also be a much larger problem for the oilsands industry that is moving away from open pit mining to in situ methods designed to be less environmentally disruptive. The CNRL incident is raising troubling questions and providing ammunition for environmental groups to once again attack the industry. ... Given that the industry plans to recover 80 per cent of the oilsands through the in situ process, CNRL and regulators must come up with some answers. The first and most obvious is question is what happened at the company's operations near Cold Lake? It doesn't matter if you call it a leak or a spill or an underground blowout - we need to know what caused it and what it means to the integrity of the oilsands industry.

[The question of causality is central. If that question can be answered with sufficient certainty, the next questions would be how to minimize the probability of future occurrences; whether it is possible to staunch an underground release once it occurs; what are the effects upon the containment integrity of the bitumen reservoir and the future capacity to extract the remaining bitumen; and what are the effects upon groundwater, surface water, and overlying ecosystems. Until these questions can be answered with sufficient certainty, further HPCSS operations may present an unacceptable risk.]

3.5.8 13 August 2013 (Hislop 2013)

Four years ago, when a similar leak happened in the same area with the same producer, Canadian Natural Resources Limited, the public debate over the Canadian oil sands wasn't quite as intense. Today, the oil sands are in the centre of a public relations hurricane. Think of the events and issues that have dragged the oil sands kicking and screaming onto the world stage: The Keystone XL pipeline controversy, opposition to the Northern Gateway proposal, the 2010 Enbridge pipeline spill at Kalamazoo, Mich., numerous high-profile pipeline ruptures, and a concentrated campaign by environmental groups, often supported by Canadian First Nations.

Four years is too long to wait for the report on this latest leak. Especially since the 2009 report suggests the cause of the previous leak may have been CNRL's production procedures, approved by the Alberta Energy Regulator, that were the root cause of the failure.

What caused the [2009] release? According to the regulator, the steam volume during Cycle 1 was "significantly higher" due to "reduced well spacing." ... The reports says [*sic*] that CNRL agrees the increased amount of steam injected into the reservoir was likely the culprit. Steam volume was higher for two reasons. One, CNRL pumped more steam into the Primrose Area 1 wells than it did in other areas of the field. Two, the Alberta Energy Regulator [*sic*, ERCB] allowed CNRL to space wells at 60 metres apart instead of the previous 180 metres. More steam being pumped into more wells. Stands to reason all that steam, and the bitumen it produced, had to find someplace to go. CNRL and the regulator don't agree on the specific pathway it took to the surface, or if a wellbore failure was a contributing factor, but the pathway doesn't really matter. The cause of the failure was CNRL's decision, approved by the regulator, to pump too much steam into the affected wells. [This statement has not been substantiated.]

Primrose bitumen leak – CNRL not answering Beacon News questions

Were too high steam volumes the cause of the 2013 seepage? We don't know because CNRL won't address the question. On Aug. 6 the CNRL media representative asked that I submit my questions via email. To date I have had no response from the company. Here are the questions:

1. What is the well spacing for the wells in the vicinity of the Primrose bitumen emulsion leak? Has that spacing changed recently?
2. What is the usual steam volume and pressure for those wells? Have volume and pressure changed recently (say, within the past 3-6 months)?
3. CNRL said in its press release that the cause of the leak was mechanical failures in the wellbores. How many wellbores had mechanical failures? What is the nature of the failures?
4. Is it company policy and/or practice to exceed usual steam volume and pressure in order to extract more oil from wells?
5. What is the typical steam/oil ratio for the wells suspected of leaking the bitumen emulsion? Has the SOR changed recently?
6. Did CNRL change its operating procedures after the 2009 failure in the Primrose field?

Media were invited to tour the leak site Aug. 8. Beacon News did not receive an invitation, despite CNRL having received questions for this column on Aug. 6.

Cara Tobin, spokesperson for the Alberta Energy Regulator, did say in an email that well spacing for the Primrose East field varies from 60 metres to 188 metres. Which raises the question, if tight well spacing was responsible for the 2009 leak, why is it still being allowed?

For the record, CNRL said in a press release that the cause of the recent bitumen emulsion seepage is "mechanical failures of wellbores in the vicinity of the impacted locations."

One of the three experts (two production engineers familiar with cyclic steaming and a former CNRL employee) I consulted for this story says the gossip in the oil patch is that CNRL is blaming shoddy casing cement work by a sub-contractor for the leak. The engineer says casing

cement failure is a perfectly plausible explanation for the leak. But the former CNRL employee says it is common knowledge within the company that CNRL sometimes jacks up the steam volume to increase production. This allegation, admittedly unproved, is nevertheless supported by Figure 10 [not included in the excerpt quoted here], which shows very clearly that Primrose East Area 1 had much higher steam volumes than other areas.

... Was the latest bitumen emulsion leak caused by mechanical failures, as CNRL claims? Or was it caused by too much steam being pumped into too many wells for a given area? The company's explanation suggests the leak was an accident, perhaps preventable, but perhaps not, just one of those things that's bound to happen with any industrial process. But the second scenario, if true, is an indictment of both CNRL and the Alberta Energy Regulator (and by extension, the Alberta government) for undertaking and approving procedures that in the past caused a bitumen emulsion leak and damage to the environment.

"AER staff have been working with the company to control these releases and understand why they happened in the first place," said Jim Ellis, Alberta Energy Regulator CEO in an August 2 press release. "The AER's formal investigation into the cause of these incidents is actively underway. We do not currently have the evidence or data to support any conclusions as to the cause of the incident and look forward to reviewing CNRL's information supporting their conclusions on the root cause of the releases." Ellis and his team should expedite the investigation and report this fall if at all possible. Four years to report on the 2009 incident was too long. And CNRL should respond to media questions rather than dodging them.

The world is watching. And if the Alberta Energy Regulator and CNRL don't provide adequate explanations in a timely fashion, observers will draw their own conclusions, possibly the wrong ones.

[The failure of industry to answer questions posed to them is a recurrent deficiency in the current system.]

3.5.9 8 August 2013 (AWA 2013)

... The recent CNRL incidents are not the first time that in-situ operations have suffered unexplained failures. Similar releases have occurred in the past at Total's Joslyn Creek SAGD operation in 2006, at Devon Canada's Jackfish SAGD operation in 2010 as well as a previous release at CNRL's Primrose operation in 2009. The most recent releases at the CNRL Primrose operation, as of August 5, have released over 7,300 barrels of bitumen emulsion, killed over 120 animals and impacted 20.7 hectares, including an open water wetland.

"While the AER has suspended and restricted steam injection operations at the CNRL Primrose operations in response to the most recent events, it is unacceptable to have long fissures in the ground that will continue to spill toxic heated bitumen to surface, and to further risk our water and groundwater resources from these activities. The time has come for a broader inquiry into CSS and SAGD steam injection operations", said Carolyn Campbell, Conservation Specialist with the Alberta Wilderness Association.

[The account points to previous in situ bitumen release incidents; that near surface horizontal bedrock fissures that are releasing bitumen present an unacceptable new hazard; and that a public inquiry of in situ operations is required.]

3.5.10 21 August 2013 (Acuña 2013)

This incident [CNRL winter-summer 2013] will be the first real test of the effectiveness of the AER, which was recently created to take over the regulation function previously served by the Energy Resources Conservation Board. If history is any indicator, however, the ultimate outcome will be a lengthy report by the government regulator, that may or may not be made

public, and business as usual for CNRL and all other companies using HCSS and SAGD to extract bitumen.

This may sound cynical, but that was exactly the result the last time this type of leak happened in the same area, to the same company, using the exact same process. In January 2009, CNRL reported a release from its Primrose site to the ERCB. The ERCB responded to that incident by immediately ordering CNRL to cease injections in the area, and commenced an in-depth investigation. It is important to point out here that the results of that investigation were not made public until January 2013, long after CNRL was allowed to resume steam injection in the area, and only four months before this latest leak was spotted.

After that incident, just like this time, CNRL insisted that the bitumen released was caused by mechanical failure of old well-bores, and that they knew what to do to prevent future leaks of this type. The ERCB report, however, disagreed with CNRL's assessment. The ERCB concluded that the most likely reason for the incident was the geology of the area itself. In other words, there are weaknesses in the various underground strata in the area that cannot withstand the pressure from the steam injections.

That determination from the ERCB should be quite worrisome to Albertans—steam injection was being allowed to happen in an area where the geology was totally inadequate for the process. Did the ERCB not look at this before it granted the initial permit to CNRL? Was CNRL not required to provide incontrovertible proof that the process would be safe as part of its initial application to the ERCB? Either way, how many other similar projects are currently ongoing around the province with similar vulnerabilities?

What should be downright terrifying to Albertans, however, is the fact that even after the ERCB's report into the 2009 incident identified the geology in the area as the culprit, CNRL was allowed to continue using the exact same process in the exact same area. Who made that decision and why? Who signed the authorization to resume work? Was the energy minister aware of this at the time? Whoever made the decision showed a blatant, and potentially criminal, disregard for the public interest and environmental well-being in the province. Ultimately, that's where full responsibility for this current incident should be placed.

Now, the AER has the opportunity once again to get it right. The Alberta government claims it has world-class environmental monitoring, regulations and accountability, and this is a perfect opportunity for them to prove it through their actions. I, however, wouldn't recommend you hold your breath and wait for it to happen.

[The author points out that the public was not made aware of the 2009 incident until four years after its occurrence and after steaming operation were allowed to recommence in the area. He also indicates that CNRL's response to the present incidents mirrored that of the 2009 incident... blaming of a defective well bore and a promise that it knew what to do to prevent future incidents of this type; and that the AER is not in agreement with CNRL's simple explanation about defective well bores.. He justifiably asks what other ongoing energy projects in the province may present similar risks; and why CNRL was allowed to recommence operations given the unanswered causality and unquantified risks. He concludes by challenging the Alberta government's claims of world-class environmental monitoring, regulations, and accountability.]

3.5.11 9 October 2013 (Severson-Baker 2013)

In a drastic move to contain an on-going and unstoppable bitumen blowout in Cold Lake, Alberta, the province's department of environment has ordered Canadian Natural Resource [sic] Ltd. (CNRL) to drain two thirds of a 53-hectare lake. According to CNRL, some of the removed water will be stored in the remaining one third of the lake, with the rest piped to a nearby pit and wetland.

Draining the water body will allow the company to seal the fissure currently seeping bitumen into the lake, and allow the Alberta Energy Regulator (AER) to compare it with three others on site. According to eyewitnesses, the fissures are as much as 150 meters in length.

In an online statement, CNRL said:

“We are at a phase in our restoration plan [...] where we require access to the fissure below the shallow water body. We have determined the best regulatory approach to manage this work is through the Environmental Protection Order process. Canadian Natural requested and received an Environmental Protection Order for the 9-21 site from ESRD (Environment and Sustainable Resource Development).”

[The statement by CNRL that they are engaged in “restoration” is misleading. At best, the company is attempting to mitigate damage. It is not engaged in restoration.]

The order contradicts many of the public statements made by CNRL since the incident was made public: bitumen continues to seep from all four ground-fissures, none of the four leaking sites are contained, and the cause of the blowout remains unknown — as does information regarding how long the bitumen emulsion has actually been leaking.

Stretching the definition of reasonable

Section 112 of the Environmental Protection and Enhancement Act states that, upon the release of a substance that may cause adverse impacts to the environment, the company must take all reasonable measures to address its effects on the environment, prevent further impacts and return the environment to a “satisfactory condition.” It’s under this rule that CNRL has received approval to drain the 53-hectare lake impacted by its in-situ operations.

The fact that CNRL must take drastic measures, including draining a water body, to deal with the impacts of their blowout highlights both the serious environmental damage caused by these incidents to date, as well as its ongoing impact on the environment.

In addition to the lake drainage, the order indicates that CNRL must adhere to a comprehensive remedial plan — including a wetlands impact assessment, water body restoration plan and a bitumen emulsion containment plan. Though new points of accountability have been created between the company and the Regulator, it is unclear to what extent any of the information will be made publically available.

Slow motion disaster

Remarkably, nearly 11,000 barrels of bitumen have seeped to the surface of the Cold Lake facility. This bitumen has soiled lakes and the surrounding ecosystem and has proven deadly to 214 animals. An unknown volume of bitumen and process affected water has moved out of the bitumen bearing formation and into groundwater bearing zones in the general area.

New research from Timoney and Lee notes that CNRL’s spills present a more challenging clean up scenario than a pipeline spill, since they cause both damage deep underground and to the surface above ground. Our analysis of the spill locations provided in the Regulator’s Incident Reporting archive shows that the furthest distance between two spills is approximately fifteen kilometers, while the shortest distance is slightly more than one kilometer. The high-pressure nature of Cyclic Steam Stimulation technology has perhaps resulted in the bitumen emulsion following the path of least resistance through the formation’s rock and shale to the surface at four distinct areas on the Primrose and Wolf Lake lease.

The Regulator is leading the investigation into the cause of the bitumen releases to surface, and Environment Canada is assessing if any federal environmental or wildlife laws have been broken. However, these investigations have yet to include members of the public, members of the Cold Lake First Nations or interested stakeholder organizations, and no new information regarding the parameters of the investigation has been made available.

Community members left with unanswered questions

Communities have expressed concerns regarding the potential for aquifer contamination and the health of lands. Crystal Lameman of Beaver Lake Cree summed up her concerns this way:

“This area will never be the same and it shows the damage oilsands spills can cause and just how little we know about this type of underground technology.”

The Regulator’s decision to suspend and restrict steaming operations at the Primrose sites until they are satisfied that CNRL has fully identified the cause of the four distinct bitumen releases is a credible response to the incident. Moreover, its requirement that the company develop a plan to ensure releases of a similar nature do not re-occur on site is appropriate and timely. However, to date, the Regulator has withheld information needed by stakeholders and the public and First Nations to be confident in the investigation.

[It is not within the power of the regulator or the company to ensure that future incidents of this nature do not reoccur. The best that can be done is to decrease the probability, but the probability cannot be reduced to zero.]

Transparent investigation processes are critical in order to gain public trust in the management of the oilsands. [The deposits are not “oilsands”.] Unfortunately, the province has so far not included non-government organizations, First Nations, and nearby communities from its investigation at CNRL. These most recent events – including the drastic draining of a lake – bring new questions to the fore regarding the safety of CSS projects. As the spills continue to mount, so to [*sic*] will public concern over in-situ safety.

3.5.12 6 November 2013 (Williamson and Morgan 2013)

[Excerpts from an article in Alberta Oil magazine follow.]

...

“We’re very sorry this happened and we’re going to do everything we can to make sure it’s cleaned up,” he [CNRL President Laut] says. CNRL is spending \$40 million on the cleanup and, for the first time in years, hosting a gaggle of reporters on a three-hour tour of the operation near Cold Lake, explaining how the company’s facility works and what went wrong. Laut says the bitumen emulsion on the property shared with the Canadian Forces was most likely caused by an oil wellbore drilled by another operator in 1997. But what makes the media tour and Laut’s comments remarkable is their rarity.

[The title of the Alberta Oil article is apt: “Media-shy Canadian Natural Resources...”. As the documentation in this report demonstrates, CNRL continues to struggle to provide accurate and timely information to the public.]

In the weeks that followed the first reports of bitumen emulsion at Primrose, media-shy CNRL kept its characteristic silence on the issue. Eventually, the company started taking it on the chin from Calgary’s dailies for what they said was CNRL’s failure to communicate the problems at Primrose despite the public’s demand for answers.

...

... The company maintained its steadied silence when an explosion at the Horizon oil sands operation, caused by a coke drum opening at the facility's main upgrader, injured five workers in January 2011. It updated the public with news releases but provided no interviews.

It was a similar approach to the one the company took in 2007, when two Chinese workers died building out the tank farm at Horizon. A total of 53 charges were eventually laid against three companies, including 29 against CNRL that were eventually stayed, for that incident. And in 2009, when bitumen started seeping up from the ground at Primrose (just as it did this past spring and summer), CNRL worked to fix the problem and filed the requisite regulatory reports with the Energy Resources Conservation Board, but provided no interviews.

[It would be interesting to learn why the charges were stayed.]

...

This time around, CNRL is saying faulty wellbores caused the problem, and both the company and the AER are investigating to determine what exactly happened. In a quarterly earnings call, Laut responded to an analyst's question on what the company thought had caused the seepage, saying: "We are very confident this is a failed wellbore." The AER has said it's impossible to be certain until a thorough investigation is complete. Environment Canada is investigating the incident as well.

... CNRL's case shows that oil and gas producers in the province no longer have a choice on whether or not they want to communicate with the public when emergencies happen.

If they don't, the AER will do it for them. However, companies still have a social obligation to go beyond the disclosure requirements of the AER and communicate directly with the local communities affected by emergencies like bitumen emulsion. In CNRL's case, that included a responsibility to communicate with the Frog Lake and Cold Lake First Nations.

[Meeting the letter of disclosure requirements is not equivalent to meeting the spirit of disclosure requirements. Although it is true that both CNRL and AER have released information about the Primrose incidents, much of the information has been tardy, incomplete, inaccurate, or misleading. Much progress remains to be made.]

Joe Dion, the chairman and CEO of the FLFN-owned Frog Lake Energy Resources Corp., says, "They probably didn't think it was necessary to contact us because it happened about 60 to 70 kilometers north of the nation, but they should. I think they should have made a courtesy call to us, absolutely." Frog Lake Chief Clifford Stanley says he wasn't contacted either.

Cecil Janvier, councillor with the Cold Lake First Nation, says communication between CNRL and his community has always been spotty at best, and that has not changed. "We have always had problems with CNRL. I was chief previously for three years and, in fact, I even started litigation with regards to other applications that they made to the province so we really don't have a good relationship with CNRL compared to a couple of other industry players," he says. "If the CNRL seepage was to happen now that we have this website in place – because it wasn't when those first incidents were reported – it would have gotten the posting as well as the news release."

Janvier says the First Nation won't be happy until the seepage, which he learned about not long before the media, is resolved and answers are brought to light. But he also says there are more

parties to blame than just the company whose equipment may or may not have proved faulty. “Our concerns are not only with CNRL but with the AER. They don’t know what caused it. They don’t know how they’re going to alleviate the situation; we don’t know what’s happening. We don’t know about what’s underground, so that’s a lot of our concern. Basically that’s our qualm is nobody knows what’s going on – while somebody should know what’s going on. It’s the new millennium.”

[The continued use of high pressure steaming operations, while fundamental questions remain unanswered as to causality and safety, underline the conflict of interest presented when the regulator is charged with both promoting the industry and regulating it.]

In a press release dated September 16, Cold Lake First Nation Chief Bernice Martial also expressed concern, saying the ongoing emulsion problems at Primrose have raised safety and health issues. “I’m really distressed about the safety of our drinking water, animals, vegetation, and how this is affecting the aquifers underneath our Dene lands,” Martial writes. The release also states that fears of wolves and bears migrating into the community are front of mind, and the Cold Lake First Nation “would like inclusion on the safe restoration of their lands, compensation and accommodation due to the damage of lands and water.”

[Now that an unquantified volume of bitumen emulsion has escaped containment, but not reached the surface where it can be removed, how will long-term ecosystem and safety concerns be addressed?]

3.5.13 31 December 2013 (Mendler 2013)

... As of Sept. 14, ... 515 cubic metres of oily vegetation and 14,491 metric tonnes of soil due to the impact caused by the bitumen releases.

... Former Bonnyville Mayor Ernie Isley, who participated in a tour on August 8, felt the clean-up efforts were going great and that the company was being “super-responsible”.

“This is the cost of doing business,” said Isley. The company is “expending a lot of money [*sic*] and a lot of resources to find out the source of the leaks and fix it. You never want to see this but you’re in this business and there will be equipment failures and machines break.”

[It is debatable whether the clean-up efforts were “going great”, whether the company was being “super-responsible”, and whether the environmental costs of this incident are the acceptable costs of doing business.”]

... Former Alberta Energy Minister Ken Hughes visited the Primrose sites a few times over the course of the year and has continued to receive updates on the situation.

“I can tell you that (CNRL) is under the very tight guidance of the regulator to ensure we understand exactly what is going on there and that this kind of emulsion of bitumen does not happen again,” said Hughes, in an interview with the Bonnyville Nouvelle.

“The regulator is working with the company to try and understand exactly what the root cause of the problem is and that will inform the regulator about what the company can do in the future to specifically avoid this happening again.”

[The repeated assurances by government and industry that these uncontrolled bitumen releases can be prevented in the future are unsupportable. The subsequent (3 January 2014) bitumen release incident that occurred at CNRL’s Primrose operations highlights the unpredictable nature of incidents in a cyclic steaming regime.]

November saw another enforcement order handed out to CNRL, which required the company to determine the impact on subsurface groundwater and find the root cause of all four bitumen releases.

According to the 15-page enforcement order, bitumen emulsion, which has been seeping to the surface on an ongoing basis for the past six months, “has entered local non-saline groundwater aquifers, likely contaminating the groundwater.”

[The possibility that contamination of groundwater by underground hydrocarbon releases may be widespread in Alberta requires urgent scientific attention.]

... Canadian Natural will continue to make available any resources for investigation and clean-up and towards putting safeguards in place to ensure events such as these do not happen again.”

[Neither industry nor government can ensure that these incidents do not happen again.]

3.5.14 5 January 2014 (McDermott 2014)

... Eight months after Canadian Natural Resources discovered bitumen was seeping out of the ground at several of its locations, the leaks have still not stopped as the new year begins.

Since May 20, bitumen has been bubbling to the surface at an uncontrollable rate at Primrose, although the province believes the leaks may have started last winter.

Laut also admitted the company did a poor job at informing the public, the media and neighbouring communities with current information regarding the spill, but did not know when the leaks will stop.

“You’ll know it stops when you see it stop flowing,” said Laut.

[CNRL continues to do a poor job of informing the public, as demonstrated in the CNRL correspondence section of this report (Section 3.4). For the president of CNRL to state that “you’ll know it stops when you see it stop flowing” demonstrates the uncontrollable nature of these bitumen releases.]

3.5.15 14 January 2014 (Reuters 2014)

A leak at Canadian Natural Resources’ Primrose field in the Alberta oil sands continues to seep bitumen crude six months after it started, the head of the company said on Monday.

The Alberta Energy Regulator has been investigating the cause of leaking bitumen crude at the CNR-operated field since July. About 1 million litres of heavy bitumen crude have spilled from the Primrose field since then.

[This is inaccurate. Based on figures released by CNRL, the total volume of bitumen released to surface as of 14 January should be about 1.9 million L.]

“There is a low rate of seepage,” Steve Laut, president of CNR, told Reuters on the sidelines of the TD Securities’ London Energy Conference on Monday.

“The seepage was caused by a wellbore failure. The investigation is well under way and the solution is well defined. We’re working to make sure these things don’t happen again.”

[The cause(s) of the bitumen releases at the four sites has not been determined to date. Nor, is it within the power of CNRL to “make sure these things don’t happen again.” The new bitumen release that was reported 6 January 2014 underscores this fact.]

Laut said the field was seeping at about “one cubic metre squared per day” [*sic*, m³] but that the company expected to be able to halt the leak shortly.

The seepage is not expected to have a sustained impact on production, Laut said.

The Primrose field was hit by a second incident at the start of this year, when 27,000 litres of bitumen were accidentally released underground. That release has since been stopped.

Presenting at the conference, Laut said the company expects to increase its production by around 9% in 2014 to 711,000-757,000 barrels of oil equivalent per day. About 75% of the firm’s production is oil.

[It is significant that CNRL admitted to a daily release as of 14 January of about 1 m³. No increases to the total volume released at the four sites were made available at the AER website after 14 November 2013. Then, on about 19 January 2014, AER released an update in which the total volume of bitumen released was decreased relative to that reported on 14 November 2013.

As of the date of release of this report, AER has not explained why their estimates of bitumen released or recovered differ from those provided by CNRL despite the fact that the regulator depends upon the company for its incident data.]

3.5.16 2 February 2014 (Fekete 2014)

OTTAWA — Satellite imagery used by the federal government to review a major bitumen leak last year in Alberta has found the project's steam-based extraction caused "measurable levels of ground deformation in the area of the leak" at a rate 10 times faster than other oilsands operations.

The data obtained from satellite observations — and presented to senior officials at Natural Resources Canada last fall — are sparking new questions about the incident at a Canadian Natural Resources Limited (CNRL) operation in northeast Alberta and the safety of bitumen extraction.

The information is also sounding more alarm bells for the nearby Cold Lake First Nations, who are worried various oilsands operations in the area are contaminating local groundwater and damaging their traditional lands.

Briefing materials prepared for the deputy minister of Natural Resources Canada, and obtained by Postmedia News under access-to-information legislation, show the federal government used satellite imagery from RADARSAT-2 to study the extent of ground deformation — caused by steam-based extraction — in the vicinity of a major bitumen leak in June 2013 at CNRL's Primrose operation approximately 45 kilometres northwest of Cold Lake, Alta.

The CNRL project is a thermal in situ operation that sees high-pressure steam injected into the ground down a wellbore to reduce the viscosity of the oilsands product and allow the bitumen to be pumped to the surface (in what's called cyclic steam stimulation).

After the bitumen emulsion leak was reported by the Alberta Energy Regulator on June 24, 2013, the Canada Centre for Mapping and Earth Observation (CCMEO, which is located within Natural Resources Canada) used what are called earth observation techniques to assess the bitumen leak, and discovered subsidence and uplift of the land over several years.

"Results obtained using imagery from Canada's RADARSAT-2 (satellite) indicate that steam-based extraction caused measurable levels of ground deformation in the area of the leak, within the 2009-2013 period," say September 2013 briefing notes prepared for NRCan's deputy minister, who reports to federal Natural Resources Minister Joe Oliver.

The satellite data found that between 2009 and 2013, the values of ground deformation (both subsidence and uplift) at the CNRL operation were often in the range of 10-30 centimetres over various sampled 24-day periods.

"Preliminary analysis also shows that the rate of ground deformation is approximately 10 times faster than changes observed by CCMEO in the Fort McMurray area, which uses the lower-pressure steam-assisted gravity drainage (SAGD) method," say the briefing notes.

"While the deformation rates observed here are high relative to the SAGD steam-based operations, we cannot at this point indicate that these are atypical of this process in this region and/or are related to the bitumen leak."

More than one million litres of bitumen has seeped to the surface from the major leak, which still continues several months later, albeit very slowly during the winter months.

There have been at least three other separate, much smaller, leaks to the surface reported at different locations in CNRL's Primrose operations. As of Jan. 10, 69,700 tons of impacted soil and vegetation had been removed from all the leak sites.

The Alberta Energy Regulator, which was informed of the satellite data and associated findings last fall, is still conducting its investigation into the major leak.

The regulator is trying to determine whether the bitumen leaked through cracks in the rock above the deposit and was driven to the surface by the high-pressure steam pumped underground in the extraction process.

CNRL has since been ordered to halt its steaming operations at the site of the leaks.

The company blames the major leak on a well failure and is spending \$40 million to clean it up. It was ordered to drain a small lake on the Cold Lake Air Weapons Range to find a way to contain bitumen that was seeping into the water.

The Alberta Energy Regulator, however, said earlier this month it doesn't necessarily share CNRL's view that a well failure is solely to blame, although its investigation continues. The regulator's data show there are at least eight different cyclic steam stimulation bitumen operations throughout the Cold Lake, Athabasca and Peace River oilsands formations in northern Alberta.

The nearby Cold Lake First Nations says details about the land deformation — and it occurring at a much faster rate than other oilsands operations — have not been shared with them.

Cold Lake First Nations Councillor Sally Scanie said council members have done a fly-over of the major leak but have not been allowed on the land to see it up-close. They remain worried the oilsands operations could be contaminating their ground water, and irrevocably damaging the land and future hunting.

"It has always been a concern for Cold Lake First Nations," Scanie said. "Continuous abuse of the Mother Earth is just coming to the surface now, and it could get worse. Do we anticipate it to get worse? Of course we do, and that's why we're raising concerns."

A spokesperson for CNRL said the cyclic steam stimulation extraction technique has been used in the Cold Lake area for more than 30 years, with the surface deformation having been measured since the 1980s and satellite data used since the 1990s.

"Canadian Natural is committed to continuous improvement. We have been using this valuable (satellite) data [*sic*] to effectively calibrate our models and optimize our steaming operation since 2002," CNRL spokesperson Zoe Addington said in an email.

The company is undertaking a comprehensive review to determine the cause of the bitumen flowing to the surface, she said.

To date, "all the evidence and data collected" suggest the bitumen can only leak to the surface by a failed or partially failed wellbore, she said.

Darin Barter, spokesman for the Alberta Energy Regulator, said it's "premature" to discuss the AER's scientific assessments of the satellite data and other information because the investigation continues. He notes, though, the AER has not deemed the incident 'over.'

"Until the investigation is complete, we cannot speculate on regulatory changes that may or may not occur," Barter said in an email.

[As of September 2013, the federal government, AER, and CNRL were aware that vertical ground deformation on the order of 10-30 cm in the CNRL Primrose HPCSS area was occurring at rates about ten times faster than that observed in SAGD areas. Although both the AER and CNRL have indicated a commitment to improving their communications with the public, their failure to inform the public about the important ground deformation findings undermines that stated commitment. Although CNRL has reverted to its simplistic view that bitumen can reach the surface only via a failed wellbore(s), the company admitted in August 2013 (Pratt 2013) that migration of bitumen through bedrock fissures could follow release from a failed well bore.]

4. Discussion and Conclusions

4.1 The CNRL Pad 74 Incident

On 3 January 2009, bitumen emulsion originating in the Clearwater bitumen reservoir flowed to surface in the vicinity of well 1A74 at CNRL's Primrose East high pressure cyclic steam stimulation (HPCSS) Pad 74 located in LSD 14, Sect 1, Twp 67, Rge 03, W4. The surface release, which totaled an estimated 2500 m³, resulted in notification of the regulator (then, ERCB) and stakeholders and the cessation of steam injection at the site. From 3 January to 17 April 2009, a static investigation of the surface lease was conducted concurrent with reservoir depressuring. On 4 May 2009, CNRL submitted an interim report to the regulator that concluded a program of diagnostic steaming would be required to better understand the conditions that led to loss of reservoir containment. A dynamic investigation that involved diagnostic steaming of 73 wells was conducted from 17 August 2009 to 24 March 2010. From the results of the static and dynamic investigations, ERCB (2011) concluded:

“The key results from the diagnostic steaming program were:

“Diagnostic steaming did not result in a reactivation of the release pathway in those portions of the pads that had been previously steamed. Based on this, it can be concluded that the original release pathway has sealed itself such that it could withstand the stress of HPCSS operations.

“Diagnostic steaming did not result in caprock failure in those portions of the pads that had not been previously steamed. It can be concluded that HPCSS does not routinely result in caprock failure.

“Diagnostic steaming operations did not contribute any incremental bitumen release from the Clearwater Reservoir into the Quaternary aquifers, or at surface.

“The surveillance systems in Primrose East are capable of monitoring for any significant loss of reservoir containment.

“The nature and magnitude of the poroelastic heave pressures which occurred in overlying formations during Primrose East HPCSS operations have been quantified from field observation.

“With respect to the release to surface it was concluded [by ERCB 2011]:

“The failure which led to the bitumen release at surface is not a geographically widespread phenomenon. The release appears to have occurred from a single point, or possibly through a number of points located in close proximity to one another.

“The release of bitumen from the Clearwater Formation into the Grand Rapids Formation probably occurred in proximity to Pad 74. The diagnostic steaming program did not yield a precise location of the source of the release.

“The cause of the release from the Clearwater reservoir cannot be determined with certainty from the available data. Canadian Natural concludes that the release may be the result of the confluence of a geologic weakness and operational stresses. The geologic weakness in the cap may have components related to deposition, subsequent erosion, or stressing along the salt edge,

though no evidence for any of these were found. Exposure of this localized weakness to the stress load at the leading edge of a large volume HPCSS steam wave in the absence of any preconditioning of the reservoir resulted in the failure. However, flow through the Clearwater caprock along a wellbore cannot be entirely ruled out.

“The detailed flow path to surface also could not be ascertained from the available data, but a general pattern could be inferred. Once through the Clearwater capping shale, the emulsion migrated through the Grand Rapids via a vertical induced fracture. Propagation through the Colorado Group involved, at least in part, flow along a wellbore or wellbores to the vicinity of Pad 74. Once in the Lea Park the emulsion migrated through an induced vertical fracture system to the surface. Three possible scenarios were presented which conform to this general pattern, but none can fully explain all the observation data.

“With respect to environmental impacts:

“The surface release was confined to the vicinity of Pad 74 and the associated impacts have been removed.

“A collection and containment system continues to be operational and will collect any additional seepage from the original releases.

“The in-situ spill of bitumen emulsion in the Quaternary aquifers is localized to the vicinity of the induced fracture.

“Concentrations of dissolved phase constituents in groundwater are very low; exceedances of Alberta Tier 2 guidelines as a result of the release have only been noted for benzene, ethylbenzene and toluene in water samples taken from two wells (located along the fracture) which contain bitumen.

“The robust surveillance system is functional and continues to monitor the impact and potential need for active remediation

“In consideration of future bitumen depletion in the Primrose East area the following was concluded:

“The plan to complete the depletion of the four existing Primrose East HPCSS pads has been developed with consideration of the learnings obtained during diagnostic steaming operations.

“With enhanced surveillance and monitoring, this plan will minimize environmental risk and maximize resource recovery.

“Diagnostic steaming has created voidage and inter-well communication in the entire developed Primrose East area; therefore, overburden stresses during subsequent HPCSS operations will be reduced.

“On balance the evidence from the investigation demonstrates that the Clearwater capping shale remains the primary barrier to fluid loss and the Colorado Group shales are the ultimate seal for HPCSS operations.

“This report recommends that the depletion of Primrose East Development Area 1 continue with enhanced surveillance monitoring.”

The ERCB summary is noteworthy and relevant to the current investigation for the following reasons:

- (1) The report concluded that the release to surface was not a geographically widespread phenomenon. In contrast, the four 2013 bitumen release incidents were spread over an area that extended about 14.6 km east-west and 4 km north-south.
- (2) Neither the precise location nor the cause of the Pad 74 bitumen release could be determined with certainty. Although CNRL concluded that the release was related to geological weakness and operational stresses, ERCB did not find evidence for this explanation. Flow through the Clearwater Shale cap rock could not be ruled out. The general pathway for release was believed to be through the Clearwater Shale followed by migration through the Grand Rapids formation along a vertical fracture. Flow through the Colorado Group was believed to be, at least in part, along a wellbore(s) to the vicinity of Pad 74. Once the bitumen had reached the Lea Park formation, it flowed to surface via a vertical fracture system.
- (3) Although ERCB stated that the “associated impacts have been removed”, it is unclear what this statement means in an ecological or environmental sense. Recovery of released bitumen does not necessarily mean that impacts have been averted. The ERCB report states that: “The bitumen emulsion impacted snow, ice and soil that was present in the southeast corner of the pad was excavated and hauled offsite for disposal with other soil materials at the CCS Bonnyville Class II Landfill Facility in February 2009.” There is little in the ERCB (2011) report that documents ecological and environmental conditions pre- and post-release. In the absence of an actual environmental assessment of effects upon the biota, the statement that the “impacts have been removed” lack credibility.
- (4) Bitumen was released into the Quaternary aquifers and organic contaminants (BTEX, phenols, naphthalene) were detected in groundwater in wells near the fracture. Concentrations of benzene exceeded the Canadian Drinking Water Maximum Acceptable Concentration. Contaminant sampling focussed on a relatively small number of parameters. What other contaminants were introduced into the groundwater that were not assayed?
- (5) In spite of the uncertainties as to cause, pathways to surface, and potential effects on groundwater, the ERCB concluded that depletion of the bitumen reservoir could recommence. This decision appears to have stemmed from a belief that the Pad 74 event was a single anomalous incident. The 2009 Pad 74 bitumen release lies only about 700 m and 1200 m, respectively, from two of the summer 2013 bitumen release events (Figure 10).
- (6) Although an estimated 2,500 m³ of bitumen emulsion were reported released to surface, the volume of bitumen emulsion that escaped containment underground remains unknown. What proportion of bitumen emulsion reached aquifers? Similarly, although the ERCB spills database indicates a recovery of 2400 m³ bitumen emulsion, the ERCB (2011) report indicates that about 2144 m³ of emulsion were recovered.
- (7) The estimated total bitumen release for the four 2013 incidents was less than the total bitumen released in the Pad 74 2009 incident, yet the 2009 incident received little or no coverage in the media.

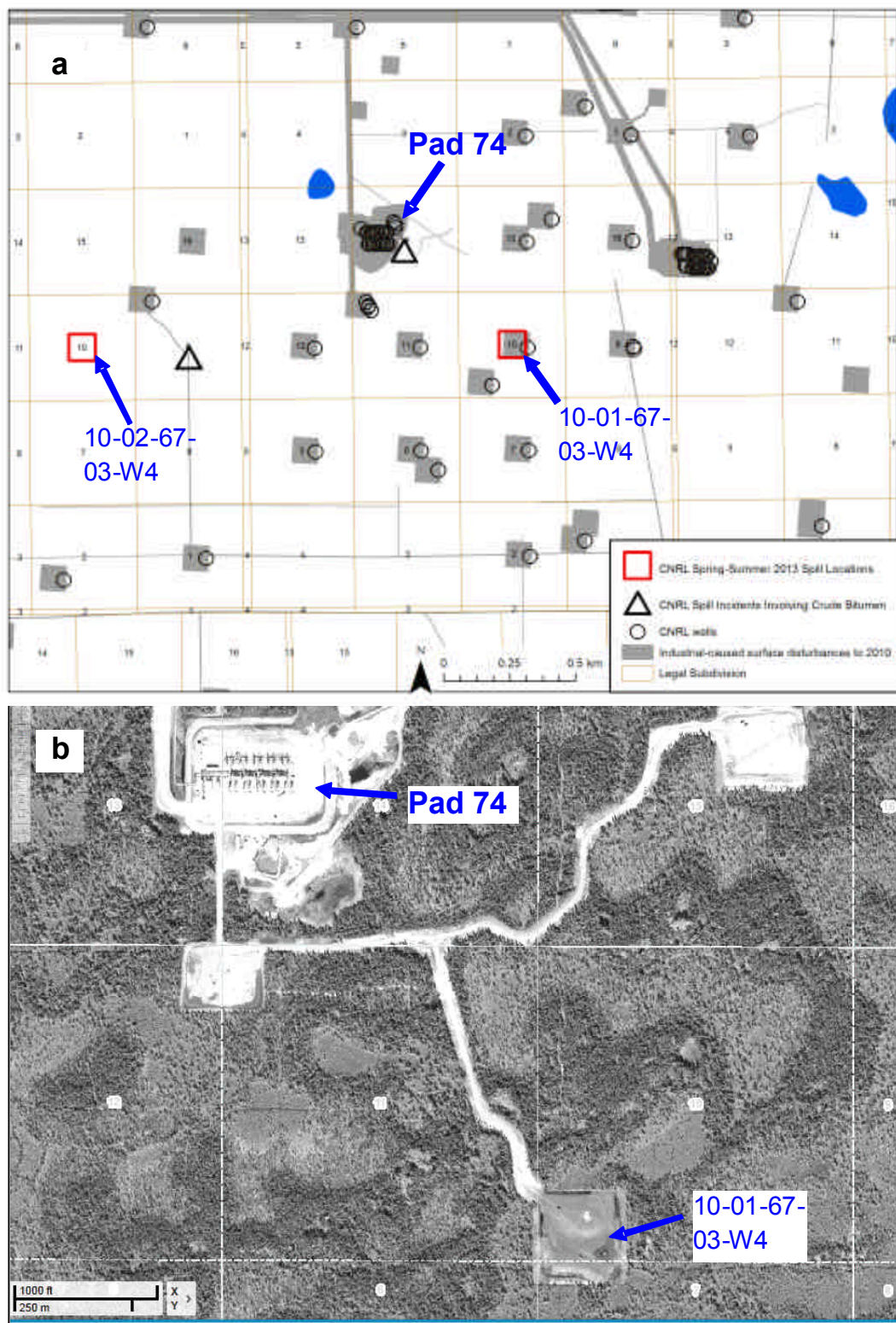


Figure 10. (a) Locations of two winter-summer 2013 CNRL bitumen releases (10-01-67-03-W4, 10-02-67-03-W4) in relation to CNRL Pad 74. The numbers in the center of each square are the LSDs. (b) Aerial view of the vicinity of the Pad 74 and 10-01-67-03-W4 bitumen release sites from an undated Government of Alberta image. Note the large scale of the images.

4.2 Failure to Provide Accurate, Complete, and Timely Information to the Public

The evidence gathered in this bulletin documents inadequate provision of timely and accurate information to the public both on the part of the AER and CNRL. Evidence is presented that illustrates that media releases contained misleading, unverified, or incomplete information. Misleading or inconsistent information was conveyed about the timing of incidents, the location of incidents, the volumes of bitumen released or recovered, and impacts to wetlands; by referring to data that were not supplied; by misinterpreting data (e.g., on detection of hydrocarbons); by equating the finding of dead animals as total wildlife impacts; and by the use of ambiguous language.

In response to queries, a timely, accurate, and complete reply was sometimes provided. In other cases, a reply was provided after delay; a query went unanswered without acknowledgment; a query was acknowledged but not answered; a query was answered with irrelevant information; or a query was answered with inaccurate or incomplete information.

CNRL has shown itself reluctant to provide timely, accurate, or complete information to the public. Yet, CNRL President Laut recently acknowledged a need to communicate more effectively (Tait 2013). It is not clear that the acknowledgment will translate into action.

Failure to inform the regulator has also been documented. CNRL (2010) admitted to 41 incidents from 2009 that were either not submitted or provided incomplete information to the Casing Failure Submission Electronic System. The incidents involved well casing failures, lack of regulatory approval, and overdue inspections.

4.3 Unanswered Questions and Concerns

4.3.1 Questions Posed to the Regulator

One of the chief concerns evident from study of energy industry incidents, and the response to these incidents by industry and the regulator, is that questions arise which, when posed to the responsible party, do not receive timely answers. As an illustration, during the course of a recent study (Timoney and Lee 2013), the investigators posed a set of written questions to the ERCB in mid-June 2013 that pertained to the ERCB's database of energy industry spills. We were informed that the ERCB (now AER) would respond as time allowed. In mid-August 2013, we sent a reminder to ERCB that the questions remained unanswered. We were informed that the contact would follow up with his colleagues to determine the status of their reply.

The questions posed to ERCB about its incident database were:

- (1) What does it mean when the amount released is zero and the amount recovered is some non-zero number?
- (2) For a large number of incidents, the volume recovered is equal to the volume released. Does ERCB verify both the volume released and the volume recovered for each spill?
- (3) How would a company achieve 100% recovery of a spill?
- (4) Especially when the spill is into water? [Examination of the ERCB (AER) spills data reveal a remarkably high correlation between the volume spilled and the volume recovered. The fact

that released and recovered volumes are reported by industry and apparently receive no independent verification calls into question both the reliability of the data and the diligence of the regulator. Without verification of such critical information, the public has reason to suspect that clean-up of toxic releases is not as effective as the regulator and industry maintain.]

(5) How does the ERCB determine that there is no effect on wildlife?

(6) Does it conduct a study or get the information from the company? [Post-spill studies of environmental and ecological impacts are rarely conducted. In some cases, they may be conducted when the spills are into water bodies and are reported in the media (e.g., oil spill into Wabamun Lake). Given the paucity of post-spill studies, statements to the effect that no environmental impacts were observed are reduced to tautologies.]

(7) Why are there no records prior to 1975? [Note: Later examination found that five of the 61,587 spill records occurred prior to 1975.]

(8) Are there spills that are missing from the database?

(9) What causes ERCB to specify "unknown" as the operator responsible for a release?

In mid-December 2013, AER responded to the questions. Those responses will be discussed in an upcoming bulletin.

4.3.2 ERCB (AER) Spill Data and Post-Spill Cleanup

Examination of the ERCB spills data found that some recovered bitumen volumes exceeded the released volumes. Recovered volumes could exceed released volumes in one of two ways: (1) Either one or both of the released and recovered volumes are inaccurate; or (2) the bitumen volume recovered includes an indeterminate volume of extraneous material such as soil and subsoil, vegetation, or water. If (1) is true, it indicates that the AER data are unreliable. If (2) is true, it raises the question for all spill incidents of what proportionate volume of the recovered material is something other than bitumen, and its corollary, what volume of bitumen remains on site as residual after the cleanup operation?

The refusal on the part of AER to address questions about how the release and recovery data are gathered and whether they are verified lends further reason to question the regulator's data. From an environmental remediation standpoint, it is difficult to understand how industry could achieve near-perfect recovery of released bitumen. There are few scientific studies that quantify post-spill residual petroleum products in freshwater and wetland systems and a review of that literature lies beyond the scope of this bulletin. There is, however, one important study that merits attention. Wang et al. (1998) quantified residual petroleum hydrocarbons in the soil and subsoil at three former spills ("Nipisi", "Rainbow", and "Old Peace River") that occurred near Lesser Slave Lake, Alberta from 1970-72. Interestingly, although the ERCB (AER) spill database extends back in time to the period of these three spills near Lesser Slave Lake, these spills are absent from the database

The Nipisi spill was one of the largest inland spills in Canadian history in which an estimated 60,000 barrels (9,551 m³) of oil were released onto a 10 ha area. Twenty-five years after cleanup operations, Wang et al. (1998) quantified the residual hydrocarbons present in the soil and observed four site groups, as follows:

Background... "These samples were taken at sites outside the dike. Generally, no petrogenic hydrocarbons, in particular no alkylated PAH homologues and petroleum

characteristic biomarker compounds such as pentacyclic hopanes and C27-C29 steranes, were detected and can be categorized as background.” (Nipisi and Rainbow sites)

Group 1... “These surface samples were taken from the upper 4 cm. They were highly contaminated (TPH [total petroleum hydrocarbon] levels: 20 000-256 000 ppm), and most of them were highly weathered/degraded.” (Nipisi and Rainbow sites)

Group 2... “These subsurface samples were mostly taken from 10 to 40 cm. They were highly contaminated (TPH levels: 10 000 ppm to 165 000 ppm) and lightly to moderately weathered/degraded.” (All three sites)

Group 3 ... “These samples were taken below 80 cm and from a depth of 40 cm at the Nipisi and Rainbow sites, respectively. They were lightly contaminated with oil and vegetation hydrocarbons (TPH < 673 ppm).” (Nipisi and Rainbow sites)

The Wang et al. (1998) study indicates that post-cleanup residual hydrocarbons may present long-term concerns. Although eventually biodegradation is thought to remove the majority of hydrocarbons after terrestrial oil spills, the biological, chemical, and physical degradation processes can take decades, and most of the resins and polar fractions of the oil may persist in the soil (Prince et al. 2003). Conventional cleanup methods in wetlands contaminated by spills includes excavation, trenching, use of sorbent pads, bellholes, and low-pressure flushing, and burning of hydrocarbons. These methods have been shown to be expensive, may have limited effectiveness, and can result in long-term harm to the wetland ecosystem (Moore et al. 1997). It would be worthwhile to quantify the long-term impacts and the residual hydrocarbons and other spilled materials present in the soil at major spill sites in Alberta, particularly at those where AER data indicate perfect recovery (100 %) of the spilled material.

There is an indeterminate number of other pipeline spills absent from the regulator’s database. Four additional examples follow:

- (1) A January 1975 spill from a Suncor pipeline into the House River at 09-34-77-15-W4 (which was also the site of a later spill on 20 June 1992; HBT Agra Ltd 1992);
- (2) A 41,000 L spill of untreated naphtha at Syncrude on 4 October 2009 (Alberta Environment incident number 345114; Timoney and Lee 2013);
- (3) A spill of light crude oil into the southwest fork of the Waskahigan River near Valleyview was detected in May 2005. The spill, of unknown volume, resulted from rupture of a 75 mm outside diameter CNRL pipeline at 09-08-64-23 W5 (AAR 2006). Although the media apparently reported that the release took place for three days, a confidential source informed the investigators that the spill may have been ongoing for three years prior to discovery. Why this large and documented spill is missing from the ERCB spill database is unclear.
- (4) “Tailings line rupture.... flowed through pipeline corridor... Tailings released from line 13 and drained into the emergency pond by Primary Extraction Plant 86. 70 to 150m³ of tailings released (based on a 800 KPA pressure drop across the failure opening lasting from 15:00 to 15:30 hrs on January 20, 2009...)” (Alberta Environment incident number 322650, Suncor Oil Sands; Timoney and Lee 2013).

Together, these seven missing spills (three near Lesser Slave Lake and the four noted above) further undermine confidence in the regulator’s data.

The 20 June 1992 spill of naphtha and diesel product into the House River (cited above, and present in the ERCB data) is noteworthy for two reasons: (1) it is one of a small number of spills that have received adequate post-spill study; and (2) the recovery rate was 32.9 % (about 2,500 barrels were recovered from the estimated 7,600 barrel release ; HBT Agra Ltd 1992), further suggesting that the near perfect spill recovery rates indicated in the ERCB spills data are not based on empirical observations.

4.3.3 Causality

Specific to the current incidents in CNRL Primrose, the primary question that arises from the CNRL bitumen surface releases pertains to causality. Of the two competing hypotheses, failure of well bores and failure of geological containment, the simultaneity of the four incidents in winter-summer 2013 render the well bore failure hypothesis unlikely.

Consider the following: The probability of a well bore failure that results in release of bitumen to surface is small—were it not a low probability event, the thousands of wells subjected to this process would have resulted in many incidents over time. For the sake of discussion, let us assume that the probability that a well bore will fail and release bitumen to surface during a month of operation is 1/1000 (the probability must be lower than this given the number of wells and number of these incidents, so setting the probability at 1/1000 favors the well bore failure hypothesis). The probability that four well bores (the winter-summer 2013 event) would fail within a given month is the product of their independent probabilities: $(1/1000) \times (1/1000) \times (1/1000) \times (1/1000) =$ one in a trillion. Simultaneous multiple well bore failure is unlikely to explain the incidents. A more likely explanation might be stress-induced fracture of a single geologic structure, the shale cap rock. Failure of non-thermal cement in abandoned wells may have occurred in both scenarios, but this failure would be related to the wells being subjected to the high pressure cyclic steam process and therefore linked to the industrial process that underlies the concern.

Given the fractured nature of the bedrock in the region, it is possible that a single well bore failure resulted in the conduction of emulsion through the cap rock containment, after which the bitumen emulsion was free to migrate along the three-dimensional network of bedrock fissures to later surface at four locations.

Although no mention of sub-surface release of bitumen has been made in regard to the ongoing CNRL releases, the question needs to be addressed. What is the total volume of bitumen that has escaped containment but has not reached the surface? The volume of such escaped sub-surface bitumen may be greater than that released to the surface.

4.3.4 Were the Ongoing Bitumen Releases Unforeseen and Unpredictable?

There is evidence to suggest that both the regulator and industry were aware of the possibility of loss of containment and other geological and operational risks prior to the 2013 incidents at CNRL Primrose. Although a review of the data lies beyond the scope of this bulletin, several points highlight the need for a public discussion.

(1) There is evidence of inter-well communication in the CNRL HPCSS operations near Cold Lake, which means that wells believed to be unconnected to steaming operations were in contact with steam and other fluids (CNRL 2010). Although this problem decreases the efficiency of bitumen extraction, the connectedness of presumably unconnected wells also indicates a failure of containment and therefore presents geological and environmental risks.

(2) In 2009, the Alberta Geological Survey initiated its “Oil Sands Cap Rock Integrity Project” whose goal was to “assess the potential risk for human-induced geological hazards” that might result from in situ methods (AGS 2013). The project was to “examine the caprock integrity of units above bitumen resources in northeastern Alberta and assess their capacity to contain steam, bitumen[,] and formation water when subjected to high temperature and/or high pressure operating conditions.” For Phase III of the study, AGS (2013) stated: “Uncontrolled releases of steam, oil[,] or formation water caused by in situ oil production (e.g., cyclic-steam stimulation and steam-assisted gravity drainage) create concerns for resource and environmental conservation. A better understanding of the affect [*sic*, effect] the geological setting has on the containment of the operations is needed. Therefore, we will analyze the incidences [*sic*, incidents] to determine the common trends, potential causes[,] and data gaps that should be

resolved. We will create an incident database that includes an overview of all failures or releases at in situ operations. This is a multi-year project beginning in spring 2009. We will distribute the results via reports and presentations available on our website.”

That the Alberta Geological Survey has undertaken the study and has planned to assemble a database of *in situ* incidents suggests that there has been formal recognition of geological risks related to *in situ* operations. In a follow-up, the investigators asked the Oil Sands Cap Rock Integrity Project (OSCRIP) contact, Kristine Haug, on 26 September: “Have there been any publications/presentations/posters/articles resulting from the Oil Sands Caprock Integrity Project?” Haug responded (26 September 2013): “Unfortunately the OSCRIP website is very out-of-date and the scope of the project has changed for a variety of reasons. We are in the process of updating the website and it will be completed very soon (hopefully some time next week) and the available publications will be there for download.” We wrote again (6 October 2013): “has the website been updated? If so, could you send [sic] me the url link?” No reply has been received to that email.

In summary, four and one-half years into the cap rock integrity project, the Alberta Geological Survey has released no information, the cap rock integrity website is outdated, the scope of the project has changed, and no information is forthcoming as to when information may become available.

(3) The major bitumen release that occurred in 2009 at CNRL’s Pad 74 (ERCB 2011), described above, whose causality was not determined with certainty, should have provided sufficient cause for the regulator to require CNRL to proceed with more caution than was exercised. The fact that due caution was not exercised, nor required, suggests that the monetary value of production outweighed the perceived risks. When it is recalled that the eight-month revenue (January-August 2013) from the 20 wells associated with the three of the four ongoing incidents (locations 10-01, 10-02, and 02-22) totaled roughly 64 million dollars, and that hundreds of wells would be affected if a steam ban were imposed, it is understandable that neither the regulator nor the company would be eager to curtail production.

(4) On 18 May 2006, a major release of steam that resulted from cap rock failure occurred at Total’s Joslyn SAGD operations. In the Daily Oil Bulletin, almost four years after the incident Roche (2010) reported:

“Total E&P Canada Ltd. was exceeding the approved steam injection pressure at its Joslyn Creek thermal bitumen project in 2006 when the reservoir cap rock was breached, blasting a huge crater into the ground and hurling rocks hundreds of metres into the air... The ERCB’s 177-page report found the steam release occurred near the heel of the first well pair in pad 204, creating a 125-by-75 -metre ‘surface disturbance’ and hurling rocks ‘up to 300 metres horizontally from the main crater’ A one-kilometre-long dust plume extended to the southwest after the blast. ‘The majority of this displaced material was deposited in the immediate area, but there was evidence of a fine dusting of material and rock across an area about one kilometre long by 100 metres wide to the southwest of the release point,’ the report says.

“Joslyn SAGD reserves were debooked [deregistered] at the end of 2008 and last June Total received ERCB approval to suspend operations. Last month, the company applied to abandon the project, said Elizabeth Cordeau-Chatelain, a Total Canada spokeswoman... The ERCB approved the SAGD scheme to operate below the fracture pressure of the bitumen-bearing McMurray formation. Joslyn Creek has 17 well pairs drilled from four surface pads. The steam release occurred above the injector/producer well pair 1 of pad 204 (well pair 204-I1P1, injector 03/01-33-095-12 W4M and producer 05/01- 33/095-12 W4M).

“ERCB investigators concluded Total was in non-compliance with its regulatory approval conditions by: --Operating at bottomhole pressures significantly higher than the 1400 kilopascals

(absolute) proposed in its scheme application; --Failing to implement alarms and automatic shutdown of wells exceeding the 1800-kilopascal bottomhole reservoir fracture pressure; and -- Exceeding the Directive 051 approved maximum wellhead injection pressure of 1800 kilopascals...

“Board investigators concluded the following is the most likely steam release scenario: -- The underlying cause of the steam release was the injection of steam at excessively high pressures. --The conversion of the well pair from steam circulation to semi-SAGD forced high-pressure steam into the bitumen reservoir. Eighteen days later, on April 12, 2006, a vertical fracture was initiated near the heel of the injector and established communication with the Wabiskaw C gas sand. --High-pressure steam and water pooled under the Wabiskaw A shale, causing it to fail on April 21, 2006, and establishing communication between the injector and the Wabiskaw A water sand directly underlying the Clearwater cap rock. --Between April 21 and May 18, 2006, high-pressure steam and water pooled under the Clearwater cap rock, causing it to fail. --Once the Clearwater was breached, pressure fell rapidly. ‘This pressure drop caused hot water that had accumulated in the Wabiskaw A water sand and the Wabiskaw C gas sand to flash to vapour. This provided the energy for a catastrophic explosion that disturbed a large surface area and subsurface volume and threw rocks several hundred metres into the air...

“The ERCB report said the following actions have been taken since the mishap: --An ongoing rewrite of ERCB Directive 051: Injection and Disposal Well--Well Classifications, Completions, Logging, and Testing Requirements to address thermal in situ operations; -- Development of specific application requirements to investigate cap rock integrity and maximum operating bottomhole pressures; and --An ongoing joint study of cap rock integrity by the ERCB's geology and reserves group and Alberta Geological Survey.” [It is noteworthy that as of 25 September 2013, the joint AER - Alberta Geological Survey study of cap rock integrity has still not released any results.]

The ERCB report of the Joslyn incident was released four years after the event, incidentally the same inordinate delay observed in release of the CNRL Pad 74 incident. When interviewed about the report in July 2010, Davis Sheremata, an ERCB communications advisor stated: “There hasn't been one (incident) since and the measures that we've put in place are designed to ensure that we never have one again” (De Souza 2010). Was Mr. Sheremata misinformed on two counts? (a) There had been another catastrophic event since the Joslyn event, the CNRL Pad 74 event in 2009. (b) Whatever measures were put in place were insufficient to prevent their reoccurrence, such as the four 2013 events. It is inappropriate for the regulator to imply that it can prevent reoccurrences of incidents of this nature. Although industry frequently resorts to this categorical “it will never happen again” terminology in public relations communications, a regulator should be more circumspect and evidence-based in its assertions.

Carlson (2012) studied the Joslyn cap rock failure. Conclusions and observations included: (a) The Joslyn event was a significant catastrophic failure that may affect future licensing of SAGD projects if the cause(s) of the failure cannot be determined with certainty; (b) Existing reports by Total and the Alberta government did not conclusively identify the cause(s) of the failure; (c) Computer simulations of SAGD wells indicate that pressure spikes are likely to occur; the author concluded that a steam pressure spike might was a plausible mechanism for the cap rock failure; (d) Although both Total and the Alberta government had attempted to explain the Joslyn cap rock failure, other failure mechanisms should be considered; (e) Determining the cause of failure at Joslyn will be critical for safe licensing of future projects; (f) Significant bitumen reserves will be sterilized (made unavailable) if safe operation cannot be assured.

(5) Khan et al. (2011a) applied an integrated geomechanical model to evaluate cap rock integrity subjected to thermal *in situ* operations. They found that: (a) Maintaining the injection pressure below the fracture pressure (as determined in mini-frac tests) does not guarantee cap rock

integrity; (b) A variety of cap rock failure modes must be incorporated to understand the possible effects of thermal operations on reservoir containment.

(6) In a related study, Khan et al. (2011b) concluded that: (a) Steam injection results in complex thermal and hydraulic processes underground that can alter *in-situ* stresses, reduce rock strength, cause new fractures, or reactivate old fractures, which together can increase the risk of cap rock failure. (b) Cap rock failure can lead to breaches in well or reservoir integrity and provide pathways for bitumen or steam to migrate to shallow aquifers or to the surface; (c) Loss of containment poses significant environmental and safety risks.

(7) Satellite-based synthetic aperture interferometry is useful in measuring small movements of the Earth's surface and can be used as a tool to avoid dangerous industrial activities in areas of faults and fractures (Stancliffe and van der Kooij 2000). In the Cold Lake area, the injection of steam has been observed to cause pump jacks to heave and subside by up to 30 cm during the first steam cycle. Interferograms from Imperial Oil's Cold Lake HPCSS field indicated vertical movements of over 36 cm in one month. Average vertical movements in the Cold Lake HPCSS areas are 10 to 35 cm (Teatini et al. 2010). Vertical heave generally increases with time as an area is heated and accumulates dilation strain.

(8) Dusseault et al. (2001) documented well shearing, a type of well failure, caused by shear stresses imposed by movement of geologic strata as a result of HPCSS operations near Cold Lake, Alberta.

"In the cyclic-steam approach, the same wellbore is used for both steam injection and oil production. Downhole well spacing is 4 acres on a 1.7 aspect ratio (approximately 170/100 m per well), and wells are drilled from pads usually containing 20 wellsites. A typical well will go through 10 or more injection/production cycles, each lasting several months. The cased well is exposed cyclically to fracture-injection pressures up to 10 to 12 MPa and temperatures up to 325 °C.

"More than 250 wells have failed at the Cold Lake heavy-oil field. Well failures have occurred at the top of the producing interval, at a shallow shale interval in the overburden, and near the base of the Colorado shale. Inclinator surveys indicate localized shear displacements on weak bedding planes on the order of 100 mm and in some cases larger than 200 mm near the top of the producing interval. These arise because of pressure and thermally induced expansion and contraction of the oil sands... Failures higher in the overburden occur by slip along weak bedding planes because of cyclic reservoir heave and compaction...

"When the reservoir is steamed, it expands in all directions as fluids are injected into the sand matrix. Uplift or "heave" in excess of 500 mm is recorded at the surface, and the tendency for lateral movement is accommodated by bedding-plane slip... Well damage from formation shear occurs primarily in two zones: uphole failures near the base of the Colorado shale layers, and downhole failures within the Clearwater oil sands and at the interface between the Clearwater and overlying Grand Rapids formations. As usual, slip occurs at interfaces where strain discontinuities develop, and along the weakest beds, again near interfaces, in uphole regions.

"About 85 to 90% of the downhole failures at Cold Lake, more than 200 wells, occurred at the top of the producing interval at the interface with an overlying Grand Rapids shale stratum. These failures are a direct result of shear stresses generated by steam injection and production in the oil sands. The overlying strata are not pressurized or heated and resist the tendency of the injection zone to expand, resulting in shear at the interface. Shear slip in the opposite sense undoubtedly also occurs when the reservoir compacts during the production phase.

“The wells at Cold Lake are fully cemented across the Clearwater/Grand Rapids interface and hence, cannot accommodate much shear displacement. Vertical deformations also can induce shear deformations on deviated wells...

“Downhole integrity loss often can be repaired, but uphole shear failures at Cold Lake are serious events that could result in the release of fluids to the surface. These cannot be repaired, and the wells must be abandoned. Multiple uphole casing failures have caused the abandonment of an entire pad of wells resulting from destabilization of the shale zone where shear is concentrated.”

The foregoing findings provide context for the four ongoing bitumen releases at CNRL Primrose and suggest the following.

- (1) Well failures due to shear stresses imposed by geologic strata subjected to steaming operations are common in the Cold Lake region of Alberta.
- (2) Both government and industry were aware that catastrophic failure of containment and subsequent uncontrolled bitumen, emulsion, or steam releases had happened before the 2013 releases.
- (3) The regulator’s inability to determine the causes of previous cap rock failures while allowing HPCSS operations to continue in the absence of improved safeguards has imposed unquantified risks to bitumen resources, groundwater, and adjacent ecosystems.

4.4 Significance, Implications, and Recommendations

The four-year delay between the 2009 bitumen incident and release of the investigation report to the public was excessive. The AER should place a high priority on the investigation of the four 2013 releases and release its report as soon as is feasible. Concurrently, government, not industry, should undertake a review of the integrity of all wells in regions subjected to HPCSS. All wells that are found to be structurally problematic should be serviced to minimize the risk of future bitumen releases.

Industry and regulator performance in regard to public communication about energy industry incidents must be improved. The public has a right to timely, accurate, and complete information. The resources being exploited are owned by the public and the exploitation is taking place on public land.

The science that exists on oil spill recovery rates indicates that 100 % recovery is rare, but the AER incident data indicate that perfect or near-perfect recovery of hydrocarbon spills is the norm. The most parsimonious explanation for the discrepancy between AER and scientific data is that the AER data are unreliable. Given that industry is reporting both the spilled and the recovered volumes to the regulator, that industry has an incentive to report 100 % recovery, and that the regulator does not verify the industry-reported data, it is likely that AER spill-recovery data overestimate actual recovery rates.

Until the reliability of incident data is confirmed, the credibility of the regulator and the industry are in question. Alberta’s Auditor General, Merwan Saher, announced in September 2013 that his office plans to audit “... the government’s monitoring systems to ensure compliance with Alberta’s pipeline regulations. Our audit would include inspection and enforcement processes” (Wood 2013). As described, the audit is too narrow. The audit should include the regulator’s methods of data collection in response to release incidents and the reliability and accuracy of those data.

ERCB admitted to not knowing the cause of the 2009 Pad 74 incident; therefore, safeguards were not instituted that might have acted to lower the risk of future bitumen releases. In light of the unquantified risks to the bitumen reservoir, groundwater, and the adjacent ecosystems, the decision by the ERCB to allow HPCSS to continue during and after the Pad 74 incident was unjustified by the available evidence.

The proximity of Pad 74 to the four 2013 bitumen releases suggests that the five releases may be causally-related. The two 2013 release sites with the earliest reported releases of bitumen to surface at 10-01-067-03 W4 and 10-02-067-03 W4 (both reported 20 May, but apparently one or both sites began releasing bitumen in winter) lie the shortest distance from Pad 74. The next release, at 02-22-067-03 W4, was reported 8 June and is intermediate in distance from Pad 74. The last release, at 09-21-067-04 W4, was reported 24 June and lies the greatest distance from Pad 74. The spatial and temporal pattern of the bitumen releases suggests that they may share a common source area located near Pad 74. Migration of the bitumen to the four release sites would have occurred via a network of vertical and horizontal fissures. Whether vertical migration included failed well bores is uncertain, but the near simultaneity of the four releases argues against well bore failure as the sole explanation.

The recent bitumen release incidents at CNRL's Primrose operations, along with the cap rock failure at Total's Joslyn project, raise concerns. Potential impacts of *in situ* bitumen development on groundwater and interconnected surface waters are poorly understood and require urgent study. The Council of Canadian Academies (CCA 2009) noted that *in situ* operations will likely have a greater impact on groundwater than will surface mining operations because *in situ* operations will cover a much larger area than surface mines and will use both non-saline and saline groundwater. Barson et al. (2001) raised several issues in regard to the SAGD method of *in situ* bitumen exploitation: its requirement for large volumes of water; the disposal of wastewater by injection into underlying bedrock formations; the protection of both energy resources and groundwater; and the avoidance of large-scale cross-formational flow. They observed that although the basal McMurray aquifer in the Fort McMurray region is being used for disposal of SAGD wastewater, it is not suitable for storing large volumes of wastewater in that it outcrops along the Christina and Athabasca Rivers and the overlying aquitard middle McMurray Formation derives its confining properties from the bitumen that fills the pore spaces. The removal of bitumen will undermine the aquitard's ability to confine wastewater (Barson et al. 2001). The HPCSS method of bitumen exploitation may present similar or even greater concerns for groundwater and cross-formational integrity given that SAGD uses gravity drainage to retrieve the bitumen whereas HPCSS fractures underlying bedrock and expels the bitumen under pressure.

The 2009 bitumen release followed by the four bitumen releases to surface attributed to HPCSS that have occurred during the first six months of 2013 in the CNRL Primrose area present a clear warning. Due diligence dictates that HPCSS operations should be suspended or curtailed until major unknowns are addressed. Over-pressuring of bitumen reservoirs should be prohibited.

Another release of bitumen in the CNRL Primrose South operation was reported on 6 January 2014 in which 27 m³ of steam/bitumen were released into a subsurface geological formation in an area 45 km NW of Cold Lake. According to the AER website updated late January 2014 (AER incident 20140048, see Figure 3), "A well casing failure occurred during normal steaming operations on Primrose Pad 30 and caused a subsurface steam/bitumen release

into the formation. Steaming operations at the pad have been suspended and well repair options are being explored. No reported impacts to wildlife or waterbodies.”

A CNRL spokesperson questioned the AER’s decision to categorize the incident as a release and indicated that the event was routine because bitumen did not reach the surface: “There’s no spill... Casing failures do happen, and they’re generally not reported as spills” (Dawson 2014).” This complaint may have prompted the AER to edit the incident description to include the note: “The AER notes that this incident is operational in nature and poses no risk to the public or environment. Although incidents like this must be reported to the AER, they do not meet the criteria established for the incident reporting web page. This incident was inadvertently posted on the incident reporting page.”

As with other statements made in the course of this investigation, the AER statement raises questions. Here the regulator divulges that this sub-surface release of bitumen did not meet the criteria for public reporting on its web page. What other sub-surface releases of industrial liquids and other compounds are occurring in the province? Where are they? What is the volume released for each kind of hydrocarbon, saline water, fracking fluid, and other chemicals? Are the releases escaping to groundwater? Is there scientific investigation or monitoring of these sub-surface events?

As of mid-January 2014, the location of the incident had not been disclosed despite repeated requests on our part to both AER and CNRL. Finally, on 28 January 2014, the location was provided by AER. Reference to the AER spills database reveals that this location has had a troubled history in recent years, as follows: 4 January 2007, release of 390.5 m³ crude bitumen, along with 1,171.5 m³ of salt and produced water, and 1,000 m³ of raw production gas (incident # 20070035); 25 February 2007, release of 2 m³ crude bitumen (incident # 20070556); 7 May 2007, release of 2 m³ crude bitumen (incident # 20071146); and 23 September 2010, release of 100 m³ of raw production gas (incident # 20101731).

The mid-January 2014 incident is interesting for four reasons: (1) This is the fifth AER-reported incident at this legal location. (2) There was a three-day delay between occurrence of the incident and its being reported to the regulator. (3) AER refers to the release as steam/bitumen (i.e., emulsion) whereas CNRL refers to the release as “27 cubic meters of steam” (Mendler 2014). (4) Although CNRL views the incident as “in no way connected to the four previous spills” (Mendler 2014), it is premature to conclude that prior to completion of investigations. Moreover, although the January 2014 release of bitumen at CNRL Primrose may not be directly related to the four ongoing bitumen releases, the fact is that bitumen emulsion was released as a result of high pressure steaming operations. Whether the emulsion was conducted via a defective well bore or via fractured bedrock is not material.

Recent media attention has focussed on the four uncontrolled releases of bitumen that continue as of January 2014, but it is important to realize that releases to the environment at CNRL’s operations in the Cold Lake area are not uncommon. Reference to the AER spills database reveals the following. For CNRL’s operations in Townships 65 to 68, Ranges 1 to 7, W4, which encompass a portion of CNRL’s operations northwest of Cold Lake and straddle the southern boundary of the Cold Lake Air Weapons Range, there were 32 primary releases of crude bitumen (over the period 2003 to early 2013), 44 primary releases of crude oil (1985 to 2008), 34 primary releases of process water (1999 to early 2013), 121 primary releases of salt/produced water (1985 to 2012), and 15 primary releases of waste (2008 to 2012). Many incidents involved the release of more than one substance (e.g., a primary release of crude bitumen can also include other releases that are referred to as secondary, tertiary, etc.) and several release types are not included in this tabulation (e.g., condensate, drilling mud, raw production gas, lubricants, and oily sludge). These releases may be resulting in environmental impacts.

Underground migration of bitumen through fractured bedrock that result from failures of geological containment would be difficult to detect if they do not result in measureable changes in reservoir pressure or well production. All six of the documented releases of bitumen to date (Total Joslyn in 2006, CNRL Pad 74 in 2009, and the four CNRL 2013 events) became known only when they released bitumen above ground. It is therefore pertinent to ask whether covert incidents that involve releases of bitumen belowground, but not to the surface, have occurred.

Investigation of groundwater quality has detected hydrocarbon contamination in the aquifer(s) overlying the Colorado Shale in the Cold Lake area. Given that HPCSS is designed to fracture the reservoir, it is possible that undetected bitumen releases are common, are resulting in loss of hydrocarbon reserves, and are contaminating other geological formations including groundwater.

Given that there were 48,344 abandoned petroleum and natural gas wells in northern Alberta as of 25 August 2009 and 17 active and future cyclic steam stimulation projects in the same region (Figure 11, Tables 3 and 4), recent uncontrolled bitumen releases suggest that an in-depth, independent scientific investigation of the geological, hydrological, and ecological risks associated with HPCSS operations should be conducted immediately. High pressure cyclic steam stimulation methods may be leading to degradative changes in the quality of groundwater and the integrity and containment capability of bitumen reservoirs and may be placing adjacent ecosystems at risk of bitumen releases that are difficult to control. Expansion of *in situ* methods of bitumen exploitation across Alberta is outpacing the increase in knowledge of the potential below-ground and surface impacts of these methods. By the time the effects of these methods are sufficiently understood, it may be too late to remediate. Continued use of HPCSS may result in large and unpredictable costs, and those costs will not be borne by the energy companies but by future generations of Canadians.

Acknowledgments and Disclosure

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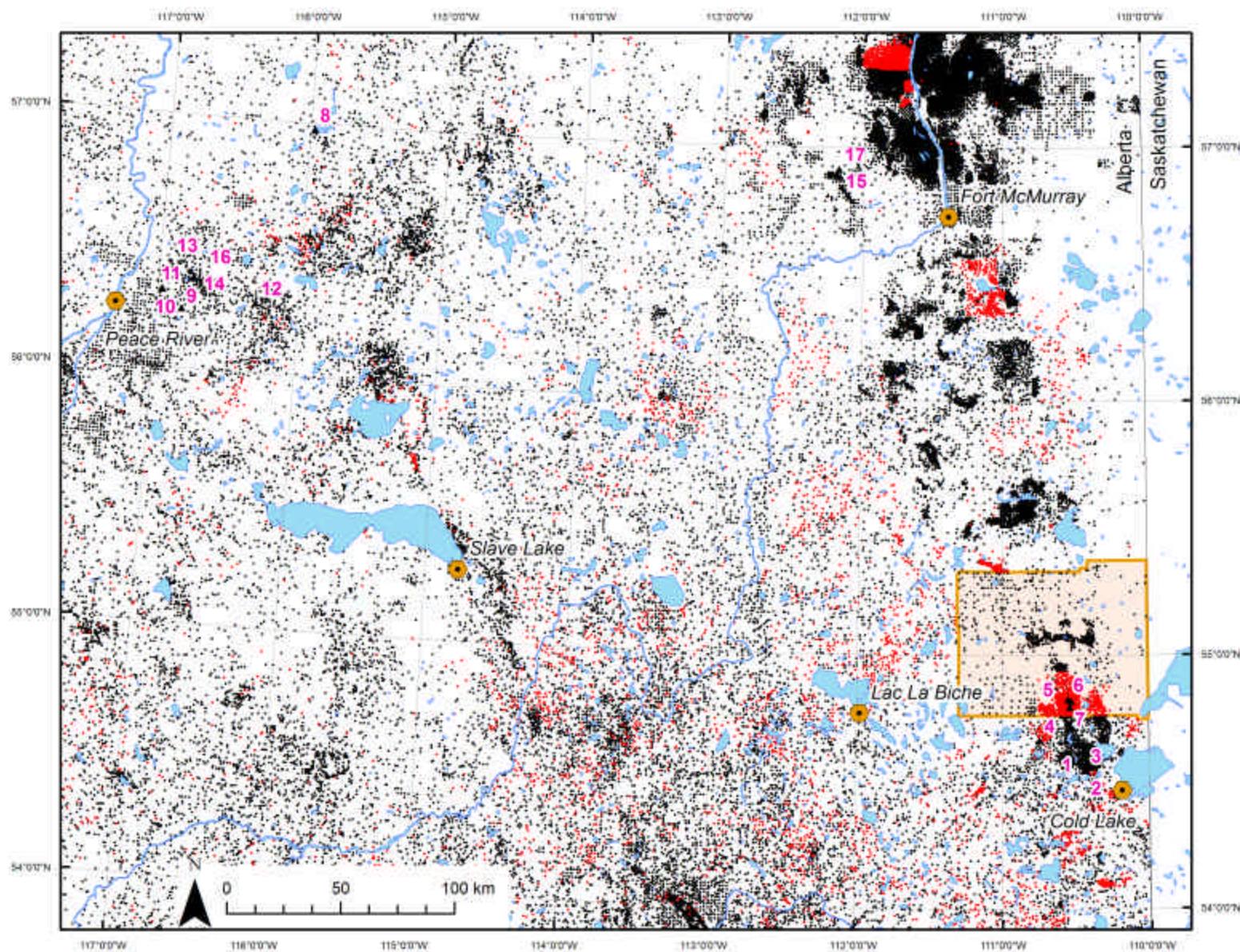


Figure 11. The distribution of abandoned wells in northern Alberta in relation to cyclic steam stimulation projects. There were 19,027 abandoned wells in the region as of 25 August 2009. Red dots symbolize CNRL abandoned wells; black dots symbolize other company abandoned wells. Numbers refer to the projects listed in Table 3.

Table 3. Key to the 17 current and future cyclic steam stimulation bitumen projects in northern Alberta (refer to Figure 11). TBD = to be determined. Data from Alberta Government (2013a).[^]

Project	Capacity (barrels/day)*	Start- Up
(1) Imperial Oil Limited Cold Lake Phase 1-10	110,000	1985
(2) Imperial Oil Limited Cold Lake Phase 11-13	30,000	2002
(3) Imperial Oil Limited Cold Lake Phase 14-16	40,000	2014
(4) Canadian Natural Resources Limited Wolf Lake	13,000	1985
(5) Canadian Natural Resources Limited Primrose East	32,000	2008
(6) Canadian Natural Resources Limited Primrose North	30,000	2006
(7) Canadian Natural Resources Limited Primrose South	45,000	1985
(8) Northern Alberta Oil Sawn Lake	700	TBD
(9) Penn West Petroleum Harmon Valley	TBD	TBD
(10) Penn West Petroleum Seal Main Commercial	10,000	2015
(11) Penn West Petroleum Seal Main Pilot	75	2011
(12) Royal Dutch Shell PLC Cadotte Lake	12,500	1986
(13) Royal Dutch Shell PLC Carmon Creek - Phase 1	40,000	2015
(14) Royal Dutch Shell PLC Carmon Creek - Phase 2	40,000	2018
(15) Southern Pacific Resource Corp. Commercial	10,000	TBD
(16) Southern Pacific Resource Corp. Pilot Expansion	3,000	TBD
(17) Southern Pacific Resource Corp. Pilot	1,000	2009

[^] In its most recent quarterly update (Alberta Government 2013b), which was released after the four CNRL incidents were made public, the update did not differentiate the *in situ* technology (e.g., SAGD, CSS, THAI) used in each project. Why this information was removed between the spring and summer updates is not clear.

* Barrels/day is the assumed unit, although this was not specified in the source document tabular data.

Table 4. Top ten companies for number of abandoned wells by three categories of abandonment for northern Alberta (as delimited in Figure 11). The total number of abandoned wells for each category includes all companies within that abandonment category. There were 48,344 abandoned wells in the region for the three categories as of 25 August 2009 (data from Alberta Energy).

No Reclamation Status		Reclamation Certified		Reclamation Exempt	
Company	Wells (n)	Company	Wells (n)	Company	Wells (n)
Canadian Natural Resources Limited	3921	Canadian Natural Resources Limited	1681	Suncor Energy Inc.	2519
Suncor Energy Inc.	2120	Husky Oil Operations Limited	1172	Syncrude Canada Ltd.	2319
Husky Oil Operations Limited	1462	Talisman Energy Inc.	795	Imperial Oil Resources Limited	1558
Total E&P Joslyn Ltd.	1233	BP Canada Energy Company	584	Shell Canada Limited	1255
Imperial Oil Resources Limited	912	Devon Canada Corporation	582	Gulf Canada Limited	1012
ConocoPhillips Canada Resources Corp.	712	ConocoPhillips Canada (BRC) Ltd.	523	BP Canada Energy Company	842
Shell Canada Limited	709	Suncor Energy Inc.	507	Canadian Natural Resources Limited	659
EnCana Corporation	534	ConocoPhillips Canada Resources Corp.	408	Chevron Canada Limited	605
EnCana FCCL Ltd.	502	Taqqa North Ltd.	325	Devon Canada Corporation	425
StatoilHydro Canada Ltd.	461	Imperial Oil Resources Limited	322	Husky Oil Operations Limited	373
Total (336 Companies)	20465	Total (463 Companies)	11926	Total (153 Companies)	15953

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Appendix. Environmental Protection Order EPO 2013-33/NR issued to CNRL on 24 September 2013. Note that this EPO is specific to the 09-21 "aquatic release site". The Enforcement Order issued to CNRL on 21 October 2013 pertains to the three "terrestrial release sites" (10-01, 10-02, and 02-22).

Environment and Sustainable Resource Development

ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT

BEING CHAPTER E-12 R.S.A. 2000 (the "Act")

ENVIRONMENTAL PROTECTION ORDER NO. EPO-20 13- 33/ NR

Canadian Natural Resources Limited

Suite 2500

855 - 2nd Street SW

Calgary, Alberta

T2P 4J8

WHEREAS Canadian Natural Resources Limited [CNRL] holds *Environmental Protection and Enhancement*

Act [EPEAJ Approval No. 0011115-03-00, as amended , to operate the Primrose-Wolf Lake enhanced recovery in-situ oil sands and heavy oil processing plant and oil production site [the "Primrose-Wolf Lake Plant"] within the Cold Lake Air Weapons Range at 65 & 66 - 5 & 6 - W4M, 67 - 3, 4 & 5 - W4M, and 68 - 4 & 5 - W4M, in the Province of Alberta;

WHEREAS On June 24, 2013, CNRL discovered and reported to Alberta Environment and Sustainable Resource Development (ESRD) a release of a substance, namely a bitumen emulsion [the "Substance"], within an un-named permanent water body [the "Water Body"], which Water Body covers portions of NE21 -67-4-W4M, SE21-67-4-W4M, NW22-67-4-W4M, SW27-67-4-W4M, and SE28-67-4-W4M at 0921-067-04 W4M, all of which are hereinafter referred to as the "Aquatic Release Site", on the Primrose Wolf Lake Plant site;

WHEREAS it is unknown how long the release had been occurring prior to June 24, 2013;

WHEREAS the bitumen emulsion consists of a mixture of hydrocarbons and water;

WHEREAS the cause of the release of the bitumen emulsion within the Water Body is unknown;

WHEREAS although CNRL has initiated some temporary containment measures, the bitumen emulsion release into the Water Body is on-going, and CNRL has been unable to determine the exact location and the subsurface conditions under which the release is continuing;

WHEREAS CNRL has advised ESRD that in order for CNRL to assess these underlying conditions of the Substance release into the Water Body and eventually contain the release, stop the release and carry out remedial action, CNRL must dewater a portion of the Water Body;

WHEREAS on September 20, 2013, CNRL submitted to ESRD a Revised Dewatering Feasibility Assessment and Water Management Plan (the "Dewatering Plan"), which proposes that CNRL be permitted to dewater approximately two thirds of the Water Body and divert that water to a local borrow pit and the remaining one third of the Water Body;

WHEREAS the bitumen emulsion is a "substance" pursuant to section 1(mmm) of EPEA;

WHEREAS pursuant to section 1(tt) of EPEA, CNRL is a 'person responsible' for the Substance;

WHEREAS the Substance may cause and is causing an adverse effect on the environment, including the death of and damage to aquatic and terrestrial vegetation, aquatic and terrestrial invertebrates, aquatic life, amphibians, mammals and birds, and the degradation of water quality;

WHEREAS pursuant to section 112 of EPEA, CNRL has a duty to take all reasonable measures to:

Repair, remedy and confine the effects of the substance;

Remediate, manage, remove or otherwise dispose of the substance in such a manner as to prevent an adverse effect or further adverse effect; and

Restore the environment to a condition satisfactory to the Director;

WHEREAS Michael Aiton, Regional Compliance Manager, [the "Director"], has been designated a Director for the purposes of issuing environmental protection orders under the Act

WHEREAS the Director is of the opinion that a release or a substance into the environment has occurred and is occurring and the release may cause or is causing an immediate and significant adverse effect;

THEREFORE, I, Michael Aiton, Regional Compliance Manager, pursuant to sections 113 and 114 of the *Environmental Protection and Enhancement Act*, DO HEREBY ORDER:

The Comprehensive Plan

1. CNRL shall prepare, in writing for the Director's approval, a Comprehensive Remedial Plan, the constituents of which have due dates set out herein.
2. In the Comprehensive Remedial Plan, CNRL shall include, at a minimum, each of the following:
 - a. Water Management Plan for Dewatering;
 - b. Water Body Monitoring Plan;
 - c. Erosion and Sedimentation Prevention Plan;
 - d. Phase 2 Environmental Site Assessment Plan
 - e. Bitumen Emulsion Delineation and Containment Plan;
 - f. Amphibian Salvage Plan
 - g. Fish and Fish Habitat Assessment Plan;
 - h. Wetlands Impact Assessment Plan;
 - i. Water Body Restoration Plan.
 - j. Wildlife Management Plan, and
 - k. Waste Management Plan
3. CNRL shall implement of each and every part of the Comprehensive Plan under the direct supervision of a Qualified Aquatic Environmental Specialist, currently registered as a Professional Biologist with the Alberta Society of Professional Biologists.

Water Management Plan for Dewatering

4. CNRL shall, by September 26, 2013, submit to the Director for the Director's approval, the written Water Management Plan for Dewatering.
5. In the Water Management Plan for Dewatering, CNRL shall include, at a minimum, each of the following:
 - a. A detailed description of the techniques that will be used for de-watering the Water Body;
 - b. A detailed description of all of the following:
 - i. Pump locations;
 - ii. Pumping rates;
 - iii. Estimated volumes to be removed from the Water Body; and
 - iv. Discharge locations;
 - c. A map depicting all of the following:
 - i. Discharge locations; and
 - ii. Pump locations;
 - d. A detailed description of each of the sites to be used to store liquids removed from the Water Body, including but not limited to:
 - i. Capacity; and
 - ii. Location;
 - e. A detailed description of the water quality monitoring parameters that will be monitored throughout all dewatering activities, including but not limited to
 - i. The frequency, quantity and location of all samples that will be taken and analysed;
 - ii. a comparison of the analytical results, for all parameters monitored to
 - A. the Water Quality Guidelines for the Protection of Freshwater Aquatic Life in the Surface Water Quality Guidelines for Use in Alberta (Alberta Environment - November 1999) [the "Surface Water Quality Criteria"], for all water that will remain in or be returned to any water body; and
 - B. Table C-11 of the Alberta Tier 1 Soil and Groundwater Remediation Guidelines (December 2010, Alberta Environment), for all water that will not remain in or be returned to any water body; and
 - iii. A description of how an on-site analytical laboratory will be obtaining and analysing the samples.
 - f. A written commitment to cease all dewatering activities if there is an exceedence of any of the Surface Water Quality Criteria or Table C-11 of the Alberta Tier 1 Soil and Groundwater Remediation Guidelines (December 2010, Alberta Environment, unless otherwise authorized by the Director;
 - g. A detailed description of the water treatment techniques and equipment that will be used

- to treat all water in the Water Body that exceeds any of the Surface Water Quality Criteria so that it meets the Surface Water Quality Criteria;
- h. A detailed description of how and to what location any water not meeting the Surface Water Quality Criteria will be disposed of;
 - i. Isolation techniques to be used that will maintain the pre-disturbance water levels in all water-covered areas on the Aquatic Release Site, except for the Water Body; and
 - j. A schedule of implementation for the Water Management Plan for Dewatering, with a dewatering completion date of no later than October 15, 2013, unless otherwise authorized in writing by the Director.

6. CNRL shall implement the Water Management Plan for Dewatering in accordance with the Director's written authorization.

Water Body Monitoring Plan

7. CNRL shall by September 26, 2013, submit to the Director for the Director's approval the written Water Body Monitoring Plan.

8. In the Water Body Monitoring Plan, CNRL shall include, at a minimum, each of the following:

a. A detailed description of how the entirety of the Aquatic Release Site will be monitored throughout the implementation of the Comprehensive Plan, including, at minimum:

- i. The water quality parameters that will be monitored;
- ii. The locations within the Water Body and Aquatic Release Site from which samples will be collected;
- iii. The locations downstream of the Aquatic Release Site from which samples will be collected;
- iv. The points of discharge from the Water Body from which samples will be collected;
- v. The frequency of the collection and analyses of all samples; and
- vi. The water levels in the Aquatic Release Site that are isolated from the dewatered areas of the Water Body;

b. A detailed description of how, throughout the implementation of the Comprehensive Plan, groundwater infiltration into the Water Body will be monitored; and

c. A schedule of implementation for the Water Body Monitoring Plan.

9. CNRL shall implement the Water Body Monitoring Plan in accordance with the Director's written authorization.

10. Beginning on October 7, 2013, and continuing on the first Monday of every month thereafter, CNRL shall submit in writing to the Director a Water Body Monitoring Report.

11. In each Water Body Monitoring Report, CNRL shall include a written summary describing the results, including an appendix with all laboratory reports, of all of the information described in clauses 8(a) and 8(b) of this Order.

Erosion and Sedimentation Prevention Plan

12. CNRL shall, by **September 26**, 2013, submit to the Director for the Director's approval the written Erosion and Sedimentation Prevention Plan.

13. In the Erosion and Sedimentation Prevention Plan, CNRL shall include, all of the following:

a. A detailed description of how, throughout the implementation of the Comprehensive Plan, erosion of all land impacted in the implementation of the Comprehensive Plan will be prevented, including but not limited to:

- i. The bed and shore of
 - A. the Water Body;
 - B. the fen that is hydrologically connected to the Water Body;
 - C. all other water covered areas of the Aquatic Release Site; and
 - D. the unnamed tributary to the Wolf River; and
- ii. The discharge locations described in accordance of clauses S(b) and S(c) of this Order;

b. A detailed description of how, throughout the implementation of the Comprehensive Plan, siltation of:

- i. The Water Body;
- ii. the fen that is hydrologically connected to the Water Body;

- iii. all other water covered areas of the Aquatic Release Site;
 - iv. The unnamed tributary to the Wolf River; and
 - v. All water bodies downstream of the Water Body will be prevented.
 - c. A description of the structures and mechanisms that will be used throughout the implementation of the dewatering process to manage the discharge exiting the Water Body so that none of the downstream water bodies are not [*sic*] impacted;
 - d. A description of the discharge rates to each downstream water body from each discharge location, including an assessment of the potential for erosion down gradient from the release point due to the additional flow;
 - e. A map and any associated hydrology information detailing:
 - i. The pre-disturbance drainage patterns into and out of the Water Body; and
 - ii. The planned changes to the pre-disturbance drainage patterns as a result of implementing the Comprehensive Plan; and
 - f. A schedule of implementation for the Erosion and Sedimentation Prevention Plan.
14. CNRL shall implement the Erosion and Sedimentation Prevention Plan in accordance with the Director's written authorization.

Phase 2 Environmental Site Assessment and Remedial Plan

15. CNRL shall by, October 15, 2013, submit to the Director for the Director's approval the written Phase 2 Environmental Site Assessment and Remedial Plan.
16. In the Phase 2 Environmental Site Assessment and Remedial Plan, CNRL shall include at a minimum, all of the following:
- a. A detailed plan for the complete delineation of impacts of the release of the Substance to soils and sediments
 - i. on the Aquatic Release Site;
 - ii. Under the Aquatic Release Site; and
 - iii. All lands adjacent to the Aquatic Release Site to which the substance may have migrated;
 - b. A detailed plan for the complete delineation of any impacts of the release of the Substance to all shallow groundwater:
 - i. Under the Aquatic Release Site;
 - ii. Up-gradient of the Aquatic Release Site; and
 - iii. Down-gradient of the Aquatic Release Site;
 - c. A plan to provide to the Director the raw analytical results of all sampling and analyses planned (which analyses must include chromatograms for hydrocarbon analyses) and a comparison of those results to
 - i. At least one off-site control; and
 - ii. The applicable guidelines in the Alberta Tier 1 Soil and Groundwater Remediation Guidelines (December 2010, Alberta Environment) [the "Criteria"];
 - d. A detailed plan for the assessment of the connectivity between shallow groundwater and surface water and subsurface flow rates
 - i. Under the Aquatic Release Site;
 - ii. Up-gradient of the Aquatic Release Site; and
 - iii. Down-gradient of the Aquatic Release Site;
 - e. A detailed plan for the assessment of the subsurface flow rates and direction under the Aquatic Release Site;
 - f. A detailed remedial plan including, at a minimum, all of the following:
 - i. The proposed measures to recover the released Substance from soils and sediments on the Aquatic Release Site;
 - ii. The proposed measures to remedy all soil or sediment contamination resulting from the release of the Substance to meet the requirements of the Criteria, prior to water being restored to the Water Body;
 - iii. The proposed measures to remedy all surface water contamination resulting from the release of the Substance to meet the Surface Water Quality Criteria; and
 - iv. The proposed measures to remedy all the groundwater contamination resulting from

the release of the Substance to meet the requirements of the Criteria; and
g. A schedule of implementation for the Phase 2 Environmental Site Assessment and Remedial Plan, to begin immediately after the Water Body has been dewatered, but no later than October 15, 2013.

17. CNRL shall implement the Phase 2 Environmental Site Assessment and Remedial Plan in accordance with the Director's written authorization.

Bitumen Emulsion Delineation and Containment Plan

18. CNRL shall by, October 6, 2013, submit to the Director for the Director's approval the written Bitumen Emulsion Delineation and Containment Plan.

19. In the Bitumen Emulsion Delineation and Containment Plan, CNRL shall include, at a minimum, detailed descriptions of all of the following:

- a. The measures needed to fully identify and characterize the release point for the bitumen emulsion flow to surface;
- b. The methods proposed to be used to gather data on the potential causes of the release;
- c. The preliminary design of measures proposed to contain the flow of bitumen emulsion to surface for the duration of the implementation of the Comprehensive Plan, once dewatering is complete;
- d. The schedule for submission to the Director of a written final design for permanent containment of the bitumen emulsion; and
- e. An overall schedule of implementation for the Bitumen Emulsion Delineation and Containment Plan.

20. CNRL shall implement the Bitumen Emulsion Delineation and Containment Plan in accordance with the Director's written authorization.

Amphibian Salvage Plan

21. CNRL shall by, September 26, 2013, submit to the Director for the Director's approval the written Amphibian Salvage Plan.

22. In the Amphibian Salvage Plan, CNRL shall include at minimum all of the following:

- a. A detailed description of a comprehensive sampling program to determine the
 - i. Presence;
 - ii. Species; and
 - iii. Quantitiesof amphibians in the Water Body~
 - b. A detailed description of the
 - i. Capture; and
 - ii. Handlingtechniques that will be used in the implementation of the Amphibian Salvage Plan;
 - c. the proposed amphibian relocation strategy, including a map, identifying potential amphibian relocation sites; and
 - d. A schedule of implementation for the Amphibian Salvage Plan,
23. CNRL shall implement the Amphibian Salvage Plan in accordance with the Director's written authorization.

Fish and Fish Habitat Assessment Plan

24. CNRL shall by, September 26, 2013, submit to the Director for the Director's approval the written Fish and Fish Habitat Assessment Plan.

25. In the Fish and Fish Habitat Assessment Plan, CNRL shall include at minimum all of the following:

- a. A detailed description of a sampling program to determine the
 - i. Presence;
 - ii. Species; and
 - iii. Quantitiesof all fish in the Water Body while dewatering occurs;
 - b. A detailed description of a proposed fish habitat identification plan for the Water Body; and
 - c. A schedule of implementation for the Fish and Fish Habitat Assessment Plan.
26. CNRL shall implement the Fish and Fish Habitat Assessment Plan in accordance with the Director's written authorization.

27. CNRL shall submit to the Director a Summary Report on Fish and Fish Habitat based upon the implementation of clauses 25(a)-(c), inclusive, by October 30, 2013.

Wetlands Impact Assessment Plan

28. CNRL shall by, September 30, 2013, submit to the Director for the Director's approval the written Wetlands Impact Assessment Plan.

29. In the Wetlands Impact Assessment Plan, CNRL shall include at minimum, all of the following:

- a. The classifications of all areas covered by water on the Aquatic Release Site pursuant to the Alberta Wetland Inventory Classification System (Halsey et al. 2004), including detailed description of wetland characteristics supporting the classifications;
- b. A determination of the area covered by water on the Aquatic Release Site, including but not limited to
 - i. The Water Body;
 - ii. The adjacent fen, and
 - iii. All transition zones from aquatic to terrestrial vegetation;
- c. A map depicting water depths for the entire Water Body;
- d. A detailed description of all
 - i. Flora species;
 - ii. Fauna species;
 - iii. Rare species; and
 - iv. Endangered speciespresent on the Aquatic Release Site; and
- e. A schedule of implementation for the Wetlands Impact Assessment Plan.

30. CNRL shall implement the Wetlands Impact Assessment Plan in accordance with the Director's written authorization.

31. CNRL shall submit to the Director a Summary Report on Wetlands Impacts based upon the implementation of clauses 29(a)-(e), inclusive, by October 30, 2013.

Water Body Restoration Plan

32. CNRL shall by, November 30, 2013, submit to the Director for the Directors approval the written Water Body Restoration Plan.

33. In the Water Body Restoration Plan, CNRL shall include, at a minimum, all of the following:

- a. A detailed description of how the Water Body will be restored to its pre-disturbance condition;
- b. A detailed plan and schedule for refilling the restored Water Body, utilizing the stored water;
- c. A long term monitoring plan for assessing progressive
 - i. habitat restoration
 - ii. re-establishment of fauna;
 - iii. re-establishment of flora; and
 - iv. return to Water Body water levels consistent with pre-disturbance conditionson the Aquatic Release Site;
- d. A detailed plan for maintaining the downstream fen in an unimpacted state during the implementation of the Water Body Restoration Plan; and
- e. A schedule of implementation for the Water Body Restoration Plan.

34. CNRL shall implement the Water Body Restoration Plan in accordance with the Directors written authorization.

35. At least 60 days prior to CNRL requesting closure of this Order, CNRL shall:

- a. provide to stakeholders and First Nations a Draft Summary Report on Water Body Restoration Status; and
- b. Compile all comments received.

36. CNRL shall submit to the Director a written Final Summary Report on Water Body Restoration, including all reviewer comments, one month prior to requesting closure of this Order.

Wildlife Management Plan

37. CNRL shall continue to implement the Wildlife Management Plan, dated July 13, 2013 addressing wildlife deterrents, capture and treatment of impacted wildlife and

rehabilitation/release options, until otherwise authorized in writing by the Director.

Waste Management Plan

38. CNRL shall continue to implement the Waste Management Plan, dated July 4, 2013, until otherwise authorized in writing by the Director.

Communications Plan

39. CNRL shall, by October 1, 2013, submit to the Director, for the Director's approval, a written Communications Plan.

40. In the Communications Plan, CNRL shall include, at a minimum, all of the following:

a. A description of the monthly update to be posted on CNRL's public website, which shall contain:

i. The status of the efforts taken in the dewatered areas of the Water Body;

ii. A summary of all monitoring information obtained in the implementation of Plans required under this Order and a comparison of that monitoring information to all applicable Criteria cited in this Order;

iii. A description using maps or diagrams of the monitoring locations and their relationships to the monitoring objectives in accepted monitoring plans required by this Order; and

iv. Status of restoration of the Water Body once the restoration process begins in 2014.

b. A plan to prepare a weekly photographic record of Water Body status, starting with the first day of the issuance of this Order, and post it weekly on CNRL's public website;

c. Other methods to be utilized to communicate, on at least a monthly basis, to stakeholders and First Nations, information on the Aquatic Release Sites status;

d. A plan to communicate to the Director a summary of any issues raised to CNRL by stakeholders and First Nations throughout the implementation of the Comprehensive Plan, which shall be included in the reports to the Director required by Clause 10 of this Order; and

e. CNRL shall provide the Summary Report on Fish and Fish Habitat, prepared in accordance with clause 27 of this Order, to stakeholders and First Nations once it is accepted in writing by the Director.

f. CNRL shall provide the Summary Report on Wetland Impacts, prepared in accordance with clause 31, to stakeholders and First Nations once it is accepted in writing by the Director.

g. CNRL shall:

i. Implement the Communications Plan in accordance with the Director's written authorization; and

ii. Notwithstanding clause 41 of this Order, continue implementing the Communications Plan until otherwise authorized in writing by the Director.

General

41. Where no other deadlines have been specified in this Order, CNRL shall

a. complete all requirements of this Order; and

b. complete the implementation of all Plans required by this Order

no later than March 31, 2014, unless otherwise authorized in writing by the Director.

42. CNRL shall begin Water Body restoration work no later than April 1, 2014 including Water Body recharge from storage sources, unless otherwise authorized by the Director in writing.

Reporting

43. CNRL shall, until advised otherwise in writing by the Director, provide to the Director weekly written reports by noon of every Monday, of all steps taken to comply with this Order, unless a different frequency of reporting is authorized in writing by the Director.

44. CNRL shall provide to the Director a Final Summary Report, detailing the results and outcomes of all plans submitted as part of the Comprehensive Plan, one month prior to any request for closure of this Order, for the Director's review.

DATED at the City of Edmonton in the Province of Alberta this 24th day of September, 2013 .

Michael Aiton

Regional Compliance Manager

Section 91 of the *Environmental Protection and Enhancement Act* may provide a right of appeal against this decision to the Alberta Environmental Appeals Board. There may be a strict time limit for filing such an appeal. A copy of section 91 is enclosed. For further information, please contact the Board Secretary at #306 Peace Hills Trust Tower, 10011-109 Street, Edmonton, Alberta, T5J 3S8; telephone (780) 427-6207; fax (780) 427-4693. Notwithstanding the above requirements, the Party(ies) shall obtain all necessary approvals in complying with this order.

Take notice that this environmental protection order is a remedial tool only, and in no way precludes any enforcement proceedings being taken regarding this matter under the *Environmental Protection and Enhancement Act* or any other legislation.