Horizon Oil Sands Mine
North Pit Extension

Supplemental Information Request 2
Submitted to Alberta Energy Regulator

January 2019
Canadian Natural Resources Limited (Canadian Natural) submitted the proposed Horizon Oil Sands and Processing Plant (Horizon) North Pit Extension (NPE) Project (the Project) Integrated Application and Environmental Impact Assessment (EIA) to the Alberta Energy Regulator (AER) April 30, 2018. Responses to the Supplemental Information Requests (SIR) R1 received from the AER August 30, 2018 were submitted October 25, 2018.

In order for the AER to continue its evaluation of the Project's Integrated Application and EIA, Canadian Natural submits its responses to the SIR R2 received from the AER December 18, 2018.

If you have any questions regarding this application, please contact the undersigned or Kirsten Pinney at 403.386.8194 or via email at kirsten.pinney@cnrl.com.

Sincerely,

CANADIAN NATURAL RESOURCES LIMITED

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Enclosures: Supplemental Information Request 1
Errata

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Rod Godwaldt, Alberta Energy Regulator
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Melanie Daneluk, Alberta Environment and Parks
Magdalena Greenough, Alberta Indigenous Relations
Peter Ng, Alberta Transportation
# Acronym and Abbreviation List

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<tr>
<th>Acronym</th>
<th>Description</th>
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<td>Aboriginal Consultation Office</td>
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<td>AENV</td>
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<td>AER</td>
<td>Alberta Energy Regulator</td>
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<td>BSFC</td>
<td>brake-specific fuel consumption</td>
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<td>BSFCss</td>
<td>steady-state brake-specific fuel consumption</td>
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<td>Canadian Natural</td>
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<tr>
<td>CO</td>
<td>carbon monoxide</td>
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<td>CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>carbon dioxide</td>
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<td>CO&lt;sub&gt;2&lt;/sub&gt;e</td>
<td>carbon dioxide equivalent</td>
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<td>COPC</td>
<td>concentrations of the chemicals of potential concern</td>
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<td>DDA</td>
<td>Dedicated Disposal Area</td>
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<td>DF&lt;sub&gt;HC&lt;/sub&gt;</td>
<td>deterioration factor for HC</td>
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<td>DOE</td>
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<td>EDS</td>
<td>Electronic Disposition System</td>
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<td>EIA</td>
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<td>EMP</td>
<td>Environmental Monitoring Plan</td>
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<td>EPA</td>
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<td>EPL</td>
<td>End Pit Lake</td>
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<td>FT</td>
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<td>GHG</td>
<td>Greenhouse gas</td>
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<td>HC</td>
<td>hydrocarbon</td>
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<td>HC&lt;sub&gt;ss&lt;/sub&gt;</td>
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<td>Horizon</td>
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<td>IB</td>
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<td>LAT</td>
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RSA Regional Study Area
SCO synthetic crude oil
SIR Supplement Information Request
TAF_{BSFC} transition adjustment factor for brake-specific fuel consumption
TAF_{HC} transition adjustment factor for hydrocarbon
TEK Traditional Ecological Knowledge
the Project North Pit Extension
TLU Traditional Land Use

Unit List

% percent
g grams
g/hp-hr grams per horsepower per hour
Hp Horsepower
lb/hp-hr pounds per horsepower per hour
m metre
m^{3} cubic metre
m^{3}/day cubic metre per day
Mm^{3} million cubic metre
Mtonnes millions of tonnes
T/m^{3} tonne per cubic metre
Table of Contents

1.0 OIL SANDS CONSERVATION ACT .............................................................................................................. 1
  1.1 Mining ................................................................................................................................................... 1
  1.2 Geotechnical ...................................................................................................................................... 13

2.0 GENERAL ..................................................................................................................................................... 15
  2.1 Waste Management ........................................................................................................................... 15
  2.2 Socioeconomic ................................................................................................................................... 16

3.0 AIR ................................................................................................................................................................ 17
  3.1 Emissions Management ..................................................................................................................... 17

4.0 WATER ......................................................................................................................................................... 20
  4.1 Water Management ............................................................................................................................ 20
  4.2 Hydrogeology ..................................................................................................................................... 21

5.0 TERRESTRIAL ............................................................................................................................................. 23
  5.1 Wildlife ................................................................................................................................................ 23
  5.2 Land Use and Land Management ...................................................................................................... 24

6.0 HEALTH ........................................................................................................................................................ 25

7.0 ERRATA ........................................................................................................................................................ 26

TABLES
Table 2-1: Annual Volume of Construction Material Placed per Dyke (End of Period) ...................................... 10
Table 3-1: Capacity and Total Tailings Storage Volume of each DDA (End of Period) ...................................... 12
Table 15-1: Horizon North Pit Extension Traditional Land Use Study Status Update ..................................... 27
FIGURES

Figure 2-1: DDA2 Annual Dyke and Tailings Elevations ................................................................. 2
Figure 2-2: DDA3 Annual Dyke and Tailings Elevations ................................................................. 3
Figure 2-3: DDA5 Annual Dyke and Tailings Elevations ................................................................. 4
Figure 2-4: DDA6 Annual Dyke and Tailings Elevations ................................................................. 5
Figure 2-5: DDA9A Annual Dyke and Tailings Elevations ............................................................. 6
Figure 2-6: DDA9 Annual Dyke and Tailings Elevations ............................................................... 7
Figure 2-7: DDA8 Annual Dyke and Tailings Elevations ............................................................... 8
Figure 10-1: The Devonian Groundwater (Environmental) Head in Relation to the Top of Devonian ..... 22
1.0 OIL SANDS CONSERVATION ACT

1.1 Mining

SIR 1) SIR 3, Page 8
Figure 3-1, Page 9

In SIR 3, CNRL states, “The existing and approved Horizon Oil Sands Mine and Processing Plant (Horizon) operates within the condition of a 250m setback from the edge of the wetted width of the Athabasca River during spring flow.” CNRL also states, “...if this setback is adjusted by the AER to maintain a minimum buffer of 250 m from the valley break of the Athabasca River, Canadian Natural would comply with the updated setback for the Project.” In review of CNRL’s information the AER has identified areas in which CNRL’s valley break determination and associated buffer varies with a determination made by the AER. The AER determination of the expected buffers are shown in Appendix A (CNRL_Horizon_NorthMineRiverBuffer.pdf).

a) Provide a date by which CNRL will provide a mine plan that conforms to the Athabasca River valley break setback and erosional features buffer requirements.

Response:

a) Canadian Natural Resources Limited (Canadian Natural) will provide a revised mine plan that conforms to the Athabasca River valley break setback and erosional feature buffer requirements no later than November 13, 2019.

SIR 2) SIR 5b, Figures 5-1 to 5-7, Pages 14 to 20, Table 5-1, Page 12

In SIR 5c, CNRL was requested to provide tailings fill curves for each DDA individually. CNRL did not provide the fill curves for any of the DDAs, and indicated that they have “sufficient tailings storage capacity over time”. The AER is not able to evaluate the progress of dyke construction or the fluid tailings storage capacity of CNRL’s tailings facilities without individual tailings filling curves.

a) Update Figures 5-1 to 5-7 with elevations of the clear water zone and top of 5 % solids content at the end of each year.

b) Provide in a table the capacity and actual fluid tailing storage volume of each DDA at the end of each year.

Response:

a) Yearly dyke elevations for each Dedicated Disposal Area (DDA) planned to accept tailings during the life of mine are provided in Figures 2-1 through 2-7 (formerly Figures 5-1 through 5-7 in the North Pit Extension [NPE] Supplemental Information Request [SIR] R1 Responses from Canadian Natural Resources Limited [Canadian Natural]). These elevations are driven by the mine plan’s waste placement schedule in accordance with material planned for construction as provided in the Mining section of the Environmental Impact Assessment (EIA; Volume 1, Table 4.2-3). These elevation data conform with the tailings inventory chart in the Tailings Management section of the EIA (Volume 1, Figure 6.3-2).

At any point in time, the elevation of a structure is planned to be equal throughout the entire length of the structure. That is, it is constructed so that its crest is raised at the same rate along its entirety.

In-pit waste structures that are not dyke structures have been removed from the figures for clarity.
Figure 2-1: DDA2 Annual Dyke and Tailings Elevations
Figure 2-2: DDA3 Annual Dyke and Tailings Elevations
Figure 2-3: DDA5 Annual Dyke and Tailings Elevations
Figure 2-4: DDA6 Annual Dyke and Tailings Elevations

1 In Volume 1, Section 6, Table 6.3-1 of the Horizon North Pit Extension Integrated Application and Environmental Impact Assessment the elevation of dedicated disposal area (DDA) 6 was noted to be 295 m; this should be 285 m.
Figure 2-5: DDA9A Annual Dyke and Tailings Elevations
Figure 2-6: DDA9 Annual Dyke and Tailings Elevations
Figure 2-7: DDA8 Annual Dyke and Tailings Elevations
b) High spec interburden (IB) is one of only three waste material types that can be used in dyke structures. Of IB mined, only 80% is considered available at any time for dyke construction. The 80% therefore is the maximum capture rate. The planned value never exceeds the available amount, whether with respect to IB or overburden (OB). Planned values for IB or OB in a given year may be less than the available amount, however, planned values must ensure dykes are constructed to elevations which are higher than the projected tailings levels. Planned values must also respect all geotechnical constraints as well as conditions mandated by regulatory permitting for each dyke structure.

The second waste material type used in dyke construction is high spec OB, the availability of which is obtained by calculating a maximum capture of 80% of the Upper McMurray stratigraphic unit that is less than 6% bitumen content by mass and is situated directly below the Clearwater (overburden) Formation.

The third waste classification for dyke construction is low spec OB. This material has a maximum capture rate of 75% of the Clearwater Formation. A minimal portion of available low spec OB is directed to mine operations projects work outside of dyke construction.

Table 2-1 contains the tonnage of respective construction material placed per year for each dyke. Canadian Natural assumes a density of 2.1 T/m³ for all waste material.
## Table 2-f: Annual Volume of Construction Material Placed per Dyke (End of Period)

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SIR 3) SIR 5c, Page 21
Figures 5-1 to 5-7, Pages 14 to 20

In SIR 5c, CNRL was requested to provide tailings fill curves for each DDA individually. CNRL did not provide the fill curves for any of the DDAs, and indicated that they have “sufficient tailings storage capacity over time”. The AER is not able to evaluate the progress of dyke construction or the fluid tailings storage capacity of CNRL’s tailings facilities without individual tailings filling curves.

a) Update Figures 5-1 to 5-7 with elevations of the clear water zone and top of 5% solids content at the end of each year.

b) Provide in a table the capacity and actual fluid tailing storage volume of each DDA at the end of each year.

Response:

a) Figures 2-1 through 2-7 (formerly Figures 5-1 through 5-7 in the North Pit Extension [NPE] Supplemental Information Request [SIR] R1 Responses from Canadian Natural Resources Limited [Canadian Natural]) have been updated to include the beach elevations on an annual basis for dedicated disposal area (DDA) 2, DDA3 and DDA5. Horizon’s main tailings treatment technology is Non-Segregating Tailings (NST) and as such, the main tailings volume to be contained in each DDA is NST beach. Canadian Natural has included the fluid elevation for DDA2, DDA3 and DDA5 as requested. Only a high level of deposition planning for DDA6 through DDA8 has been completed and therefore only the total tailings elevations have been added to the figures.

b) Canadian Natural has provided information within the North Pit Extension Integrated Application and Environmental Impact Assessment (EIA) to demonstrate to the Alberta Energy Regulator (AER) there is sufficient tailings storage capacity over time (Volume 1, Section 6.3 of the EIA). The NPE Project deposition tailings volume does not exceed the cumulative tailings capacity (Volume 1, Figure 6.3-2 of the EIA).

As per the tailings capacity versus tailings inventory chart (Volume 1, Figure 6.3-2 of the EIA) and the total available volumes per DDA listed in Volume 1, Table 6.3-1 and in Volume 1, Figure 6.4-1 of the EIA, there is demonstrated containment for all tailings within the life of mine.

Table 3-1 indicates the available and required tailings containment capacities for each DDA on an annual basis. As discussed in response 2b), the total tailings containment has been reported, not only the fluid tailings volume as requested.
Table 3-1: Capacity and Total Tailings Storage Volume of each DDA (End of Period)

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$^2$In Volume 1, Section 6.0, Table 6.3-1 of the Horizon North Pit Extension Integrated Application and Environmental Impact Assessment the available volume was noted to be 587 Mm$^3$ at an elevation of 285 m. The elevation should be 288 m with a capacity of 620 Mm$^3$. 

12
SIR 4) Application, Volume 1, Figure 6.4-1, Page 6-17

The DDA2 schedule in 6.4-1 indicates capping will occur between 2030 and 2033. It also shows fluid tailings storage from 2020 to 2043, extending ten years post-cap placement. All other DDAs are capped following fluid tailings storage.

a) Explain how CNRL will sequence deposition, storage and capping of DDA2, and how the management of DDA2 differs from the remaining terrestrial deposits.

Response:

a) Canadian Natural plans to place the required capping volume material at the periphery of the dedicated disposal area (DDA) 2 by 2033. The volume required is the equivalent of placing 1 m over the DDA2 total surface. The total volume is not placed by the end of 2033; the remaining volume will be placed in 2044 and 2045, after the fluid tailings (FT) is transferred to DDA9. The sand volume placement will be distributed over the DDA2 surface by mechanical methods. Should this additional sand capping be required, a two-year capping period will be added to the DDA2 schedule to ensure sufficient sand volume is placed and distributed over the surface. A detailed deposition plan for DDA2 will be submitted to the AER one year prior to tailings being deposited in DDA2.

Current planning assumptions have all other terrestrial deposits capped with sand in a minimum 1 m lift following deposition.

1.2 Geotechnical

SIR 5) SIR 7, Page 22
Application, Volume 1, Figure 4.1-1, Page 4-1
Application, Volume 1, Figure 4.5-5, Page 4-32

Figure 4.5-5 of the Application shows final pit wall development along the east end of the pit in 2022. CNRL also states, “The IPA5 foot print and proximal areas may be subject to further delineation drilling before construction is set to begin, to eliminate or reduce the potential for sterilization of oil sands resources pursuant to the requirements of Directive 082”.

The AER notes that there are erosional channels along the Athabasca River at approximately 71800N and 70800N that extend through the 250 m offset defined by Alberta Environment and Parks, and into the mining area defined by the North Pit Extension. The AER also notes a history of geotechnical instability along the west bank of the Athabasca River in this area.

The AER is concerned that CNRL has not adequately characterized the risks involved in commencing mine development activity along a relatively poorly understood geological and geotechnical region of the Athabasca River. Further, given CNRL’s proposed plan to commence mining in this area in 2022, the AER is concerned that CNRL has not provided sufficient time for adequate site characterization.

a) Provide a geotechnical assessment of the potential for mining activities in the North Pit Extension area to impact the stability of the erosional channels and the integrity of the bank of the Athabasca River and its tributaries.

b) Provide a geotechnical and environmental monitoring plan for the erosional channels shown in Appendix A.
Response:

Canadian Natural Resources Limited (Canadian Natural) respects the Alberta Energy Regulator’s (AER) concern regarding development along the west bank of the Athabasca River. Canadian Natural has completed works in the area in order to better understand the geology and geotechnical aspects of the area and has gained a good understanding of the geology and portions of the Devonian hydrogeology. Canadian Natural will also be obtaining additional geological, hydrogeological, geophysical and geotechnical data in order to quantify potential risks in the area due to the erosional features that the AER has identified in Appendix A of the Supplemental Information Request (SIR) R2 and to ensure appropriate mitigation is in place including providing and adhering to a Geotechnical and Environmental Monitoring Plan to ensure risks are monitored and managed throughout the mining process.

a) Canadian Natural will provide the geotechnical assessment in relation to developing the North Pit Extension (NPE) area and the integrity of the of the west bank of the Athabasca River and its tributaries one year in advance of overburden removal. In order to provide the geotechnical assessment the following data collection and process will occur:

- Address data gaps and uncertainties within existing data;
- Complete additional geological, geotechnical and hydrogeological drilling and lab testing;
- Complete geotechnical design and assessment of the NPE area; and
- Finalize design and assessment and file one year in advance of overburden removal.

b) Canadian Natural will provide the Geotechnical and Environmental Monitoring Plan to the AER one year in advance of overburden removal in the NPE area in alignment with completing the geotechnical assessment.
2.0 GENERAL

2.1 Waste Management

SIR 6) SIR 22, Page 41
Volume 1, Section 9.3, PDF page 189
Volume 3, Section 11.6.2.1.1, PDF page 874

CNRL states that “The existing landfill will be extended to the North Pit Extension (the Project). Horizon Oil Sands Mine and Processing Plant (Horizon) constructed a Class II Landfill and waste storage area for non-hazardous and hazardous wastes as well as recyclables authorized by the Alberta Energy Regulator (AER; AENV 2005 and AER 201; Volume 1, Section 9)”. CNRL also states that “Hazardous wastes and hazardous recyclables will be accepted into the landfill facility for bulking and storage only”.

It is unclear if CNRL is extending the landfill to the NPE area or whether the landfill will be expanded in size to allow for the receipt of wastes associated with the NPE project.

a) Clarify what is meant by extension of the landfill to the North Pit Extension (NPE). Explain whether the scope is to expand the landfill to accommodate waste from NPE or something else. Provide details on the expansion of the existing landfill (i.e. whether cells will be added within the existing landfill area or if a new landfill area will be required) and confirm whether the existing landfill will be large enough to accommodate waste from Horizon and NPE.

b) Provide additional details on the waste storage area described in the SIR response, including:

   i) Storage configuration (i.e., indoors or outdoors) for wastes including discussion of secondary containment; and

   ii) Changes in the size of the existing waste storage area to accommodate additional wastes associated with NPE.

Response:

a) The statement was made in error. The sentence from Supplement Information Request (SIR) R1 ‘The existing landfill will be extended to the North Pit Extension (the Project)’ should be replaced with ‘The existing landfill will accommodate any waste generated from the North Pit Extension (NPE) Project (the Project)’.

The Horizon Oil Sands Mine and Processing Plant (Horizon) constructed a Class II Landfill and waste storage area for non-hazardous and hazardous wastes as well as recyclables authorized by the Alberta Energy Regulator (AER; AENV 2005, Volume 1, Section 9 of the Environmental Impact Assessment [EIA]). Canadian Natural Resources Limited (Canadian Natural) is not altering the existing landfill for the Project. The Project will not alter the types of waste generated, the operation and size of the current landfill, or the waste storage, monitoring and reporting procedures and protocols currently in place at Horizon (Volume 1, Section 9.2 of the EIA). The existing landfill at Horizon will accommodate any waste generated from the Project.

Canadian Natural is not altering the existing and approved Class II landfill at Horizon (AENV 2005) for the Project. As built drawings for the existing landfill were provided to Alberta Environment (AENV) August 23, 2006.
Reference:

2.2 Socioeconomic
SIR 7) SIR 21, Page 39

CNRL states “Canadian Natural is currently updating these 2018 economic parameters for the Alberta Government Department of Energy (DOE). Canadian Natural proposes to submit the information requested in SIR 21 to the Alberta Energy Regulator on December 1, 2018 as a supplement to Canadian Natural’s round one SIR submission.” The AER has not yet received this information.

a) Provide the response.

Response:

a) As per direct communication with the Alberta Energy Regulator (AER), January 25, 2019 (C. MacDonald, personal communication, January 25, 2019), Canadian Natural Resources Limited (Canadian Natural) submitted an extension request, January 29, 2019 to the AER in providing a response to Supplemental Information Request (SIR) R2 7a).
3.0 AIR

3.1 Emissions Management

CNRL states that “GHG emission sources from the Project are limited to mine fleet exhaust and mine face fugitives. As the Project is a continuation of Horizon's mine sequence, the Project is not expected to change the overall GHG emissions from Horizon” and that “The GHG emissions and intensity from a fully developed Horizon are presented in Volume 3, Section 2.7.5.1. The GHG emission intensity is based on reported GHG emissions from 2014 and 2015 (Government of Canada 2017) and reported synthetic crude oil (SCO) production data (AER 2017). The maximum GHG emissions intensity from a fully developed Horizon is scaled from the 2014 and 2015 data, which are expected to be representative of typical operating years. Data used in the calculation of GHG emissions intensity is provided in Table 23-1”.

CNRL reported a fixed mine fleet CO₂e based on a computation employing the annual fuel consumption rate and a CO₂e emissions factor. In Appendix 2A of the EIA report, there is discussion of Mine Fleet Exhaust (Section 2A2.3.1, Adobe PDF page 10/1519). In this section there is discussion of the evolution of the CNRL fleet over time, in particular the assumption that United States Environmental Protection Agency (EPA) rated Tier 4 engines will be available after 2025. Tier 4 engines will have different emissions than engines in the current CNRL Horizon fleet.

a) Discuss whether the change over time of engines in the CNRL Horizon Mine Fleet will change the GHG emissions associated with the NPE through the mine life.

b) If the response to a) shows a reduction of GHG emissions over time, provide an updated Table 23-1 showing the change in GHG intensity over time.

Response:

a) The United States Environmental Protection Agency (U.S. EPA) emission standards for non-road diesel engines, which have been adopted by Canada in the Off-Road Compression-Ignition Engine Emission Regulations (Government of Canada 2012), were introduced to primarily reduce nitrogen oxides (NOₓ) and particulate matter (PM) and to a lesser extent, carbon monoxide (CO) and hydrocarbon (HC) emissions from non-road diesel engines. Greenhouse gas, in the form of carbon dioxide (CO₂), is not an intended target of emission reduction by these emission standards. However, CO₂ emissions can be reduced as a result of some of the technologies adopted by the engine manufacturers to reduce NOₓ, PM, CO and HC emissions, such as improved engine design to achieve higher engine fuel efficiency.

While in-engine refinements helped engine manufacturers achieve Tier 1, Tier 2 and Tier 3 emission standards, Tier 4 emission standards require exhaust aftertreatment to achieve the desirable reduction in NOₓ and PM emissions. In-engine refinements that allow the compliance with the Tier 1, Tier 2 and Tier 3 emission standards include more advanced fuel injection, precise injection timing, advanced electronic engine controls, and advanced turbocharging. Some of these refinements could result in better improvement in engine fuel efficiency and indirectly reduce the exhaust CO₂ emissions. Tier 4 engines primarily rely on exhaust aftertreatment technology, such as selective catalytic reduction, diesel particulate filters, and exhaust gas recirculation to achieve the desired NOₓ and PM emission reductions. These exhaust aftertreatment technologies are designed to achieve the same or less fuel consumption as pre-Tier 4 engines; therefore, the reduction in CO₂ emissions by switching from a Tier
The percentage CO₂ emission reduction that can be achieved by the transition from Tier 2 engine to Tier 4 engine for a large haul truck (e.g., Caterpillar 797 haul truck) is estimated using U.S. EPA NONROAD emission model (U.S EPA 2010). Haul trucks will contribute approximately 40 to 50% of the Project mine fleet greenhouse gas (GHG) emissions year-to-year. In the NONROAD model, CO₂ emissions are calculated by the following equation:

\[
CO₂ = (BSFC \times 453.6 - HC) \times 0.87 \times (44/12) \text{ } [\text{Equation 1}]\]

Where:

- CO₂ is in g/hp-hr
- BSFC is the in-use adjusted brake-specific fuel consumption in lb/hp-hr
- 453.6 is the conversion factor from pounds to grams
- HC is the in-use adjusted hydrocarbon emissions in g/hp-hr
- 0.87 is the carbon mass fraction of diesel
- 44/12 is the ratio of CO₂ mass to carbon mass

BSFC and HC are further defined in Equations 2 and 3, respectively:

\[
BSFC = BSFC_{SS} \times TAF_{BSFC} \text{ } [\text{Equation 2}]\]

Where:

- BSFC is the in-use adjusted brake-specific fuel consumption in lb/hp-hr
- BSFC_{SS} is the steady-state brake-specific fuel consumption in lb/hp-hr
- TAF_{BSFC} is the transition adjustment factor for brake-specific fuel consumption

\[
HC = HC_{SS} \times TAF_{HC} \times DF_{HC} \text{ } [\text{Equation 3}]\]

Where:

- HC is the in-use adjusted hydrocarbon emissions in g/hp-hr
- HC_{SS} is the steady-state hydrocarbon emission factor in lb/hp-hr
- TAF_{HC} is the transition adjustment factor for hydrocarbon emission factor
- DF_{HC} is engine deterioration factor for HC

By substituting Equations 2 and 3 into Equation 1, the CO₂ emission factor can be estimated by Equation 4:

\[
CO₂ = ((BSFC_{SS} \times TAF_{BSFC}) \times 453.6 - (HC_{SS} \times TAF_{HC} \times DF_{HC})) \times 0.87 \times (44/12) \text{ } [\text{Equation 4}]\]

For a Tier 2 CAT 797F haul truck with a 4,000 horsepower (hp) engine, the CO₂ emission factor is:

\[
CO₂_{Tier \text{ } 2} = ((0.3670 \times 1.010) \times 453.6 - (0.1669 \times 1.05 \times 1.034)) \times 0.87 \times (44/12) = 535.8 \frac{g}{hp \text{ } hr}
\]

For a Tier 4 CAT 797F haul truck with a 4,000 hp engine, the CO₂ emission factor is:

\[
CO₂_{Tier \text{ } 4} = ((0.3670 \times 1.000) \times 453.6 - (0.1314 \times 1.00 \times 1.027)) \times 0.87 \times (44/12) = 530.6 \frac{g}{hp \text{ } hr}
\]
The percentage reduction in CO₂ emissions from Tier 2 to Tier 4 can then be calculated as follows:

\[
\text{\% CO}_2 \text{ Reduction} = \frac{535.8 - 530.6}{535.8} \times 100 = 0.97 \%
\]

Based on the above sample calculations, the percentage of CO₂ emission reduction by switching from Tier 2 to Tier 4 engines by a haul truck is less than 1%, which is considered negligible. Overall, the percentage of CO₂ emission reduction by switching from pre-Tier 4 engines to Tier 4 engines on the Project's mine fleet CO₂ emissions is also expected to be negligible.

b) Overall, the percentage of CO₂ emission reduction by switching from pre-Tier 4 engines to Tier 4 engines on the Project's mine fleet CO₂ emissions is expected to be negligible. Therefore, an updated Table 23-1 is not provided.

Reference:


4.0 WATER

4.1 Water Management

SIR 9) SIR 36, Figure 36-7, Page 90
SIR 6, Page 21
SIR 28 (e), Page 59

CNRL’s hydrograph for the warm-dry modelling scenario shows a maximum decline of approximately 5 m for End Pit Lake 2 (EPL 2). Given that EPL 2 is proposed to contain 177 Mm$^3$ of fluid tailings capped with water, the potential risks and implications of this predicted water level decline on the function of the water cap during a warm-dry climate change scenario has not been assessed. Based on the End Pit Lakes Guidance Document (CEMA, 2012), the aspects related to EPL depth that affect lake water quality are sediment resuspension by wave action, evapoconcentration, and meromixis. Potential for sediment resuspension is to be addressed for each specific case of EPL design.

a) Discuss any considerations and assumptions made in the design of EPL2 with regard to mixing depth relative to water cap depth.

b) Identify and discuss any potential risks and implications of a 5 m water level decline in EPL2 relative to the intended function of the water cap to prevent resuspension of tailings to the upper water column.

Response:

a) The design of End Pit Lake 2 (EPL2) for the Canadian Natural Resources Limited (Canadian Natural) North Pit Extension (NPE) Project (the Project) included consideration of wave action on sediment resuspension. The water cap depth is approximately 35 m in the Application Case. Typical effects of waves on sediment resuspension are negligible beyond a depth of 8 m (Lawrence, Tedford and Pieters 2016) in pit lakes in the oil sands region. Therefore, wave action is anticipated not to cause sediment resuspension in EPL2. The other main mechanisms to cause potential sediment resuspension are lake currents induced through wind shear and lake turn-over due to potential density currents (e.g. during spring and fall). These latter two phenomena are the subject of on-going study and research by Canadian Natural which will inform design of the EPL2 in the future (Canadian Natural 2018). A list of potential mechanisms for re-suspension of sediments is provided in Lawrence, Tedford and Pieters (2016).

b) Climate change may potentially reduce the EPL2 water cap depth by a maximum of 5 m (i.e., from 35 to 30 m) (Volume 3, Section 7.8.4.3 of the Environmental Impact Assessment). As discussed in a), the 30 m depth is still much greater than the 8 m depth beyond which wave action is predicted to have negligible effects on sediment resuspension. Therefore, the EPL2 water cap has sufficient depth to prevent wave action from resuspending the sediment, even when the potential climate change effects are considered.

Reference:


4.2 Hydrogeology

SIR 10) SIR 35, Pages 81 to 84

In Figure 35-1, CNRL has provided a site plan showing the Devonian groundwater (environmental) head in relation to the top of the Devonian formation. In Figure 35-2, CNRL has provided a site plan showing the total dissolved solids concentrations within the Basal Water Sand Formation.

SIR #35 indicates that CNRL will submit a Basal Water Management Plan by the end of 2019. In addition, CNRL will implement a Devonian Geohazard Protocol to minimize the risk from unexpected inflows of saline Devonian water.

Field scale studies to completely characterize the structural geology in the Devonian, including fractures and karsting, have not been undertaken by CNRL. However, the existing information (e.g. the Devonian head as presented in Figure 35-1, and the pockets of higher salinity groundwater within the Basal Water Sand formation), indicates that Devonian inflow can be reasonably expected at specific locations. Devonian inflow can be expected when the top of the Devonian is exposed, or when enough of the McMurray formation has been removed, when the mine floor elevation is lower in elevation than the Devonian fresh-water head.

a) Based on the information provided to date, indicate the areas that are expected to have a higher risk of Devonian inflow.

b) Provide the volume of Devonian inflow that CNRL expect over the life of the mine.

c) Provide CNRL’s plan to deal with this expected volume of Devonian inflow.

Response:

a) Figure 10-1 shows that the area with the highest environmental hydraulic head in the Devonian is located in the very southern limit of the North Pit Extension (NPE) Project (the Project) proposed pit. The environmental hydraulic heads were calculated using varying density of groundwater from site-specific data (freshwater hydraulic head assumes that the groundwater has no variations in density). To mitigate the risk of Devonian inflow in this area, less of the overlying McMurray formation will be removed at the pit edge.

b) The volume of Devonian inflow that Canadian Natural Resources Limited (Canadian Natural) expects over the life of the Project is dependent on both the mine plan and backfill schedule. Using the maximum exposed pit area, Canadian Natural expects low volumes, approximately 25 m³/day of Devonian pit inflow. Therefore, an upper estimate of Devonian inflow for the life of the Project (from the start of mining in 2022 to 2029) is approximately 73,000 m³.

c) Due to low anticipated volume of Devonian inflow (25 m³/day), this water will be handled as part of the Basal Water Management Plan. Canadian Natural will submit a Basal Water Management Plan by the end of 2019 as required under Condition 4.5.19 of Environmental Protection and Enhancement Act (EPEA) Approval No. 149968-01-01, as amended. Although Devonian inflow volumes are expected be low, Canadian Natural will prepare a Devonian Geohazard Protocol that will be designed to recognize adversely trending conditions aimed at preventing an inflow risk from escalating. This will include use of the monitoring network and observation data within the pit. Mitigation may include but not limited to an expedited backfill plan and containment within the pit. The handling of any unexpected water will be detailed in the Basal Water Management Plan.
THE DEVONIAN GROUNDWATER (ENVIRONMENTAL) HEAD IN RELATION TO THE TOP OF DEVONIAN Horizons

CLIENT
Canadian Natural

PROJECT
Horizon Mine North Pit Extension

TITLE
THE DEVONIAN GROUNDWATER (ENVIRONMENTAL) HEAD IN RELATION TO THE TOP OF DEVONIAN

CONSULTANT
GOLDER

YEAR-MM-DD
2019-01-28

PREPARED
PK

DESIGN
GAM

REVIEW
RM

APPROVED
JW

PROJECT No.
1664211

CONTROL
Rev.

FIGURE
10-1
5.0 TERRESTRIAL

5.1 Wildlife

SIR 11) SIR 55, Pages 118 to 119
Volume 2, Section 5.1.2.4.1, PDF Page 1328

CNRL states “Of the 110 observations, 102 could be positively identified to species or species group based on echolocation frequency and pattern”. The SIR response states, “All bat netting and detector plots sampled in 2001 [recorded] no bat captures or detections in over 10 hours of survey effort. The area therefore is predicted to be of similar suitability for bats between sampling years”. CNRL also states “The absence of detections at the 2001 plots is unlikely due to a lack of survey effort [and] provides a moderate to high degree of confidence in the presence/absence of bats near those sites” and “Based on the small observed changes in habitat in the area, there is no reason to expect marked differences in bat richness and abundance between 2001 and 2017”.

a) Provide a discussion regarding the differences in datasets regarding bat observations with 110 observations noted in the EIA report, which are assumed to be detected during recent survey efforts, compared to the zero detection from the 2001 surveys.

i) Include in the discussion, the potential reason for the 110 observations in more recent data collection versus the zero detection rate from the 2001 data set.

ii) Discuss what a “marked difference” is and how it is determined.

Response:

i) The 2001 plots (n=5)\(^3\), as referenced in the Supplemental Information Requests (SIR) R2 11), represent a subset of the total plots established in 2001 and were selected because they occurred in the Horizon Oil Sands Mine and Processing Plant (Horizon) and within the North Pit Extension (NPE) local study area (LSA), close to the Calumet River and within proximity of one another (i.e., the five plots established in 2001 were all placed within 200 m of each other). An additional 16 survey plots consisting of eight detector plots and eight netting plots were established in 2001 outside the LSA boundaries but within the regional study area (RSA). While no bat observations were recorded at the five plots established in the LSA, a total of 355 bat observations (including 11 netted individuals and 344 passes) were recorded over the additional 16 RSA survey plots established in 2001.

Since 2001, 27 bat detector plots and zero bat netting plots were established within the LSA boundaries. These 27 detector plots accounted for the 110 bat observations (i.e., 110 passes) described in Volume 2, Section 11 of the Environmental Impact Assessment [EIA]. A total of 49 observations were made across 12 survey plots in 2013 and 61 observations were made across 15 plots in 2017. The 2013 and 2017 plots were established throughout the LSA but did not overlap with the exact location of the plots sampled in 2001. The spatial arrangement of survey plots established in the LSA is shown in Figure 4.2-3 of Volume 2 of the EIA.

The reason for the disparity in bat observations made in the LSA in 2001 compared to 2013 and 2017 is uncertain. While the number and spatial coverage of plots established within the LSA during 2001 was limited, the survey effort at those plots (i.e., the number of detector and netting hours) was high with over ten hours of surveys effort completed. The difference in bat observations at the scale of the LSA is likely attributable to the greater number of plots established in the latter years and the greater variety of areas and habitats surveyed in

\(^3\) The 2001 survey effort for bats in the LSA included three detector plots and two netting plots. The previous response to SIR R1 55) had identified only one netting plot in error.
2013/2017 compared to 2001. Natural variation in the spatial-temporal ranging patterns of animals could also contribute to the observed differences. Given the proximity of plots established in 2001, similar detection patterns across these plots would be expected. The results and conclusions outlined in the Wildlife and Wildlife Habitat section of the EIA (Volume 3, Section 12) would not change if the 2001 surveys in the LSA were excluded from the assessment.

ii) The use of the term “marked difference” simply refers to a noticeable or obvious difference in bat abundance and richness. In this context it is used as an adjective to describe a substantial change. The statement was made using professional judgement, based on evidence suggesting that the specific location where the 2001 surveys occurred (i.e., in the east side of the LSA, close to the Calumet River) had not been altered by human or fire disturbance since 2001; therefore, the habitat structure and complexity of this area was unlikely to have changed dramatically from its 2001 condition. A corresponding change in the bat population from 2001 conditions (i.e., zero bat detections) was therefore not expected.

Surveys conducted in 2013 and 2017 did not re-sample this exact portion of the LSA, precluding a confirmation of our hypothesis. As described in the previous response to SIR R1 55, two of the 15 plots established in 2017 occurred within 150 m of the Calumet River (but more than 1 km from the 2001 sampling sites). One of these two sites had no bat observations while the other had four passes from big brown/silver-haired bat (1 pass), silver-haired bat (2 passes), and low-frequency bat (1 pass) (Volume 2, Section 11 of the EIA).

5.2 Land Use and Land Management

SIR 12) SIR 66, Page 184
PLA Supplement (located in EDS)

a) Identify the specific standards that cannot be met in the mitigation table with justification and mitigation. If applicable, reference the specific section, figure and volume in the integrated application that applies to the standard.

Response:

a) Canadian Natural Resources Limited (Canadian Natural) generated a new Landscape Analysis Tool (LAT) on January 9, 2019 for the Horizon Oil Sands Mine and Processing Plant (Horizon) North Pit Extension (NPE) Project (the Project) to review any new conditions identified in the LAT from the updated Master Schedule of Standards and Conditions (MSSC, GoA 2018). The revised generated LAT identified twelve approval standards. The revised LAT will be uploaded through EDS.

Canadian Natural will adhere to all applicable approval standards. Existing Horizon environmental mitigations and monitoring plans will be expanded to accommodate the development of the Project.

Reference:

6.0 HEALTH

SIR 13) SIR Appendix C

Numerous risk results provided throughout the tables in Appendix C report negative values for the Project case. This indicates that the Application Case results are lower than the Baseline results which is not consistent with the definition of the Application case (Application Case = Baseline + Project). The production of negative risk values would assume the use of a negative exposure concentrations or exposure limits which is not consistent with standard human health risk assessment (HHRA) methodology.

a) Provide correct risk values for the Appendix C tables, or,

b) Provide a rationale for the negative risk values provided in Appendix C.

Response:

a) The risk values for Appendix C of the Supplemental Information Requests (SIRs) R1 are correct. Please see the response to part b)

b) The Canadian Natural Resources Limited (Canadian Natural) North Pit Extension (the Project) is an extension of the previously approved North Pit of the Horizon Oil Sands Mine and Processing Plant (Horizon) rather than a new source of chemical emissions in the local study area (LSA). As a result of the proposed extension, there will be a shift in the mine fleet emissions from the southern portion of the Project footprint under the Baseline Case to the northern portion under the Application Case. This shift in mine fleet emissions results in a decrease in the predicted ground-level air concentrations of the chemicals of potential concern (COPC) associated with the mine fleet between the Baseline Case and the Application Case at several of the discrete locations situated to the south of the Project. This decrease in the predicted ground-level air concentrations of the COPC between the Baseline Case and Application Case can be seen as negative values for the Project Case in Appendix C of the R1 SIRs.
7.0 ERRATA

SIR 14) SIR 1, Page 4

CNRL references the following report: Stoakes, Frank A., 2016. Draft Devonian Geology of the Canadian Natural Horizon Lease, Northeast Alberta Consultant report for Canadian Natural Resources Limited.

a) Provide a copy of the referenced work by Stoakes, 2016.

Response:

a) The report 'Draft Devonian Geology of the Canadian Natural Horizon Lease, Northeast Alberta Consultant report for Canadian Natural Resources Limited' is a propriety report that was commissioned by Canadian Natural Resources Limited (Canadian Natural) to Frank A. Stoakes. The draft report was not finalized and as such, Canadian Natural is not in a position where it can make the report publicly available at this time. Canadian Natural has replaced the Stoakes (2016) reference provided in Supplemental Information Request (SIR) R1 1) and 34) with Hauck, et al. (2016).

Reference:


SIR 15) SIR 18, Page 35

Volume 2, Section 4.2.2, PDF Page 1508
Volume 3, Section 15.2, PDF Page 1290

Canadian Natural states “Supplemental TLU information that is provided in the TLUs, within the agreed-upon timelines, will be included as updates to the EIA and incorporated appropriately into applicable assessment conclusions and matters relating to the TLU and TEK assessment”.

a) Indicate how these timelines fit into Project timelines.

b) If the Supplemental TLU information is provided outside of the agreed-upon timelines, provide the steps that will be taken to acquire TLU information.

Response:

a) Canadian Natural Resources Limited (Canadian Natural) anticipates receiving all supplemental Traditional Land Use (TLU) studies for the North Pit Extension Project (the Project) by the middle of March 2019, based on approved scopes of work (approval granted May, August and September 2018), direct communication (ongoing) and status updates that were provided by Indigenous groups to Canadian Natural in December 2018. Table 15-1 provides a summary of the date of receipt or the anticipated date of receipt of the supplemental TLU studies from Indigenous groups.

The agreed-upon timelines for receipt of the supplemental TLU studies will fit into the Project timelines and Canadian Natural's planned supplementary filings with the AER and the Aboriginal Consultation Office (ACO). Following receipt of all supplemental TLU studies by the middle of March 2019, Canadian Natural will incorporate
the supplemental TLU information into the TLU and Traditional Ecological Knowledge (TEK) assessment conclusions of the EIA. Updates of the applicable assessment conclusions and relevant matters in these sections will be provided to the AER and the ACO through a supplemental filing in Q2 2019. Those updates will also be shared with the Indigenous groups that Canadian Natural is consulting or engaging with on the Project.

Table 15-1: Horizon North Pit Extension Traditional Land Use Study Status Update

<table>
<thead>
<tr>
<th>Indigenous group</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athabasca Chipewyan First Nation</td>
<td>Anticipated mid-March, 2019</td>
</tr>
<tr>
<td>Mikisew Cree First Nation</td>
<td>Anticipated mid-March, 2019</td>
</tr>
<tr>
<td>Fort McKay First Nation</td>
<td>Anticipated January 31, 2019</td>
</tr>
<tr>
<td>Fort McMurray First Nation #468</td>
<td>Received October 15, 2018</td>
</tr>
<tr>
<td>Fort McKay Métis Community Association</td>
<td>Received December 10, 2018</td>
</tr>
<tr>
<td>Fort McMurray Métis Local 1935</td>
<td>Anticipated January, 2019</td>
</tr>
</tbody>
</table>

Canadian Natural also remains committed to engaging and consulting with Indigenous groups in relation to the Project through the additional steps outlined below:

- Responding to eight statement of concerns (SOCs) received between June and September 2018, all registered with the AER.
- Responding to three Technical Reviews representing seven Indigenous groups. The SOCs received from Indigenous groups identify that additional information will be provided in connection with the technical reviews.
- Filing a Specific Concerns and Response Table (SCRT) with each Record of Consultation (RoC) Log for each First Nation (Athabasca Chipewyan First Nation, Fort McKay First Nation, Mikisew Cree First Nation, and Fort McMurray First Nation #468) that Canadian Natural was directed to consult with.

b) Table 15-1 above provides the date of receipt or the anticipated date of receipt of supplemental TLU studies from Indigenous groups. As noted above in the response to 15 a), Canadian Natural anticipates approved TLU studies will be received no later than the middle of March 2019, based on direct communication with the Indigenous groups. Canadian Natural will continue regular communication with the remaining Indigenous groups still in the process of completing the TLU studies in Q1 2019 to ensure the timeline remains achievable.

If any Indigenous group requires additional time to complete a supplemental TLU study, Canadian Natural will engage in regular communication and work with the individual group to accommodate any requests within reason, so as to ensure that Canadian Natural can meet project timelines and provide the AER and ACO with an update to the EIA in Q2 2019, as planned.