

Canadian Natural Upgrading Limited

Application for Muskeg River Mine Tailings Management Plan

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Alberta Energy Regulator

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Mine Tailings Management Plan

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Abbreviations

AER	Alberta Energy Regulator
AFD	atmospheric fines drying
BML	Base Mine Lake
CNUL	Canadian Natural Upgrading Limited
CT	composite tailings
<i>EPEA</i>	<i>Environmental Protection and Enhancement Act</i>
ERCB	Energy Resources Conservation Board
ETF	external tailings facility
EUB	Alberta Energy and Utilities Board
<i>ICAF</i>	<i>Integrated Compliance Assurance Framework</i>
MRM	Muskeg River Mine
NPD	North Pool Deposit
<i>OSCA</i>	<i>Oil Sands Conservation Act</i>
OSEC	Oil Sands Environmental Coalition
PASS	passive aquatic storage system
RTR	ready-to-Reclaim
SB	Sharkbite
SOC	statement of concern
<i>TMF</i>	<i>Lower Athabasca Region: Tailings Management Framework for Mineable Athabasca Oil Sands</i>
TMP	tailings management plan
TSRU	tailings solvent recovery unit

Executive Summary

The Alberta Energy Regulator (AER) approves Canadian Natural Upgrading Limited's (CNUL's) application 1870302, subject to the approval terms and conditions in appendix 1.

Background

The AER regulates tailings arising from oil sands mining operations to ensure that the tailings are managed in an efficient, safe, orderly, and environmentally responsible manner over their entire life cycle. Tailings are a by-product of the process used to extract bitumen from mined oil sands and consist of water, silt, sand, clay, and residual bitumen.

The AER applies a risk-based approach to regulating, where higher-risk activities receive the greatest regulatory oversight. Given the nature and scale of fluid tailings generated by oil sands mine operations, and the ongoing research and development of tailings treatment technology, fluid tailings management is one of Alberta's higher-risk industrial activities.

The regulation of tailings has been an evolving issue in Alberta. In 2009, the Energy Resources Conservation Board (ERCB) released *Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes*, introducing specific performance criteria for the reduction of fluid tailings and the formation of trafficable deposits. To further manage and decrease liability and environmental risk resulting from the accumulation of fluid tailings on the landscape, the Government of Alberta issued the *Lower Athabasca Region: Tailings Management Framework for Mineable Athabasca Oil Sands (TMF)* in 2015. The *TMF* sets out the objective that fluid tailings accumulation is minimized by ensuring that fluid tailings are treated and reclaimed progressively during the life of a project and all fluid tailings associated with a project are ready to reclaim (RTR) within 10 years of the end of mine life. In addition, the *TMF* establishes four outcomes: land use must be returned to Albertans, sustainable ecosystem, liability is minimized to Albertans, and environmental effects are managed. As part of the implementation of the *TMF*, the AER released *Directive 085: Fluid Tailings Management for Oil Sands Mining Projects*, which set out new requirements for fluid tailings management plans (TMPs), including both existing fluid tailings (i.e., legacy) and new fluid tailings.

CNUL's Approval

The Muskeg River Mine (MRM) was approved by an Alberta Energy and Utilities Board (EUB) hearing panel in 1999 (*Decision 99-2*). MRM started production in December 2002 and tailings placement began in the external tailings facility (ETF). An expansion to the MRM was approved by a joint panel established by the EUB and the Government of Canada in 2006 (*Decision 2006-128*). In-pit tailings placement began in 2010 (site map provided in appendix 2).

On October 14, 2016, the AER registered application 1870302, filed by Shell Canada Limited pursuant to section 13 of the *Oil Sands Conservation Act (OSCA)* for approval of the TMP for MRM. CNUL acquired the MRM from Shell in May 2017 and is the current holder of approval 8512.

The AER enhanced involvement by providing opportunities for CNUL and statement of concern (SOC) filer the Oil Sands Environmental Coalition (OSEC) to provide feedback on circulated draft approval conditions on two separate occasions.

Amendment Application

The AER is approving CNUL's TMP for the short-term management of fluid tailings. There is sufficient information in CNUL's application to demonstrate its ability to manage tailings for the next few years.

However, the AER is unable to assess whether CNUL will be able, over the medium and long term, to manage its fluid tailings and treated tailings deposits to meet the *TMF*'s objective and *Directive 085* requirements due to uncertainties and deficiencies in the application. There are three main issues. CNUL's new fluid tailings profile is not aligned with the *TMF* and *Directive 085*; CNUL's approach to fluid tailings treatment technology is inadequate; and CNUL's proposed ready-to-reclaim (RTR) criteria, RTR trajectory, and targeted ecosites have a degree of uncertainty over the medium and long term.

CNUL is required to submit an amendment application by September 30, 2021, that contains the TMP for the life of the project and that addresses the uncertainties and deficiencies identified in this report.

CNUL is also required to submit a number of other plans and updates (see appendix 3) before September 30, 2021, to assure the AER that the uncertainties and deficiencies identified in this report will be adequately addressed in the amendment application. This includes the submission of a plan by December 31, 2018, describing how CNUL will ensure that the treatment capacity is equal to or greater than the production rate of new fluid tailings and that all legacy fluid tailings will be RTR by MRM's end of mine life (e.g., increase fluid tailings treatment capacity), describing the fluid tailings treatment technology options, and describing how the RTR criteria and trajectory will be updated and validated.

Fluid Tailings Profile

One of the reasons CNUL is required to submit the amendment application is that the proposed new fluid tailings profile is not aligned with the *TMF* and *Directive 085* over the medium and long term.

CNUL's new fluid tailings profile is not aligned because

- the proposed peak volume and time to accumulate the peak volume is greater than the volume and longer than the duration guided by the *TMF* and *Directive 085*,
- the end of mine life target is greater than 5 years of fluid tailings production at the MRM,

- it does not demonstrate that fluid tailings treatment capacity is equal to or greater than the new fluid tailings production rate, and
- it does not demonstrate that all new fluid tailings generated at the MRM are RTR reclaim within 10 years from MRM's end of mine life (2058).

Further, CNUL's new fluid tailings profile includes fluid tailings volumes from the Jackpine Mine.

As the new fluid tailings profile is aligned only for the short term, the AER is approving CNUL's new fluid tailings profile only until 2022. CNUL is required to submit revised new fluid tailings profile in the amendment application.

While CNUL's legacy fluid tailings profile meets the *TMF*'s objective, the legacy fluid tailings profile could be affected by CNUL's technology implementation or by the revisions to its new fluid tailings profile. As such, the legacy fluid tailings profile is approved until 2022, and CNUL is required to submit a revised legacy fluid tailings profile in the amendment application.

The AER has set the thresholds based on the approved short-term fluid tailings profiles. The thresholds will remain in effect until the AER decides on the amendment application.

Tailings Treatment Technology Selection and Performance

Another reason CNUL is required to submit the amendment application is that CNUL's approach to fluid tailings technology is inadequate over the medium and long term.

CNUL proposed to introduce new technology in 2022, based on an ongoing technology selection project. CNUL did not submit evidence that demonstrated the proposed technologies would provide sufficient treatment capacity for all new fluid tailings produced or that the technologies could produce a deposit that would be on a trajectory to support future reclamation activities, achieve stable targeted ecosites, and meet the *TMF*'s outcomes

In light of the absence of a chosen fluid tailings treatment technology following 2022 and associated evidence, the AER is unable to assess whether CNUL will be able, over the medium and long term, to manage its fluid tailings production to meet the requirements of the *TMF* and *Directive 085*. CNUL is required to address this deficiency in the amendment application. In the interim, CNUL is required to provide an annual update to the AER on its tailings treatment technology selection project.

CNUL is authorized to continue to use composite tailings (CT) to complete Cell 2 and to continue to use thickeners with a co-deposition of the thickened tailings with tailings solvent recovery unit (TSRU) tailings, whole tailings, and coarse sand tailings to form North Pool Deposit (NPD) Type deposits.

The AER is concerned with CNUL's ability to replicate the NPD Type deposit and sustain this co-deposition approach over the medium and long term. The AER is also concerned with the ability of the

NPD Type deposits to support future reclamation activities, achieve stable targeted ecosites, and meet the *TMF*'s outcomes. CNUL is required to assess the performance and limitations for the NPD Type deposits, and monitor quarterly and report annually on the NPD Type deposits.

CNUL is not authorized to use centrifuge, fluid tailings drying, or atmospheric fines drying (AFD) at this time. CNUL's TMP did not provide sufficient information for the AER to evaluate the use of these technologies at MRM.

There is another concern with respect to technology. CNUL proposed to cover two tailings deposits (Cell 1 and Sharkbite [SB] Cell 6) with water to create a water-capped deposit as a closure landscape feature ("water-capped pit lake"). However, water-capping technology is subject to further assessment, research, and future policy. Therefore, the approval prohibits water-capped pit lakes and requires CNUL to meet future policy on water-capped pit lakes.

Because CNUL currently plans to use water-capped pit lakes, CNUL is also required to provide a feasible alternative tailings treatment technology and implementation plan in the amendment application.

CNUL is required to research and report on its pit lakes as part of its *Environmental Protection and Enhancement Act (EPEA)* approval, including providing information on the applicability of current research to its proposed water-capped pit lakes, to support future regulatory decisions associated with water-capping technology.

Ready-to-reclaim (RTR) Criteria

Finally, CNUL is required to submit the amendment application given the degree of uncertainty in CNUL's proposed RTR criteria over the medium and long term. CNUL is required to submit updated RTR criteria for each deposit in the amendment application.

For the NPD Type deposits (i.e., ETF, Cell 1, and Cell 3), the AER is specifying the following RTR criteria: 70 per cent solids by weight based on deposit sampling within five years of tailings placement, and groundwater monitoring in accordance with the *EPEA* approval.

CNUL is required to provide new RTR criteria for the Cell 2 deposit because the proposed RTR criteria were not acceptable. CNUL cannot remove CT in Cell 2 from the fluid tailings inventory unless and until the revised RTR criteria are approved.

Further, the AER does not authorize RTR criteria for thickened tailings deposits, centrifuge deep deposits, or thin lift deposits, because there are concerns with the proposed RTR criteria of 40 per cent solids in three months to one year, and CNUL did not propose to develop these types of deposits before 2021.

Enhancements to Research

Research is key to manage risk and resolve site-specific uncertainties in CNUL's TMP. The AER is relying on a number of research conditions in the *EPEA* approvals to manage risk and resolve uncertainties. Further, CNUL is required to provide a capping research plan by September 30, 2018.

20180523A

**Canadian Natural Upgrading Limited
Application for Approval of Muskeg River Mine Tailings Management Plan**

Application 1870302

Decision

[1] The Alberta Energy Regulator (AER) approves Canadian Natural Upgrading Limited's (CNUL's) application 1870302, subject to the approval terms and conditions, and issues *Oil Sands Conservation Act* (OSCA) Approval No. 8512I (appendix 1).

[2] In reaching its decision, the AER considered all relevant material constituting the record of CNUL's application. The record consists of the application, which includes supplemental information requests; supplemental information filed by CNUL; the statement of concern (SOC) filed by the Oil Sands Environmental Coalition (OSEC); and the feedback on draft conditions of approval provided by CNUL and OSEC.

[3] References in this decision to specific parts of the record are intended to assist the reader in understanding the AER's reasoning on a particular matter and does not mean that the AER did not consider all relevant portions of the record with respect to the matter.

[4] This report highlights the AER's consideration of the application.

Application

[5] The Muskeg River Mine (MRM) was approved by the Alberta Energy and Utilities Board (EUB) in 1999 (*Decision 99-2*). The MRM is located about 75 kilometres north of Fort McMurray, Alberta, in the Regional Municipality of Wood Buffalo (site map provided in appendix 2). The MRM started production in December 2002 and tailings placement began in the external tailings facility (ETF). An expansion of the MRM was approved by a joint EUB and Government of Canada panel in 2006 (*Decision 2006-128*). In-pit tailings placement began in 2010.

[6] On October 14, 2016, the AER registered application 1870302, filed by Shell Canada Limited pursuant to section 13 of the *OSCA*, for approval of its tailings management plan (TMP) for the MRM.

[7] Under application 1870302, Shell sought approval for its TMP to 2115, which is 57 years beyond the MRM's end of mine life.

[8] CNUL acquired the MRM from Shell in May 2017 and is the current holder of approval 8512.

Statements of Concern and Enhanced Involvement

[9] The AER published a public notice for application 1870302 and received one SOC from OSEC in November 2016.

[10] CNUL provided a written submission to OSEC and the AER on May 31, 2017, which responded to the technical concerns outlined in OSEC's SOC.

[11] On December 14, 2017, the AER circulated draft conditions of approval for feedback by January 12, 2018, from CNUL and OSEC to enhance involvement in and inform the decision on application 1870302. The AER decided to circulate the draft conditions of approval for feedback rather than conduct a facilitated technical meeting with CNUL and OSEC, based on a number of factors, including the issues and concerns raised by OSEC.

[12] The AER subsequently extended the deadline for feedback on the draft conditions of approval from January 12, 2018 to January 19, 2018. The AER received written feedback from CNUL and OSEC.

[13] The initial circulation of draft conditions of approvals requested specific feedback on two options: "Option 1 requires that CNUL meet a specified new fluid tailings profile for the life of mine, while option 2 provides for a new fluid tailings profile only until 2023." CNUL and OSEC were advised that: "the attached draft approval reflects option 1; should option 2 be ultimately adopted several of the conditions requiring plans within the next five years will be unnecessary and therefore will require deletion or modification. In addition to these changes, CNUL would be required to submit an application prior to September 30, 2021."

[14] Following receipt of the feedback on the initial draft and options, the AER circulated a second set of draft approval conditions on February 6, 2018, seeking feedback on the specific conditions proposed for a short-term approval of the TMP and the requirement of an amendment application (i.e., option 2).

[15] Upon receipt of feedback from CNUL and OSEC, the AER reviewed the entire record, considered OSEC's SOC and the submissions by CNUL and OSEC, and made its decision on CNUL's application 1870302.

Approval Discussion

Introduction

[16] The AER finds that there is sufficient information to authorize CNUL to manage its fluid tailings and treated tailings deposits for the next few years based on the terms and conditions of the approval. However, the AER is unable to assess whether CNUL will be able, over the medium and long term, to manage its fluid tailings and treated tailings deposits to meet the *TMF's* objective and *Directive 085* requirements due to uncertainties and deficiencies in the application and so has included approval

conditions to address these uncertainties and deficiencies, including requiring an amendment application be submitted by September 30, 2021.

[17] The approval conditions address the following:

- amendment application requirements;
- project-specific thresholds for both new and legacy fluid tailings;
- tailings treatment technology and deposit performance plans and updates over the short term in support of the medium- and long-term management of fluid tailings, including mitigation measures and research, monitoring, evaluation, and reporting;
- stakeholder and indigenous community engagement; and
- environmental effects and implications.

[18] The approval conditions are subject to the AER's *Integrated Compliance Assurance Framework (ICAF)* and *Manual 013*. In addition, the management actions as set out in the *TMF* and *Directive 085* are new tools available to the AER. A common theme in *ICAF*, the *TMF*, and *Directive 085* is a flexible approach; namely, to allow for the discretion to choose the appropriate tools to the specific circumstances to ensure the most effective compliance or enforcement outcome.

[19] The TMP was submitted as an application under *OSCA* and the decision on the application was made pursuant to *OSCA*. This report also makes reference to other approvals, in particular the *Environmental Protection and Enhancement Act (EPEA)* approval issued to CNUL in relation to this project. Further, various letters issued pursuant to *OSCA*, the *Water Act*, and *EPEA* approvals that are related to the matters discussed in this report have been attached to this report.

Amendment Application

Context

[20] *Directive 085* indicates that amendment applications are dependent on conditions of approval and are necessary where there are changes to the end of mine life dates that affect thresholds or changes to the TMP that affect thresholds or increase risk.

Decision Summary

[21] CNUL is required to submit an amendment application by September 30, 2021 that contains the TMP for the life of the project and that addresses the uncertainties and deficiencies identified throughout the subsequent sections in this report.

[22] There is sufficient information in CNUL's application to demonstrate its ability to manage tailings for the next few years. Therefore, the AER is approving CNUL's TMP for the short-term

management of fluid tailings. However, the AER is unable to assess whether CNUL will be able, over the medium and long term, to manage its fluid tailings and treated tailings deposits to meet the *TMF*'s objective and *Directive 085* requirements due to the uncertainties and deficiencies in the application.

- CNUL's new fluid tailings profile is not aligned with the *TMF* and *Directive 085* because the proposed peak volume, time to accumulate the peak volume, and end of mine life target are greater than allowable, and the profile does not demonstrate that treatment capacity is equal to or greater than production or that the *TMF*'s objective is met.
- CNUL's approach to fluid tailings treatment technology is inadequate because CNUL did not submit evidence that demonstrated that the proposed technologies would provide sufficient treatment capacity for all new fluid tailings produced, that the deposit performance would be on a trajectory to support future reclamation activities, or that the deposits would achieve stable targeted ecosites and meet the *TMF*'s outcomes.
- CNUL's proposed ready-to-reclaim (RTR) criteria, RTR trajectory, and targeted ecosites are uncertain and do not provide the AER with assurance that the deposit's physical properties are on a trajectory to support future stages of reclamation, or that the effects the deposit has on the surrounding environment are minimized and the ability to reclaim to a locally common, diverse, and self-sustaining ecosystem is not compromised.

[23] These uncertainties and deficiencies are further discussed in subsequent sections in this report. The AER has also identified the areas of particular concern in the amendment application requirements to ensure the amendment application is not deficient. This includes additional information on CNUL's bitumen expansion plan and the capacity needed to manage both forecasted fluid tailings volumes and the potential additional fluid tailings volumes from any expansion.

[24] Although the amendment application is required by September 30, 2021, CNUL may submit the amendment application at any time before this date.

[25] CNUL is also required to submit a number of plans and updates (see appendix 3) before September 30, 2021, to assure the AER that the uncertainties and deficiencies identified in this report will be adequately addressed in the amendment application. This includes a plan by December 31, 2018, describing how CNUL will ensure that the treatment capacity is equal to or greater than the production rate of new fluid tailings and all how legacy fluid tailings will be RTR by MRM's end of mine life (e.g., increase fluid tailings treatment capacity), describing the fluid tailings treatment technology options, and describing how the RTR criteria and trajectory will be updated and validated.

Fluid Tailings Profiles and Project-Specific Thresholds

[26] The *TMF* and *Directive 085* require that new and legacy fluid tailings must be treated and progressively reclaimed during the life of a project, with all fluid tailings RTR ten years after the end of

mine life. The *TMF* and *Directive 085* also provide guidance that operators must consider in the development of their TMPs.

[27] The fluid tailings profile represents the volume of fluid tailings that are not RTR (e.g., do not meet RTR criteria). Both the new and legacy fluid tailings profiles are important tools by which the performance of an operator will be measured.

New Fluid Tailings Profile

Context

[28] The *TMF* defines new fluid tailings as fluid tailings that are produced after January 1, 2015. All new fluid tailings must be RTR within ten years of end of mine life.

Decision Summary

[29] CNUL's new fluid tailings profile meets the *TMF* and *Directive 085* profile guidance until December 31, 2022. CNUL's new fluid tailings profile is authorized until December 31, 2022, as shown in appendix B of the approval (appendix 1). As a result, no end of mine life target is authorized. The solid blue line in figure 1 depicts the authorized new fluid tailings profile that CNUL must achieve until December 31, 2022. The dotted blue line in figure 1 depicts the AER's medium- and long-term expectations for the new fluid tailings profile. The dotted red line in figure 1 depicts CNUL's proposed new fluid tailings profile.

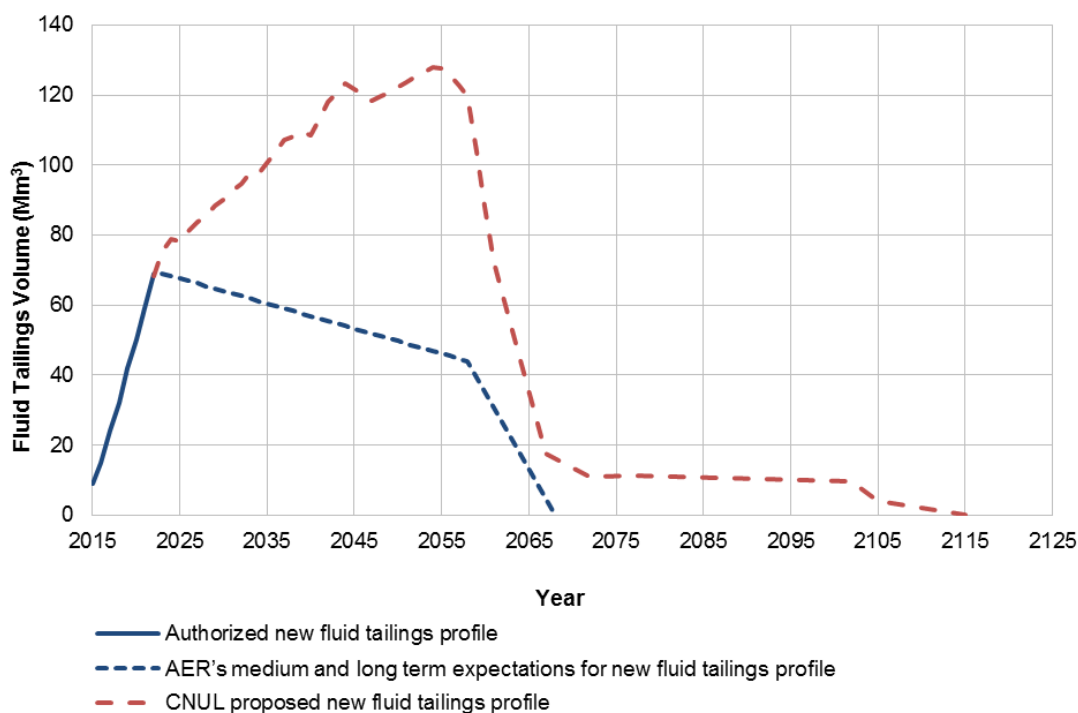


Figure 1. New fluid tailings profile

[30] However, CNUL's proposed new fluid tailings profile beyond 2022 does not meet the *TMF*'s objective or the *TMF* and *Directive 085* profile guidance for the following reasons:

- The *TMF* and *Directive 085* expect that projects manage the inventory of new fluid tailings in the range of the volume that is expected to be produced during 3 to 10 years of full production. Based on a production rate of about 8.5 million cubic metres per year (Mm^3/year) (estimated by the AER using CNUL's rate of growth) and the proposed peak accumulation of 127.8 Mm^3 , CNUL's proposed new fluid tailings profile indicates an inventory of about 15 years of full production.
- Although the *TMF* acknowledges that it may take more than 3 to 10 years to accumulate the peak volume, CNUL is proposing growth in tailings accumulation until 2054, which is nearly 40 years to accumulate the peak volume.
- CNUL has not demonstrated that the fluid tailings treatment capacity is equal to or greater than the new fluid tailings production rate, as required by the *TMF* and *Directive 085*.
- The end of mine life target is greater than five years of fluid tailings production at MRM. The *TMF* and *Directive 085* require the end of mine life target to be the equivalent of five years or less of fluid tailings accumulation. Based on production rate of about $8.5 \text{ Mm}^3/\text{year}$, CNUL's end of mine life target would be about 43 Mm^3 instead of the proposed 120 Mm^3 .
- The proposed new fluid tailings profile does not demonstrate that all new fluid tailings generated at the MRM are RTR within 10 years of MRM's end of mine life (2058).
- The *TMF* and *Directive 085* require profiles to be project specific. CNUL's new fluid tailings profile includes fluid tailings volumes generated from froth transferred to the MRM from the Jackpine Mine. Profiles are required to track project-specific fluid tailings volume, regardless of fluid or treated tailings storage and final placement locations.

[31] OSEC shares some of these concerns, including the time to accumulate the peak fluid tailings volume.

[32] To address the concerns, in the amendment application CNUL is required to provide a revised new fluid tailings profile that

- is representative of MRM tailings only,
- includes an end of mine life target that is no greater than five years accumulation of fluid tailings production at MRM,

- ensures treatment capacity is equal to or greater than the production rate of new fluid tailings, and
- demonstrates that all new fluid tailings generated at MRM are RTR within ten years from end of mine life.

[33] At a minimum, the AER expects CNUL's amendment application to meet the new fluid tailings profile depicted in the dotted line in figure 1.

[34] In addition, the new fluid tailings profile is subject to a number of uncertainties, including treatment technology implementation and performance, deposit performance and RTR criteria, the treatment and management of tailings solvent recovery unit (TSRU) tailings, capping feasibility, the resource optimization program, and bitumen expansion plans. In the amendment application, CNUL is required to address these uncertainties and the requirements of *Directive 085*, which include describing uncertainties and identifying mitigation measures and contingency plans.

Legacy Fluid Tailings Profile

Context

[35] Legacy fluid tailings are fluid tailings that existed before January 1, 2015. All legacy fluid tailings must be RTR by end of mine life.

[36] Legacy fluid tailings are located in the ETF, Cell 1, and Cell 2.

Decision Summary

[37] CNUL's legacy fluid tailings profile meets the *TMF*'s objective because the existing volume of 91.4 Mm³ will be treated and will achieve RTR status by 2050, eight years before the end of mine life. However, the uncertainties over the medium and long term associated with technology implementation, the RTR criteria, and the revision of the new fluid tailings profile could impact the legacy fluid tailings profile. Consequently, CNUL's legacy fluid tailings profile is authorized until December 31, 2022, as shown in appendix B of the approval (appendix 1). The solid line in figure 2 depicts the authorized legacy fluid tailings profile that CNUL must achieve until December 31, 2022. The dotted line in figure 2 depicts CNUL's commitment to achieve RTR status for all legacy fluid tailings eight years before the end of mine life. The AER expects the legacy fluid tailings profile in CNUL's amendment application will meet or exceed this commitment.

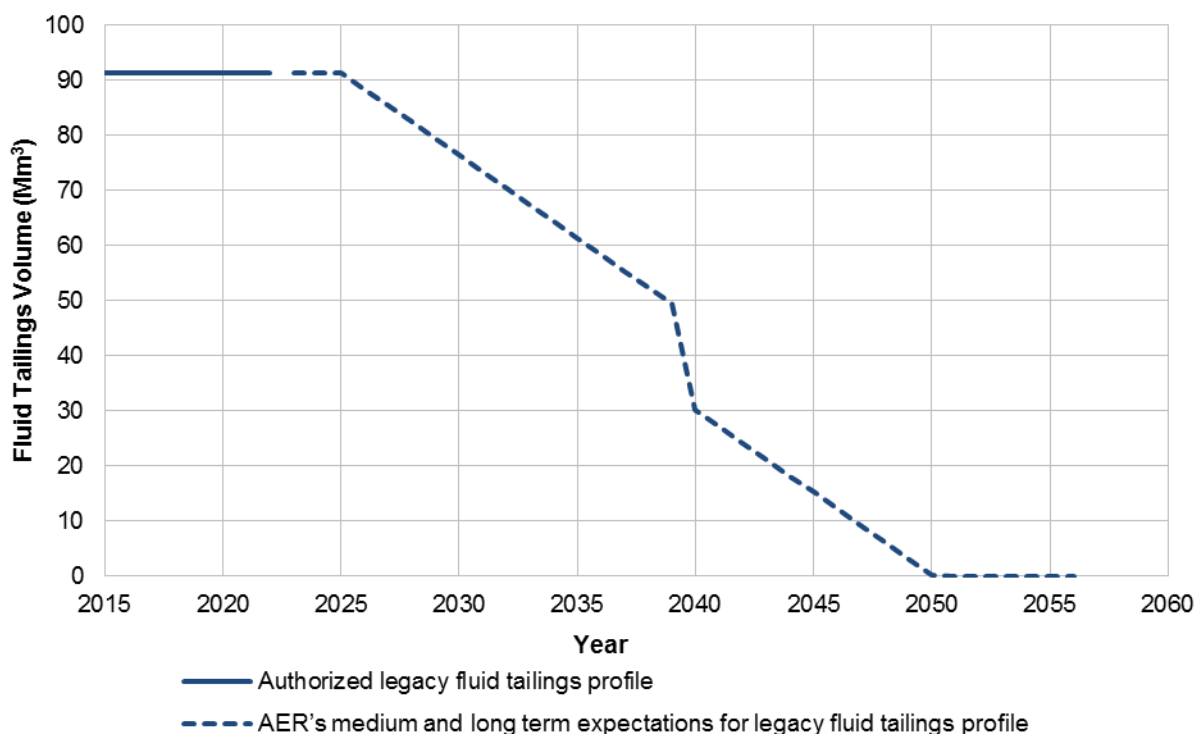


Figure 2. Legacy fluid tailings profile

[38] Further, CNUL is required to submit a revised legacy fluid tailings profile in the amendment application that

- is representative of MRM tailings only and
- demonstrates that all legacy fluid tailings generated at the MRM are RTR by end of mine life.

[39] The AER expects the legacy fluid tailings profile in CNUL's amendment application will meet or exceed its commitment that all legacy fluid tailings generated at the MRM are RTR by eight years before the end of mine life. At a minimum, the AER expects CNUL's amendment application to meet the legacy fluid tailings profile depicted in the dotted line in figure 2.

Thresholds

Context

[40] The volume of accumulated fluid tailings is the primary indicator in the *TMF* used to manage and decrease liability and environmental risk resulting from the accumulation of fluid tailings. Triggers and a limit (collectively referred to as "thresholds") will be set relative to the fluid tailings profiles. The thresholds will ensure that fluid tailings are not accumulating beyond a volume or at a rate that precludes operators from meeting the *TMF*'s objective. These are tools to be used to manage risks associated with TMPs. Various management actions are required when thresholds are exceeded.

[41] Three project-specific thresholds are set based on an operator's fluid tailings profiles in accordance with the *TMF* and *Directive 085*.

[42] The three thresholds are the profile deviation trigger, the total volume trigger, and the total volume limit:

- Profile deviation trigger:
 - Alerts regulators and operators when the volume of fluid tailings is growing 20 per cent faster than that approved for the profile. Additional management action is required when the profile deviation trigger is exceeded.
 - This trigger is based on when the fluid tailings volume growth is 20 per cent higher than that in the approved profile.
 - The *TMF* states that the profile deviation trigger allows a five-year rolling average to account for year-over-year variability. The profile deviation trigger applies to both legacy fluid tailings and new fluid tailings profiles.
- Total volume trigger
 - Indicates that the volume of fluid tailings has exceeded its approved maximum accumulation and requires additional management action.
 - The *TMF* states that this trigger is based on 100 per cent of the greater of the maximum approved fluid tailings volume profile or the end of mine life target.
 - The *TMF* states the end of mine life inventory, or target, is a volume of fluid tailings that can be managed to a ready-to-reclaim state within 10 years after end of mine life and is the equivalent of 5 years, or less, of fluid tailings volume accumulation.
 - The total volume trigger applies to the new fluid tailings profile.
- Total volume limit
 - Indicates that the volume of fluid tailings presents an unacceptable risk to the environment and potential long-term liability. Exceedance of this limit will compromise the ability of an operator to have all of their fluid tailings in an acceptable management state (i.e., RTR) within ten years of the end of mine life. Therefore, the most severe management responses are initiated.
 - The *TMF* states that this limit is based on 140 per cent of the greater of the maximum approved fluid tailings volume profile or the end of mine life target.
 - The total volume limit applies to the new fluid tailings profile.

Decision Summary and AER Findings

[43] The *TMF* states the profile deviation trigger allows a five-year rolling average to account for year-over-year variability. To allow for year-over-year variability, the AER has set the profile deviation trigger for CNUL as a five-year rolling average of the annual profile deviation. The profile deviation trigger is applicable to both the new fluid tailings and legacy fluid tailings profiles.

[44] The AER's decision to authorize the new fluid tailings profile until December 31, 2022, affects the approach taken in setting the total volume trigger and total volume limit. The total volume trigger and limit are based on the greater of the maximum approved fluid tailings volume profile or end of mine life target. As there is no end of mine life target authorized, the AER setting the total volume trigger at 69 Mm³ and the total volume limit at 97 Mm³.

[45] These thresholds remain in effect beyond December 31, 2022. The thresholds may be revised depending on the AER's decision on the amendment application.

[46] If any threshold is exceeded, CNUL is required to comply with the management response or action directed by the AER. If CNUL exceeds a threshold after December 31, 2022, *Directive 085* provides that "the AER makes the final decision of the fluid tailings volume to be placed in the fluid tailings inventory, any threshold exceedance, and the assigned management level."

Fluid Tailings Treatment Technology

[47] The *TMF* stipulates that all fluid tailings must be treated with an accepted technology. The risks, benefits, and trade-offs associated with the proposed technology must be understood, have contingencies identified, and risks mitigated.

Technology Selection

Context

[48] *Directive 085* requires operators to justify that selected technologies are the best available for the project.

[49] The MRM currently uses a combination of composite tailings (CT) and thickeners with a co-deposition of thickened tailings with TSRU tailings, whole tailings, and coarse sand tailings to form North Pool Deposit (NPD) Type deposits. CNUL will discontinue the use of CT by the end of 2018 upon completion of Cell 2.

[50] CNUL proposed that future growth in new fluid tailings production would be treated by centrifuge or an equivalent tailings treatment technology, with additional capacity deployed as production increased. Furthermore, CNUL continues an ongoing tailings technology selection project which will

determine its preferred treatment technology or technologies. These technologies could include centrifuge, fluid tailings drying, or atmospheric fines drying (AFD).

[51] CNUL also proposed to create two water-capped deposits.

Decision Summary

[52] A key component for the AER in evaluating the performance capabilities and limitations of a technology for the life of the project is determining whether the technology and the subsequent tailings deposit management requirements are sustainable and whether the required resources, materials, and time to achieve the *TMF*'s outcomes are available.

[53] The AER has concerns with CNUL's tailings treatment technology and the subsequent tailings deposit performance capabilities. To address these concerns, the AER is requiring information from CNUL in the short term in a number of plans, updates, and the amendment application.

[54] CNUL is authorized to use CT to complete Cell 2, subject to the approval terms and conditions, because CNUL will discontinue the use of CT by the end of 2018 upon completion of Cell 2 and CNUL would be able to employ mitigation measures (e.g., rehandling, additional treatment, capping with additional material) should Cell 2 underperform or it is determined that CNUL cannot achieve long-term reclamation outcomes.

[55] CNUL is authorized to use thickeners with a co-deposition of the thickened tailings with TSRU tailings, whole tailings, and coarse sand tailings to form NPD Type deposits, subject to the approval terms and conditions, based on the following considerations:

- The thickeners provide marginal tailings treatment, and CNUL relies on co-deposition of thickened tailings in the NPD Type deposit to achieve initial deposit performance expectations for physical properties such as stability, strength, and settlement.
- The NPD Type deposit performance data indicates that CNUL should be able to achieve initial deposit performance expectations for physical properties.
- CNUL would be able to employ mitigation measures (e.g., rehandling, additional treatment, capping with additional material) should the mixed deposit underperform or it is determined that CNUL cannot achieve long-term reclamation outcomes.
- Before CNUL's planned deployment of additional treatment technologies, further review and assessment of thickeners and NPD Type deposit performance will be undertaken through the amendment application.

[56] Given the AER's concerns with CNUL's tailings treatment technology and the subsequent tailings deposit performance capabilities, the AER added approval conditions, including requiring the amendment application. The amendment application must address the medium- and long-term

uncertainties associated with the NPD Type deposit, including environmental risk, segregation, settlement, capping material availability, deposit performance, and the ability of the NPD Type deposits to support future reclamation activities and achieve stable targeted ecosites that meet the *TMF*'s outcomes. Additional AER findings with respect to the NPD Type deposit can be found in the section "North Pool Deposit (NPD) Types."

[57] OSEC raised concerns with CNUL's treatment technology plans. The AER shares these concerns. The continued use of CT and thickeners with a co-deposition to form NPD Type deposits provides insufficient treatment capacity to manage the MRM's fluid tailings. CNUL indicated that additional or other treatment technologies will be implemented in 2022, 2023, and 2024 to add additional treatment capacity as production increases. However, CNUL also requires additional treatment capacity to meet or exceed the forecasted growth in the proposed new fluid tailings profile, manage TSRU tailings, and compensate for uncertain deposit performance. CNUL is required to provide, in the amendment application, a plan for additional fluid tailings treatment technology that ensures sufficient treatment capacity.

[58] It is unclear how CNUL will manage fluid tailings treatment over the medium and long term. Therefore, CNUL is required to submit a plan by December 31, 2018, that will address the work CNUL will undertake to

- ensure that the treatment capacity is equal to or greater than the production rate of new fluid tailings and that all legacy fluid tailings will be RTR by MRM's end of mine life (e.g., increase fluid tailings treatment capacity) and
- evaluate the fluid tailings treatment technology options (including a description of the options that CNUL will assess) and explain the approach to identifying and mitigating uncertainties associated with the tailings treatment technologies evaluated.

[59] CNUL is currently evaluating tailings treatment technology. CNUL's ongoing tailings technology selection project is designed to evaluate tailings treatment technology options, which may result in CNUL selecting different technologies. CNUL is required to report annually on the progress of the ongoing tailings technology selection project.

[60] Considering the concerns with CNUL's current treatment technologies, CNUL needs to evaluate whether

- the selected treatment technologies and the types of deposits the technologies form are appropriate,
- mitigation measures are needed to be employed in the current tailings deposits, and
- the selected treatment technologies and the tailings deposits support future reclamation activities and achieve stable targeted ecosites that meet the *TMF*'s outcomes.

[61] CNUL is not authorized to use centrifuge treatment technologies, fluid tailings drying, or AFD at MRM. CNUL's TMP did not provide sufficient information for the AER to evaluate the use of these technologies at the MRM, and CNUL did not identify any volume of fluid tailings that will be treated using fluid tailings drying or AFD technologies.

[62] Furthermore, the approval prohibits placing any water, which includes industrial wastewater, above treated or untreated tailings for the purpose of creating a water-capped deposit as a closure landscape feature ("water-capped pit lake"). The AER's findings with respect to the water-capped pit lake, including the prohibition, can be found in the section "Water-Capping Technology."

[63] If the uncertainties in CNUL's TMP (e.g., NPD Type deposit performance) are not adequately addressed, there are increased risks, including risks to CNUL (e.g., financial, reputational). If these uncertainties cannot be resolved or mitigated, or if deposits underperform, CNUL must modify the TMP and mitigate its tailings deposits to achieve the *TMF* outcomes. Like every operator, CNUL is required to achieve a stable landscape and a diverse, locally common, and self-sustaining ecosystem, as established in the *TMF* outcomes.

North Pool Deposit (NPD) Types

Context

[64] CNUL is co-depositing thickened tailings, TSRU tailings, whole tailings, and coarse sand tailings in a single deposit, creating an NPD Type. CNUL stated that the long-term performance of the NPD Type deposits is the ultimate indicator of whether the deposit will meet its end land use.

Decision Summary

[65] The NPD Type deposit approach is approved by the AER, subject to the approval terms and conditions.

[66] Although the AER expects CNUL should be able to achieve initial deposit performance expectations in the NPD Type deposit, the AER is concerned that the NPD Type deposit performance may not be repeatable because this type of deposit's design and operation is not well understood. To address these concerns and confirm performance, CNUL is required to monitor and report on NPD Type deposit performance.

[67] To ensure annual data do not obscure the variability within CNUL's monitoring results, CNUL is required to monitor, on a quarterly basis, the volume of thickened tailings, TSRU tailings, whole tailings, and coarse sand tailings placed in each NPD Type deposit together with the solids content and sands-to-fine ratio of the thickened tailings being placed in each NPD Type deposit and is required to report annually on these monitoring results.

[68] CNUL identified operating targets (i.e., ratios of each tailings stream) for each NPD Type deposit. If the operating targets in application 1870302, Table 1: WT/CST proportions relative to thickened tailings and TSRU are not met for more than two consecutive quarters, CNUL is required to take actions, including cause identification, impact assessment, and mitigation, and is required to report annually on these actions. The AER recognizes that the timeframe of two consecutive quarters may need to be adjusted based on CNUL's operation and performance.

[69] CNUL has not specified what engineered designs and operational controls will be used for the formation of the NPD Type deposit other than the ratios of each tailings stream. The AER considers the engineered design and operational controls critical to successfully manage the formation of each NPD Type deposit. CNUL is required to provide annually a description of the engineering design and operation controls employed to form each NPD Type deposit during the reporting period.

[70] The AER is also concerned with the ability of the current and new NPD Type deposits to achieve sustainable targeted ecosites and the *TMF* outcome of a diverse, locally common, and self-sustaining boreal forest ecosystem. CNUL is required, in the amendment application, to assess the performance and limitations for the NPD Type deposit and addresses the uncertainties and deficiencies associated with the NPD Type deposit that are identified in this report, including those related to environmental effects and settlement.

TSRU Tailings

Context

[71] In the froth treatment plant, solvent is added to froth to help separate bitumen from water and solids. The water and solids (i.e., tailings) from the froth treatment plant are sent to the TSRU to recover the solvent. Once the tailings are processed by the TSRU, they are known as TSRU tailings. Although TSRU tailings are less than 10 per cent of overall tailings volumes at CNUL's project, these tailings can pose higher environmental risks because they contain residual solvent, other hydrocarbons (including asphaltenes), and sulphides.

[72] CNUL proposed to place TSRU tailings in all NPD Type deposits.

[73] Transfer of froth from the Jackpine Mine to the MRM was previously authorized. As part of the Jackpine Mine expansion application and decision (2013 ABAER 011), Shell indicated that a froth treatment plant would be built at the Jackpine Mine, and TSRU tailings would then be managed at the Jackpine Mine. However, CNUL's TMP indicates that Jackpine Mine froth will continue to be transferred to the MRM, and TSRU tailings will continue to be managed at the MRM until Jackpine Mine's end of life, which is inconsistent with what was proposed as part of the Jackpine Mine expansion application.

Decision Summary

[74] OSEC raised concerns with the treatment of TSRU tailings.

[75] The AER is not authorizing any changes to CNUL's current approvals for the construction of a froth treatment plant at Jackpine Mine or transfer of froth between the MRM and Jackpine Mine.

[76] The TMP does not contemplate constructing a froth treatment plant at Jackpine Mine or TSRU tailings management at Jackpine Mine. CNUL indicated that it is completing work to evaluate TSRU tailings transfer to Jackpine Mine after MRM's end of mine life. The AER notes that this evaluation should include an assessment of any environmental and reclamation impacts and the effectiveness of mitigation measures.

[77] Any decisions regarding the froth treatment plant at Jackpine Mine and the transfer of froth from Jackpine Mine to the MRM will inform the amendment application. In the amendment application, CNUL is required to include an assessment and proposal of alternatives for TSRU tailings management, which includes treatment and placement.

[78] CNUL provided limited information in the TMP on how TSRU tailings affect the NPD Type deposit performance. It is uncertain how risks to the surrounding environment or long-term reclamation outcomes from TSRU tailings placement in the NPD Type deposits will be managed by CNUL. CNUL indicated that it is evaluating specific environment risks associated with TSRU tailings. CNUL is required to research tailings and reclamation under its *EPEA* approval, and the AER expects that this research, along with CNUL's evaluation of specific environmental risks associated with TSRU tailings, will address site-specific uncertainties such as the environmental effects of paraffinic froth, presence of asphaltenes, and spatial extent of deposits containing TSRU tailings.

[79] CNUL stated that its evaluation of specific environmental risks associated with TSRU tailings would continue through 2018 and that it was not planning to commence its next NPD Type deposit (Cell 4) until 2021. Therefore, CNUL is required to provide an update on TSRU tailings management by September 30, 2020. The update must include

- the options CNUL is considering for the treatment and placement of TSRU tailings,
- how TSRU tailings impact the NPD Type deposit performance,
- the effects of TSRU tailings on the surrounding environment, and
- any changes CNUL is evaluating for the management of TSRU tailings in Cell 4.

[80] The timing of this update will ensure the AER has sufficient time to evaluate the results before CNUL's proposed use of Cell 4.

Water-Capping Technology

Context

[81] Water-capping technology involves the placement of water above untreated or treated tailings for the purpose of creating a water-capped deposit as a closure landscape feature (“water-capped pit lake”). CNUL proposed to cover two tailings deposits (Cell 1 and Sharkbite [SB] Cell 6) with water to create a water-capped pit lake and indicated that a portion of the deposits would be covered with coarse sand tailings before being capped with water.

[82] CNUL indicated it planned to apply the findings from Syncrude’s Base Mine Lake (BML) and Suncor’s Passive Aquatic Storage System (PASS) research.

Decision Summary

[83] OSEC expressed concern over the use of water-capped pit lake and water-capping technology. As part of its feedback on the draft conditions of approval, OSEC believed the AER was permitting water-capped pit lakes. OSEC maintained that CNUL had not provided sufficient rationale or analysis and that water-capping technology had a high degree of uncertainty and risk.

[84] Water-capping technology is subject to further assessment, research, and future policy. Therefore, CNUL is prohibited from placing any water, including industrial wastewater, above treated or untreated tailings for the purpose of creating a water-capped pit lake. This provision applies regardless of whether the water is in direct contact with treated or untreated tailings, or not. Further, CNUL is required to provide, in the amendment application or future deposit plan, as the case may be, a feasible alternative tailings treatment technology and implementation plan if the amendment application were to include water capping. This alternative to water-capped pit lakes must meet the *TMF*’s outcomes and *Directive 085* requirements, including RTR criteria and identification of risks and uncertainties and associated mitigation measures.

[85] Given the timelines for BML and PASS research, the assessment of water-capping technology is expected to be ongoing for some time.

[86] The AER recognizes that extensive research on water-capped tailings continues and the Government of Alberta will be developing policy for water-capping technology and water-capped pit lakes. If the feasibility of water-capped pit lakes is demonstrated and the Government of Alberta implements policies permitting their use, operators may apply to the AER to amend their approvals. In CNUL’s case, clause 54 of the approval expressly contemplates future amendment of the approval to permit placement of water above treated or untreated tailings to create water-capped pit lakes.

[87] CNUL may continue to plan on the basis that water-capped pit lakes are an option unless water-capped tailings technology proves to not be feasible and/or Government of Alberta policy does not allow

it. In the meantime, as per clauses 25(f) and 36(c) of the approval, CNUL is required to plan for an alternative to water-capped pit lakes.

[88] Although CNUL intends to apply the findings from BML and PASS research, CNUL has not provided sufficient information for the AER to determine if BML or PASS research will address CNUL's site-specific uncertainties, such as the NPD Type deposit design and the presence of paraffinic froth TSRU tailings. The AER is concerned that it will not have timely or adequate information available to inform future decisions on water-capping technology. Therefore, CNUL is required, as part of its end-pit lake research and development report required under its *EPEA* approval, explain

- the applicability of BML and PASS research to CNUL's circumstances,
- how CNUL will address uncertainties and risks where BML and PASS research is not applicable, and
- the tailings research related to human health risk and long-term chemistry and mineralogy for pit lakes (appendix 4).

Capping Material Availability

Context

[89] Adequate capping material, such as tailings sand, is necessary for landform contouring and stability, providing increased tailings deposit strength and trafficability, managing settlement, controlling the location of the groundwater table, controlling surface water drainage, and preventing tailings pore water from contaminating reclaimed areas. Without adequate capping material, CNUL may not meet the *TMF*'s outcomes. However, there are competing demands for capping materials and it is unclear if there are sufficient materials available to meet CNUL's needs.

[90] CNUL requires tailings sand for the following activities:

- formation of NPD Type deposits
- cell construction for the purposes of building dams and tailings containment structures
- infilling of the ETF
- tailings deposit capping

Decision Summary

[91] CNUL is required to report on capping and tailings deposit stability as part of its tailings research report required under its *EPEA* approval as set out in appendix 4.

Decision Summary

[92] CNUL's ability to meet *TMF* outcomes and future reclamation outcomes will be compromised if there are insufficient capping materials.

[93] CNUL needs to ensure there is adequate tailings sand, or other types of capping material, available to support its activities; otherwise, long-term reclamation and the *TMF*'s outcomes may not be achieved, and the timeliness of achieving the outcomes may be affected. Material balances for sand and other suitable capping materials are forecasts against which performance will be assessed. As set out in appendix 5, pursuant to its *EPEA* approval, CNUL is required to provide the following information as part of its life of mine closure plan and mine reclamation plan:

- capping material types, objectives, and implications to developing long-term reclamation outcomes;
- material balances for sand and any other suitable capping materials to meet final landscape outcomes; and,
- contingency plans for capping material shortages.

[94] Given CNUL's limited capping experience, CNUL's capping material needs remain uncertain. Research will provide timely, and site-specific, information with respect to capping material needs and availability. If there is a capping material shortage, CNUL may need to adjust its tailings treatment technology selection to ensure its long-term reclamation outcomes can be achieved.

[95] The AER acknowledges that CNUL has provided some capping research information as part of its *EPEA* approval. However, there are gaps in that information. CNUL did not specify what uncertainties associated with the TMP the research is planning to address, for example how capping material shortages may affect tailings treatment technology selection, future reclamation activity, or the achievement of the *TMF*'s outcomes. CNUL is required to submit a capping research plan by September 30, 2018, for its deep-fines-dominated, fines-enriched sand, sandy fines, and thin-layered fines dominated deposits.

[96] CNUL must provide details that support its research, including the objective and the applicability of that objective in addressing the uncertainties and risks associated with CNUL's TMP. The AER expects CNUL to use standard scientific methodology in the design of its research plan and that CNUL will draw upon existing industry research on capping.

[97] The AER expects that research plans will focus on addressing site-specific uncertainties to ensure that the *TMF*'s objective and outcomes are met, and reclamation timelines are not extended. CNUL should consider the benefits of peer-reviewed research.

[98] All research plans should include the following:

- a rationale for proposed monitoring that supports research;

- a discussion of how the selection of performance measures, criteria, and validation methods relate to implementation;
- the applicability and scalability of the research to full implementation;
- a discussion on impact to long-term reclamation outcomes and timing for the site; and
- a description of the changes that would be necessary to the mine design and materials requirements to enable long-term reclamation outcomes.

[99] In the amendment application CNUL must also address the *Directive 085* requirements, which includes describing uncertainties (e.g., capping material availability, capping feasibility) and mitigation measures during reclamation and closure stages, and explain how the results of capping research have been incorporated. The AER expects that CNUL will explain whether the results of capping research impacts its tailings treatment technology selection (i.e., inform the need for any alternative or supplemental tailings treatment technology), targeted ecosites, future reclamation activity, or the ability to achieve the *TMF*'s outcomes.

[100] CNUL is also required to explain how the results of capping research have been incorporated into the future deposit plans.

[101] CNUL is required to report on capping and tailings deposit stability as part of its tailings research report required under its *EPEA* approval, see appendix 4.

Storage

Context

[102] Site-wide storage space is needed to contain and manage fluid tailings, treated tailings, and water, including industrial wastewater. Where on-site storage capacity is exceeded, there is the potential to compromise tailings management, increase land disturbance, require the construction of additional storage facilities, sterilize resources, delay progressive reclamation activities, and impact dam safety.

[103] CNUL indicated that it would maintain a minimum of six months of tailings contingency storage space at all times for the life of the mine.

Decision Summary and AER Findings

[104] The MRM's storage capacity needs are uncertain due to

- CNUL's bitumen expansion plans,
- resource optimization program outcomes,

- froth transfer from Jackpine Mine to the MRM, and
- storage competition between mine waste and tailings.

[105] CNUL is required to report annually on the available storage capacity of each tailings deposit or pond that contains water or tailings, and the storage volume requirements for water or tailings for the next five years.

Pilots, Prototypes, and Demonstrations

Context

[106] Innovation is a principle of the *TMF* and *Directive 085*. CNUL proposed an ongoing tailings technology selection program.

Decision Summary

[107] To facilitate innovation at the MRM and to address administrative inconsistencies between *OSCA* and *EPEA*, the AER has updated the requirements in CNUL's *OSCA* approval to be consistent with the principles of the *TMF* and *Directive 085* and the requirements under *EPEA*.

[108] CNUL is required to notify the AER six months in advance of any proposed on-site pilots, on-site prototypes, or on-site demonstrations. CNUL may not construct or implement any proposed on-site pilots, on-site prototypes, or on-site demonstrations unless a written authorization or approval amendment is granted.

[109] The AER continues to acknowledge and support the importance of technological innovation, understanding, and certainty around fluid tailings treatment options.

Ready-to-Reclaim (RTR) Criteria

[110] As stated in the *TMF* and *Directive 085*, fluid tailings are considered RTR when they have been processed with an accepted technology, placed in their final landscape position, and meet RTR criteria.

[111] RTR criteria support the objective of reclaiming oil sands mining projects to self-sustaining locally common boreal forest ecosystems that are integrated with the surrounding area and consistent with the values and objectives identified in local, subregional, and regional plans.

[112] RTR criteria are used to track the performance of a tailings deposit towards its ability to be reclaimed as predicted and in the time predicted. Consequently, RTR criteria are critical in evaluating trends and managing performance.

[113] There are two subobjectives that address different aspects of performance:

- Subobjective 1: The deposit's physical properties are on a trajectory to support future stages of activity.
- Subobjective 2: To minimize the effect the deposit has on the surrounding environment and ensure that it will not compromise the ability to reclaim to a locally common, diverse, and self-sustaining ecosystem.

[114] The *TMF* and *Directive 085* allow operators to develop RTR criteria that are suitable to their type of tailings, technology, deposit, and future reclamation activities. *Directive 085* provides guidance on RTR criteria and requires operators to include information that supports their choice of RTR criteria.

[115] RTR is a new concept and CNUL's RTR criteria may not adequately track the performance of a treated tailings deposit. Improvements to or additional RTR criteria will likely be required. The AER expects that research and monitoring results will inform and lead to modified or new RTR criteria. CNUL's approval is conditioned to allow for improvements or additions to RTR criteria.

[116] In accordance with *Directive 085*, where treated tailings meet their RTR criteria, they can be removed from the fluid tailings inventory because they are on a trajectory to meet long-term reclamation outcomes. In circumstances where RTR criteria are no longer met or there is a deviation from the expected trajectory, CNUL must identify the volume not meeting the RTR criteria and the degree of nonperformance.

[117] OSEC raised concerns with the degree of uncertainty in the RTR criteria as proposed by CNUL. The AER has similar concerns which are further discussed in the following sections.

Measurement and Averaging

Context

[118] Each treated tailings deposit must be measured to determine if the RTR criteria has been achieved. *Directive 085* requires operators to submit a measurement system plan six months from the date of an approved TMP.

Decision Summary

[119] CNUL is required to develop a measurement system plan (see appendix 6 for requirements). The measurement system plan must include

- definitions of parameters for fluid tailings and RTR criteria measurements;
- reference to standards and procedures used to measure fluid tailings and treated tailings and RTR criteria;

- an explanation of and justification for measurement procedures that are unique to CNUL and its plan;
- evidence that the plan will address the measurement outcomes as per section 5 of *Directive 085*;
- an explanation of how each of the deposit's RTR criteria will be measured using deposit sampling, calculated, and reported;
- a description of the tailings deposit sampling, measurement, and survey program; and
- justification of how measurement, sampling, and spacing intervals will
 - show the variation of the tailings deposit properties,
 - verify that the tailings deposit is achieving RTR criteria, and
 - identify if any material in the tailings deposit is not achieving RTR criteria.

[120] RTR criteria alone do not explain how CNUL will determine the volumes of treated tailings that do not meet RTR criteria. CNUL did not propose how it would determine the volume of fluid tailings to be returned to the fluid tailings inventory where subobjective 1 or subobjective 2 RTR criteria were not met. CNUL's measurement system plan must describe how CNUL will measure the volume of treated tailings that do not meet RTR criteria.

[121] CNUL proposed to use the average solids content by weight of the entire deposit as an RTR criteria. The AER does not accept CNUL's proposal, as averaging does not provide sufficient information to identify variations in tailings characteristics across a deposit, in particular when considering the NPD Type deposit and its potential for variability. The use of an average limits the ability to assess risks and liabilities for underperforming treated tailings and the effect on a deposit's performance towards the targeted ecosites. A deposit may show excellent performance on average while a significant portion of the tailings deposit is actually underperforming, compromising the ability to reclaim. The averaging process obscures a meaningful understanding of the deposit volumes that have been treated unsuccessfully or are failing to improve as expected.

[122] Therefore, CNUL is required to measure the volume of treated tailings that meets the RTR criteria based on deposit sampling, and the volume cannot be determined using an annual average solids content by weight for the entire deposit. The deposit sampling is expected to be sufficient to identify variability within the entire deposit. CNUL cannot use an annual average for the entire deposit to determine the volume of treated tailings meeting RTR criteria.

[123] The AER recognizes that characterization of a tailings deposit is challenging and that CNUL may use some form of 3D modelling or spatial statistics to determine the volume not meeting the performance criteria and the degree of inadequate performance. The AER expects that the frequency and spatial extent of monitoring, and the statistical methods applied, will minimize the margin of error.

Subobjective 1: Solids Content

Context

[124] Subobjective 1 RTR criteria are related to the performance of the deposit's physical properties.

[125] CNUL proposed to use the solids content by weight of a deposit as a subobjective 1 RTR criteria measure. Solids content represents the percentage of solid material by weight present in a sample.

[126] This section only discusses CNUL's proposed use of solids content by weight. The AER findings on the associated criteria (e.g., 70 per cent solids content by weight) are discussed in "Subobjective 1: North Pool Deposit (NPD) Type Deposit Trajectory."

Decision Summary

[127] CNUL indicated that solids content by weight was chosen as a subobjective 1 RTR criteria measure

- based on historical data,
- as solids content can be used to evaluate the progress of consolidation, the degree of saturation, and the readiness for capping of a deposit, and
- given that increasing solids content can be correlated to strength gain in the deposit.

[128] However, solids content alone may not be sufficient to measure a deposit's performance or its ability to meet future stages of reclamation activity. Solids content can remain constant while other deposit measures, such as sands-to-fine ratio, effective stress, deposit consolidation, pore water pressure, and clay types and percentage can vary. The variation of these measures may be equally critical in determining the performance of the deposit, understanding RTR criteria, and determining the deposit's ability to enable future reclamation activity and achieve the *TMF*'s outcomes.

[129] CNUL is required, for each treated tailings deposit, to monitor and report, on an annual basis, sands-to-fine ratio, effective stress, deposit consolidation, pore water pressure, clay types and percentage (including representative cross-sections), and any other parameters considered relevant by the AER or CNUL. The results of this monitoring could result in improvements or additions to subobjective 1 RTR criteria measures.

[130] Given the additional monitoring and reporting required, the use of the solids content by weight of a deposit is an acceptable subobjective 1 RTR criteria measure for NPD Type deposits in the ETF, Cell 1, and Cell 3 until a decision is made on the amendment application.

[131] Therefore, the AER only authorizes the use of solids content by weight as a subobjective 1 RTR criteria measure for deposits that exist between now and a decision on the amendment application (e.g.,

ETF, Cell 1, and Cell 3). The amendment application will include updated RTR criteria for all tailings deposits.

Subobjective 1: North Pool Deposit (NPD) Type Deposit Trajectory

Context

[132] *Directive 085* indicates that a trajectory or progression of RTR criteria over time may be necessary in order to successfully enable future reclamation activity.

Decision Summary and AER Findings

[133] The AER does not accept CNUL's proposed RTR criteria of 60 per cent solids content by weight achieved in one year, with a proposed target end of 70 per cent or a capping milestone achieved within at least fifteen years.

[134] CNUL's proposed RTR criteria may not adequately track the performance of the NPD Type deposit and does not provide the AER with assurance that the deposit's physical properties are on a trajectory to support future stages of activity. All of which introduce an unacceptable risk to achieving the long-term *TMF* outcomes for the NPD Type deposits. CNUL's application did not include an assessment of the long-term deposit properties required to ensure that the NPD Type deposit can achieve stable targeted ecosites and the *TMF*'s outcomes.

[135] In the plan required by December 31, 2018, CNUL is required to describe how it will update and validate the RTR criteria and trajectory for the NPD Type deposits. In addition, updated RTR trajectory and criteria must be included in the amendment application. The AER expects that research and monitoring results will lead to improvements or additions to RTR criteria.

[136] CNUL stated that historical NPD Type deposits have achieved 70 per cent solids by weight within three to five years of placement. This is a substantially shorter time period than the fifteen years proposed by CNUL. Further, the shorter time period provides greater support for the *TMF*'s progressive reclamation outcome.

[137] For the short term, and until updated RTR criteria is authorized in the amendment application, CNUL is required to meet the following subobjective 1 RTR criteria for NPD Type deposits: 70 per cent solids by weight within five years of tailings placement. This RTR criteria is based on the historical performance data provided by CNUL, CNUL's proposed end target, and the timing of the amendment application, and provides the AER with a degree of assurance that CNUL is targeting a higher solids content by weight at least over the short term.

Subobjective 2

Context

[138] Subobjective 2 RTR criteria focus on circumstances where the operator may propose management strategies, design features, or mitigation measures for risks associated with the specific nature of the deposit or its surrounding environment that could impact reclamation—for example, design features that control specific water movement such as drainage control systems, or management of risks associated with deposit characteristics such as treated froth fluid fine tailings, acidification, specific additives, or gas formation.

Decision Summary

[139] The AER approves CNUL's proposal to use its existing groundwater monitoring program as a subobjective 2 RTR criteria for the NPD Type deposits in the ETF, Cell 1, and Cell 3. CNUL's groundwater monitoring program can provide early indicators of contaminant mobility from tailings deposits, and it addresses the risk of seepage to groundwater and surface water. The information gathered can be used to ensure that the effects on the surrounding environment of each deposit will not compromise the ability to reclaim to a locally common, diverse, and self-sustaining ecosystem. CNUL is required to ensure that there is alignment between the groundwater monitoring program and the RTR measurement system plan (appendix 6).

[140] As the AER is only authorizing the subobjective 1 RTR criteria for the NPD Type deposits in the ETF, Cell 1, and Cell 3, subobjective 2 RTR criteria is only authorized for these same deposits.

[141] While the surface water monitoring will inform the nature and magnitude of future risks to the surrounding environment and to future reclamation outcomes, the surface water monitoring program does not include deposit design features or criteria to evaluate contaminant mobility prevention or control from tailings deposits. Therefore, CNUL's proposed *EPEA* surface water monitoring program is not approved as a subobjective 2 criteria.

[142] The AER is concerned that CNUL's NPD Type deposits present unique risks due to the presence of TSRU tailings and the high residual water content in the deposits from thickened tailings and TSRU tailings. It is uncertain whether the groundwater monitoring program alone is sufficient to address the effects of TSRU tailings and high residual water content on the surrounding environment and on the ability of the NPD Type deposit to achieve long-term reclamation outcomes. CNUL indicated that it is evaluating specific environment risks associated with TSRU tailings.

[143] CNUL is required to provide an update on TSRU tailings management by September 30, 2020, including an evaluation of how TSRU tailings impact NPD Type deposit performance, the effects on the surrounding environment, and the ability to achieve long-term reclamation outcomes. The AER will use

this information to assess the risk posed by TSRU tailings and any proposed mitigation measures before CNUL's placement of tailings into Cell 4 in 2021.

[144] To ensure that CNUL addresses the AER's concerns, CNUL is required to provide a description of how CNUL will update and validate the RTR criteria and trajectory, which includes subobjective 2 RTR criteria, in the plan required by December 31, 2018.

[145] CNUL is also required to provide in the amendment application updated RTR criteria, including subobjective 2 RTR criteria, for each type of deposit. The AER expects that the TSRU tailings evaluation will inform appropriate treatment, placement, and management to mitigate unique risks and lead to modified or new subobjective 2 RTR criteria.

[146] CNUL will continue to research risks associated with tailings and the achievement of ecosystems as part of its *EPEA* approval. Research and other monitoring results may also modify or identify improvements or additions to subobjective 2 RTR criteria.

Thickened Tailings, Composite Tailings, Centrifuge and Thin Lift Deposits

Context

[147] CNUL proposed the following RTR criteria:

- for thickened tailings deposits: 60 per cent solids content by weight in three years
- for CT deposits: 65 per cent solids content by weight in one year
- for centrifuge product and AFD deep deposits (centrifuge deep deposits): 40 per cent solids content by weight in one year
- for combination of fluid fine tailings drying, AFD, and centrifuge product in thin lift deposits (centrifuge thin lift deposits): 40 per cent solids content by weight in three to six months or placement of material in dumps.

[148] The *TMF* and *Directive 085* are applicable to all fluid tailings, including CT.

Decision Summary

[149] CNUL does not have any thickened tailings deposits. Thickened tailings are deposited with other tailings streams to form NPD Type deposits. As such, the AER does not authorize any RTR criteria for thickened tailings deposits.

[150] The AER does not authorize CNUL's proposed Cell 2 (CT) RTR criteria. The AER finds that CNUL's proposed RTR criteria of 65 per cent solids in one year does not assure the AER that the deposit's physical properties are on a trajectory to support future stages of activity. CNUL is required to provide subobjective 1 and subobjective 2 RTR criteria for Cell 2 by September 30, 2019.

[151] CNUL is prohibited from removing any volume of CT in Cell 2 from the fluid tailings inventory unless the AER has revised appendix C of the approval.

[152] Further, CNUL stated that its CT deposit would reach either 70 per cent solids or a capping milestone in at least ten years. However, CNUL provided a capping start date in 2044, which is twenty-six years after final CT placement, not 10 years.

[153] The AER is concerned that CNUL's focus on achieving 65 per cent solids in one year, with an unknown trajectory that progresses to 70 per cent solids over a ten- to twenty-six-year period, introduces a risk to achieving the long-term *TMF* outcomes for Cell 2.

[154] To address the discrepancy in CNUL's stated Cell 2's capping date, CNUL is required to submit an updated plan for Cell 2 by September 30, 2019, that ensures capping activity timelines are accelerated. The AER expects that the RTR criteria provided for Cell 2 will consider any mitigation measures to accelerate capping.

[155] CNUL's application stated that future growth in new fluid tailings production would be treated either by centrifuge or by an equivalent tailings treatment technology. Since it is unknown if CNUL will ultimately use centrifuge technology, the AER does not authorize CNUL's proposed RTR criteria for centrifuge deep deposits or thin lift deposits.

[156] Furthermore, the AER does not authorize CNUL's proposed RTR criteria for centrifuge deep deposits or thin lift deposits as the AER has concerns with the proposed RTR criteria and end targets. The criteria and end targets do not provide the AER with assurance that the deposit's physical properties are on a trajectory to support future stages of activity. The AER expects CNUL to improve and develop RTR criteria based on what it learns as it continues its ongoing technology selection project.

[157] To ensure that CNUL addresses the AER's concerns, CNUL is required to provide a plan by December 31, 2018, describing how CNUL will update and validate the RTR criteria for any chosen technology.

Water-Capped Deposits

Context

[158] RTR criteria for water-capped deposits are subject to further assessment, research, and future policy.

[159] CNUL proposed the following RTR criteria for water-capped deposits: "the depth of clear water zone is as per design."

Decision Summary

[160] The AER does not authorize water-capped deposits or any RTR criteria for water-capped deposits.

[161] CNUL did not provide evidence to support its proposed RTR criteria.

[162] As part of its feedback on the draft conditions, OSEC stated that RTR criteria for water-capped deposits (Cell 1 and SB Cell 6) should be defined by the AER.

[163] To support the assessment of water-capped fluid tailings technology, the Government of Alberta will likely be developing policy and performance criteria. The AER will adjust its approach to water-capped fluid tailings in this event.

[164] As discussed in the section “Water-Capping Technology,” if the feasibility of water-capped pit lakes is demonstrated and the Government of Alberta adopts applicable policy, CNUL may apply to amend the approval.

Deposit Settlement

Context

[165] As tailings settle, tailings pore water seeps upward. This upward flux can cause a rise in the water table, contamination of the soil cover, discharge to surface water drainage systems, a change in the size and distribution of wetlands, or the formation of unplanned wetlands or lakes, all of which can threaten long-term reclamation outcomes and the *TMF*’s outcomes.

Decision Summary

[166] OSEC raised concerns that deposit performance would dictate the final landform, as opposed to the final landform dictating deposit performance requirements. The AER shares this concern.

[167] The AER expects that CNUL’s capping research plan will address deposit settlement, including wetland implications. For example, CNUL indicated that the distribution of end land use may have more localized wetlands, and that some wetlands may become deeper following total settlement. This increases the risk of not achieving locally common boreal forest wetlands, which would result in failing to achieve long-term reclamation outcomes and the *TMF*’s outcomes.

[168] It is important to understand how planned wetlands will become larger or deeper, if settlement will cause lakes to form, or how opportunistic wetlands will develop from the collection of water in low-lying areas or depressions that arise from differential settlement. This understanding is necessary to ensure that the RTR criteria align with the targeted final landforms and the targeted range of ecosites, that the *TMF*’s outcomes are achievable, and that there will be no significant adverse effects such as erosion or water releases.

[169] To better understand the risks to *TMF* outcomes, CNUL is required to provide a consolidation model or engineering analysis, along with any supporting information, including milestones, that the AER requires, for Cell 2, Cell 1, and Cell 3. These models or analyses provide a basis to predict future settlement, flux, piezometric pressures, groundwater table levels, pore water discharge to surface drainage systems, and capping material requirements.

[170] The consolidation model or engineering analysis for Cell 2 is required by February 28, 2019,

- to manage the uncertainties associated with Cell 2's capping activity milestones and Cell 2's ability to support future stages of activity and
- to align the submission with CNUL's next geotechnical report.

[171] CNUL is required to explain how model or analysis results have been incorporated into the Cell 2 capping plan, which is required by September 30, 2019, and into the amendment application; CNUL is also required to include in future deposit plans a consolidation model or engineering analysis, along with any supporting information, including milestones, that the AER requires, for the tailings deposit. This information may address the AER's concerns that settlement poses a risk to a deposit's ability to enable future reclamation activity.

[172] To understand how capping is influencing consolidation in Cell 1 and to allow time for assessment of the results before capping in Cell 3, which is planned to start before December 31, 2022, the consolidation models or engineering analyses for Cell 1 and Cell 3 are required by September 30, 2020.

[173] The results of the models or analyses are expected to be used to improve or develop RTR criteria.

Deposit Milestones

Context

[174] *Directive 085* states that approval conditions will address fluid tailings deposit milestones. *Directive 085* requires applicants to identify critical milestones for each deposit including deposit preparation, start of fluid tailings placement, capping, and start of further reclamation activities.

Decision Summary

[175] CNUL is required to meet the following capping milestones:

- Capping of the ETF must commence prior to December 31, 2021.
- Capping of Cell 3 must commence within one year of completing tailings placement (capping of Cell 3 proposed to commence in 2022).

[176] The AER set milestones until the anticipated timing of the decision on the amendment application.

[177] CNUL's TMP indicates that capping of the ETF will begin in 2019 and of Cell 3 one year after tailings placement is completed. CNUL provided the AER with additional information under the *Water Act* to extend the capping date for the ETF from 2019 to 2021.

Stakeholder and Indigenous Community Engagement

[178] The *TMF* and *Directive 085* describe the importance of transparency, engagement, and enhancing stakeholder and indigenous community understanding of fluid tailings management.

Decision Summary

[179] As part of its SOC, OSEC commended the original applicant, Shell, for its proactive, inclusive, and constructive engagement of genuine-interest stakeholders. OSEC also expressed support for further bilateral and multilateral cooperation among stakeholders.

[180] To ensure continued transparency, information sharing, and involvement in tailings management, CNUL is required to engage stakeholders and indigenous communities on tailings management activities undertaken pursuant to the approval. The AER expects that

- the required engagement efforts will include OSEC;
- over the life cycle of CNUL's mine operations, the stakeholders and indigenous communities who are engaged may change to reflect the issues and concerns of the day, and, as such, the AER expects CNUL to conduct its engagement activities accordingly; and
- CNUL's engagement will incorporate its research and lessons learned from ongoing operations and will be timely and meaningful.

[181] CNUL is also required to hold an annual forum with stakeholders and indigenous communities regarding tailings management activities undertaken pursuant to the approval. The AER is not specifying the format of the forum (e.g., workshop, meeting) as the AER believes that it is appropriate to leave the design and scope of the event to CNUL. However, the AER expects that the annual forum will be tailored to what has occurred in the past year and what is upcoming regarding tailings management activities. It can be used to provide information, gather input, and describe plans on how engagement will occur for the upcoming year. In addition, it is expected that the annual forum in 2020 may be more robust as CNUL will submit the amendment application and begin placement of tailings in Cell 4 in 2021.

[182] CNUL is required to report to the AER annually on its engagement efforts.

Environmental Effects and Implications

[183] The *TMF*'s objective is to minimize fluid tailings accumulation, which may reduce environment effects such as seepage, occurrences of wildlife contact with tailings ponds, and the tailings footprint.

Context

[184] Efforts to minimize fluid tailings volumes may result in potential changes or trade-offs to other environmental risks and effects to air, land, and water. These changes or trade-offs must be identified and their short-term and long-term implications to environmental performance assessed. The identity, nature, location, and magnitude of environmental effects and implications need to be understood.

[185] For approved projects, the proposed TMP should be consistent with the previously predicted environmental outcomes or identify any inconsistencies. The existing and proposed monitoring plans will confirm that environmental performance is achieved.

[186] TMPs, including mitigation measures and contingency plans, will minimize the risk of environmental effects over the life of a project.

[187] Based on CNUL's TMP, there are no *EPEA* terms and conditions, including approval limits, being amended. However, there are environmental effects and implications that the AER addresses below.

Air

[188] No *EPEA* approval air emission limits are being amended as a result of the TMP.

[189] The AER recognizes that there is ongoing work with respect to *Recurrent Human Health Complaints Technical Information Synthesis: Fort McKay Area* (September 2016), which may result in modified or new conditions related to odours and emissions.

Surface Water and Groundwater

[190] There are no changes arising from the TMP that require changes to previously-assessed impacts to surface water and groundwater quality during the mine's operating phase.

[191] The AER finds that CNUL's existing surface water and groundwater control measures manage the environmental risks and effects during the mine's operating phase. CNUL must operate these measures in accordance with the terms and conditions in its *EPEA* approval. The AER expects that the duration of surface water and groundwater control measures will continue to be addressed in CNUL's *EPEA* life of mine closure plan.

[192] During operation, oil sands process water, tailings, and mine-affected water are intercepted and kept in a closed-circuit water system. Surface water drainage within the tailings deposit is designed to

keep precipitation that falls onto process-affected areas within the tailings area and within the closed-circuit water system.

[193] A network of groundwater wells are in place to manage oil sands process water that could seep into the groundwater from tailings deposits. Depending on the circumstances, the AER may require that additional wells be drilled to monitor groundwater flow and water chemistry as mine operations continue.

[194] CNUL is required to continue to research pit lakes and to evaluate the risks to and uncertainties around water quality as part of its *EPEA* approval, including research concerning long-term chemistry and mineralogy of tailings and tailings water and their implications to the environment, human health, and reclamation (appendix 4) and must provide evidence supporting pit lake sustainability (appendix 5). The AER expects that this will address uncertainties and risks concerning water quality, the viability and sustainability of water-capped pit lakes, the effect of source water quality on the viability of water-capped pit lakes, and the ability of wetlands and water-capped pit lakes to become self-sustaining boreal forest ecosystems.

Tailings Water Release

[195] Water release is not authorized except in accordance with CNUL's *EPEA* approval.

[196] OSEC raised concerns with water release and an absence of a provincial water release policy.

[197] CNUL did not request approval to release water as part of application 1870302.

[198] CNUL is required to continue to research and to evaluate the risks to and uncertainties around water quality, implications for reclamation, and tailings water release as part of its *EPEA* approval.

Additives and Polymers

[199] CNUL disclosed the polymers it used with AFD technology but did not disclose the additives or polymers intended for use in CT or the thickeners. CNUL is required to provide additional information related to the additives and polymers used in CT and the thickeners as set out in appendix 7.

[200] Research requirements under CNUL's *EPEA* approval are expected to provide the necessary information concerning the long-term environmental uncertainties with and risks to the targeted ecosites associated with the polymers and additives. CNUL can and should also draw upon existing industry research.

[201] CNUL may propose to change additives or polymers in the future, or the manufacturer's formulas may change under the same product name. In accordance with *EPEA*, CNUL is required to notify the AER of any proposed change to an additive or polymer or any manufacturer modifications to an approved additive or polymer formula. Depending on the significance of the proposed changes, additional authorizations or amendments may be required.

Other Technical Issues

TMP and OSCA Mine Plan Alignment

[202] *Directive 085* requires that TMPs include sufficient information to demonstrate alignment with existing approvals and plans, including mine plans. Where alignment does not occur, the applicant must identify the inconsistencies and describe how alignment will be achieved.

[203] CNUL stated that its TMP was based on the 2015 mine and tailings plan, integrated with a two-year resource optimization program assumption. The AER authorized the continuation of the resource optimization program in December 2016.

[204] Although CNUL submitted mass balance tables and status maps as part of the TMP application, CNUL has not provided a mine plan for the MRM for the period until end of mine life because of the authorized continuation of the resource optimization program (December 2016). Therefore, the alignment of the TMP to the mine plan cannot be validated. CNUL is required to provide a mine plan for the period until end of mine life by September 30, 2018, to ensure it is consistent with the TMP.

TMP and EPEA Plan Alignment

[205] *Directive 085* requires that TMPs include sufficient information to demonstrate alignment with existing approvals and plans, including the *EPEA* life of mine closure plan. Where alignment does not occur, the applicant must identify the inconsistencies and describe how alignment will be achieved.

[206] The AER notes three areas that warrant review to ensure alignment with the TMP. First, OSEC raised concerns with the clarity of the pit lake location. The AER shares this concern; the locations of the proposed pit lakes in the ETF and SB Cell 6 appear different than those proposed in the MRM closure plan submitted December 2016, and there appears to be a potential pit lake in SB Cell 3 which was not contemplated in the 2016 closure plan. CNUL did not identify these inconsistencies, describe how alignment between the TMP and 2016 closure plan would be achieved, or provide sufficient information to evaluate the rationale for and implications of these apparent changes.

[207] Second, CNUL identified considerable changes to reclamation targets for wetter ecosite types for treated tailings deposits. CNUL did not provide adequate information to assess the nature and magnitude of these changes.

[208] Third, in the amendment application, CNUL is required to describe how alignment between the TMP and the life of mine closure plan will be achieved and describe how environmental effects and risks to achieve the *TMF*'s outcomes will be managed or mitigated. Depending on the content of the amendment application, CNUL may require an application under *EPEA* or additional authorizations or amendments to its approvals. Further, CNUL is required to demonstrate alignment as part of its *EPEA* life of mine closure plan and mine reclamation plan (appendix 5).

[209] The AER is not authorizing changes to CNUL's *EPEA* 2016 life of mine closure plan or the *EPEA* approval as part of this decision.

Future Deposits

[210] CNUL's TMP provides limited information on future tailings deposits. As placement in the various new deposits will occur over the span of many decades and the AER expects tailings management to evolve over that time, an updated plan is required one year before placement in a new deposit, to ensure the AER is provided the most current information.

[211] The AER requires CNUL to submit a plan that updates fluid tailings management one year before placing fluid tailings or treated fluid tailings in Cells 4 to 9, SB Cells 1 to 6, and Lease 90-Cell. The plans must address the requirements of *Directive 085* (including RTR criteria), confirm the ability to achieve the fluid tailings profiles, evaluate performance of similar deposits, incorporate research results reported through CNUL's *EPEA* approval, incorporate the long-term reclamation outcomes in the *EPEA* life of mine closure plan, and mitigate uncertainties. These plans cannot be implemented by CNUL until written authorization or an approval amendment is granted by the AER.

Dam Decommissioning

[212] The AER is concerned that CNUL may not be able to decommission dams when tailings ponds and deposits still contain treated fluid tailings, even if those tailings deposits have achieved RTR status.

[213] In accordance with the *Water Act*, CNUL is required to submit a plan for decommissioning dams at least twelve months before commencing capping of any tailings pond or deposit (appendix 8).

[214] Future work with respect to dam decommissioning may result in modified or new decommissioning requirements.

Conclusion

[215] The AER has determined there is sufficient information to authorize CNUL to manage its fluid tailings and treated tailings deposits for the next few years based on the terms and conditions of the approval. However, there are significant uncertainties and deficiencies in the application relating to the medium and long-term management of fluid tailings and treated tailings deposits. As a consequence, the AER is requiring CNUL to submit a TMP amendment application by September 30, 2021, that contains the TMP for the life of the project and addresses the uncertainties and deficiencies identified in this report.

[216] There are three reasons why the AER is requiring the amendment application in 2021. First, the new fluid tailings profile proposed by CNUL is not in alignment with the *TMF* and *Directive 085* over the medium and long term. Second, CNUL's proposed fluid tailings treatment technology is inadequate, and

the AER is currently unable to assess whether CNUL will be able, over the medium and long term, to meet the *TMF*'s objective and *Directive 085* requirements. Third, CNUL's proposed RTR criteria, RTR trajectory, and targeted ecosites are uncertain over the medium and long term.

[217] To assure the AER that the uncertainties and deficiencies identified in this report will be adequately addressed in the amendment application, CNUL must also submit several plans and updates, the first of which is a plan required by December 31, 2018. The plan requires CNUL to describe how it will ensure that the treatment capacity is equal to or greater than the production rate of new fluid tailings, describe how all legacy fluid tailings will be RTR by MRM's end of mine life (e.g., increase fluid tailings treatment capacity), describe the fluid tailings treatment technology options, and describe how RTR criteria will be updated and validated.

[218] The AER's decision to authorize the new fluid tailings profile until December 31, 2022, affects the approach taken in setting the total volume trigger and total volume limit. These thresholds may be revised depending on the AER's decision on the amendment application.

[219] If any threshold is exceeded, CNUL is required to comply with the management response or action directed by the AER. If CNUL exceeds a threshold after December 31, 2022, *Directive 085* clearly states that "the AER makes the final decision of the fluid tailings volume to be placed in the fluid tailings inventory, any threshold exceedance, and the assigned management level."

[220] In alignment with the enhanced transparency and increased role of stakeholders and indigenous communities introduced by the *TMF* and *Directive 085*, the AER expanded the involvement of stakeholders and indigenous communities. That transparency continues through the approval conditions.

[221] This approval takes a balanced approach to the continued involvement of stakeholders and indigenous communities. The approval requires CNUL to engage with stakeholders and indigenous communities about tailings management, including holding an annual forum and annually reporting on its engagement efforts to the AER. The approval also provides CNUL with the flexibility in who it engages with and how it undertakes its engagement activities.

Dated in Calgary, Alberta, on May 23, 2018.

Alberta Energy Regulator

<original signed by>

Paul Ferensowicz

Senior Advisor

Alberta Energy Regulator

Appendix 1 Approval

MADE at the City of Calgary, in the Province of Alberta, on <original dated>	<original signed> ALBERTA ENERGY REGULATOR
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IN THE MATTER of a commercial scheme of Canadian Natural Upgrading Limited (hereinafter called “the Operator”) for the recovery of oil sands products from the Wabiskaw-McMurray Deposit in the Athabasca Oil Sands Area, as outlined in Appendix A to this approval.

WHEREAS the Operator has applied to the Alberta Energy Regulator (hereinafter called the “AER”) to amend the approval for its commercial scheme under the *Oil Sands Conservation Act* in respect of the Operator’s Tailings Management Plan; and

WHEREAS the AER is confining substantive changes in this Scheme Approval No. 8512I (hereinafter called “the Scheme Approval”) to those arising from the Operator’s Tailings Management Plan application;

WHEREAS the AER deems it administratively desirable to consolidate the Scheme Approval and all previously issued amendments to the Scheme Approval granted under the *Oil Sands Conservation Act*.

Therefore, pursuant to Section 13 of the *Oil Sands Conservation Act*, being chapter O-7 of the Revised Statutes of Alberta 2000, the AER orders as follows:

1. (a) The commercial scheme applied for by the Operator for the recovery of oil sands and production of oil sands products, from the area shown on the attachment marked Appendix A to this Scheme Approval, as such commercial scheme is described in
 - (i) Applications No. 970588, 990514, 1398411, 1606863, 1625812, 1665596, 1760349, 1771891, 1762915, 1870302, and 1873918
 is approved, subject to the *Oil Sands Conservation Act*, the *Oil Sands Conservation Rules*, and the terms and the conditions herein contained.
 - (b) Subclause (a) does not preclude alterations in design or equipment, provided the AER is satisfied the alterations are compatible with the outline of the commercial scheme, meet the operating criteria in the Scheme Approval, are made for the better operation of the commercial scheme and do not result in unacceptable adverse impacts.
2. The Operator shall carry out its operations in a manner that, under normal operating

conditions on a calendar year basis, meet the following operating criteria:

- (a) reclamation material stockpiles shall be removed at the appropriate time to recover the ore underneath the stockpiles;
 - (b) on an annual average basis, the Operator must limit site-wide solvent losses to not more than 4 volumes per 1000 volumes of bitumen production under all operating conditions;
 - (c) no untreated froth treatment tailings shall be released to the tailings pond.
3. (a) The Operator shall provide to the AER on or before 28 February of each year a report of its development work related to the extraction and froth treatment processes until operating criteria are met.
- (b) Once operating criteria are met, every year on or before 28 February the Operator shall submit in the annual report a description of the performance of the Muskeg River Mine extraction and froth treatment processes for the previous year. The report shall demonstrate that the operating criteria set out in Clause 3 of this approval are still appropriate for the Muskeg River Mine.
4. The Operator shall provide to the AER on or before 28 February of each year a summary for the previous year indicating the amount of asphaltene rejected on an annual basis. If the Operator anticipates that the asphaltene rejection will be greater than 9 per cent of the bitumen contained in the oil sands feed to the plant on an annual average basis, in the next year, it shall provide justification for the increase in asphaltene rejection and describe the impact on operations.
5. The Operator shall submit to the AER for approval a further evaluation of the south discard site area six months prior to clearing. The report shall compare resource quality, recoverability, and ultimate capacity of each of the south and north discard sites.
6. The Operator shall submit to the AER for approval:
- (a) a detailed assessment of resource potential and the geotechnical design for all out-of-pit discard sites one year prior to field preparation; except the south discard site referred to in Clause 5;
 - (b) in each instance where the mineable resource extends across the lease boundary, a description of how the resource at the lease boundary will be mined including impacts on the mining plan and tailings plan, five years prior to commencement of mining at the lease boundary;
 - (c) in each instance where the mineable resource extends across the lease boundary, a detailed design including mining plan and tailings management plan showing how the proposed plan maximizes recovery of the resource at the lease boundary, two years prior to commencement for mining at the lease boundary;
 - (d) an assessment of the resource potential in the areas affected by permanent utility corridors and main access roads on Lease 13, and the method proposed to recover the ore, five years prior to commencement of mining in the vicinity of the affected areas; and
 - (e) a detailed evaluation of the mine plan adjacent to the Muskeg River which addresses

the impact to the potential future recovery of the resource under and near the Muskeg River two years prior to depositing consolidated tailings in the first mine pit.

7. The AER approves in concept the integration of the Muskeg River Mine and Jackpine Mine subject to the following conditions:
 - (a) Beginning in 2007, as part of its annual mine plan submission, the Operator must report on all changes in the mining, tailings, and reclamation management plans as a result of transferring bitumen and water streams.
 - (b) One year prior to the first transfer of bitumen froth between the Jackpine Mine and the Muskeg River Mine, the Operator must provide measurement plans to the AER for review and approval, including process and instrumentation diagrams, metering, sampling methods, and material balancing procedures that satisfy the requirements of *AER Directive 082: Operating Criteria: Resource Recovery Requirements for Oil Sands Mine and Processing Plant Operations*.
 - (c) One year prior to commissioning of the emergency tailings transfer line, the Operator must provide measurement plans to the AER for review and approval that include process and instrumentation diagrams, metering, sampling methods, and material balancing procedures.
 - (d) The Operator must immediately notify the AER of any emergency situation requiring a transfer of tailings volumes between operations and must subsequently provide the AER with a description of the impact that the transfer will have on the mining, tailings, and reclamation plans.
 - (e) Except in emergency situations, the Operator must not transfer tailings between the projects without prior approval by the AER.
 - (f) Not less than six months prior to field preparation, the Operator must submit to the AER for review and approval the detailed geotechnical designs for all external overburden disposal areas.
8. Five years prior to mining at any lease boundary or final pit wall, the Operator must submit to the AER for review and approval a report containing:
 - (a) a comprehensive evaluation of the lease boundary geology and reserve
 - (b) geotechnical conditions,
 - (c) alternative mining scenarios and impacts,
 - (d) associated costs in accordance with Section 3 of *AER Directive 082*.
 - (e) the final results on agreements reached between the Operator and adjacent leaseholders,
 - (f) any impacts on landform design and drainage, and
 - (g) efforts made by the Operator to enhance cross-boundary coordination of mining and closure.
9. As part of its annual mine plan reporting, the Operator must provide an update of its efforts to coordinate mine planning and closure with other operators in terms of landform

design, drainage, and material balances.

10. The Operator must provide the AER with appropriate five-year planning and implementation plans for approval in order to better ensure that adequate mine design and development coordination occur.
11. Commencing with its annual report due on February 28, 2008, the Operator must submit to the AER on an annual basis a report that describes the Operators' end-pit lake (EPL) research and development efforts for the previous year and the plans and timelines for completion of a demonstration lake. This report should include all of the Operator's efforts and its contributions to any industry collaboration on an EPL demonstration.
12. The Operator shall provide a presentation to the AER outlining the performance and operations of the resource optimization program on a quarterly basis, or as otherwise specified by the AER starting on or before February 28, 2017.
13. The Operator shall submit progressive reports to the AER on the resource optimization program bi-annually, or as otherwise specified by the AER, starting February 28, 2017.
14. The Operator shall submit resource optimization program results tables to the AER including material mined, segregated material, and plant feed on a quarterly basis starting on or before February 28, 2017.
15. The Operator shall submit model losses to the AER including surveyed wireframes, ore tonnage, modelled grade, and field grade on a quarterly basis starting on or before February 28, 2017.
16. Clauses 12 to 15 shall expire when any existing resource recovery requirements are revised or when any new resource recovery requirements come into effect. The Operator must meet the new requirements.
17. The Operator shall provide by September 30, 2018, or such other date as the AER may stipulate in writing, an updated mine plan for the period until end of mine life.
18. The plan in clause 17 shall include:
 - (a) ore production, mine waste, tailings, and water mass balance tables;
 - (b) mine plan status maps;
 - (c) any other tables and figures considered relevant by the Operator; and
 - (d) any other information the AER may require.
19. The Operator shall achieve the:
 - (a) profile specified in Appendix B, Table 1; and
 - (b) profile specified in Appendix B, Table 2.
20. The Operator shall not exceed:
 - (a) any of the profile deviation trigger, total volume trigger or total volume limit specified in Appendix B, Table 3; and
 - (b) the profile deviation trigger specified in Appendix B, Table 4.
21. If any limit or trigger in clause 20 is exceeded, the Operator shall comply with the

management response or action directed by the AER.

22. The Operator shall provide by December 31, 2018, or such other date as the AER may stipulate in writing, a plan.
23. The plan in clause 22 shall:
 - (a) describe how the Operator will ensure that
 - (i) the treatment capacity is equal to or greater than the production rate of new fluid tailings; and
 - (ii) all legacy fluid tailings will be ready to reclaim by Muskeg River Mine's end of mine life;
 - (b) describe the fluid tailings treatment technology options to be assessed;
 - (c) describe how the Operator will update and validate the ready to reclaim trajectory and criteria for North Pool Deposit type, centrifuge deposit types, or other types of deposits, including evidence that these types of deposits will reasonably achieve the targeted final landforms and the acceptable distribution of upland ecosite phases and wetland types;
 - (d) explain the approach to identify and mitigate uncertainties associated with the proposed tailings treatment technologies and implementation timeframes, tailings deposit performance, ready to reclaim trajectory, environmental effects and implications, including implications to the previously identified targeted ecosites; and
 - (e) provide any other information the AER may require.
24. The Operator shall provide an amendment application by September 30, 2021, or such other date as the AER may stipulate in writing.
25. The amendment application in clause 24 shall comply with the application requirements in *Directive 085: Fluid Tailings Management for Oil Sands Mining Projects*, as amended or replaced (hereinafter called *Directive 085*), and shall include, but not be limited to the following:
 - (a) the results from the plan in clause 22 and the update in clause 31;
 - (b) the bitumen production expansion rates and implementation dates;
 - (c) revised profiles for new and legacy fluid tailings that:
 - (i) are representative of Muskeg River Mine fluid tailings only;
 - (ii) provide a revised end of mine life target that is no greater than 5 years of fluid tailings production at the Muskeg River Mine site;
 - (iii) ensure that the treatment capacity is equal to or greater than the production rate of new fluid tailings;
 - (iv) demonstrate all new fluid tailings are ready to reclaim within 10 years from Muskeg River Mine's end of mine life; and
 - (v) demonstrate that all legacy fluid tailings are ready to reclaim by Muskeg River Mine's end of mine life;

- (d) a plan, with supporting justification, for additional fluid tailings treatment capacity that ensures
 - (i) the treatment capacity is equal to or greater than the production rate of new fluid tailings;
 - (ii) that all legacy fluid tailings will be ready to reclaim by Muskeg River Mine's end of mine life; and
 - (iii) implementation by December 31, 2022.
 - (e) assess and propose the alternatives for tailings solvent recovery unit tailings management;
 - (f) where the Operator is proposing to place water, including industrial wastewater, above treated or untreated tailings for the purpose of creating a water capped deposit as a closure landscape feature ("water capped pit lake"), provide feasible alternative tailings treatment technologies and implementation plan;
 - (g) evaluate the performance of past and current tailings deposits where similar tailings treatment technology and targeted ecosites were proposed;
 - (h) provide an update to the ready to reclaim trajectory and criteria for each type of deposit, including the evidence to support that each type of deposit will reasonably achieve the targeted final landforms and the acceptable distribution of upland ecosite phases and wetland types;
 - (i) justify the required activities, materials and timelines to achieve milestones;
 - (j) assess the performance and limitations for North Pool Deposit type and composite tailings type deposits;
 - (k) explain how any consolidation model or engineering analysis results have been incorporated;
 - (l) explain how research results, including capping research, and long-term reclamation outcomes have been incorporated;
 - (m) mitigate uncertainties associated with the tailings treatment technology, tailings deposit performance and ready to reclaim trajectory; and
 - (n) provide any other information the AER may require.
26. Subject to clause 27, the Operator shall achieve the ready to reclaim criteria as set out in Appendix C.
27. (a) If, at any time, the AER is not satisfied with the ready to reclaim criteria in Appendix C, the Operator shall address the issues, concerns or deficiencies identified in writing by the AER by the date specified by the AER.
- (b) If, at any time, the Operator proposes any new or modifications to the ready to reclaim criteria in Appendix C, the Operator shall:
- (i) address the requirements in *Directive 085*;
 - (ii) demonstrate that the proposed new or modifications to the ready to reclaim

criteria do not result in changes to any of the ready to reclaim trajectory, targeted ecosites, milestones, or fluid tailings profile;

- (iii) address any required updates to the measurement system plan; and
 - (iv) provide any other information the AER may require.
- (c) The Operator shall not use any new or modified ready to reclaim criteria unless
 - (i) the Operator has provided the information required by subclause 27(b) to the satisfaction of the AER; and
 - (ii) the AER has revised Appendix C to allow the new or modified ready to reclaim criteria.
- 28. The Operator shall submit by September 30, 2019, or such other date as the AER may stipulate in writing, ready to reclaim criteria for Cell 2.
- 29. The Operator shall not use the ready to reclaim criteria required by clause 28 unless
 - (a) the Operator has provided the information required by subclause 27(b) to the satisfaction of the AER; and
 - (b) the AER has revised Appendix C to allow the ready to reclaim criteria.
- 30. The Operator shall not remove any composite tailings in Cell 2 from the fluid tailings inventory unless the AER has revised Appendix C to include ready to reclaim criteria for Cell 2.
- 31. The Operator shall provide, by September 30, 2020, or such other date as the AER may stipulate in writing, an update on tailings solvent recovery unit tailings management.
- 32. The update in clause 31 shall:
 - (a) describe the options the Operator is considering for the treatment and placement of tailings solvent recovery unit tailings;
 - (b) provide an evaluation on how tailings solvent recovery unit tailings impact North Pool Deposit type performance, including the effects on the surrounding environment and the ability to achieve long-term reclamation outcomes;
 - (c) explain how research results have influenced the operation of the tailings deposits and the potential impacts on long-term reclamation outcomes;
 - (d) describe any changes the Operator is evaluating for the management of tailings solvent recovery unit tailings in Cell 4; and
 - (e) provide any other information the AER may require.
- 33. The Operator shall submit for Cell 2:
 - (a) by February 28, 2019, or such other date as the AER may stipulate in writing, a consolidation model or engineering analysis, along with any required supporting information, including the milestones, as specified in writing by the AER, for Cell 2; and
 - (b) by September 30, 2019, or such other date as the AER may stipulate in writing, an updated plan for Cell 2 that ensures the timeline to begin capping activities is

accelerated.

34. The plan in subclause 33(b) shall include:
- (a) current status and properties of the materials in the deposit;
 - (b) identification and evaluation of the options to enable the acceleration of the timeline to cap the deposit, together with the justification for the capping option selected;
 - (c) for the capping option selected, include:
 - (i) an implementation schedule with milestones;
 - (ii) a justification of the required activities and materials to implement the option;
 - (iii) an explanation of how consolidation model or engineering analysis results have been incorporated;
 - (iv) an explanation of how research results, including capping research, and long-term reclamation outcomes have been incorporated; and
 - (v) an analysis of any implications to the targeted final landforms and targeted range of ecosites; and
 - (d) any other information the AER may require.
35. The Operator shall provide 1 year prior to placement of fluid tailings or treated tailings in each of Cell 4, Cell 5, Cell 6, Cell 7, Cell 8 & 9, SB Cell 1, SB Cell 2, SB Cell 3, SB Cell 4, SB Cell 5, SB Cell 6, or Lease 90-Cell 1, or such other date as the AER may stipulate in writing, a plan that updates fluid tailings management.
36. Each plan in clause 35 shall:
- (a) address the application requirements specified in *Directive 085*;
 - (b) assess any implications to the fluid tailings profiles;
 - (c) where the Operator is proposing to place water, including industrial wastewater, above treated or untreated tailings for the purpose of creating a water capped deposit as a closure landscape feature (“water capped pit lake”), provide feasible alternative tailings treatment technologies and implementation plan;
 - (d) provide a consolidation model or engineering analysis, along with any required supporting information, including milestones, as specified in writing by the AER, for the tailings deposit;
 - (e) evaluate the performance of past and current tailings deposits where similar tailings treatment technology and targeted ecosites were proposed;
 - (f) explain how research results, including capping research, and long-term reclamation outcomes have been incorporated;
 - (g) mitigate uncertainties associated with the tailings treatment technology, tailings deposit performance and ready to reclaim trajectory; and
 - (h) provide any other information the AER may require.
37. The Operator shall provide by September 30, 2020, or such other date as the AER may

- stipulate in writing, consolidation model or engineering analysis, along with any required supporting information, including milestones, as specified in writing by the AER, for Cell 1 and Cell 3.
38. If a model or engineering analysis in clause 33(a) or 37 is found deficient by the AER, the Operator shall correct all deficiencies identified in writing by the AER by the date specified by the AER.
39. The Operator shall:
- (a) commence capping of ETF on or before December 31, 2021; and
 - (b) within one year of completing tailings placement in Cell 3, commence capping of Cell 3.
40. The Operator shall submit a research plan for the closure of any of the deposits upon request by the AER.
41. The Operator shall provide a capping research plan for its deep fines dominated, fines-enriched sand, sandy fines and thin-layered fines dominated deposits by September 30, 2018, or such other date as the AER may stipulate in writing.
42. The plan in clause 41 shall include:
- (a) an explanation and rationale for the:
 - (i) research objectives;
 - (ii) hypothesis to be tested;
 - (iii) models to be developed;
 - (iv) key performance measures and criteria;
 - (v) experimental controls, the design and methodology for the research, model, or technique, and the research monitoring plans and methodologies;
 - (vi) applicability of each objective to addressing the risks and uncertainties and to achieving the targeted ecosites and long-term reclamation outcomes;
 - (vii) approach to incorporating research results into any plan;
 - (viii) incorporation of existing research results to date (both general and site-specific) into the research plan;
 - (ix) summary of the research completed to date that relates to the objectives identified in (i);
 - (b) identification and explanation of research priorities that will ensure research results can be incorporated into any plans, including
 - (i) rationale for the sequence of the research;
 - (ii) timing of initiating and completing research; and
 - (iii) key activities.
 - (c) proposed schedule for research results and data submission, with a mechanism to track progress over time; and

- (d) any other information the AER may require.
- 43. The Operator shall not implement any of the plans in clauses 33(b), 35, and 41 unless an approval amendment or written authorization is granted by the AER.
- 44. If the operating targets identified in Table 1: WT/CST proportions relative to TT and TSRU in Application 1870302 are not met for a period of more than two consecutive quarters, or such other basis as the AER may stipulate in writing, the Operator shall:
 - (a) identify the causes of the failure to meet the operating targets;
 - (b) assess any impacts that the failure may have on the tailings management plan, mine plan, water management plan, mine reclamation plan, and life of mine closure plan; and
 - (c) initiate a mitigation response to address the failure and achieve operating targets.
- 45. The Operator shall monitor:
 - (a) on a quarterly basis or such other basis as the AER may stipulate in writing, the volume of whole tailings, coarse sand tailings, thickened tailings, and tailings solvent recovery unit tailings placed in each North Pool Deposit type;
 - (b) on a quarterly basis or such other basis as the AER may stipulate in writing, the solids content of the thickened tailings being placed in each North Pool Deposit type;
 - (c) on a quarterly basis or such other basis as the AER may stipulate in writing, the sands to fine ratio of the thickened tailings being placed in each North Pool Deposit type;
 - (d) on an annual basis or such other basis as the AER may stipulate in writing, the sands to fine ratio, effective stress, deposit consolidation, pore water pressure, and clay type(s) and percentage in each treated tailings deposit; and
 - (e) any other parameter on the basis specified in writing by the AER.
- 46. The Operator shall, in addition to any reporting requirements under *Directive 085* provide in the annual fluid tailings management report:
 - (a) a progress update on the ongoing tailings technology selection project;
 - (b) a description of the Operator's ability to deliver on the amendment application;
 - (c) a description of how the Operator is ensuring that the centrifuge, thickened tailings or other technologies are achieving performance parity with other treatment technologies;
 - (d) the status of bitumen production expansion rates and implementation dates;
 - (e) for each North Pool Deposit type,
 - (i) provide a comparison of the results of the quarterly monitoring required by clause 45(a) with the operating targets identified in Table 1: WT/CST proportions relative to TT and TSRU in Application 1870302,
 - (ii) provide the results of the quarterly monitoring required by clause 45(b) and (c);
 - (iii) describe the engineering design and operation controls employed to form each

North Pool Deposit type of tailings deposit during the reporting period;

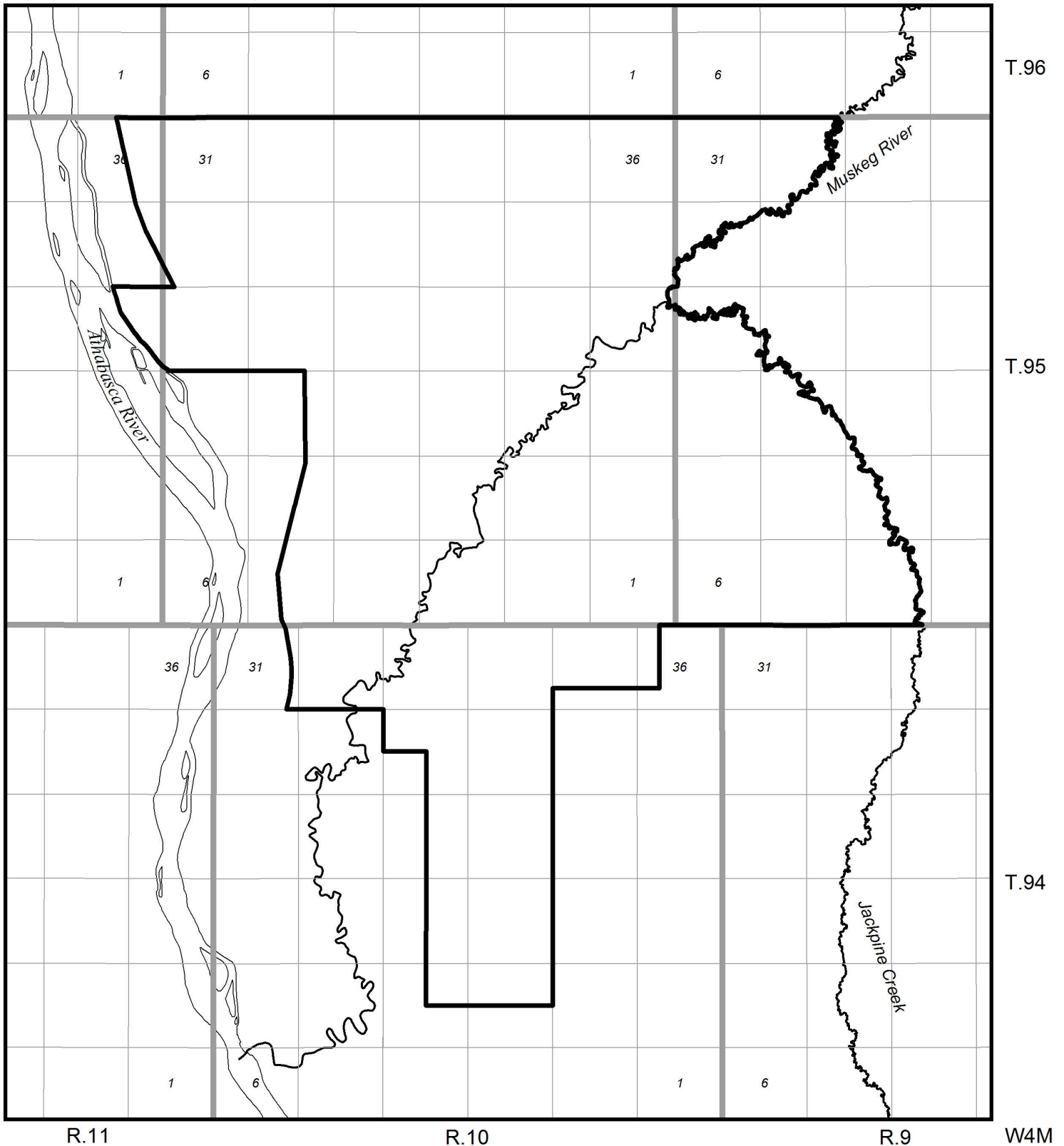
(iv) describe any actions required by clause 44 and their effectiveness;

- (f) for each treated tailings deposit, monitoring data including representative cross-sections to illustrate the variation of the following:
 - (i) sands to fine ratio;
 - (ii) effective stress;
 - (iii) deposit consolidation;
 - (iv) pore water pressure;
 - (v) clay type(s) and percentage;
 - (vi) any other parameter considered relevant by the Operator; and
 - (vii) any other parameter specified by the AER;
- (g) the available storage capacity of each tailings deposit or pond that contains water or tailings at the end of the reporting period; and
- (h) annual storage capacity and volume requirements for the five years following the end of the reporting period

unless otherwise authorized in writing by the AER.

- 47. The Operator shall not place any water, which includes industrial wastewater, above treated or untreated tailings for the purpose of creating a water capped deposit as a closure landscape feature (“water capped pit lake”).
- 48. The Operator shall not release any substance to the surrounding environment except as authorized under the EPEA Approval.
- 49. The Operator shall:
 - (a) notify the AER of any proposed on-site fluid tailings pilots, prototypes or demonstrations at least 6 months, or such other time as the AER may stipulate in writing, prior to any proposed construction or implementation; and
 - (b) not construct or implement any of the proposed on-site fluid tailings pilots, prototypes or demonstrations unless written authorization or approval amendment is granted by the AER.
- 50. The Operator shall engage with stakeholders and indigenous communities on the activities undertaken under this Scheme Approval in respect of tailings management.
- 51. The Operator shall conduct an annual forum with stakeholders and indigenous communities on the activities undertaken under this Scheme Approval in respect of tailings management.
- 52. The Operator shall report in the annual fluid tailings management report engagement efforts undertaken in the reporting period.
- 53. The report in clause 52 shall include the following:
 - (a) how the stakeholders and indigenous communities were identified for engagement;

- (b) a list of stakeholders and indigenous communities identified in (a);
 - (c) objectives for engagement, including gathering input and feedback on the development of tailings management submissions from stakeholders and indigenous communities identified in (a);
 - (d) the type of engagement activity that was undertaken and the tailings specific information that was provided to each stakeholder and indigenous community identified in (a);
 - (e) the specific frequency and duration of the engagement with each stakeholder and indigenous community identified in (a);
 - (f) what specific feedback was provided by each stakeholder and indigenous community identified in (a);
 - (g) what specific feedback on this report was provided by each stakeholder and indigenous community identified in (a);
 - (h) how the feedback and learnings from previous engagement will be incorporated into future engagement and into tailings management;
 - (i) how the Operator addressed any outstanding concerns arising from engagement; and
 - (j) outcomes from the annual forum.
54. The Operator shall apply for an amendment to this Scheme Approval to align with any applicable government policy, including, but not limited to:
- (a) tailings water release;
 - (b) placement of any water above treated or untreated tailings to create a water capped pit lake; and
 - (c) reclamation criteria.
55. The AER may,
- (a) upon its own motion, or
 - (b) upon the application of an interested person, rescind or amend this approval at any time if, in the opinion of the AER, circumstances so warrant.
56. AER Approval No. 8512, 8512A, 8512B, 8512C, 8512D, 8512E, 8512F, 8512G, and 8512H are hereby repealed, rescinded, and replaced with the AER Approval No. 8512I.



**CANADIAN NATURAL UPGRADING LIMITED
MUSKEG RIVER MINE PROJECT**

APPENDIX A TO APPROVAL NO. 85121

Legend

— OSCA Approval Area



0 0.75 1.5 3 4.5 6 Kilometers

The AER does not warrant the accuracy or completeness of the information contained in this map and is not responsible for any errors or omissions in its content and accepts no liability for the use of this information.

Base Data Provided by Spatial Data Warehouse Ltd., 2003

CANADIAN NATURAL UPGRADING LTD.
APPENDIX B TO APPROVAL NO. 8512I

Table 1. New Fluid Tailings Profile

Year	Approved Profile New FT Inventory (million cubic metres)
2015	9
2016	15
2017	24
2018	32
2019	42
2020	50
2021	59
2022	69

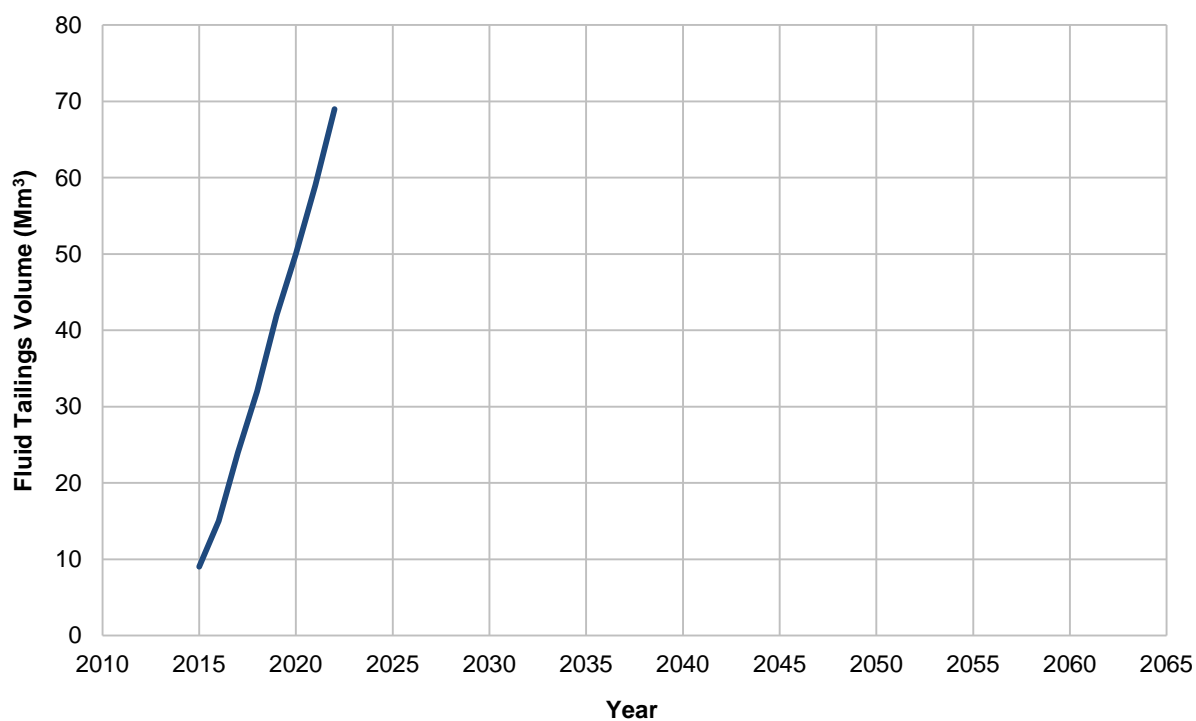


Figure 1. New Fluid Tailings Profile

Table 2. Legacy Fluid Tailings Profile

Year	Approved Profile Legacy FT Inventory (million cubic metres)
2015	92
2016	92
2017	92
2018	92
2019	92
2020	92
2021	92
2022	92

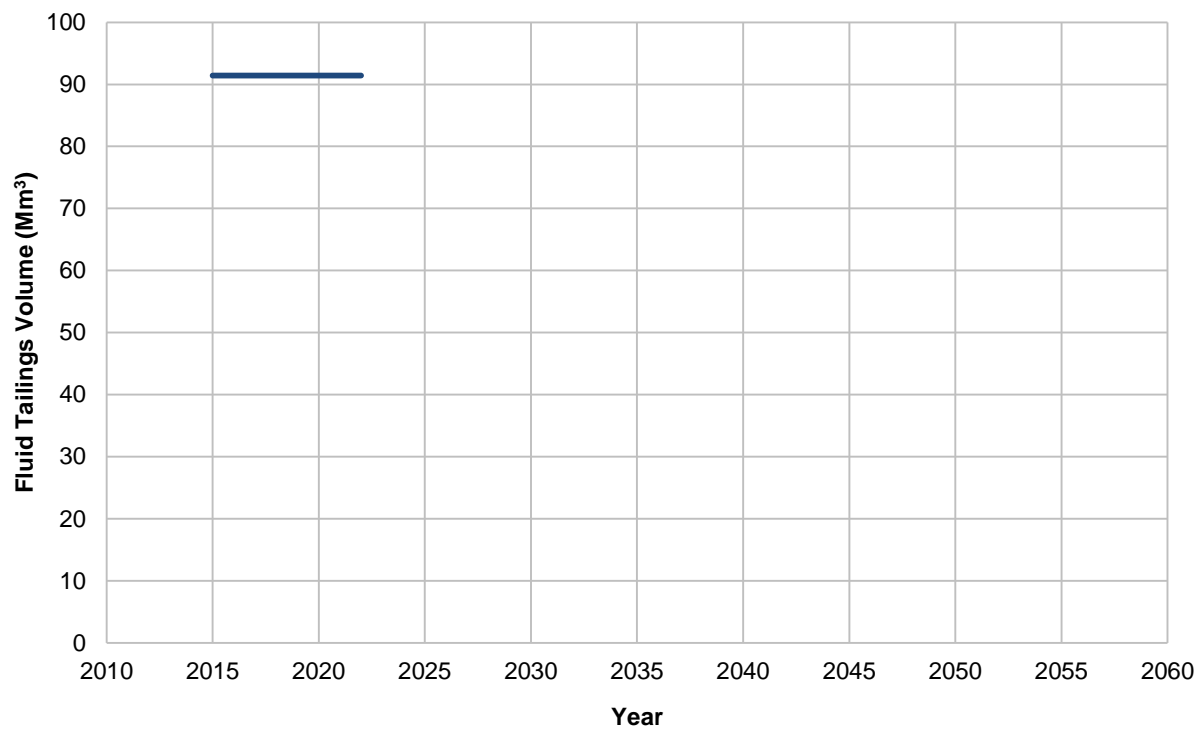


Figure 2. Legacy Fluid Tailings Profile

Table 3. Thresholds for New Fluid Tailings Profile

Threshold Type	Trigger or Limit	Calculation Factors
Profile Deviation Trigger	20 per cent	$\text{annual deviation percent}_{\text{year}} = \frac{\text{New FT Inventory}_{\text{year}} - \text{Approved Profile New FT Inventory}_{\text{year}}}{\text{Approved Profile New FT Inventory}_{\text{year}}}$ $\text{profile deviation trigger}_{\text{year}} = \frac{\sum_{i=\text{year}-5}^{\text{year}} (\text{annual deviation percent}_i)}{\text{Count}(\text{annual deviation percent}_i: \text{annual deviation percent}_{i-5})}$
Total Volume Trigger	69 million cubic metres	n/a
Total Volume Limit	97 million cubic metres	n/a

Table 4. Thresholds for Legacy Fluid Tailings Profile

Threshold Type	Trigger or Limit	Calculation Factors
Profile Deviation Trigger	20 per cent	$\text{annual deviation percent}_{\text{year}} = \frac{\text{Legacy FT Inventory}_{\text{year}} - \text{Approved Profile Legacy FT Inventory}_{\text{year}}}{\text{Approved Profile Legacy FT Inventory}_{\text{year}}}$ $\text{profile deviation trigger}_{\text{year}} = \frac{\sum_{i=\text{year}-5}^{\text{year}} (\text{annual deviation percent}_i)}{\text{Count}(\text{annual deviation percent}_i: \text{annual deviation percent}_{i-5})}$

CANADIAN NATURAL UPGRADING LTD.**APPENDIX C TO APPROVAL NO. 8512I****Table 1. RTR Criteria for Canadian Natural Upgrading Ltd.**

Deposit	Subobjective	RTR criteria
North Pool Deposit type deposits in ETF, Cell 1 and Cell 3	Subobjective 1	70 percent solids by weight (w/w), based on deposit sampling, within 5 years of tailings placement
	Subobjective 2	Groundwater is monitored as required by <i>Environmental Protection and Enhancement Act (EPEA)</i> Approval No. 20809-02-00, as amended or renewed

Appendix 3 Submissions and Deposit Milestones Timelines

	Cell 2 – final placement of CT			Cell 3 – final placement of NPD Type Deposit Cell 4 – tailings placement commences*
Month	2018	2019	2020	2021
February		Cell 2 model/analysis		
April		Additional reporting under <i>Directive 085</i>	Additional reporting under <i>Directive 085</i>	Additional reporting under <i>Directive 085</i>
September	Updated mine plan Capping research plan	Cell 2 RTR criteria Accelerated capping plan for Cell 2	Update on TSRU tailings management Cell 1 and Cell 3 model/analysis	Amendment application
November	Measurement system plan			
December	Plan addressing treatment capacity, treatment technology options, and RTR criteria and trajectory			Commence capping on ETF

*Not shown: Plans updating fluid tailings management 1 year prior to placement of fluid tailings or treated tailings in each of the tailings deposits.

Appendix 4 EPEA Tailings Research Report and End-Pit Lake Research and Development Report

<original dated>

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By e-mail only

Scott Wytrychoski, Projects and Approvals Manager

Canadian Natural Upgrading Limited

2100 855 2 Street SW

Calgary, AB T2P 4J8

E-mail: scott.wytrychoski@cnrl.com

Canadian Natural Upgrading Limited

Muskeg River Mine Tailings Management Plan, Application 1870302

Tailings Research Report and End Pit Lake Research and Development Report Requirements

Dear Mr. Wytrychoski:

In accordance with clause 5.1.2(f) of *Environmental Protection and Enhancement Act (EPEA)* Approval No. 20809-02-00 (the “Approval”) and subject to the terms and conditions of the Approval, the Alberta Energy Regulator (AER) requires the following information in Canadian Natural Upgrading Limited’s (CNUL) Tailings Research Report:

- For wetland ecosystem research:
 - stability of reclaimed tailings surfaces over time, the implications to the size and type of wetland ecosystems and the ability to create self-sustaining, locally common boreal forest wetlands,
 - capping objectives in addition to rooting-zone protection for wetland ecosystems on tailings deposits,
 - seepage from treated or untreated tailings, and placed coversoil, subsoil or overburden into groundwater or surface water, and
 - validation that developing wetlands are from surface drainage and not breakthrough to the surface from thickened or tailings solvent recovery unit tailings.

In accordance with clause 5.2.4(p) of the Approval, and subject to the terms and conditions of the Approval, the AER requires the following information in CNUL's End Pit Lake Research and Development Report:

- the applicability of Syncrude Canada Limited's Base Mine Lake (BML) research and Suncor Energy Inc.'s Passive Aquatic Storage System (PASS) research to CNUL's proposed water capping and pit lakes
- how CNUL will address uncertainties and risks where BML or PASS research is not applicable
- the research related to clauses 5.1.2(d) and 5.1.2(e) of the Approval for pit lakes

If you have any questions regarding this correspondence, please contact Rachel McMillan at (780) 642-9114 or rachel.mcmillan@aer.ca.

Regards,

<original signed by>

Paul Ferensowicz

cc: Rachel.McMillan@aer.ca Charles.MacDonald@aer.ca
Cynthia.Estrop@aer.ca Angie.Taksas@aer.ca
Eric.Chiu@aer.ca Karen.McCallion@aer.ca

Appendix 5 EPEA Life of Mine Closure Plan and Mine Reclamation Plan

<original dated>

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Scott Wytrychoski, Projects and Approvals Manager

Canadian Natural Upgrading Limited

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Calgary, AB T2P 4J8

E-mail: scott.wytrychoski@cnrl.com

Canadian Natural Upgrading Limited

Muskeg River Mine Tailings Management Plan, Application 1870302

Life of Mine Closure Plan and Mine Reclamation Plan Requirements

Dear Mr. Wytrychoski:

In accordance with clause 7.2.9 of *Environmental Protection and Enhancement Act (EPEA)* Approval No. 00020809-02-00 (the “Approval”) and subject to the terms and conditions of the Approval, the Alberta Energy Regulator (AER) requires the following information for Canadian Natural Upgrading Limited’s (CNUL) Life of Mine Closure Plan and Mine Reclamation Plan:

- Rationale for defining land capping requirements for tailings deposits, based upon research results, including
 - capping material type,
 - capping objectives, such as landform development and stability, settlement management, expressing tailings pore water and controlling the expression of tailings pore water, water table control, and landform contouring to facilitate the flushing of salts from the capping material, and
 - implications to the development of a self-sustaining boreal forest terrestrial or wetland ecosystems.
- Material balances for sand and any other suitable capping materials to meet mine closure requirements for both terrestrial and wetland outcomes, accounting for limited drilling data, technology performance demands, rooting-zone protection, the suitability of the capping

material's chemical and physical properties, and the rationale for defining land capping requirements for tailings deposits.

- Contingency plan for capping material shortages.
- Rationale for the location, spatial extent, and type of targeted wetland ecosites with justification that these ecosites are an acceptable distribution of locally common boreal forest wetlands, based on the Alberta Wetland Classification System, which supports a range of land uses including commercial forest, biodiversity, wildlife habitat, and traditional use.
- Evidence supporting the sustainability of pit lakes.
- Demonstrate alignment with the tailings management plan and the Revegetation Plan, Wetland Reclamation Plan and Forest Resource Plan required by subsection 7.2.10(h), 7.2.10(i) and 7.2.10(j), respectively, of the Approval.

If you have any questions regarding this correspondence, please contact Karen Stals at (780) 642-9204 or Karen.Stals@aer.ca.

Regards,

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Paul Ferensowicz

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Appendix 6 Measurement System Plan Requirements

<original dated>

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E-mail: scott.wytrychoski@cnrl.com

Canadian Natural Upgrading Limited

Muskeg River Mine Tailings Management Plan, Application 1870302

Measurement System Plan Requirements

Dear Mr. Wytrychoski:

In accordance with *Directive 085: Fluid Tailings Management for Oil Sands Mining Projects*, the Alberta Energy Regulatory (AER) requires Canadian Natural Upgrading Limited (CNUL) to submit by November 30, 2018, or on such other date stipulated by the AER, a measurement plan for fluid tailings, treated tailings volumes and ready to reclaim (RTR) criteria.

The measurement system plan must include the following:

- Key definition of parameters for fluid tailings and RTR criteria measurements.
- Reference of standards and procedures used to measure fluid tailings, treated tailings, and RTR criteria.
- An explanation of and justification for measurement procedures that are unique to CNUL and this plan.
- Evidence that the plan will address the measurement outcomes in section 5 of *Directive 085*, as amended.
- An explanation of how each of the tailings deposit's RTR criteria will be measured, calculated and reported.
- A description of the tailings deposit survey program.

- Justification of how measurement, sampling, and spacing intervals will show the variation of the tailings deposit properties, and verify that the tailings deposit is achieving RTR criteria.
- Identify any material in the tailings deposit not achieving RTR criteria.
- Any other information the AER may require.

Where measurement plans exist for any RTR criteria subobjectives, CNUL may incorporate references to other plans, such as the groundwater monitoring program.

CNUL must also ensure that the measurement system plan aligns with the Groundwater Monitoring Program authorized under its EPEA approval.

As per clause 45 and 46 of Approval No. 8512I, CNUL must monitor and report on volumes of whole tailings, coarse sand tailings, thickened tailings, and tailings solvent recovery unit tailings; solids content of the thickened tailings; and the sands to fine ratio of the thickened tailings being placed in each North Pool Deposit type deposit; and sands to fine ratio, effective stress, deposit consolidation, pore water pressure, clay type(s) and percentage for each treated tailings deposit. The measurement system plan must also include measurement locations and measurement methodology for this monitoring and reporting.

If you have any questions regarding this correspondence, please contact Jim Jordan at (403) 297-8504 or jim.jordan@aer.ca.

Regards,

<original signed by>

Paul Ferensowicz

cc: Tara.Wang@aer.ca Charles.MacDonald@aer.ca
Cynthia.Estrop@aer.ca Angie.Taksas@aer.ca
Eric.Chiu@aer.ca Jim.Jordan@aer.ca

Appendix 7 Chemicals Used in Tailings Treatment Information Requirements

<original dated>

By e-mail only

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Scott Wytrychoski, Projects and Approvals Manager

Canadian Natural Upgrading Limited

2100 855 2 Street SW

Calgary, AB T2P 4J8

E-mail: scott.wytrychoski@cnrl.com

Canadian Natural Upgrading Limited

Muskeg River Mine Tailings Management Plan, Application 1870302

Chemicals Used in Tailings Treatment Information Requirements

Dear Mr. Wytrychoski:

In accordance with condition 4.3.19 of the *Environmental Protection and Enhancement Act* Approval No. 20809-02-00, the Alberta Energy Regulatory (AER) requires Canadian Natural Upgrading Limited (CNUL) to submit by June 15, 2018, or on such other date stipulated by the AER, the following information about each of the chemicals currently used by CNUL for composite tailings and the thickeners or thickened tailings:

- the treatment process that employs the chemical
- the MSDS sheet for the chemical
- the technical data sheet and Certificate of Analysis for the chemical
- any relevant research or evaluation completed on the chemical
- for each chemical, the chemical's:
 - form,
 - ionic character,
 - generic name,
 - material descriptions, and

- ecological toxicity information,
- any other information the AER may require.

If you have any questions regarding this correspondence, please contact Rachel McMillan at (780) 642-9114 or rachel.mcmillan@aer.ca.

Regards,

<original signed by>

Paul Ferensowicz

cc: Rachel.McMillan@aer.ca Charles.MacDonald@aer.ca
 Cynthia.Estrop@aer.ca Angie.Taksas@aer.ca
 Eric.Chiu@aer.ca Karen.McCallion@aer.ca
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Appendix 8 Decommissioning Plan for Dams

<original dated>

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By e-mail only

Scott Wytrychoski, Projects and Approvals Manager

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Muskeg River Mine Tailings Management Plan, Application 1870302

Decommissioning Plan for Dams

Dear Mr. Wytrychoski:

In accordance with section 32 of the *Water (Ministerial) Regulation* and subject to the terms and conditions set out in *Water Act* Approval No. 00071828-01-00, the Alberta Energy Regulator (AER) sets out the following initial requirement for decommissioning any dams associated with tailings ponds or deposits:

Canadian Natural Upgrading Limited (CNUL) shall, at least 12 months prior to commencing capping activities at any tailings pond or deposit, provide the AER with a plan for decommissioning of the dams.

CNUL shall not implement the plan for decommissioning of the dams unless written authorization or approval amendment for the plan is granted by the AER.

If you have any questions regarding this correspondence, please contact Tim Eaton at (403) 297-6855 or tim.eaton@aer.ca.

Regards,

<original signed by>

Paul Ferensowicz

cc: Tim.Eaton@aer.ca
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