

Canadian Natural Upgrading Limited

Application for Jackpine Mine Tailings Management Plan

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Alberta Energy Regulator

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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
<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>
JPM	Jackpine 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
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 1870297, 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 Jackpine Mine (JPM) was approved by a joint Alberta Energy and Utilities Board (EUB) and Government of Canada panel in 2004 (*Decision 2004-009*). JPM started production in August 2010 and tailings placement began in the external tailings facility (ETF). An expansion to the JPM was approved by a joint panel established by the ERCB and the Government of Canada in 2013 (*2013 ABAER 011*). The application for the expansion under *Environmental Protection and Enhancement Act (EPEA)* is still under review. In-pit tailings placement started in Fluid Cell (FC) 1 in 2016 (site map provided in appendix 2).

On October 14, 2016, the AER registered application 1870297, filed by Shell Canada Limited pursuant to section 13 of the *Oil Sands Conservation Act (OSCA)* for approval of the TMP for JPM. CNUL acquired the JPM from Shell in May 2017 and is the current holder of approval 9756.

The AER enhanced involvement by providing an opportunity 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 TMP is inconsistent with existing approvals; CNUL's new and legacy fluid tailings profiles are not aligned with existing approvals, the *TMF*, or *Directive 085*; 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. Finally, the AER has concerns with CNUL's proposed tailings treatment technology.

CNUL is required to submit an amendment application by September 30, 2022, that contains the TMP for the life of the project and that addresses the uncertainties and deficiencies identified in this report.

TMP and Existing Approval Alignment – End of Mine Life and TSRU Tailings

One of the reasons CNUL is required to submit the amendment application is that the TMP is not aligned with existing approvals. Under the TMP, CNUL indicated that no bitumen production expansion is planned, which extends the end of mine life date from 2052 to 2105. In addition, CNUL indicated that JPM froth will continue to be transferred to the Muskeg River Mine, and tailings solvent recovery unit (TSRU) tailings will continue to be managed at the Muskeg River Mine until JPM's end of mine life. All of this is inconsistent with what was proposed in the JPM expansion applications.

Fluid Tailings Profile

Another reason CNUL is required to submit the amendment application is that the new and legacy fluid tailings profiles in CNUL's application are not aligned with existing approvals, the *TMF*, or *Directive 085* **over the medium and long term.**

CNUL's new and legacy fluid tailings profiles are not aligned because

- the proposed time to accumulate the peak volume is longer than the duration guided by the *TMF* and *Directive 085*;

- the end of mine life target is greater than five years of fluid tailings production at JPM;
- the proposed profiles do not demonstrate that fluid tailings treatment capacity is equal to or greater than the new fluid tailings production rate;
- the proposed profiles were premised on an end of mine life of 2105, whereas the current authorized end of mine life is 2052; and
- the proposed profiles do not demonstrate that all legacy fluid tailings are RTR by the JPM's end of mine life (2052) and that all new fluid tailings generated at the JPM are RTR within ten years from JPM's end of mine life.

As the new and legacy fluid tailings profiles are aligned only for the short term, the AER is approving CNUL's new and legacy fluid tailings profiles only until 2023. CNUL is required to submit new and legacy fluid tailings profiles in the amendment application.

CNUL's proposed end of mine life of 2105 is not authorized. CNUL's application did not include sufficient information to support the change, such as an updated mine plan and life of mine closure plan.

The AER has set the thresholds based on the approved short-term new and legacy fluid tailings profiles. The thresholds will remain in effect until the AER renders a decision on the amendment application.

Ready-to-reclaim (RTR) Criteria

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

For the mixed deposits formed by thickened tailings, whole tailings, and coarse sand tailings in the ETF (mixed deposits), 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.

The AER does not authorize RTR criteria for the centrifuge deep deposits because the AER has concerns with the proposed RTR criteria of 40 per cent solids in one year. CNUL is therefore required to provide new RTR criteria for the centrifuge deep deposits as the proposed RTR criteria were not acceptable. CNUL cannot remove centrifuge tailings from the fluid tailings inventory until the revised RTR criteria are approved.

The AER does not authorize RTR criteria for the centrifuge thin lift deposits because there are concerns with the proposed RTR criteria of 40 per cent solids in three to six months, and CNUL did not propose to develop this type of deposit before 2022.

Tailings Treatment Technology Selection and Performance

CNUL uses thickeners and combines the thickened tailings with whole tailings and coarse sand tailings to form a mixed deposit. CNUL is also using four centrifuge units to treat tailings. The thickener operation began at the JPM start-up in 2010, with placement of thickened tailings in the ETF's Dedicated Disposal Area (DDA) 1. Centrifuge tailings treatment technology was commissioned in 2014 with placement of centrifuge tailings in DDA1.

The AER is concerned with CNUL's treatment technologies and the ability of the tailings deposits to support future reclamation activities, achieve stable targeted ecosites, and meet the *TMF*'s outcomes.

CNUL is authorized to continue to use thickeners and combine the thickened tailings with whole tailings and coarse sand tailings to form a mixed deposit in the ETF's DDA1, subject to the approval terms and conditions. CNUL is also authorized to continue to operate its four centrifuge units, subject to the approval terms and conditions. CNUL is required, in the amendment application, to assess the performance and limitations of tailings deposits containing thickened tailings, whole tailings, and coarse sand tailings; tailings deposits containing centrifuge tailings; and other types of deposits, and monitor quarterly and report annually on the mixed deposits.

The AER has concerns with CNUL's current treatment technologies. CNUL needs to evaluate in the amendment application whether the selected treatment technologies and the types of deposits the technologies form are appropriate, whether mitigation measures need to be employed in the ETF, and whether the AER's concerns are adequately addressed. CNUL is required, in the amendment application, to assess, describe, and propose the selected treatment technologies that 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 JPM's end of mine life.

CNUL is not authorized to use 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 the JPM.

With respect to water-capping technology, CNUL is not proposing to have any water-capped pit lakes at the JPM at this time. 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. Should CNUL propose a water-capped pit lake in the future, CNUL is required to provide an alternative tailings treatment technology and implementation plan in the amendment application.

Enhancements to Research

Research is essential 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.

20180523B

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

Application 1870297

Decision

[1] The Alberta Energy Regulator (AER) approves Canadian Natural Upgrading Limited's (CNUL) application 1870297, subject to the approval terms and conditions, and issues *Oil Sands Conservation Act* (OSCA) Approval No. 9756G (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 Jackpine Mine (JPM) was approved by a joint Alberta Energy and Utilities Board (EUB) and Government of Canada panel in 2004 (*Decision 2004-009*). The JPM is located about 70 kilometres north of Fort McMurray, Alberta, in the Regional Municipality of Wood Buffalo (site map provided in appendix 2). The JPM started production in August 2010, and tailings placement began in the external tailings facility (ETF). An expansion to the JPM was approved by a joint panel established by the Energy Resources Conservation Board (ERCB) and Government of Canada in 2013 (*2013 ABAER 011*). The *Environmental Protection and Enhancement Act* (EPEA) application for the expansion was not part of the joint panel proceeding. That application is still under review. In-pit tailings placement started in 2016.

[6] On October 14, 2016, the AER registered application 1870297, filed by Shell Canada Limited pursuant to section 13 of *OSCA* for approval of the tailings management plan (TMP) for the JPM.

[7] Under application 1870297, Shell sought approval for its TMP to 2105, which is 53 years beyond the end of the mine life previously approved by the *OSCA* approval under the JPM expansion applications.¹

[8] CNUL acquired the JPM from Shell in May 2017 and is the current holder of approval 9756.

Statements of Concern and Enhanced Involvement

[9] The AER published a public notice for application 1870297 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 1870297. 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, 2022."

[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).

¹ The JPM expansion included applications under both *OSCA* and *EPEA*. Because these applications were submitted before the proclamation of the *Responsible Energy Development Act*, the applications were before different regulators. The *OSCA* portion of the application was considered and decided upon by the joint panel proceeding and an approval was issued. That application proposed an end of mine life of 2052. The *EPEA* application, which is still under review, also proposes an end of mine life of 2052.

[15] Upon receipt of the 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 1870297.

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 a new application be submitted by September 30, 2022.

[17] The approval conditions address the following:

- amendment application requirements;
- project-specific thresholds for both legacy and new 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 *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, 2022 that contains the TMP for the life of the project and that addresses the uncertainties and deficiencies identified 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 and treated 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 TMP is not aligned with its existing approval. Under the TMP, CNUL indicated that no bitumen production expansion is planned, which extends the end of mine life date from 2052 to 2105. In addition, CNUL indicated that JPM froth will continue to be transferred to the Muskeg River Mine, and tailings solvent recovery unit (TSRU) tailings will continue to be managed at the Muskeg River Mine until JPM's end of mine life. All of this is inconsistent with what was proposed in the JPM expansion applications.
- CNUL's proposed new and legacy fluid tailings profiles are not aligned with the existing approvals, the *TMF*, or *Directive 085* because the proposed time to accumulate the peak volume and the end of mine life target are greater than allowable. The proposed profiles do not demonstrate that treatment capacity is equal to or greater than production and are premised on an end of mine life of 2105 instead of 2052.
- CNUL's proposed ready-to-reclaim (RTR) criteria, RTR trajectory, and targeted ecosites are uncertain and do not assure the AER that the deposit's physical properties are on a trajectory to support future stages of reclamation, that the effects the deposit has on the surrounding environment are minimized, and that 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 the 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 satisfactory. This includes additional information on CNUL's selected treatment technologies, its bitumen expansion plan, and the treatment technology 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, 2022, CNUL may submit the amendment applications at any time before this date.

[25] A summary of the various plans and updates required by the approval are in appendix 3.

TMP and Existing Approval Alignment – End of Mine Life and TSRU Tailings

Context

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

[27] Under the JPM expansion applications and the *OSCA* approval, bitumen production was increased, the end of mine life was 2052, a froth treatment plant was to be constructed, and TSRU tailings were to be placed at the JPM. The application for the expansion under *EPEA* is still under review.

[28] Under the TMP, CNUL indicated that no bitumen production expansion is planned, that the end of mine life was not 2052 but 2105, that a froth treatment plant would not be constructed, and that TSRU tailings would continue to be managed at the Muskeg River Mine until JPM's end of mine life. All of this is inconsistent with what was proposed in the JPM expansion applications.

Decision Summary

[29] The TMP is not aligned with the existing *OSCA* approval or content of the *EPEA* application for the expansion.

[30] CNUL's TMP did not provide adequate information to identify the inconsistencies nor describe how alignment would be achieved. CNUL is required, in the amendment application, address the bitumen production expansion rates and implementation dates, provide revised fluid tailings profiles that align with the JPM's end of mine life of 2052, and include the results of the TSRU tailings update. TSRU tailings are discussed in the section "TSRU Tailings."

[31] CNUL's proposed end of mine life of 2105 is not authorized. CNUL's application did not include sufficient information to support the change. Some of the information that would be required would include information on an updated mine plan (see section "TMP and *OSCA* Mine Plan Alignment") and life of mine closure plan (see section "TMP and *EPEA* Plan Alignment").

Fluid Tailings Profiles and Project-Specific Thresholds

[32] 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.

[33] The new and legacy fluid tailings profiles represent 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.

Legacy Fluid Tailings Profile

Context

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

[35] Legacy fluid tailings are located in the ETF.

[36] Under the existing *OSCA* approval, the JPM's end of mine life is 2052.

Decision Summary

[37] CNUL's legacy fluid tailings profile does not meet the *TMF*'s objective over the medium and long term due to the following:

- *Directive 085* indicates that the TMP must include sufficient information to demonstrate alignment with existing approvals. Under the existing *OSCA* approval, the JPM end of mine life is 2052, not 2105 as proposed by CNUL.
- The proposed legacy fluid tailings profile does not demonstrate that all legacy fluid tailings are RTR by the JPM's end of mine life (2052).

[38] CNUL's legacy fluid tailings profile is authorized until December 31, 2023, as shown in appendix B of the approval (appendix 1). The solid line in figure 1 below depicts the authorized legacy fluid tailings profile that CNUL is required to achieve until December 31, 2023. The dotted line in figure 1 depicts the AER's medium- and long-term expectations for the legacy fluid tailings profile.

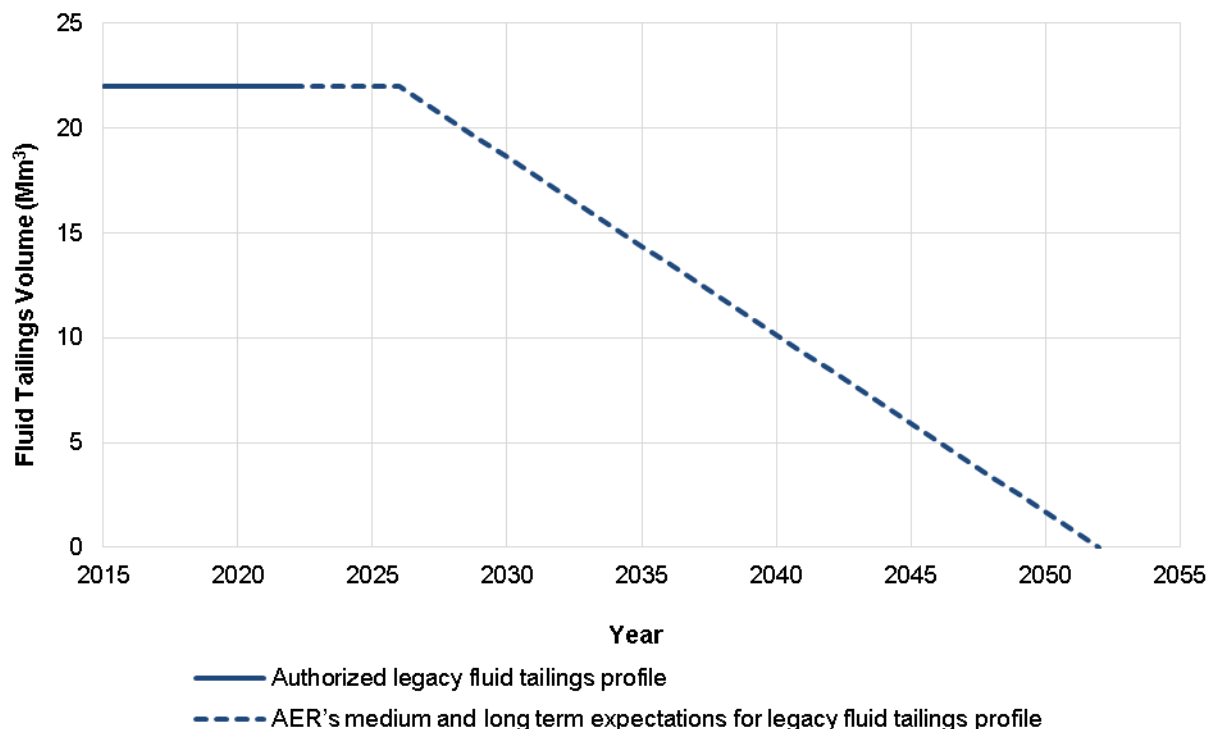


Figure 1. Legacy fluid tailings profile

[39] In the amendment application CNUL is required to provide a revised legacy fluid tailings profile that demonstrates that all legacy fluid tailings are RTR by the JPM's end of mine life and align with JPM's end of mine life (2052). At a minimum, the AER expects CNUL's amendment application to meet the legacy fluid tailings profile depicted in the dotted line in figure 1.

New Fluid Tailings Profile

Context

[40] 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.

[41] Under the existing *OSCA* approval, the JPM end of mine life is in 2052.

Decision Summary

[42] CNUL's new fluid tailings profile meets the *TMF* and *Directive 085* profile guidance until December 31, 2023. CNUL's new fluid tailings profile is authorized until December 31, 2023, 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 2 below depicts the authorized new fluid tailings profile that CNUL is required to achieve until December 31, 2023. The dotted blue line in figure 2 depicts the AER's medium and long

term expectations for the new fluid tailings profile. The solid red line in figure 2 depicts CNUL's proposed new fluid tailings profile between 2053 and 2110.

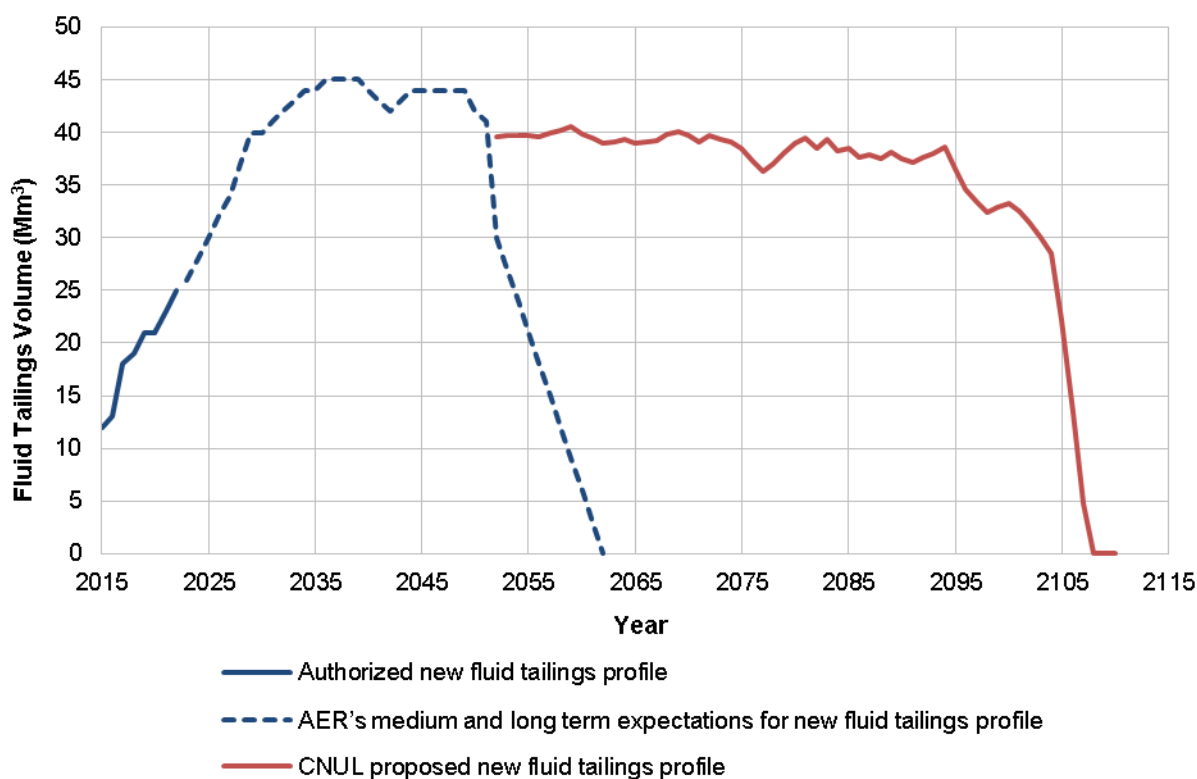


Figure 2. New Fluid Tailings Profile

[43] However, CNUL's proposed new fluid tailings profile beyond 2023 (see solid red line depicted in figure 2) does not meet the *TMF*'s objective or the *TMF* and *Directive 085* profile guidance:

- Although the *TMF* acknowledges that it may take more than three to ten years to accumulate the peak volume, CNUL is proposing growth in tailings accumulation until 2038, which is more than twenty years to accumulate the peak volume.
- The end of mine life target is greater than five years of fluid tailings production at JPM. 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 a production rate of about 6 million cubic metres per year (Mm^3/year) (estimated by the AER using CNUL's rate of growth and centrifuge production forecasts), the end of mine life target in 2052 should not exceed 30 Mm^3 , while CNUL proposed a volume of 40 Mm^3 in 2052.
- *Directive 085* indicates that the TMP must include sufficient information to demonstrate alignment with existing approvals. Under the existing *OSCA* approval, the JPM end of mine life is in 2052, not 2105 as proposed by CNUL in the TMP.

- The proposed new fluid tailings profile does not demonstrate that all new fluid tailings are RTR within ten years of JPM's end of mine life (2052).
- The *TMF* and *Directive 085* require profiles to be project specific. CNUL's new fluid tailings profile excludes fluid tailings volumes generated from froth transferred to the Muskeg River Mine from the JPM. Profiles are required to track project-specific fluid tailings volume, regardless of fluid or treated tailings storage and final placement locations.

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

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

- includes TSRU tailings from JPM,
- includes an end of mine life target that is no greater than five years accumulation of fluid tailings production at JPM, and
- demonstrates that all new fluid tailings generated at the JPM are RTR within ten years from end of mine life and align with the JPM's end of mine life (2052).

[46] At a minimum, the AER expects CNUL's amendment application to meet the new fluid tailings profile depicted in the dotted line in figure 2.

[47] 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 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.

Thresholds

Context

[48] 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 new and legacy 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 tailings management plans. Various management actions are required when thresholds are exceeded.

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

[50] 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 the new and legacy 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

[51] 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 and legacy fluid tailings profiles.

[52] The AER's decision to authorize the new fluid tailings profile until December 31, 2023, 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 is setting the total volume trigger at 26 Mm³ and the total volume limit at 36 Mm³.

[53] These thresholds remain in effect beyond December 31, 2023. The thresholds may be revised depending on the AER's decision on the amendment application.

[54] 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, 2023, *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

[55] 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

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

[57] CNUL currently uses thickeners and combines the thickened tailings with whole tailings and coarse sand tailings to form a mixed deposit. CNUL is also using four centrifuge units to treat tailings.

[58] CNUL continues to validate its tailings treatment technology and deposit performance. The thickener operation began at the JPM start-up in 2010, with placement of thickened tailings in a mixed deposit in the ETF's Dedicated Disposal Area (DDA) 1. The ETF is made up of Sand Cell (SC) 1, SC2, and DDA1. Centrifuge units were commissioned in 2014 with placement of centrifuge tailings into the ETF's DDA1. CNUL plans to start placing tailings in its next tailings deposit, Cell 1, starting in 2024.

[59] CNUL proposed that future growth in new fluid tailings production would be treated by additional centrifuges (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. CNUL continues to test tailings technology selection, including fluid tailings drying and AFD.

Decision Summary

[60] 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.

[61] 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 updates and the amendment application.

[62] Given the AER's concerns with thickeners, CNUL is authorized to use thickeners and combine the thickened tailings with whole tailings and coarse sand tailings to form a mixed deposit in the ETF's DDA1, subject to the approval terms and conditions, based on the following considerations:

- The thickeners provide marginal tailings treatment, and CNUL relies on combining thickened tailings with whole tailings and coarse sand tailings to achieve initial deposit performance expectations for physical properties such as stability, strength, and settlement.
- The ETF DDA1's (i.e., mixed 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 mixed deposit performance will be undertaken through the amendment application.

[63] The AER is concerned that CNUL will not be able to achieve initial deposit performance expectations in the mixed deposit. Further, the AER is concerned that the mixed 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 North Pool Deposit (NPD) Type deposit performance.

[64] 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, whole tailings, and coarse sand tailings placed in each mixed deposit together with the solids content and sands-to-fine ratio of the thickened tailings being placed in each mixed deposit and is required to report annually on these monitoring results.

[65] In light of the AER's concerns with centrifuge technology, CNUL is also authorized to continue to operate its four centrifuge units, subject to the approval terms and conditions, based on the following considerations:

- The continued use of CNUL's four centrifuge units and centrifuge tailings deposit will enable CNUL to evaluate the appropriateness of its plan to expand centrifuge treatment technology to match fluid tailings production over the life of the mine, starting with additional centrifuges (or equivalent technology) being deployed starting in 2027.
- CNUL would be able to employ mitigation measures (e.g., rehandling, additional treatment, capping with additional material) should the centrifuge deposit underperform or it is determined that CNUL cannot meet its long-term reclamation outcomes. Before CNUL's planned deployment of further centrifuges, further review and assessment of centrifuges and centrifuge deposits will be undertaken by the AER through its consideration of the amendment application.
- Any centrifuge tailings deposit must meet the future authorized RTR criteria (see the "Centrifuge Deposits" section).

[66] The AER is concerned with both of CNUL's treatment technologies and the ability of the tailings deposits to support future reclamation activities, achieve stable targeted ecosites, and meet the *TMF*'s outcomes. The AER has only approved a single deposit (i.e., the ETF), which is a mixed deposit and a centrifuge tailings deposit, and is requiring CNUL to submit the amendment application. The amendment application must address the medium- and long-term uncertainties associated with the mixed deposit and centrifuge tailings deposits. This includes environmental risk, segregation, settlement, capping material availability, deposit performance, and the ability of the mixed deposits and centrifuge tailings deposits to support future reclamation activities and achieve stable targeted ecosites that meet the *TMF*'s outcomes.

[67] Further, CNUL is required to include the following in the amendment application:

- an assessment of the performance and limitations for tailings deposits containing thickened tailings, whole tailings, and coarse sand tailings; tailings deposits containing centrifuge tailings; and other types of deposits that are being considered as part of its technology selection project;
- an update to the RTR 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; and

- an evaluation of the performance of past and current tailings deposits where similar tailings treatment technology and targeted ecosites were proposed.

[68] 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's TMP did not provide sufficient information for the AER to evaluate the use of fluid tailings drying or AFD at the JPM or indicate any volume of fluid tailings that would be treated using these technologies. Consequently, CNUL is not authorized to use fluid tailings drying or AFD.

[69] In the amendment application, CNUL is required to assess, describe, and propose the selected treatment technologies that 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 JPM's end of mine life.

[70] CNUL is also required to report annually on the progress of the ongoing tailings technology selection project.

[71] Because placement in the various new deposits will occur over the span of many decades, an updated plan is required one year before placement in the respective new deposit to ensure the AER is provided the most current information. CNUL is required to evaluate the performance of past or current tailings deposits where similar tailings treatment technology and targeted ecosites were proposed and mitigate uncertainties associated with the tailings treatment technology and tailings deposit performance one year before placing tailings in each new deposit. The AER will evaluate these future deposit plans and determine whether they align with applicable regulatory requirements and determine whether additional oversight is required. Additional information on the future deposit plans is in the section "Future Deposits."

[72] 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.

[73] Further, the CNUL will need to evaluate whether the treatment capacity is sufficient (i.e., equal to or greater than the new fluid tailings production rate) because CNUL may require additional treatment capacity to manage TSRU tailings and compensate for underperforming deposits.

[74] If the uncertainties in CNUL's TMP (e.g., mixed and centrifuge 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.

TSRU Tailings

Context

[75] 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 pose higher environmental risks because they contain residual solvent, other hydrocarbons (including asphaltenes), and sulphides.

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

Decision Summary

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

[78] The TMP does not contemplate construction of a froth treatment plant at JPM or TSRU tailings management at JPM. CNUL indicated that it is completing work to evaluate TSRU tailings transfer to JPM post-Muskeg River Mine'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.

[79] Any decisions regarding the froth treatment plant at JPM and the transfer of froth from JPM to Muskeg River Mine, 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.

[80] CNUL indicated that it is working to evaluate 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 impacts to JPM deposits which could contain TSRU tailings (i.e., mixed deposit and centrifuge deposits).

[81] CNUL stated that its evaluation of specific environmental risks associated with TSRU tailings would continue through 2018. 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 mixed deposit and centrifuge deposit performance, and
- the effects of TSRU tailings on the surrounding environment.

[82] The timing of this update on TSRU tailings management will be the same as the date in the Muskeg River Mine *OSCA* approval.

Water-Capping Technology

Context

[83] Water-capping technology involves the placement of water above of untreated or treated tailings for the purpose of creating a water-capped deposit as a closure landscape feature (“water-capped pit lake”).

[84] CNUL indicated that it was not proposing to have any water-capped pit lakes at the JPM.

Decision Summary

[85] OSEC expressed concern over the use of water-capped pit lakes 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-capped technology had a high degree of uncertainty and risk.

[86] Under the TMP, CNUL indicated that it was not proposing to have any water-capped pit lakes at the JPM. CNUL identified that Cell 12 would be an end-pit lake but that it would not contain any tailings.

[87] However, CNUL also indicated in its closure drainage map that Cell 3, 4, and 11, all of which contain tailings, could underlie several pit lakes. CNUL indicated it planned to apply the findings from Syncrude’s Base Mine Lake (BML) and Suncor’s Passive Aquatic Storage System (PASS) research to make future decisions on water-capped deposits. Therefore, it is unclear whether CNUL intends to use water-capping technology.

[88] 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.

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

[90] The AER recognizes that extensive research on water-capped tailings continues and the Government of Alberta likely 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 65(b) 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.

[91] CNUL may choose 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 38(g) and 48(c) of the approval, CNUL is required to plan for an alternative to water-capped pit lakes should water-capped pit lakes be proposed.

[92] Because CNUL has stated that it is not planning to use water-capping technology, the AER is not requesting additional research at this time.

Capping Material Availability

Context

[93] Adequate capping material, such as tailings sand, is 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.

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

- formation of mixed deposits
- cell construction for the purposes of building dams and tailings containment structures
- infilling activities
- tailings deposit capping

Decision Summary

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

[96] 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.

[97] CNUL is also required to provide in its annual reclamation progress tracking report the volume of tailings sand which meets the chemical criteria for suitable overburden and is available as capping material for the mixed deposit placement locations (appendix 5).

[98] 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.

[99] 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 with respect to 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.

[100] 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.

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

[102] 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.

[103] 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.

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

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

Storage

Context

[106] 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.

[107] 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

[108] The JPM's storage capacity needs are uncertain due to

- CNUL's bitumen expansion plans,
- resource optimization program outcomes,
- froth transfer from JPM to Muskeg River Mine, and
- storage competition between mine waste and tailings.

[109] 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

[110] Innovation is a principle of the *TMF* and *Directive 085*. For example, CNUL proposed an ongoing tailings technology selection project. CNUL confirmed that the ongoing tailings technology selection project, while intended to support the Muskeg River Mine, may result in changes to the type of tailings technology deployed at the JPM.

Decision Summary

[111] To facilitate innovation at JPM 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*.

[112] 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.

[113] 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

[114] 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.

[115] 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.

[116] 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.

[117] 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.

[118] 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.

[119] 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.

[120] 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.

[121] 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

[122] 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

[123] 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.

[124] 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.

[125] CNUL proposed to use the average solids content 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.

[126] 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 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.

[127] 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

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

[129] 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.

[130] 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: Mixed Deposit Trajectory."

Decision Summary

[131] 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.

[132] 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.

[133] 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.

[134] 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 the mixed deposit in the ETF, until a decision is made on the amendment application.

[135] 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., the ETF). The amendment application will include updated RTR criteria for all tailings deposits.

Subobjective 1: Mixed Deposit Trajectory

Context

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

[137] CNUL proposed the following RTR criteria for DDA1 thickened tailings deep cohesive deposit: 60 per cent solids content by weight in three years.

[138] CNUL did not include the types of ecosites it is targeting with its proposed RTR criteria.

Decision Summary

[139] CNUL proposed RTR criteria for the DDA1 thickened tailings deep cohesive deposit. However, CNUL does not have any thickened tailings deposits because the thickened tailings are placed with whole tailings and coarse sand tailings to form a mixed deposit in the ETF's DDA1. Therefore, the AER has interpreted that CNUL's proposed RTR criteria is applicable to the entire mixed deposit.

[140] The AER does not accept CNUL's proposed RTR criteria of 60 per cent solids content achieved within three years, with a proposed target end of 70 per cent or a capping milestone achieved in an undefined time period.

[141] CNUL's proposed RTR criteria may not adequately track the performance of the mixed deposit, does not assure the AER that the deposit's physical properties are on a trajectory to support future stages of activity, and introduces an unacceptable risk to achieving the long-term *TMF* outcomes. CNUL's

application did not assess the long-term deposit properties required to ensure that the mixed deposit can achieve stable targeted ecosites and the *TMF*'s outcomes and did not provide the types of ecosites it is targeting with the proposed RTR criteria.

[142] CNUL is required, in the amendment application, to provide updated RTR trajectory and criteria for each type of deposit, including mixed deposits. The AER expects that research and monitoring results will lead to improvements or additions to RTR criteria.

[143] CNUL stated that historical data shows the deposit could reach a proposed target of 70 per cent solids content in at least three years, acknowledging that this achievement may be attributed to the presence of coarse sand tailings and whole tailings.

[144] For the short term and until updated RTR criteria are authorized, CNUL is required to meet the following subobjective 1 RTR criteria for the thickened tailings, coarse sand tailings, and whole tailings mixed deposit in the ETF: 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 at least over the short term.

Subobjective 2

Context

[145] 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

[146] The AER approves CNUL's proposal to use its existing groundwater monitoring program as a subobjective 2 RTR criteria. 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).

[147] Because the AER is only authorizing the subobjective 1 RTR criteria for the ETF's mixed deposit, subobjective 2 RTR criteria is only authorized for this same deposit. Further, the ETF is the only tailings deposit operating at this time.

[148] 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 subobjective 2 criteria of the *EPEA* surface water monitoring program is not approved at this time.

[149] The AER is concerned with unique risks of the mixed deposit due to the high residual water content in the deposits containing thickened tailings or centrifuge tailings. It is uncertain whether the groundwater monitoring program alone is sufficient to address the high residual water content effects on the surrounding environment and on the ability to achieve long-term reclamation outcomes. Further, under its existing *OSCA* approval, CNUL was authorized to construct a froth treatment plant at the JPM, resulting in TSRU tailings treatment and placement at the JPM. Therefore, the AER expects that CNUL will also consider any unique risks posed by TSRU tailings management.

[150] CNUL is required to provide, in the amendment application, updated subobjective 2 RTR criteria for each type of deposit. The AER expects that CNUL will address TSRU tailings and the high residual water content and its effects.

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

Centrifuge Deposits

Context

[152] CNUL proposed the following RTR criteria:

- for centrifuge tailings and AFD in deep cohesive deposits (deep deposits): 40 per cent solids content by weight in 1 year
- for fluid tailings drying, AFD, and centrifuge tailings in thin lift deposits (thin lift deposits): 40 per cent solids content by weight in three to six months or placement of material in dumps (CNUL proposed an end target ranging between 40 and 60 per cent solids or capping)

[153] CNUL did not include the types of ecosites it is targeting with its proposed RTR criteria.

Decision Summary

[154] CNUL's proposed RTR criteria for the deep and thin lift centrifuge deposits do not represent CNUL's tailings deposits because CNUL did not identify any mixing of centrifuge tailings with AFD or dried fluid tailings.

[155] The AER does not authorize any RTR criteria for centrifuge tailings deposits, including deep deposits or thin lift deposits.

[156] CNUL's proposed RTR criteria may not adequately track the performance of the centrifuge deposits. CNUL's application did not assess the long-term deposit properties required to ensure that the centrifuge deposit can achieve stable targeted ecosites and the *TMF*'s outcomes and did not provide the types of ecosites it is targeting with the proposed RTR criteria. Neither the proposed RTR criteria or end targets assure the AER that the deposit's physical properties are on a trajectory to support future stages of activity. All of which introduces an unacceptable risk to achieving the long-term *TMF* outcomes.

[157] CNUL is required to provide subobjective 1 and subobjective 2 RTR criteria for tailings deposits containing centrifuge tailings (e.g., ETF DDA1) by September 30, 2018. Centrifuge tailings cannot be removed from the fluid tailings inventory unless the AER approves the RTR criteria for deposits containing centrifuge tailings and the deposits meet the approved RTR criteria. This includes previously deposited and future deposited centrifuge tailings.

Water-Capped Deposits

Context

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

[159] Although no water-capped deposits are proposed at the JPM, CNUL did propose an RTR criteria for water-capped deposits as "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 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, and 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 the *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 the ETF by September 30, 2019. 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] CNUL is required to explain how the model or analysis results have been incorporated 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.

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

[172] CNUL is also required to continue to report on research on stability and capping implications to wetlands reclamation risks as part of its tailings research report required under its *EPEA* approval as set out in appendix 4.

Deposit Milestones

Context

[173] *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

[174] CNUL is required to commence capping of each tailings deposit within one year of completing tailings placement in the deposit.

[175] CNUL estimated the ability to cap deposits within one year of completing tailings placement. However, CNUL did not provide specific evidence to support this conclusion. CNUL indicated it is currently validating its tailings deposit performance.

[176] CNUL is required to commence capping of each tailings deposit within one year of completing tailings placement in the deposit. This will ensure that CNUL will meet what it specified in the TMP. Additional information on the AER’s findings with respect to capping can be found in the “Capping Material Availability” and “Deposit Settlement” sections.

Stakeholder and Indigenous Community Engagement

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

Decision Summary

[178] 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.

[179] 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.

[180] 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 2021 may be more robust as CNUL will be submitting an amendment application in 2022.

[181] CNUL is required to report to the AER on the details of its engagement efforts on an annual basis.

Environmental Effects and Implications

[182] 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

[183] 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.

[184] 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.

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

[186] 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

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

[188] 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

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

[190] 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.

[191] 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.

[192] 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.

[193] CNUL is required to continue to research wetlands and 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). The AER expects that this will address uncertainties and risks concerning water quality, the viability and sustainability of pit lakes, the effect of source water quality on the viability of pit lakes, and the ability of wetlands and pit lakes to become self-sustaining boreal forest ecosystems.

Tailings Water Release

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

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

[196] CNUL did not request approval to release water as part of application 1870297.

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

Additives and Polymers

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

[199] 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.

[200] 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

[201] *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.

[202] 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.

[203] Although CNUL submitted mass balance tables and status maps as part of the TMP application, CNUL has not provided a mine plan for the JPM 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

[204] *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.

[205] The AER notes two areas that warrant review to ensure alignment with the TMP. First, CNUL identified tailings deposit configuration changes that have implications for closure, including pit lake locations. OSEC raised concerns with the clarity of the end-pit lake location. The AER shares this concern because CNUL indicated in its closure drainage map that Cell 3, 4, and 11, all of which contain tailings, could underlie several pit lake locations. CNUL plans to submit changes with the 2018 life of mine closure plan, and the amendment application is required before CNUL develops its next tailings deposit. The AER is not authorizing any configuration changes at this time.

[206] Second, CNUL identified that the technology proposed in the TMP will likely lead towards wetter ecosite types (i.e., more wetland area) on each of the tailings deposits compared to previously submitted plans for the JPM. Further, CNUL identified that it is considering future changes to proposed closure designs in the next life of mine closure plan (expected in 2018) such as modifications to the target ecosite for various tailings deposits.

[207] Further, CNUL is required to demonstrate alignment with the *TMF*'s outcomes as part of its *EPEA* 2018 life of mine closure plan and mine reclamation plan submissions (appendix 5). Further, 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 *EPEA* 2018 life of mine closure plan and the amendment application, CNUL may require an application under *EPEA* or additional authorizations or amendments to its approvals.

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

Future Deposits

[209] 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 prior to placement in the respective new deposit, to ensure the AER is provided the most current information.

[210] 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 1 to 12.

[211] Because CNUL began placing tailings in FC1 while the TMP was under review, CNUL is required to provide a plan that updates fluid tailings management in FC1 by December 30, 2018.

[212] 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

[213] 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.

[214] 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).

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

Conclusion

[216] The AER has decided to only approve the TMP profiles until December 31, 2023. CNUL is required to submit an amendment application in 2022 that contains the TMP for the life of the project and addresses the uncertainties and deficiencies identified in this report.

[217] There are three reasons why the AER has decided to require an amendment application in 2022. First, CNUL's TMP is inconsistent with existing approvals. Second, the new and legacy fluid tailings profiles in CNUL's application are not in alignment with existing approvals, the TMF, and Directive 085 over the medium and long term. Third, the degree of uncertainty in CNUL's proposed RTR criteria, RTR trajectory, and targeted ecosites over the medium and long term is unacceptable.

[218] The AER is also concerned with CNUL's treatment technologies (e.g., thickeners with the formation of a mixed deposit and centrifuges) and the ability of the tailings deposits to support future reclamation activities and achieve stable targeted ecosites to meet the *TMF*'s outcomes.

[219] In light of these concerns, CNUL must assess the tailings deposits containing thickened tailings, whole tailings, and coarse sand tailings; tailings deposits containing centrifuge tailings; and other types of deposits in the amendment application.

[220] The AER's decision to authorize the new fluid tailings profile until December 31, 2023, 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.

[221] 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, 2023, *Directive 085* clearly 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.”

[222] 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.

[223] 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 their 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

<p>MADE at the City of Calgary, in the Province of Alberta, on</p> <p><i><original dated></i></p>	<p><i><original signed></i></p> <p>ALBERTA ENERGY REGULATOR</p>
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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;

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. 9756G (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. 1271285, 1567032, 1568930, 1625823, 1760363, 1554388, 1855117, 1870297, 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 must submit a lease boundary update five years before any disturbance along a common lease boundary, unless some other reporting date is stipulated by the AER.
3. The Operator must submit, for AER approval, a resource assessment of the three waste disposal areas and reclamation material stockpile two years prior to material placement.

4. The Operator must satisfy the AER, two years prior to construction of either the Khahago surge facility or the tailings disposal area, that the design of the tailings disposal area, including the surge facility, provides for adequate capacity, stability, and minimization of resource sterilization and environmental impact.
5. The Operator must provide a report on the Operator's progress in dealing with separation characteristics of asphaltenes in the tailings solvent recovery unit (TSRU) tailings every 5 years, or as otherwise specified by the AER, starting on or before February 28, 2021.
6. The Operator must provide to the AER annually, on or before February 28, a calculation showing the amount of asphaltene rejection based on bitumen production, for the previous year of operation.
7. On an annual average basis, the Operator must limit the amount of asphaltene rejection to 10 mass per cent based on bitumen production.
8. 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. This calculation must be based on site-wide losses and must include all solvent losses during all operating conditions.
9. The Operator must not discharge untreated froth treatment tailings to the tailings ponds or deposition locations.
10. The Operator must provide a report, for AER approval, detailing its mine plans near the Pleistocene Channel Aquifer (PCA) five years prior to mining in this area to allow for the consideration of resource recovery issues and environmental impacts. Commencing in 2005, the Operator must provide to the AER an annual report on regional development cooperation.
11. The AER approves in concept the integration of the Jackpine Mine and the Muskeg River Mine subject to the following conditions:
 - (a) Beginning in 2009, as part of its annual mine plan submission, the Operator must report on all changes to its mining, tailings, and reclamation management plans as a result of transferring bitumen, tailings 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 for the AER's review and approval, including process and instrumentation diagrams, metering, sampling methods and material balancing procedures that satisfy the requirements of Directive 082: Operating Criteria: Resource Recovery Requirements for Oil Sands Mine and Processing Plant Operations.
 - (c) One year prior to commissioning the emergency tailings transfer line, the Operator must provide measurement plans for the AER's 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 any such transfer will have on the Operator's mining, tailings and reclamation plans; and
 - (e) Except in emergency situations, the Operator must not transfer tailings between

the projects without prior approval from the AER.

12. The Operator must submit, for AER approval, a geotechnical interaction assessment of the North overburden disposal area (OBDA), the Muskeg River diversion channel (MRDC), and the pit wall before any earth work begins at the interaction area of the North OBDA, the MRDC, and the pit wall.
13. The Operator must provide an update on its plans for dewatering and mining through the PCA, five years before mining operations reach the PCA. The update is to include a description of any changes that the Operator intends to make when dewatering and mining the PCA as a result of the Operator's experience at Phase 1.
14. The Operator must provide an updated geohazard management plan as a part of its annual mine plan submission, commencing with the expansion mining operations.
15. The Operator must provide a bitumen recovery improvement plan for AER approval two years before expansion project construction begins. This plan must include details of all bitumen recovery improvements the Operator intends to incorporate into its expanded Jackpine Mine plant (i.e., Phase 1 and the Project) design and mine plan.
16. The Operator must provide measurement plans, for AER approval, one year before the expanded Jackpine Mine plant start-up. These plans must include process and instrumentation diagrams, metering, sampling methods, analytical methods, and material balance procedures that satisfy AER measurement requirements.
17. The Operator must provide a commissioning and start-up plan, for AER approval, one year before the expanded Jackpine Mine plant start-up.
18. 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.
19. 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.
20. 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.
21. 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.
22. Clauses 18 to 21 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.
23. 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.
24. The plan in clause 23 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.
25. The Operator must provide, within one year after expansion operations start-up, a post-construction, comprehensive sound monitoring survey of the expansion project, including measurements of expansion equipment, to verify compliance with *Directive 038*.
 26. The Operator must provide an update to its noise impact assessment (NIA) or must complete and provide a comprehensive sound monitoring survey to demonstrate compliance with *Directive 038*, after The Operator has selected new tier IV haul trucks.
 27. The Operator must place low-permeability material against all water-bearing permeable zones exposed in the pits (including the PCA) to effectively reduce the potential for PAW to be released out of the backfill into those permeable zones.
 28. The Operator must provide as part of its annual report to the AER that describe: the Operator's EPL research and development efforts for the preceding year; the Operator's plans and timelines intended to demonstrate the efficacy of EPLs within the next twenty years; and alternatives to passively treating water in EPLs. The reports must include all of the Operator's efforts and contributions towards collaboratively demonstrating a full-scale EPL. The first such report must be provided two years before the expanded project plant start-up.
 29. Before beginning expansion mining operations, the Operator must provide a comprehensive economic assessment of feasible active water treatment options that the Operator could implement to ensure that EPLs will meet water release criteria at closure.
 30. The Operator must use all necessary strategies, including watershed design, landscape contouring, and succession and revegetation planning, to ensure the specified areas evolve into wetlands after closure.
 31. The Operator must provide a report on the status of all stages of wetland reclamation on Phase 1 and the expansion project as part of its annual conservation and reclamation report. The Panel also requires the Operator to report any findings that it makes or is aware of related to wetland reclamation research on disturbed oil sands mine sites.
 32. The Operator must remove all benching on mine discard structures before final reclamation.
 33. The Operator must provide, for AER approval, a detailed watershed design report for all mine structures one year before the final placement of reclamation material.
 34. The Operator shall achieve the:
 - (a) profile specified in Appendix B, Table 1; and
 - (b) profile specified in Appendix B, Table 2.
 35. 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.
 - (b) the profile deviation trigger specified in Appendix B, Table 4.
 36. If any limit or trigger in clause 35 is exceeded, the Operator shall comply with the management response or action directed by the AER.
 37. The Operator shall provide an amendment application by September 30, 2022, or such

other date as the AER may stipulate in writing.

38. The amendment application in clause 37 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 update in clause 44;
- (b) the bitumen production expansion rates and implementation dates;
- (c) revised profiles for new and legacy fluid tailings that:
 - (i) include TSRU tailings from the Jackpine mine site;
 - (ii) provide a revised end of mine life target that is no greater than 5 years of fluid tailings production at the Jackpine mine site;
 - (iii) demonstrate that all new fluid tailings are ready to reclaim within 10 years from Jackpine Mine's end of mine life;
 - (iv) demonstrate that all legacy fluid tailings are ready to reclaim by Jackpine Mine's end of mine life; and
 - (v) align with Jackpine Mine's end of mine life of 2052;
- (d) assess, describe, and propose the selected treatment technologies that
 - (i) ensures the treatment capacity of the selected treatment technologies is equal to or greater than the production rate of new fluid tailings; and
 - (ii) ensures legacy fluid tailings will be ready to reclaim by Jackpine Mine's end of mine life;
- (e) assess and propose the alternatives for TSRU tailings management;
- (f) demonstrate that the centrifuge, thickened tailings or selected treatment technologies achieve performance parity with other comparable technologies;
- (g) 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;
- (h) evaluate the performance of past and current tailings deposits where similar tailings treatment technology and targeted ecosites were proposed;
- (i) 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;
- (j) justify the required activities, materials and timelines to achieve milestones;
- (k) assess the performance and limitations for tailings deposits containing thickened tailings, tailings deposits containing centrifuge tailings, and other types of deposits;
- (l) explain how any consolidation model or engineering analysis results have been incorporated;

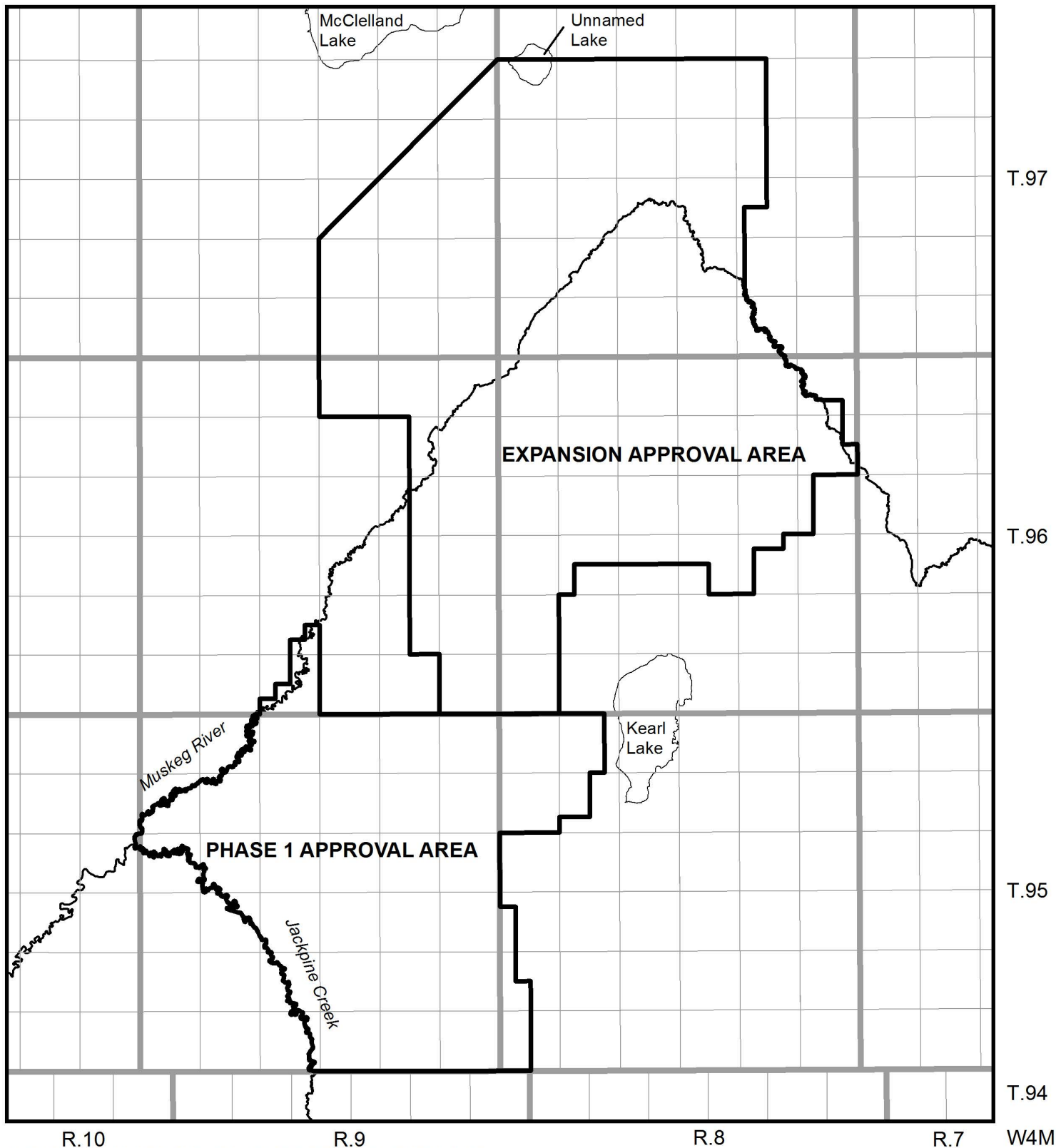
- (m) explain how research results, including capping research, and long-term reclamation outcomes have been incorporated;
 - (n) mitigate uncertainties associated with the tailings treatment technology, tailings deposit performance and ready to reclaim trajectory; and
 - (o) provide any other information the AER may require.
39. Subject to clause 40, the Operator shall achieve the ready to reclaim criteria as set out in Appendix C.
40. (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 40(b) to the satisfaction of the AER; and
 - (ii) the AER has revised Appendix C to allow the modified ready to reclaim criteria.
41. The Operator shall provide by September 30, 2018, or such other date as the AER may stipulate in writing, ready to reclaim criteria for deposits containing centrifuge tailings.
42. The Operator shall not use the ready to reclaim criteria required by clause 41 unless:
- (a) the Operator has provided the information required by subclause 40(b) to the satisfaction of the AER; and
 - (b) the AER has revised Appendix C to allow the ready to reclaim criteria.
43. The Operator shall not remove tailings treated by centrifuge from the fluid tailings inventory unless the AER has revised Appendix C to include the ready to reclaim criteria for deposits containing centrifuge tailings.
44. The Operator shall provide, by September 30, 2020, or such other date as the AER may stipulate in writing, an update on TSRU tailings management.
45. The update in clause 44 shall:
- (a) describe the options the Operator is considering for the treatment and placement of TSRU tailings;
 - (b) provide an evaluation on how TSRU tailings impact the performance of tailings deposits containing thickened tailings and centrifuge tailings 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; ~~and~~
 - (d) provide any other information the AER may require.
46. The Operator shall provide 1 year prior to placement of fluid tailings or treated tailings in each of Cell 1, Cell 2a, Cell 2b, Cell 3, Cell 4, Cell 5, Cell 6, Cell 7, Cell 8, Cell 9, Cell 10, Cell 11, or Cell 12, or such other date as the AER may stipulate, a plan that updates fluid tailings management.
47. The Operator shall provide by December 30, 2018, or such other date as the AER may stipulate in writing, a plan that updates on fluid tailings management in FC1.
48. Each plan in clause 46 and the update in clause 47 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.
49. The Operator shall provide by September 30, 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 milestones, as specified in writing by the AER, for the external tailings facility (ETF).
50. If the model or engineering analysis in clause 49 are found deficient by the AER, the Operator shall correct all deficiencies identified in writing by the AER by the date specified by the AER.
51. Within one year of completing tailings placement in each tailings deposit, the Operator shall commence capping of that tailings deposit.
52. The Operator shall submit a research plan for the closure for any of the deposits upon request by the AER.
53. 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.
54. The plan in clause 53 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.
55. The Operator shall not implement any of the plans in clauses 46, 47, and 53 unless an approval amendment or written authorization is granted by the AER.
56. The Operator shall monitor:
- (a) on a quarterly basis or such other basis as the AER may stipulate in writing, the volumes of whole tailings and coarse sand tailings mixed with thickened tailings to form the ETF;
 - (b) 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
 - (c) any other parameter on the basis as specified in writing by the AER.
57. 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) the volumes of whole tailings and coarse sand tailings mixed with thickened tailings to form the mixed deposit at the end of the reporting period;
 - (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 specified in writing by the AER.
58. 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”).
 59. The Operator shall not release any substance to the surrounding environment except as authorized under the EPEA Approval.
 60. 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 obtained from the AER.
 61. The Operator shall engage with stakeholders and indigenous communities on the activities undertaken under this Scheme Approval in respect of tailings management.
 62. 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.
 63. The Operator shall report in the annual fluid tailings management report on engagement efforts undertaken in the reporting period.

64. The report in clause 63 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.
65. 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.
66. The AER may,
- (a) upon its own motion, or
 - (b) upon the application of an interested person, rescind or amend this Scheme approval at any time if, in the opinion of the AER, circumstances so warrant.
67. AER Approval No. 9756, 9756A, 9756B, 9756C, 9756D, 9756E, and 9756F are hereby repealed, rescinded, and replaced with the AER Approval No. 9756G.



R.10 R.9 R.8 R.7
CANADIAN NATURAL UPGRADING LIMITED
JACKPINE MINE PROJECT

APPENDIX A TO APPROVAL NO. 9756G

Legend

— OSCA Approval Area



0 1 2 4 6 8
 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

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CANADIAN NATURAL UPGRADING LTD.
APPENDIX B TO APPROVAL NO. 9756G

Table 1. New Fluid Tailings Profile

Year	Approved Profile New FT Inventory (million cubic metres)
2015	12
2016	13
2017	18
2018	19
2019	20
2020	21
2021	23
2022	25
2023	26

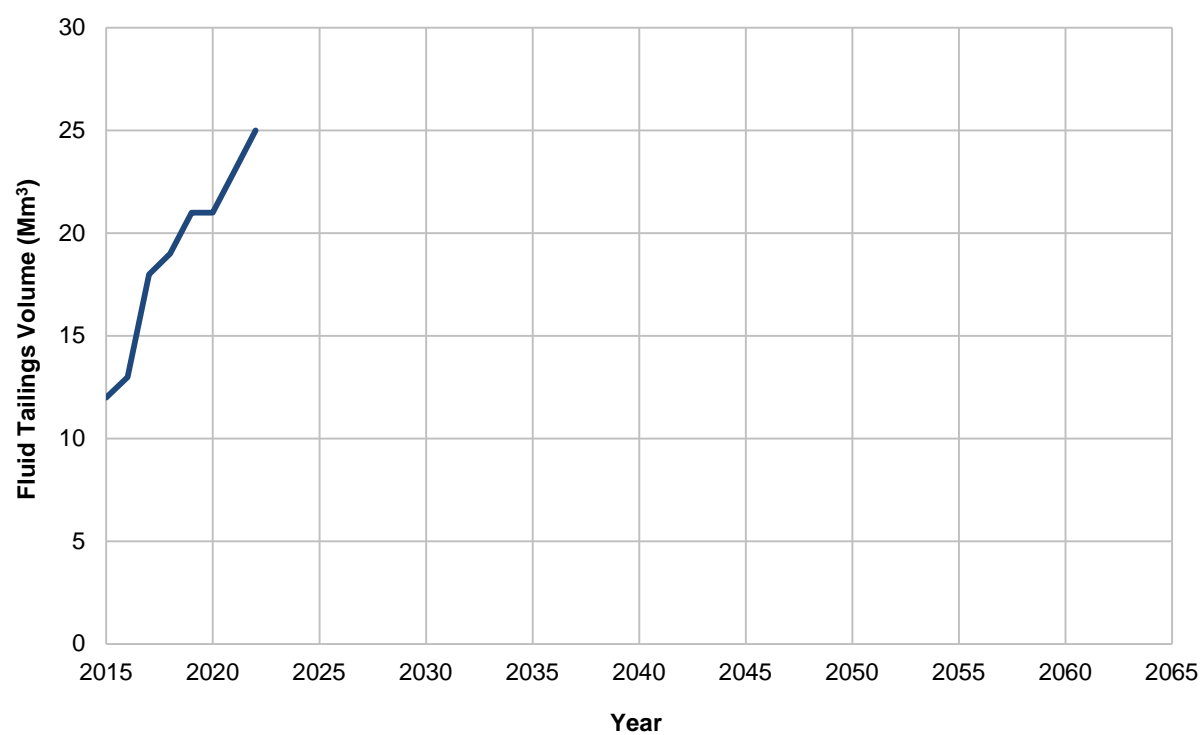


Figure 1. New Fluid Tailings Profile

Table 2. Legacy Fluid Tailings Profile

Year	Approved Profile Legacy FT Inventory (million cubic metres)
2015	22
2016	22
2017	22
2018	22
2019	22
2020	22
2021	22
2022	22
2023	22

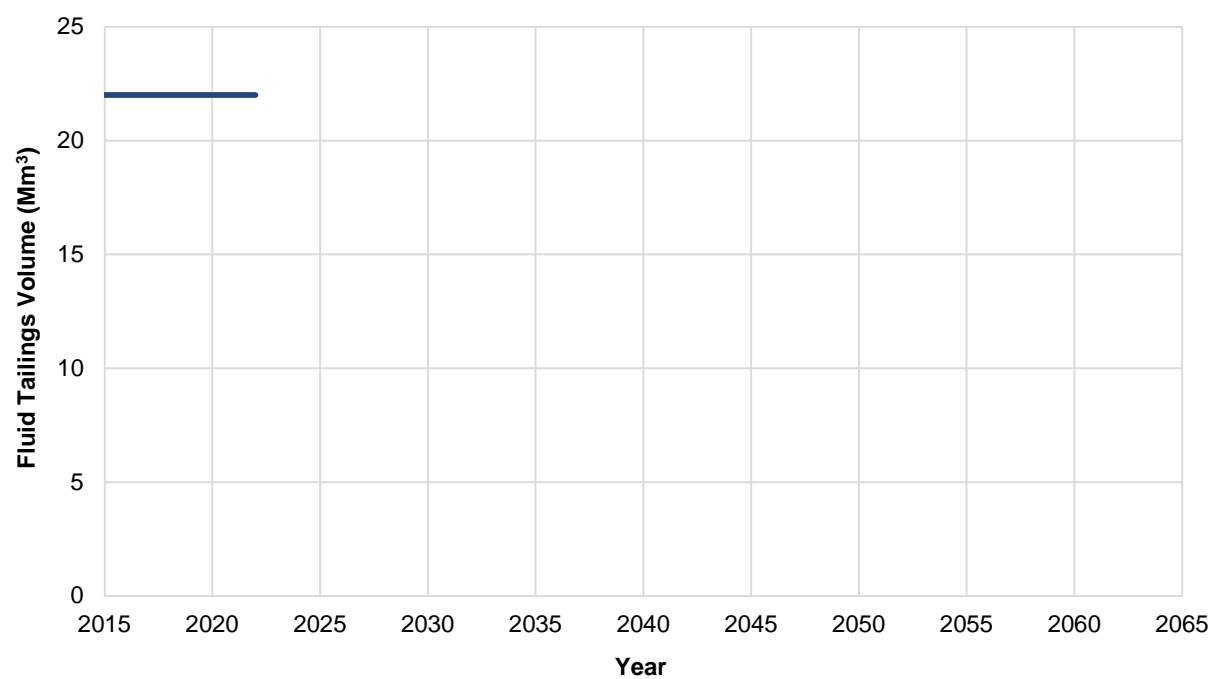

Figure 2. Legacy Fluid Tailings Profile

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	26 million cubic metres	n/a
Total Volume Limit	36 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. 9756G

Table 1. RTR Criteria for Canadian Natural Upgrading Ltd.

Deposit	Subobjective	RTR criteria
mixed deposit in ETF	Subobjective 1	70 per cent 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. 153125-00-00, as amended or renewed

Appendix 3 Submissions Timelines

Month	2018	2019	2020	2021	2022
April		Additional reporting under <i>Directive 085</i>	Additional reporting under <i>Directive 085</i>	Additional reporting under <i>Directive 085</i>	Additional reporting under <i>Directive 085</i>
September	Centrifuge tailings RTR criteria Updated mine plan Capping research plan	ETF model/analysis	Update on TSRU tailings management		Amendment application
November	Measurement system plan				
December	Update on FC1 fluid tailings management				

*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

<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

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Canadian Natural Upgrading Limited

Jackpine Mine Oil Sands Mine Tailings Management Plan

Tailings Research Report and End Pit Lake Research Plan and Report Letter

Dear Mr. Wytrychoski:

In accordance with clause 5.1.32(c) of *Environmental Protection and Enhancement Act (EPEA)* Approval No. 153125-00-00, as amended (the “Approval”), and subject to the terms and conditions of the Approval, the Alberta Energy Regulator (AER) requires the following other information to be reported in the Tailings Research Report:

- For terrestrial ecosystem research:
 - capping objectives in addition to rooting-zone protection on tailings deposits;
- For wetland ecosystem research:
 - hydrologic models to create treatment wetlands, wetlands exposed to process affected waters, or other wetlands types associated with tailings deposits in the reclaimed landscape,
 - suitability and depth of capping materials and reclamation materials required to cover tailings deposits,
 - stability of reclaimed tailings surfaces over time and the implications to the size and type of wetland ecosystems for different deposit designs 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,
 - identification of suitable soils, site preparation and soil placement for wetlands constructed on tailings deposits or those affected by tailings water inflows;
 - seepage from tailings deposits, and placed coversoil, subsoil or overburden into groundwater or surface water,
 - Validation that developing wetlands are from surface drainage and not breakthrough to the surface from mixed tailings, centrifuge or thickened tailings
- Research assumptions, predictions, and validations concerning long term chemistry and mineralogy of tailings, tailings water, and additives or polymers, and their implications to the environment, human health and reclamation, based on research topics identified in CNUL's EPEA and OSCA approvals.

If you have any questions regarding this correspondence, please contact Doug Koroluk at (403) 297-6306 or doug.koroluk@aer.ca.

Regards,

<original signed by>

Paul Ferensowicz

cc: Doug.Koroluk@aer.ca Charles.MacDonald@aer.ca
 Virginia.Hughes@aer.ca Angie.Taksas@aer.ca
 Eric.Chiu@aer.ca Karen.McCallion@aer.ca
 Jim.Jordan@aer.ca Tara.Wang@aer.ca

Appendix 5 EPEA Life of Mine Closure Plan, Mine Reclamation Plan, and Annual Reclamation Progress

<original dated>

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Canadian Natural Upgrading Limited

Jackpine Mine Tailings Management Plan, Application 1870297

**Life of Mine Closure Plan, Mine Reclamation Plan, and Annual Reclamation Progress Tracking
Report Requirements**

Dear Mr. Wytrychoski:

In accordance with clause 5.1.11 and 5.1.14 of *Environmental Protection and Enhancement Act (EPEA)* Approval No. 00153125-00-00, as amended (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) Life of Mine Closure Plan and Mine Reclamation Plan:

- Rationale for defining capping requirements for deposits formed by thickened tailings, whole tailings, and coarse sand tailings in the ETF (“mixed 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 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, and
- Demonstrate alignment with the Life of Mine Closure Plan required by *EPEA* Approval No. 00153125-00-00 and the ability to achieve self-sustaining locally common boreal forest ecosystems.

The AER also requires the following other information in CNUL's annual reclamation progress tracking report:

- the volume of tailings sand which meets the chemical criteria for suitable overburden and is available as capping material for the mixed deposit placement locations.

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

Regards,

<original signed by>

Paul Ferensowicz

cc: Allen.Xu@aer.ca Angie.Taksas@aer.ca
Camille.Almeida@aer.ca Paul.Elkins@aer.ca
Margaret.Magai@aer.ca Charles.MacDonald@aer.ca
Karen.Stals@aer.ca Doug.Koroluk@aer.ca
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Appendix 6 Measurement System Plan Requirements

<original dated>

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Canadian Natural Upgrading Limited

Jackpine Mine Tailings Management Plan, Application 1870297

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 56 and 57 of Approval No. 9756G, CNUL must monitor and report on volumes of whole tailings, coarse sand tailings, and thickened tailings being placed in each mixed 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
Virginia.Hughes@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>

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Canadian Natural Upgrading Limited

Jackpine Mine Tailings Management Plan

Environmental Protection and Enhancement Act Approval No.: 153125-00-00, as amended

Chemicals Used in Tailings Treatment Information Requirements

Dear Mr. Wytrychoski:

In accordance with clause 5.3.21 (d) of *Environmental Protection and Enhancement Act (EPEA)* Approval No. 153125-00-00, as amended, 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 thickened tailings and centrifuge 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; and
- any other information the AER may require.

If you have any questions regarding this correspondence, please contact Doug Koroluk at (403) 297-6306 or doug.koroluk@aer.ca.

Regards,

<original signed by>

Paul Ferensowicz

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Appendix 8 Decommissioning Plan for Dams

<original dated>

By e-mail only

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Canadian Natural Upgrading Limited

Jackpine Mine Tailings Management Plan, Application 1870297

Decommissioning Plan for Dams

Dear Mr. Wytrychoski:

In accordance with section 32 of the *Water (Ministerial) Regulation* and subject to the terms and conditions in *Water Act* Approval No. 00205433-00-01, the Alberta Energy Regulator (AER) sets out the following initial requirements 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 the dams.

CNUL shall not implement the plan for decommissioning the dams unless written authorization or approval amendment 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

Allen.Xu@aer.ca

inquiries 1-855-297-8311
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Angie.Taksas@aer.ca