

State of Fluid Tailings Management for Mineable Oil Sands, 2018

September 2019

Alberta Energy Regulator

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Published by

Alberta Energy Regulator

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1 Introduction

The Alberta Energy Regulator (AER) report on the *State of Fluid Tailings Management for Mineable Oil Sands, 2018* summarizes information submitted by oil sands mine operators in their annual tailings management reports.

Both an approved tailings management plan and an assessed measurement system plan are required in order to assess the data in operators' annual tailings management reports, and both are required in order to assess fluid tailings inventory data because they allow for the determination of what volumes are considered ready to reclaim (RTR) and can, therefore, be removed from the fluid tailings inventory of the operator. Operator reports for 2018 must adhere to all reporting requirements in *Directive 085: Fluid Tailings Management for Oil Sands Mining Projects* and to conditions in each operator's tailings approvals. The AER continues to assess measurement system plans submitted by operators. The tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Annual tailings management reports submitted by operators are reviewed by subject matter experts within the AER. Their review may lead to the AER asking an operator for clarification or additional information. In addition, potential compliance issues that may arise are referred to the AER's Environment and Operational Performance (EOP) team. Further review of industry information by the AER may lead to changes in data presented in the AER's annual tailings performance reports. Any changes will be incorporated into the 2019 edition of this report, which will be issued by September 30, 2020.

2 Purpose

The purpose of this year's report is to summarize information from individual operators (based on *Directive 085* requirements):

- fluid tailings volumes in the region and for each operator,
- water volumes stored in tailings ponds in the region and for each operator,
- whether operators are within their approved fluid tailings profiles,
- site-wide fluid tailings management activities for each mine site,
- tailings treatment and the development of treatment technologies,
- report on project specific performance,
- progress made in managing fluid tailings,
- alignment with approved tailings management plans,
- regulatory and management actions related to tailings taken by the AER, and

- summary of the annual review of tailings reports submitted by operators.

This report does not address mine financial security, waterfowl protection, dam safety, or air emissions (gasses released) from tailings ponds. More information on these issues can be found on the AER website (www.aer.ca) or on the Alberta Environment and Parks' oil sands information portal (<http://osip.alberta.ca/>). This report also does not include information on audits or inspections conducted by the EOP team or information reported on the AER Compliance Dashboard. However, it does include a summary of tailings-related regulatory site visits in 2018 (see appendix 1).

3 Background

The AER regulates oil sands mines and the associated management of fluid tailings as part of its mandate to ensure the safe, efficient, orderly, and environmentally responsible development of energy resources over the entire development life cycle.

About 20 per cent of Alberta's oil sands reserves are recoverable by surface mining, which excavates oil sands using trucks and shovels and transports it to extraction plants where the bitumen is then separated from the sand. This bitumen can be sold as a product or upgraded to synthetic crude oil, which is then sold. Tailings, which consist of sand, clay, water, silts, residual bitumen and other hydrocarbons, salts, and trace metals are wastes generated as part of the mining and bitumen extraction process and must be managed.

3.1 2018 Reporting

The AER requires operators to report on the status of fluid tailings management at their sites by April 30 of each year in accordance with the AER's *Directive 085*. For most operators, 2018 marked the second year for submitting annual tailings management reports. It was also the first year where all operators, with the exception of Syncrude Canada Limited (Syncrude) for its Mildred Lake project and Fort Hills Energy Corporation (Fort Hills) for the Fort Hills Mine, were required to meet full reporting requirements under *Directive 085* and their conditions of approval. Operator submissions for 2018 were made available on the AER website, www.aer.ca, on May 31, 2019, under [Providing Information > By Topic > Tailings](#).

During its evaluation and decision-making process for tailings management plans in 2018 and 2019, the AER expected operators to continue treating and managing fluid tailings, in addition to all other regulatory and legislative requirements for oil sands mining and fluid tailings management.

3.1.1 2018 Report Review

As part of its review of operator submitted reports for 2018, the AER assessed the operators' reported RTR status, progress and trends, consistency with 2017 annual reports, and approval conditions. The intent of the review is to ensure that:

- operators are implementing their approved fluid tailings management plan, including confirming that conditions related to fluid tailings management are being met and stated milestones are being achieved;
- fluid tailings performance is in accordance with their profiles;
- fluid tailings deposits are meeting RTR criteria and are on the applicable trajectory; and
- initiated mitigation actions and contingency plans are effective in managing fluid tailings and treated tailings deposit performance.

The majority of oil sands mining operators had an approved tailings management plan by the end of 2018 (see table 1). Fort Hills was not required to submit an annual report for 2018 for the Fort Hills Mine. Syncrude Mildred Lake submitted a report in 2018, even though it did not have an approved tailings management plan, because its tailings management plan was under review as part of its Mildred Lake Extension application.

Table 1. Tailings management plan approval dates

Project	Tailings management plan approval date
Suncor Energy Incorporated (Suncor) Millennium and Base Plant	October 25, 2017
Canadian Natural Resources Limited (CNRL) Horizon	December 18, 2017
Canadian Natural Upgrading Limited (CNUL) Jackpine Mine (JPM)	May 23, 2018
CNUL Muskeg River Mine (MRM)	May 23, 2018
Syncrude Aurora North	June 13, 2018
Imperial Oil Resources Limited (Imperial) Kearl	July 15, 2018
Fort Hills Mine	February 25, 2019
Syncrude Mildred Lake	July 16, 2019

3.1.1.1 Measurement System Plans and RTR Criteria

Measurement system plans contain operators' sampling, analysis, and verification systems to establish the volume of fluid tailings at a mine site. These measurement system plans influence the reported data quality and clarify the nature and degree of uncertainties of data and analysis in operator reports. Measurement system plans are necessary for in-depth review of data provided by operators. Uncertainties to be considered include operators' projections from mid-year measurements and analysis to year-end inventories. Assessments of measurement system plans may lead to clarification or adjustments to information in operators' tailings management reports, such as changes to fluid tailings volumes, treated fluid tailings volumes, or water volumes in ponds or deposits.

Key to the *Lower Athabasca Region: Tailings Management Framework for Mineable Athabasca Oil Sands* (TMF) is the quantification of the volume of fluid tailings initially formed. *Directive 085* establishes

acceptable measurement methods for this quantification (see appendix 4 of *Directive 085*). The operators' measurement system plans give details on how this method is applied to specific sites.

Completion of the assessment of operator measurement system plans is required for the AER to conduct a thorough review of the data, analysis, and information that operators report about the measured volume of fluid tailings on site and the volume and condition of treated fluid tailings that meet RTR criteria and RTR trajectory.

In 2018, operators were required to identify volumes of treated fluid tailings that met RTR criteria. The TMF and *Directive 085* both require that the progress of fluid tailings and progress of treated fluid tailings management be tracked from initial formation (accumulation) through to the initial RTR state and its continuation on a trajectory showing that it remains in its approved RTR state. Tracking includes processing with an accepted technology, final placement on the landscape, and achievement of the approved RTR trajectory and performance criteria. RTR criteria are intended to track treated fluid tailings during the operational stage of the deposit to ensure that the deposit can be reclaimed as predicted in the life-of-mine closure plan, and in the time predicted.

In 2017, some operators reported a volume of treated fluid tailings as meeting RTR criteria. The AER did not expect operators to report treated fluid tailings volumes that were considered to have reached RTR status prior to the acceptance of RTR criteria. In their 2018 reports, operators reported on the treated fluid tailings volumes that newly achieved RTR status and confirmed that treated fluid tailings in deposits continued to meet the RTR trajectory approval conditions, identifying any volumes that need to be returned to the fluid tailings inventory.

3.1.1.2 Environmental Performance Monitoring

Directive 085 requires operators to summarize environmental performance monitoring reports about fluid tailings management activities to help with the assessment of predicted environmental benefits and the risk trade-offs of tailings technologies. The summary is used to assess operator management of environmental effects and the implications of fluid tailings management activities.

To avoid reporting duplication, the AER noted during the development of *Directive 085* that it would consider allowing operators to refer to other reports already submitted to provide performance results for managing and minimizing environmental effects and the implications of fluid tailings management activities. Some 2018 operator tailings management reports refer more generally to other *Environmental Enhancement and Protection Act (EPEA)* environmental reports, providing little summary information. As a result, the AER must do further review to verify the additional data and information or to clarify reported data and information. With the exception of data on approval conditions for subobjective 2 RTR criteria and the assessment of the operators' measurement system plans, this additional review is not required for an accurate accounting of fluid tailings management activities in 2018.

3.1.2 Next Steps

In areas where the AER identified gaps or areas requiring clarification in the annual tailings reports for individual operators for 2018, the AER has followed up with operators by requesting clarification or more information. This may lead to data corrections, changes in the RTR status of treated fluid tailings in a deposit or changes in the fluid tailings inventory. Responses to these requests for clarification were not available by the September 30 publication date stated in *Directive 085*. Relevant information from requests for clarification will be in the 2019 report, which will be issued September 2020. Changes in the RTR status of a deposit may warrant mitigation or corrective action, and changes in the fluid tailings inventory may warrant additional fluid tailings management responses.

4 Regulatory and Operational Context

4.1 Regulatory Context

In 2009, the AER's predecessor (the Energy Resources Conservation Board) released *Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes*, introducing specific performance criteria for the reduction of fluid tailings and for the formation of trafficable (i.e., can be travelled upon) deposits.

On March 13, 2015, the Government of Alberta released the TMF to further manage and decrease liability and environmental risk from the accumulation of fluid tailings on the landscape. The TMF's goal is to "increase the rate of reclamation and enhance the reduction of tailings ponds," and it establishes the following policy outcomes:

- land use must be returned to Albertans,
- sustainable ecosystem (after reclamation),
- liability is minimized to Albertans,
- environmental effects are managed.

In support of the *Lower Athabasca Regional Plan's (LARP's)* strategic direction of "encouraging timely and progressive reclamation," the TMF provides guidance and an objective for managing fluid tailings so that both new and legacy tailings can be reclaimed in a timely manner. The TMF states the objective that fluid tailings accumulation be minimized by ensuring that fluid tailings are treated and reclaimed progressively during the life of an oil sands mining project and by ensuring that all of a project's fluid tailings are ready to reclaim within 10 years of the project's end-of-mine life.

On July 14, 2016, the AER released *Directive 085* under the *Oil Sands Conservation Act (OSCA)*, replacing *Directive 074*. *Directive 085* enables implementation of the TMF and aligns with *LARP*. It also sets out new application and performance reporting requirements for fluid tailings management. On

October 12, 2017, the AER updated *Directive 085* to further clarify compliance and enforcement, public education and awareness, and the review cycle.

4.2 Operational Context

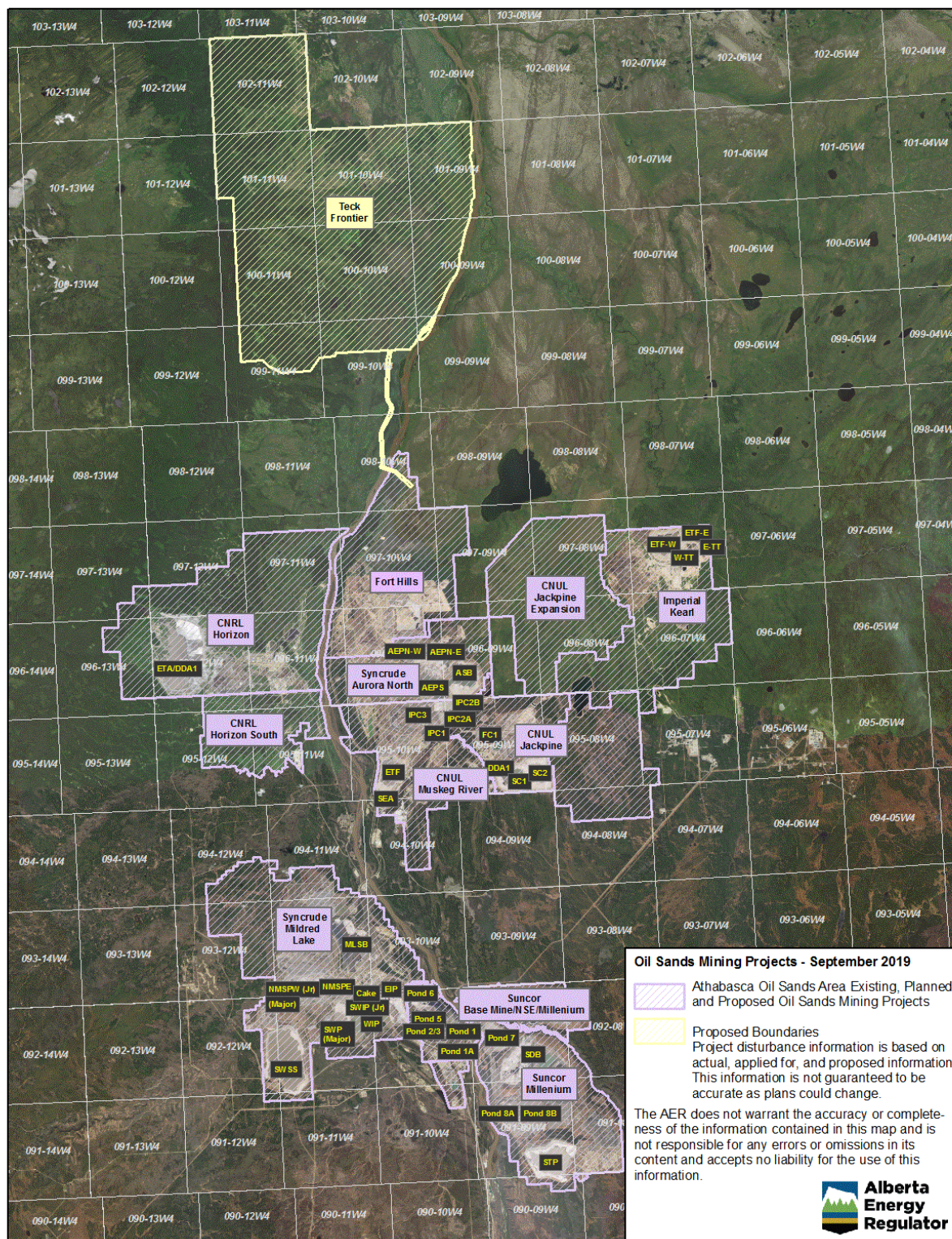
The following eight oil sands mining projects were operating in 2018:

- Suncor Base Mine, Millennium and North Steepbank
- Syncrude Mildred Lake
- Syncrude Aurora North
- CNUL Muskeg River Mine
- CNUL Jackpine Mine
- CNRL Horizon
- Imperial Kearn Oil Sands project
- Fort Hills Mine

The Fort Hills Mine began production in December 2017. However, it is not included in this report because the Fort Hills approval requires that its first tailings management report submission be filed in 2020 for the 2019 reporting year.

On November 15, 2018, the AER approved the transfer of Total E&P Canada Limited's (Total's) Joslyn North Mine to CNRL. However, fluid tailings management reporting was not required for 2018 for the Joslyn North Mine site (now called CNRL Horizon South). On July 25, 2019, a joint review panel approved Teck Resources Limited's (Teck's) application for its Frontier mine. Fluid tailings management reporting for the Frontier mine will be required once operations begin.

The locations of oil sands mining projects and their tailings ponds are shown in figure 1.



Base data contains information licensed under the Open Government Licence – Alberta

Figure 1. Map of operating and proposed oil sands mining projects and tailings ponds/deposits

5 Tailings Description

Tailings are a by-product of the process used to extract bitumen from mined oil sands. Tailings are a mixture of sand, clay, water, silts, residual bitumen and other hydrocarbons, salts, and trace metals. At the early stages of mine operations, tailings are deposited into manmade aboveground structures called external tailings ponds. Once a mined-out area (pit) becomes available, tailings are stored in these mined-out areas (in-pit tailings ponds). Tailings ponds act both as a holding area from which water can be taken and recycled back into the bitumen extraction process and as a settling basin to separate water from tailings.

The particles in a tailings pond settle out of the water at different rates. Sand particles tend to settle quickly. However, smaller particles of clay and silt (i.e., fines), 44 micrometres or less in diameter, tend to remain suspended in the water for longer periods, forming fluid tailings. Without intervention, fluid tailings can take decades to settle, and even then only into a consistency of soft mud. This makes the management of fluid tailings an ongoing challenge for the oil sands mining industry.

6 Fluid Tailings Treatment and Deposition

Oil sands mine operators use various technologies to treat fluid tailings, with some operations using multiple technologies. Development and implementation of new technologies and continuous improvement of existing technologies is critical for the successful management of fluid tailings in the oil sands mining industry. The ability to successfully reclaim to target ecosites is also affected by the deposit design and operation, including the size and depth of the deposit, and the capping design, both of which are reflected in the RTR trajectory. A summary of the treatment technologies and typical treated tailings deposits from the tailings management plans is included below.

Operators are required to submit an amendment application before implementing a new tailings treatment technology and to validate the RTR criteria and RTR trajectory for a new deposit not already included in their approval. The uncertainties and risks associated with in-deposit performance of demonstration technologies, including treated fluid tailings deposit capping, are described in the *Directive 085* [decision reports and findings](#) on the AER website, www.aer.ca.

6.1 Treatment and Deposits

6.1.1 Thin-Lift Drying

Thin-lift drying is a process whereby fluid tailings are removed from tailings ponds and mixed with additives that bind the particles in the fluid tailings together. The fluid tailings with the additives are then thinly spread over a large area. Gravity and capillary action allow the water to drain away, and ambient conditions (evaporation and freeze/thaw cycles) facilitate the drying of fluid tailings within a couple of weeks. Once dry, another layer, or “lift,” is added and the process is repeated.

Suncor uses thin-lift drying technology to move treated fluid tailings material that meets the initial drying area RTR criteria to its final placement location. Suncor refers to this technology as a tailings reduction operation (TRO) or as atmospheric fines drying (AFD). Suncor is required to provide an updated volume to be placed and RTR trajectory for this final placement location, which is targeting a terrestrial closure with a wetland. The CNUL Muskeg River Mine is currently conducting testing of the same technology for use at its mine.

6.1.2 Thickened Tailings as an Initial Treatment

Thickened tailings (TT) is a process whereby fluid tailings from bitumen extraction plants are sent directly to a thickener, where flocculants are added to bind the smaller particles together, creating thickened tailings. The warm water released from the tailings is recycled back into the extraction plant. The process is an initial stage of fluid tailings treatment, and operators employ different secondary stages of treatment and placement of TT for treated fluid tailings deposits.

The Fort Hills Mine, CNUL Muskeg River Mine, CNUL Jackpine Mine, and Imperial–Kearl use conventional thickeners to produce a thickened tailings stream with some variations at their mines. Operators use the following as a second stage of treatment:

- CNUL Muskeg River Mine is co-depositing TT, tailings solvent recovery unit (TSRU) tailings, whole tailings, and coarse sand tailings in a single deposit, creating a north pool deposit (NPD) type;
- CNUL Jackpine Mine is co-depositing TT, whole tailings, and coarse sand tailings in a single deposit, creating a mixed-deposit type;
- Imperial–Kearl treats TT with a secondary polymer addition before placement in its initial tailings deposit.

Both operators are targeting a terrestrial closure with wetlands for their deposits and are required to provide updated modelling and RTR trajectories for the deposits.

6.1.3 Nonsegregating Tailings and Composite Tailings Deposits

Nonsegregating tailings (NST) technology requires the use of a thickener. The TT is mixed with sand from the extraction plant and an added coagulant. The mixture is then placed into a tailings deposit.

Composite tailings (CT) are similar to NST. The difference is that instead of using TT, fluid tailings from ponds are mixed with sand from the extraction plant and a coagulant is added to the mixture. The mixture is then placed into a tailings deposit.

CNRL Horizon uses NST technology. CT is used by Syncrude Mildred Lake, Syncrude Aurora North, and CNUL Muskeg River Mine, with some variations.

CNRL Horizon, Syncrude, and CNUL are targeting a terrestrial closure with wetlands for their deposits and are required to provide updated modelling and RTR trajectory for the deposits.

6.1.4 Fluid Tailings Centrifugation

Fluid tailings centrifugation is a process whereby fluid tailings are removed from the tailings ponds and a flocculent is added to bind the small particles together. The mixture is pumped into a centrifuge where the water is spun out. The dewatered tailings are placed in a deposit.

Syncrude Mildred Lake and CNUL Jackpine Mine use fluid tailings centrifugation with some variations on their sites. Syncrude Mildred Lake is currently pilot testing unique capping techniques required for centrifuge cake deposits.

Both operators are targeting a terrestrial closure with wetlands for their deposits. CNUL is required to update its centrifuge initial RTR criteria and both operators are required to provide updated modelling and RTR trajectory for deposits, particularly to understand performance in deposits of increasing sizes.

6.1.5 Permanent Aquatic Storage Structure

Suncor is demonstrating performance of a new treatment technology in its commercial scale implementation of the permanent aquatic storage structure (PASS) technology. Phase 1 is the initial treatment of fluid tailings through the addition of a coagulant and a flocculent that are then placed in a deposit. The AER has approved the implementation of phase 1 only, subject to approval conditions to manage uncertainties and long-term reclamation risks since performance assumptions have not been verified at the scale and complexity of Suncor's dedicated disposal area 3 (DDA3). Suncor is required to prove the efficacy of a unique capping technique to provide a terrestrial closure on PASS-treated fluid tailings.

Suncor is required to:

- validate its RTR criteria and RTR trajectory performance for phase 1 at a large scale and
- submit research and implementation plans for terrestrial or aquatic closure options for phase 1 PASS-treated tailings in DDA3 to support a decision for the proposed closure approach in 2023.

6.1.6 Water-Capped Tailings

Water-capped tailings is an unapproved technology that is currently in the demonstration and experimental phase at Syncrude and Suncor. Water-capping technology involves placing water above untreated tailings (Syncrude Base Mine Lake at the Mildred Lake Mine) or treated tailings (phase 1 PASS-treated tailings in Suncor demonstration pit lake at the Suncor Base Mine) to create a water-capped deposit (e.g., a water-capped pit lake) as a landscape feature.

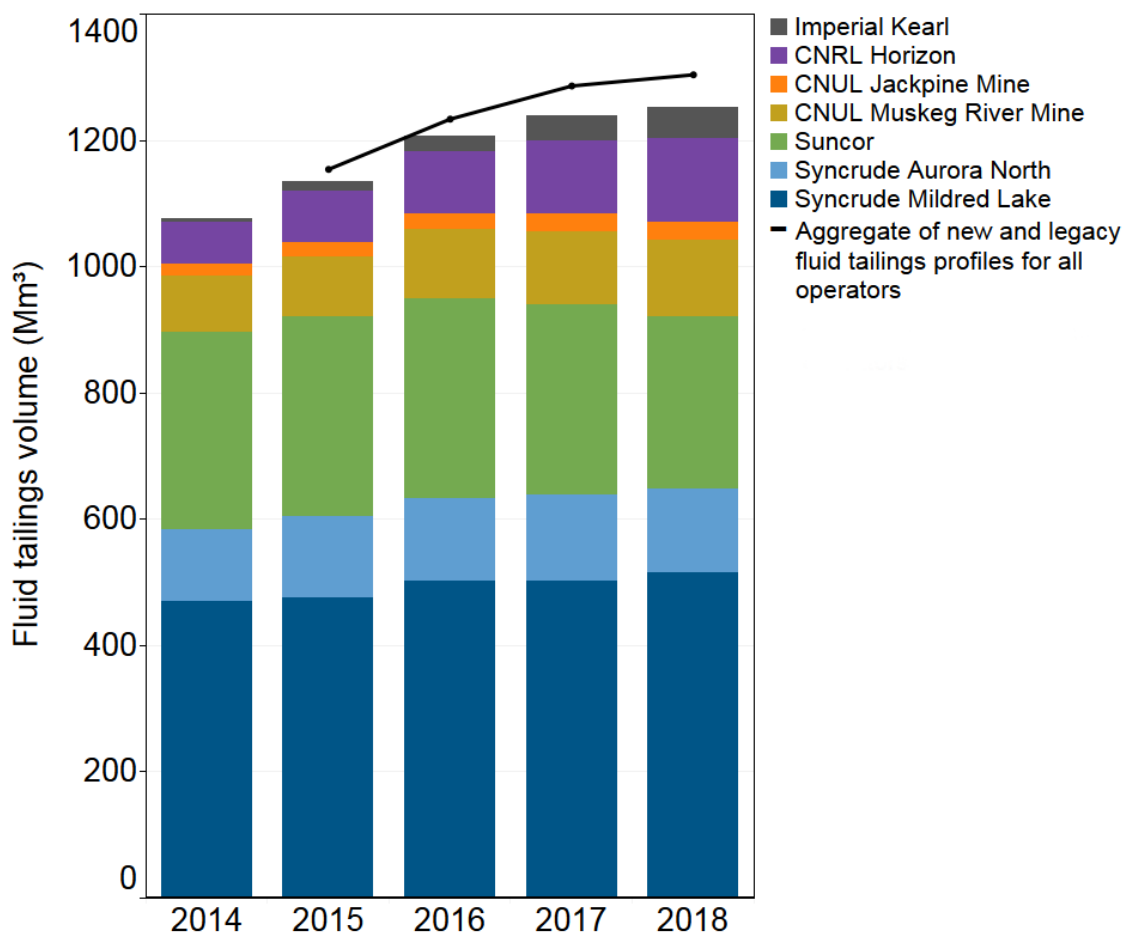
The proposed water-capping of untreated or treated fluid tailings at oil sands mines is not authorized by the AER because the technology is subject to further assessment, research, and future policy. With the exception of the identified demonstrations, all tailings management plan approvals prohibit the creation of a water-capped pit lake. The AER's decision about water-capped pit lakes, including their prohibition and the need for feasible alternative tailings treatment technologies, is provided in the water-capping technology section of tailings management plan decision reports and in operator approvals.

7 Regional Fluid Tailings Status

The total volume of fluid tailings reported, including both legacy and new fluid tailings, in the Athabasca oil sands region increased between 2014 and 2018 as expected, based on the new and legacy profiles in the tailings management plans approved by the AER. Fluid tailings volumes increased from 1075 million cubic metres (Mm³) in 2014 to 1253 Mm³ in 2018 (see figure 2 and appendix 2). Approved tailings management plans for each operator include new and legacy tailings profiles that span from 2015 until each project's end-of-mine life plus 10 years. Some exceptions are the Mildred Lake Expansion, CNUL Muskeg River Mine and CNUL Jackpine Mine, which received partial approvals. An aggregate of both profiles for all operators in each year is in figure 2.

From 2015 to 2018, the reported total volume of fluid tailings in the Athabasca oil sands region was below the aggregate of approved tailings profiles.

Figure 2 and figure 3 present fluid tailings inventory volumes as reported by the operator and do not include treated fluid tailings volumes identified by the operators as having met RTR status.



Notes: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Data are the sum of individual pond volumes submitted annually by operators. With the exception of 2018 data for Syncrude Aurora North and Mildred Lake, operators report year-end projected values.

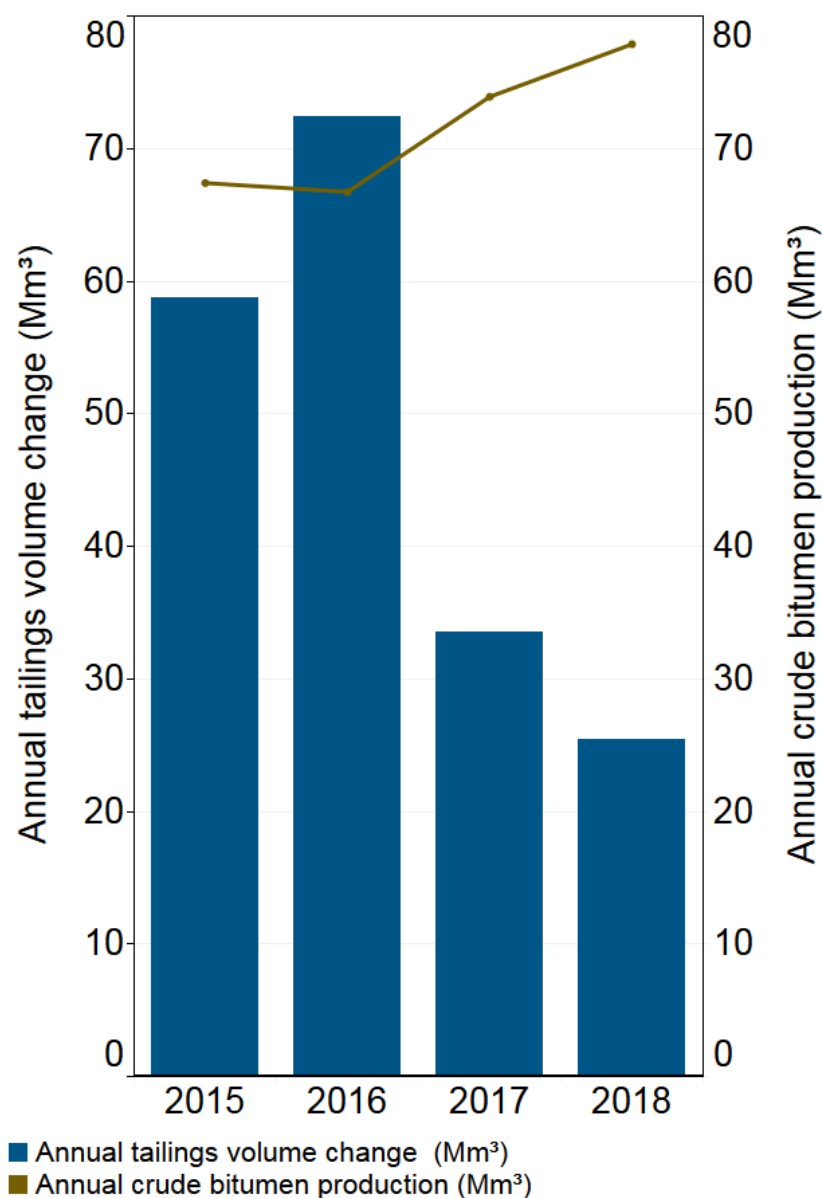
From 2014 to 2017, Syncrude Aurora North and Mildred Lake data reported are year-end projected values. In 2018, Syncrude Aurora North and Mildred Lake data are based on mid-year as-measured values, not projected to year-end.

Figure 2. Regional fluid tailings volumes and aggregate tailings profiles, 2014 to 2018

The AER identified inconsistencies with some operator's reporting in 2018 in that the sum of fluid tailings volumes reported for individual ponds (see Monitoring Reporting Data Requirements in section 6.2 of *Directive 085*) did not match the total fluid tailings inventory reported in its site-wide fluid tailings inventory table (see appendix 3 of *Directive 085*). The AER has contacted the relevant operators to determine the basis for the differences and has requested clarification from operators. Data reported in the site-wide fluid tailings inventory tables (appendix 3 of *Directive 085*) submitted by operators are used for the fluid tailings profile graphs in the individual operator sections because it provides reported changes in inventory volumes and attributions of rationale for changes to the new and legacy profiles.

The reported volume of fluid tailings added in the Athabasca oil sands region increased from 58.7 Mm³ in 2015 to 72.4 Mm³ in 2016 and decreased to 25.4 Mm³ in 2018 (see figure 3). Bitumen production increased from 60.2 Mm³ in 2014 to 77.9 Mm³ in 2018, excluding Fort Hills' bitumen production. As indicated in section 4.2, Fort Hills' is excluded from this AER report.

The change in fluid tailings volume is the volume of fluid tailings on the landscape minus the previous year's volume of fluid tailings on the landscape. Each bar in figure 3 represents the volume of fluid tailings added to the inventory on the landscape because the volume of fluid tailings produced exceeded the volume of tailings reported by industry as achieving RTR status in its final landscape position and can be removed from the fluid tailings volume inventory.



Notes: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

With the exception of 2018 data for Syncrude Aurora North and Mildred Lake, operators report year-end projected values.

From 2014 to 2017, Syncrude Aurora North and Mildred Lake data reported are year-end projected values. In 2018 Syncrude Aurora North and Mildred Lake data are based on mid-year as-measured values, not projected to year-end. Fort Hills bitumen production is not included in the crude bitumen production values.

Figure 3. Change in annual fluid tailings volume in the Athabasca oil sands region, 2015 to 2018

7.1 Fluid Tailings Treatment and Deposition

The reported volumes of treated fluid tailings produced each year by oil sands operators are in table 2.

Treated tailings volumes cannot be combined between technologies or between sites because of differences in technologies, deposit designs, deposit sizes, in-deposit performance of similar technologies, and differences in closure techniques or target ecosites at different sites.

Reported treated fluid tailings volumes do not necessarily equal the volume of treated fluid tailings in deposits meeting approved tailings management plan RTR criteria or RTR trajectories. The treated fluid tailings volume is a measure of the volume of fluid tailings to which a treatment technology is applied. The volume of treated tailings in a deposit meeting approved RTR criteria and trajectories is the measured volume that has achieved RTR status by meeting the approved RTR criteria.

Table 2. Treated fluid tailings volumes reported by operator, 2014 to 2018

Project	Technology	2014 (Mm ³)	2015 (Mm ³)	2016 (Mm ³)	2017 (Mm ³)	2018 (Mm ³)
Suncor	Thin-lift drying	11.7	14.8	9.9	18.5	14.0
	PASS	0.0	0.0	0.0	0.0	14.0
	Coke capping mitigation	0.0	0.0	0.0	20.0	0.0
Syncrude Mildred Lake	CT	5.7	4.9	0.3	2.4	2.1
	Centrifuge	2.7	4.1	6.0	6.7	6.4
Syncrude Aurora North	CT	5.0	10.9	11.8	13.7 ^a	16.3 ^a
CNUL Muskeg River Mine ^b	Thin-lift drying	3.9	0.9	0.1	0.0	0.0
	FFT drying at mine advance area	0.2	0.3	n/a	0.0	0.0
	CT	0.3	1.3	n/a	0.0	0.0
	TT	15.1 ^{c,d}	13.6 ^{c,d}	19.4 ^d	22.5 ^e	22.9
CNUL Jackpine Mine	Centrifuge	1.1	3.9	3.9	2.3	2.2
	TT	16.4 ^{c,f}	12.6 ^{c,f}	17.5 ^f	19.7 ^g	16.4
CNRL Horizon	Nonsegregating tailings (NST)	0.0	7.7 ^h	48.7 ^h	62.7 ^h	0.0
Imperial-Kearl	TT	0.0	0.0	2.4 ⁱ	8.5	8.7 ⁱ

^a Volume of CT slurry volume and CT beach deposit. Revised from CT beach deposit only in 2017.

^b Thickened tailings combined with coarse sand tailings (CST), whole tailings (WT), and tailings solvent recovery unit (TSRU) material in a single deposit forms a north pool deposit (NPD) type deposit.

^c Updated in April 2017 submission.

^d Volume of TT slurry at solids content of average 23.6 per cent from 2014 to 2016.

^e Volume of TT slurry at solids content of 21.9 per cent in 2017.

^f Volume of TT slurry at solids content of average 15 per cent from 2014 to 2016.

^g Volume of TT slurry at solids content of 13.7 per cent in 2017.

^h Volume of NST.

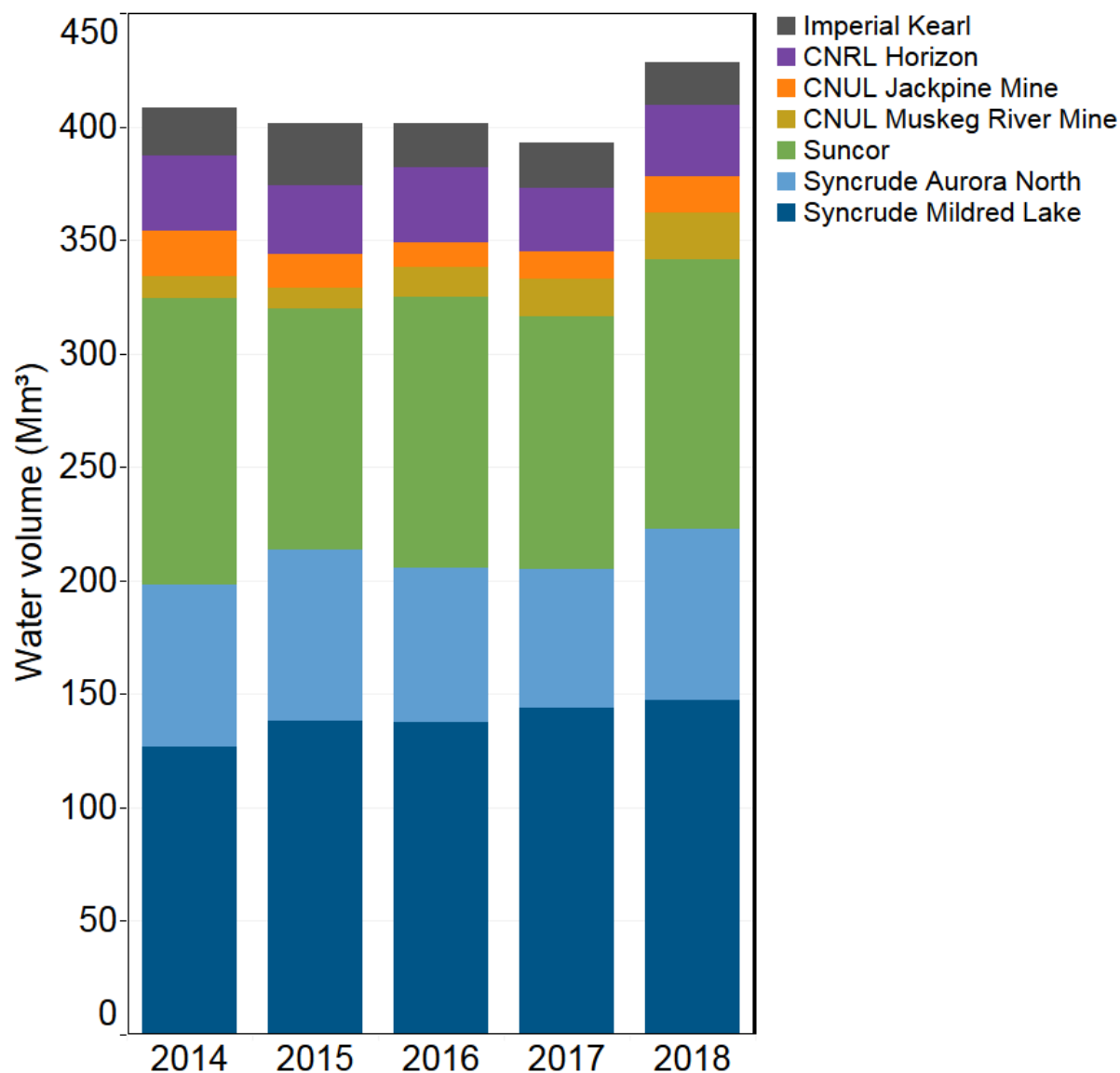
ⁱ Volume of thickened tailings in deposit after secondary chemical treatment.

Volumes cannot be added together between technologies, between sites, or within the region because of the differences in technologies and differences in performance of similar technologies at different sites. The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Due to remaining uncertainties in technology efficacy and deposit performance, uncertainties in capping techniques and capabilities, and deposit uncertainties to support target ecosites, most RTR criteria and RTR trajectories require additional monitoring, modelling, and the submission of additional assessments to prove capabilities and assure confidence in their accuracy and reliability. Accordingly, future updates to RTR criteria and RTR trajectories are expected and may result in changes to volumes of treated fluid tailings reported as achieving RTR status.

7.2 Water Volumes

Based on the data reported by operators, the volume of water contained in tailings ponds and deposits in the Athabasca oil sands region decreased from 408.4 Mm³ in 2014 to 392.8 Mm³ in 2017 and then increased to 428.1 Mm³ in 2018 (see figure 4 and appendix 3). In 2018, total oil sands bitumen production also increased, rising from 60.2 Mm³ in 2014 to 77.87 Mm³ in 2018 (excludes bitumen production from Fort Hills, which was not required to submit an annual fluid tailings management report for 2018).



Note: The AER continues to assess measurement system plans submitted by operators. As a result, the pond and deposit water volumes provided in this report are presented as reported by industry and are subject to change upon further review of water volumes and assessment of meeting RTR criteria.

Figure 4. Pondered water volume in tailings ponds, 2014 to 2018

8 Fluid Tailings Status

8.1 Suncor

Suncor uses two primary fluid tailings technology treatments to manage its fluid tailings. First, Suncor is combining in-line flocculation with thin-lift drying (TRO) in DDA1. Within one to two years, the treated tailings will be excavated and moved to Mine Dump 9 (MD9) for co-disposal with overburden. DDA1 is therefore a temporary location because all tailings treated and placed in DDA1 are re-handled and moved to MD9. Suncor has approved RTR criteria in place for DDA1: the material must achieve a clay-to-water

ratio (CWR) greater than or equal to 0.5 measured 24 hours after placement. Second, Suncor is using its PASS technology for its DDA3 deposit. Suncor has the following two RTR criteria approved for this deposit:

- CWR ≥ 0.5 (based on deposit sampling expressed water from DDA3 treated tailings)
- annual average total suspended solids (TSS) ≤ 500 parts per million

8.1.1 Fluid Tailings

In 2018, the Suncor base plant reported 273.3 Mm³ of total fluid tailings inventory (new and legacy fluid tailings combined) estimated at year-end, down from 300 Mm³ reported in 2017. Suncor base plant reported 76 Mm³ of new fluid tailings inventory and 197 Mm³ of legacy fluid tailings inventory. The delineation between legacy and new fluid tailings volumes was not reported in 2017.

In the initial thin-lift drying area, DDA1, Suncor reported 14 Mm³ of fluid tailings treated from the south tailings pond as achieving RTR status. However, Suncor did not provide the volume of treated fluid tailings that exceeded the tailings management plan RTR criterion of a CWR of 0.5. It reported that the DDA1 treated fluid tailings had an average CWR of 0.59.

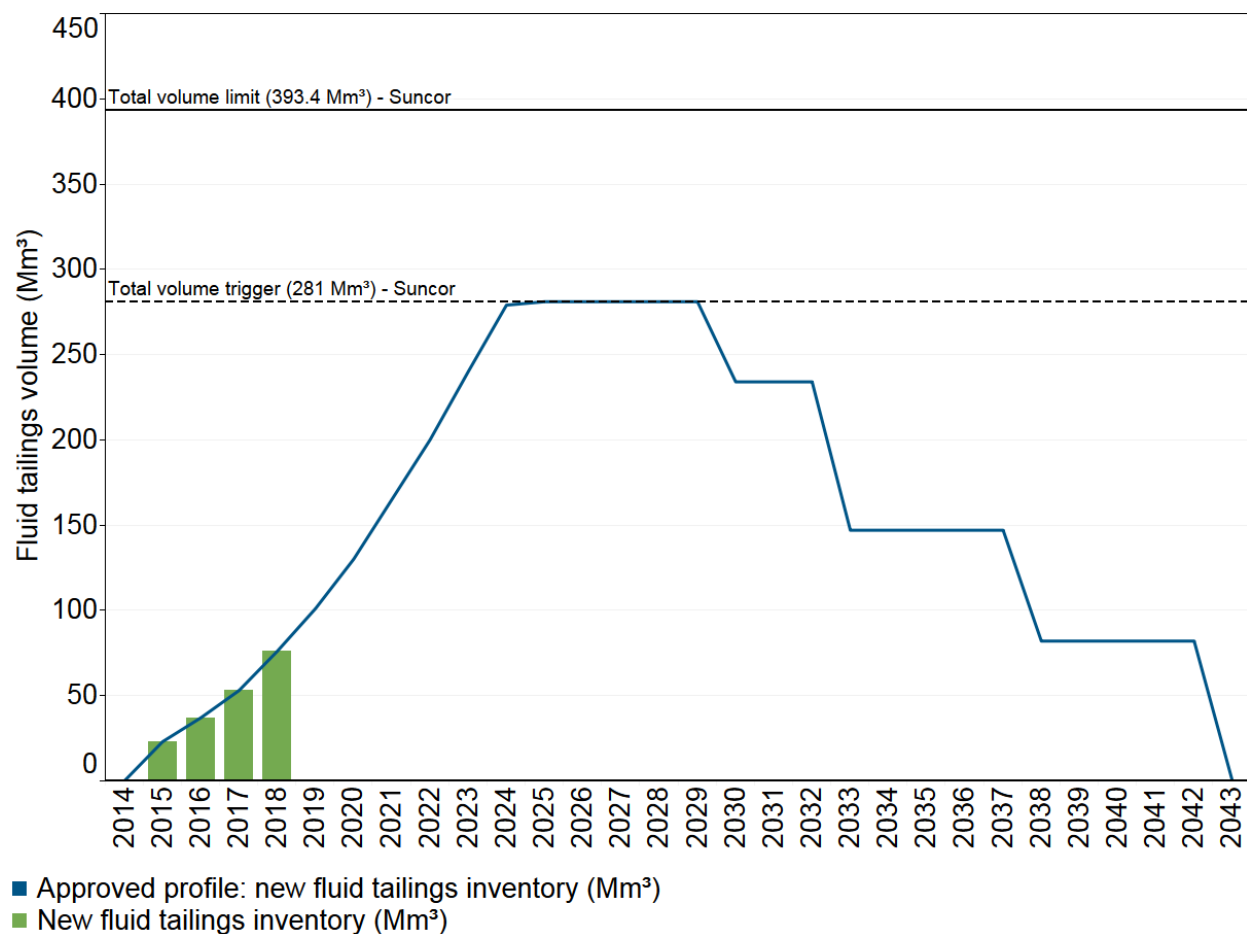
Suncor subsequently co-deposited these treated fluid tailings with overburden into its final placement location, MD9, and reported in excess of 90 per cent of the treated fluid tailings exceeding 5 kilopascals (kPa). As part of the changes proposed for MD9 for the volume of treated fluid tailings to be placed and the MD9 deposition design, Suncor is required to propose RTR criteria and RTR trajectory for MD9.

In DDA3, Suncor reported that 14 Mm³ of PASS-treated fluid tailings achieved RTR status. However, Suncor reported the DDA3 treated fluid tailings had an average CWR of 0.39, which is below the RTR criteria. Clarification has been requested from Suncor so that the AER can complete its technical review.

Both the new and legacy volumes of reported fluid tailings are within the approved fluid tailings profile volumes.

8.1.1.1 New Fluid Tailings

Suncor base plant reported 76 Mm³ of new fluid tailings inventory in 2018 (see figure 5). Suncor has a total volume trigger of 281 Mm³ and a total volume limit of 393.4 Mm³ for new fluid tailings in its tailings management approval. Based on Suncor's data in its April 2018 fluid tailings report, Suncor did not exceed its total volume trigger or total volume limit for new fluid tailings in 2018 and did not exceed its new fluid tailings profile between 2015 and 2018.

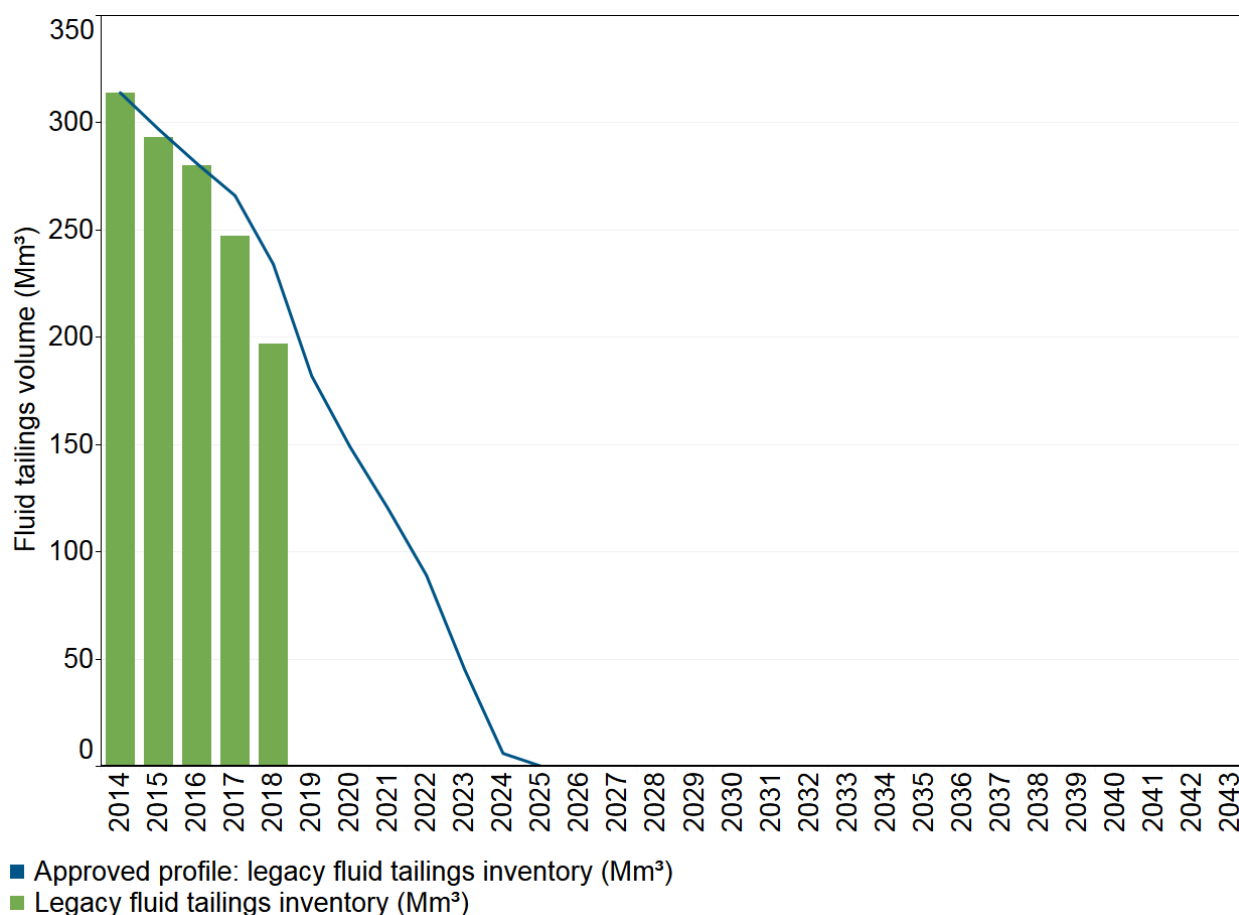


Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 5. New Fluid Tailings for Suncor, 2014 to 2018

8.1.1.2 Legacy Fluid Tailings

Suncor base plant reported 197 Mm³ of legacy fluid tailings inventory in 2018, which was below its legacy fluid tailings profile for 2018 (see figure 6).



Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 6. Legacy fluid tailings for Suncor, 2014 to 2018

8.1.2 Volume of Treated Fluid Tailings by Technology

Suncor reported treating 28 Mm³ of fluid tailings in 2018:

- 14 Mm³ with PASS technology and
- 14 Mm³ through its TRO operation.

Fluid tailings treated with PASS technology were sourced from Pond 8B and deposited into DDA3. Fluid tailings treated with TRO were sourced from the south tailings pond, placed into DDA1 for drying, and excavated and trucked to MD9 for final placement.

Suncor reported that 45.8 Mm³ of treated fluid tailings achieved RTR status by year-end 2018. It proposed removing this volume from its fluid tailings inventory. Treated fluid tailings identified as achieving RTR status include:

- coke capping of pond 5 (28.6 Mm³)
- treated tailings in DDA3 (11.7 Mm³)
- treated tailings in MD9 (5.5 Mm³)

The AER is currently assessing whether the treated tailings volume or the volume removed from either the fluid tailings inventories of pond 5, MD9, or DDA3 have achieved RTR status because Suncor's measurement system plan. An update will be given in future reports.

8.1.3 Treatment Operation and Continuous Improvement

Suncor reported progress on treating fluid tailings in 2018, including the successful start-up of its PASS technology and deposition in DDA3.

8.1.4 Technological Innovation in Fluid Tailings Treatment

Suncor reported starting treatment using PASS technology in 2018. Legacy fluid tailings are being dredged from pond 8B, treated using in-line flocculation and a coagulant, and then placed in DDA3.

8.1.5 Regulatory and Management Actions

While no new RTR criteria have been approved by the AER for 2018, Suncor has presented preliminary supporting data to establish RTR criteria for its MD9 deposit.

In addition, Suncor has applied to use pond 5 to store additional coke, which may affect the reclamation timing of this facility. Learnings from this will be applied to the pond 6 mitigation plan, which is expected in the fall of 2019.

No management actions were initiated by the AER in 2018 for Suncor's base plant tailings management operations.

8.1.6 Measurement System Audit Results

The AER has received Suncor's proposed measurement system plan, which is currently under assessment by the AER. As a result, Suncor's measurement system was not audited in 2018.

8.2 Syncrude Mildred Lake

The tailings management plan for Syncrude Mildred Lake was approved in part, and with conditions, as part of the July 16, 2019, AER hearing decision for the Mildred Lake Extension project. Some portions of the plan were not approved and, as part of the decision, Syncrude was directed to provide an updated tailings management plan for approval on or before January 31, 2023.

Syncrude did not have an approved tailings management plan in 2018 and has not yet submitted a measurement system plan, which must be submitted by January 16, 2020.

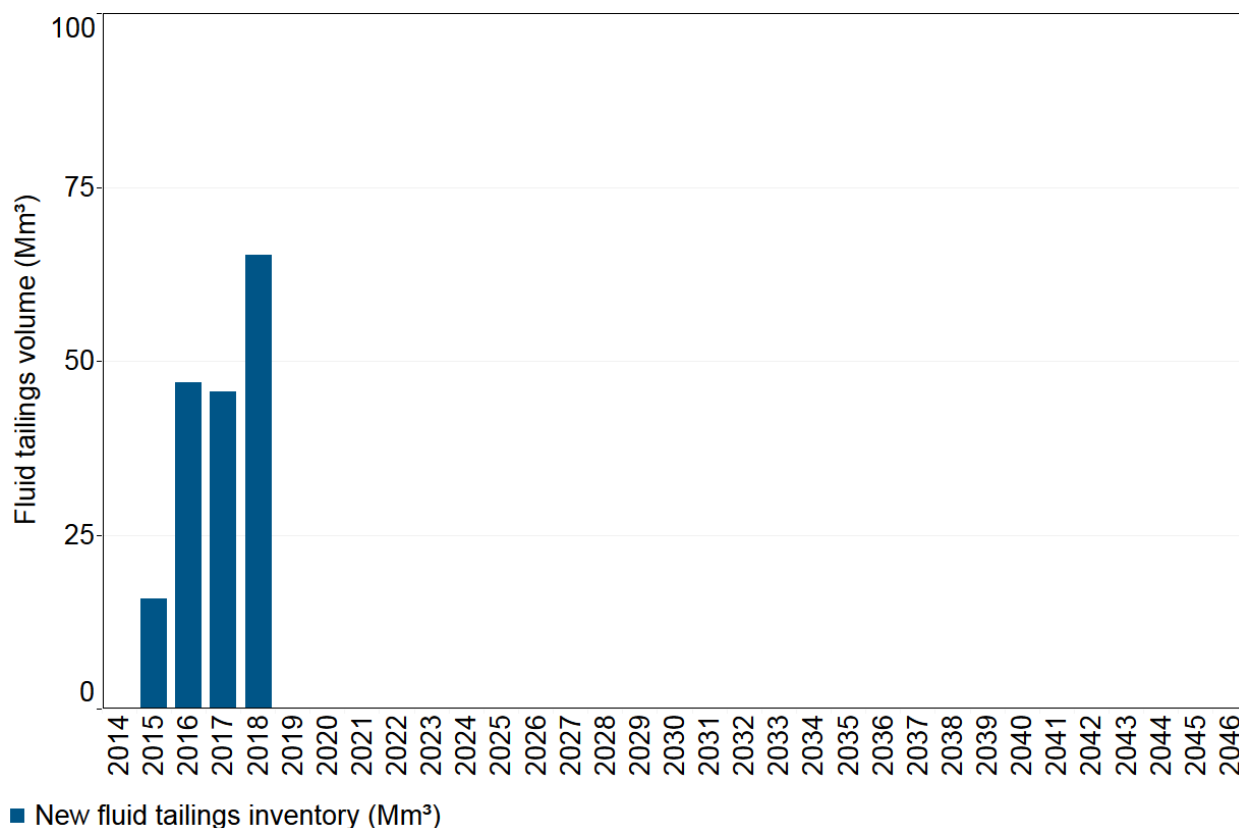
Syncrude continued treating existing fluid tailings in 2018, using CT and fluid tailings centrifugation.

8.2.1 Fluid Tailings

In 2018, Syncrude Mildred Lake reported 492.3 Mm³ of total fluid tailings inventory (new and legacy fluid tailings combined) estimated mid-year, which is down from a year-end volume of 502.1 Mm³ reported in 2017. Syncrude Mildred Lake reported 65.2 Mm³ of new fluid tailings inventory and 427.1 Mm³ of legacy fluid tailings inventory, both of which are mid-year as-measured volumes. Legacy and new fluid tailings volumes were not reported separately in 2017. Unlike previous years, the 2018 fluid tailings volumes submitted by Syncrude Mildred Lake were as-measured volumes from mid-2018 and not year-end projections. A request to provide year-end projected values for fluid tailings volumes has been issued to Syncrude.

8.2.1.1 New Fluid Tailings

Syncrude Mildred Lake reported 65.2 Mm³ of new fluid tailings inventory in 2018 (see figure 7). Syncrude Mildred Lake did not have an approved tailings management plan in 2018. It therefore did not have an approved new fluid tailings profile, total volume trigger, or total volume limit for 2018. Syncrude Mildred Lake fluid tailings volumes for 2018 are as-measured values taken mid-year and are not year-end projected values as for other operators. Syncrude Mildred Lake data between 2014 and 2017 are year-end projected values. A request has been issued to Syncrude for year-end projected values for 2018 fluid tailings volumes.

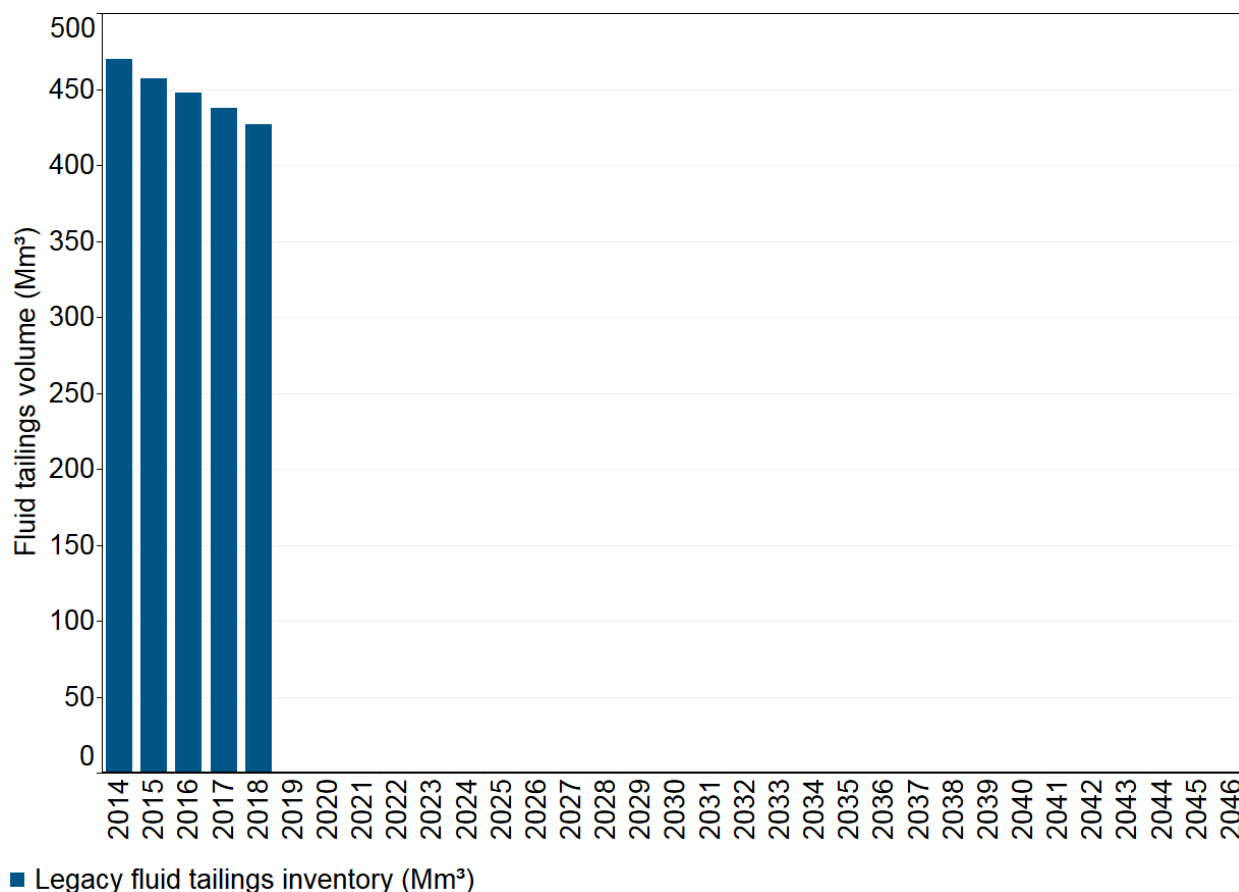


Notes: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria. 2018 data for Syncrude Mildred Lake are as-measured values taken mid-year and are not year-end projected values as for other operators. Syncrude Mildred Lake data for 2014 to 2017 are year-end projected values.

Figure 7. New fluid tailings for Syncrude Mildred Lake, 2015 to 2018

8.2.1.2 Legacy Fluid Tailings

Syncrude Mildred Lake reported 427.1 Mm³ of legacy fluid tailings inventory in 2018 (see figure 8). However, it did not have an approved tailings management plan in 2018. It therefore did not have an approved legacy fluid tailings profile for 2018. Fluid tailings volumes for Syncrude Mildred Lake in 2018 are instead as-measured mid-year and are not year-end projected values as for other operators. Syncrude Mildred Lake data between 2014 and 2017 are year-end projected values. A request has been issued to Syncrude for year-end projected values for 2018 fluid tailings volumes.



Notes: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes provided in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria. 2018 data for Syncrude Mildred Lake are as-measured values taken mid-year and are not year-end projected values as for other operators. Syncrude Mildred Lake data for 2014 to 2017 are year-end projected values.

Figure 8. Legacy fluid tailings for Syncrude Mildred Lake, 2014 to 2018

8.2.2 Volume of Treated Fluid Tailings by Technology

Syncrude Mildred Lake reported treating a total of 8.4 Mm³ of fluid tailings in 2018. Treatment by CT technology accounted for 2.1 Mm³ of treated tailings, and centrifuge cake deposited in the North Mine South Pond East accounted for 6.4 Mm³ of treated tailings.

8.2.3 Treatment Operation and Continuous Improvement

Syncrude Mildred Lake reported that the treatment plants for both treatment technologies (CT and fine fluid tailings (FFT) centrifugation) performed within target ranges. However, Syncrude altered its target sand-to-fines ratio (SFR) from 4:1 in 2017 to between 3:1 and 5:1 in 2018. Syncrude's reported SFR for 2018 was 3.0:1, lower than the 4.8:1 reported in 2017. Syncrude did not provide rationale for this change in target SFR range or the implications to RTR criteria, RTR trajectory, or its effects on its fluid tailings profiles. As a result, more information has been requested to enable the AER to complete its technical

review. Syncrude also reported that FFT centrifugation achieved an average solids content of 54 per cent, up from 53 per cent in 2017 and within its target range of 50 to 60 per cent.

Syncrude Mildred Lake reported that fluid treatment capacity was not fully used in 2018. CT production was temporarily suspended from the end of June until September because of production restrictions from an unplanned power outage in the plant. Syncrude also reported that CT production was restricted due to prioritizing containment systems to increase tailings containment space.

The FFT centrifugation plant treated 7.6 Mm³ of FFT in 2018, up from 7.3 Mm³ in 2017.

8.2.4 Technological Innovation in Fluid Tailings Treatment

Syncrude Mildred Lake reported the following operational changes and field tests to improve tailings performance in 2018:

- Modifications to the FFT centrifugation plant, including commissioning of the surge pond to provide a more consistent quality of FFT for the centrifugation plant, improving the design of the centrifuges to reduce downtime, and control changes to optimize centrifuge operation.
- A field test that co-mixed FFT with overburden clay. FFT was pumped into a test cell and overburden material was then added using excavators. Based on previous co-mixing deposit tests, a ratio of 2.1 parts overburden to 1 part FFT was used. The volume of the co-mixed FFT with overburden clay within the test cell was about 1130 m³ of FFT and 2700 m³ of overburden material.
- A field test of accelerated dewatering phase 3 (ADW3) for FFT treatment based on what was learned in the phase 1 trial in 2009 and phase 2 trial in 2017. Similar to 2017, two cells (each were 100 m long, 100 m wide, and 10 m high) were used for ADW3 testing. Monitoring is ongoing for 2018–2020.

8.2.5 Regulatory and Management Actions

The tailings management plan for Syncrude Mildred Lake was approved in part, and with conditions, as part of the July 16, 2019, AER hearing decision for the Mildred Lake Extension project. Some portions of the plan were not approved, and as part of the decision, Syncrude was directed to provide an updated tailings management plan for approval on or before January 31, 2023.

As a result, Syncrude did not have an approved tailings management plan in 2018 against which to measure its performance. No regulatory or management actions were taken by the AER in 2018 with respect to fluid tailings management.

8.2.6 Measurement System Audit Results

Syncrude Mildred Lake will submit its measurement system plan to the AER by January 16, 2020, as required by the Mildred Lake Extension approval. As a result, Syncrude Mildred Lake's measurement

system was not audited in 2018. Once the measurement system plan is submitted and assessed, audits will occur as required.

8.3 Syncrude Aurora North

Syncrude Aurora North's tailings management plan was approved on June 13, 2018, and its tailings measurement system plan was submitted on December 18, 2018. Syncrude Aurora North continued to use CT as its fluid tailings treatment in 2018, and reported that its 2018 fluid tailings inventories are below the approved new and legacy fluid tailings profiles.

8.3.1 Fluid Tailings

Syncrude Aurora North reported 125.2 Mm³ of total fluid tailings inventory (new and legacy fluid tailings combined) estimated at mid-year, down from 136.8 Mm³ reported as a year-end volume in 2017.

Syncrude Aurora North reported 37.0 Mm³ of new fluid tailings inventory mid-year, an increase from 34.5 Mm³ reported as a year-end volume in 2017. Syncrude Aurora North reported 88.2 Mm³ of legacy fluid tailings inventory mid-year, a decrease from 89.1 Mm³ reported as a year-end volume in 2017.

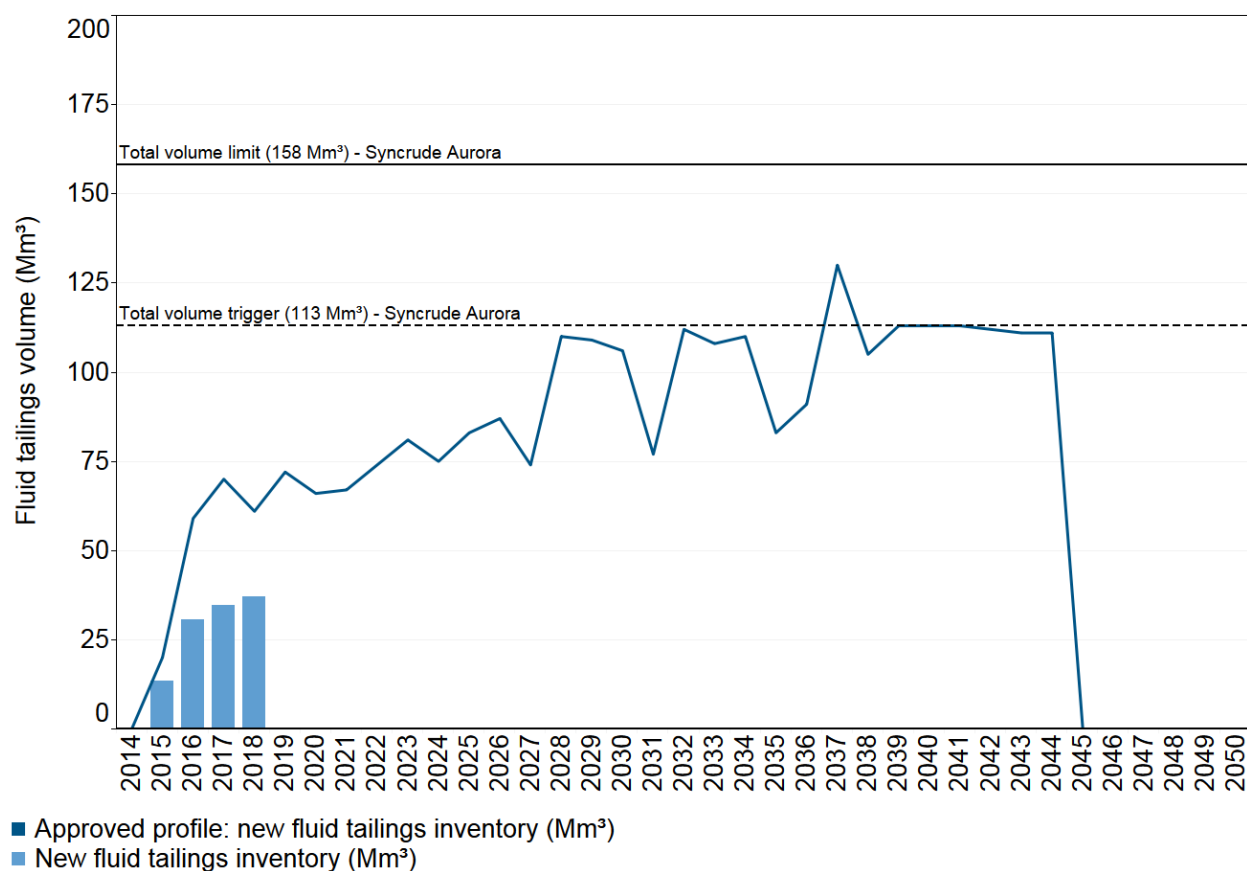
Unlike previous years, the 2018 fluid tailings volumes submitted by Syncrude Aurora North were as-measured values from mid-year and not year-end projections as required. A request has been issued to Syncrude for year-end projected values for 2018 fluid tailings volumes.

Syncrude Aurora North reported 8.4 Mm³ of material it considers to be RTR. It had a predicted RTR volume of 18.9 Mm³ in its tailings management plan. Fluid tailings volumes will be evaluated and the RTR status will be assessed and reported once RTR criteria in *OSCA* approvals are established and measurement system plans assessed.

8.3.1.1 New Fluid Tailings

Syncrude Aurora North reported 37.0 Mm³ of new fluid tailings inventory in 2018 (see figure 9).

Syncrude Aurora North had a total volume trigger of 113 Mm³ and a total volume limit of 158 Mm³ for new fluid tailings in its tailings management approval. Based on the data from Syncrude for 2018, Syncrude Aurora North did not exceed its total volume trigger or total volume limit for new fluid tailings in 2018 and was below its approved new fluid tailings profile between 2014 and 2018. Syncrude Aurora North fluid tailings volumes for 2018 are as-measured values taken mid-year and are not year-end projected values as required by the AER. Syncrude Aurora North data for 2014 to 2017 are year-end projected values. As already indicated, a request has been issued to Syncrude for year-end projected values for 2018 fluid tailings volumes.

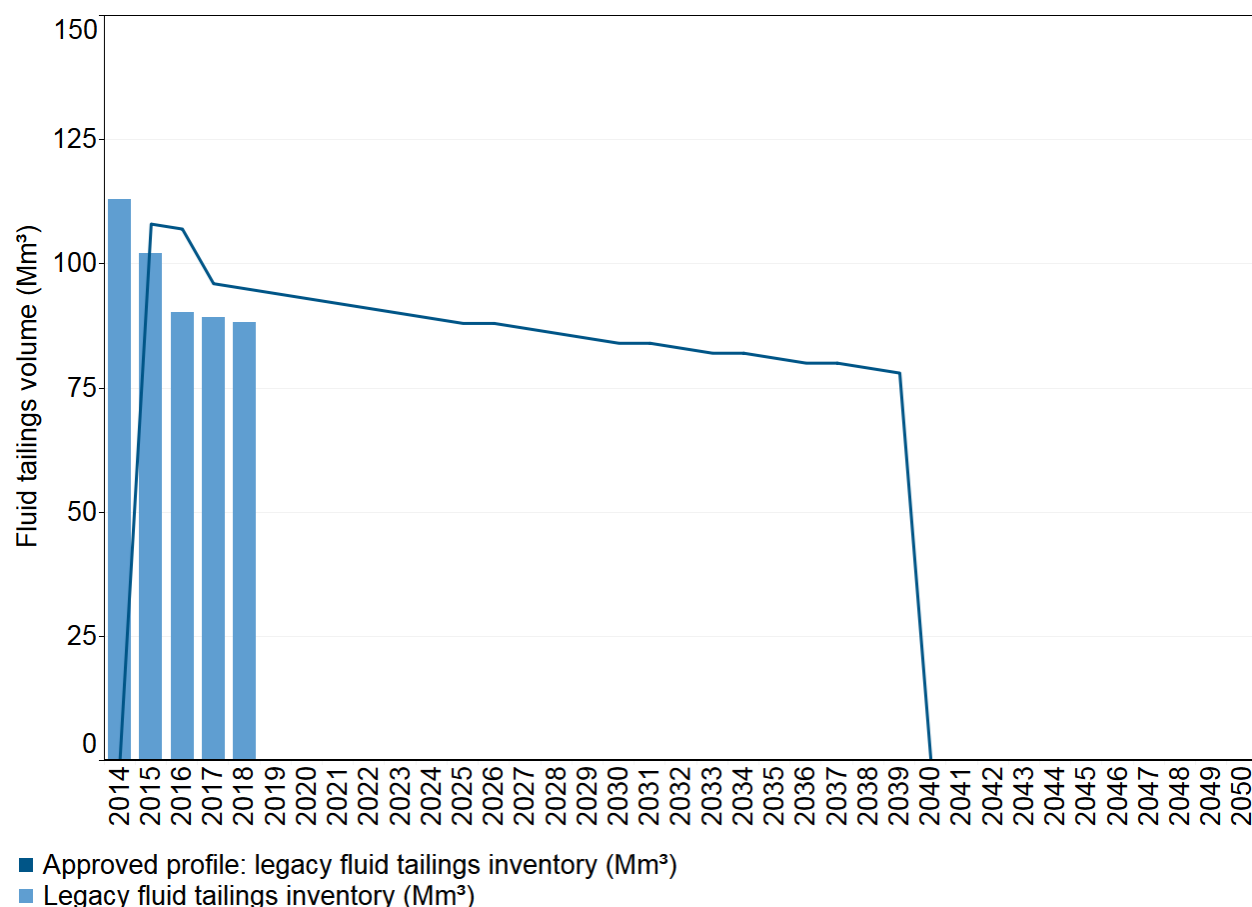


Notes: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria. 2018 data for Syncrude Mildred Lake are as-measured values taken mid-year and are not year-end projected values as for other operators. Syncrude Mildred Lake data for 2014 to 2017 are year-end projected values.

Figure 9. New fluid tailings for Syncrude Aurora North, 2014 to 2018

8.3.1.2 Legacy Fluid Tailings

Syncrude Aurora North reported 88.2 Mm³ of legacy fluid tailings inventory in 2018 (see figure 10), which was below its legacy fluid tailings profile for 2018. Syncrude Aurora North fluid tailings volumes for 2018 are as-measured values taken mid-year and are not year-end projected values as required by the AER. Syncrude Aurora North data between 2014 and 2017 are year-end projected values. As indicated earlier, a request for year-end projected values for 2018 fluid tailings volumes has been issued to Syncrude.



Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes provided in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria. 2018 data for Syncrude Mildred Lake are as-measured values taken mid-year and are not year-end projected values as for other operators. Syncrude Mildred Lake data for 2014 to 2017 are year-end projected values.

Figure 10. Legacy fluid tailings for Syncrude Aurora North, 2014 to 2018

8.3.2 Volume of Treated Fluid Tailings by Technology

CT technology is the only tailings treatment technology used on the Syncrude Aurora North site. In the report it submitted for 2018, Syncrude Aurora North reported producing a total of 16.3 Mm³ of CT, including 10.4 Mm³ of CT slurry and 5.9 Mm³ of beach deposits. The tailings were deposited into Aurora East Pit South (AEPS). This volume is less than the 18.9 Mm³ Syncrude Aurora North reported it would produce in 2018 in its tailings management plan application. Values reported by Syncrude in the AER's *State of Fluid Tailings Management for Mineable Oil Sands, 2017* report have been updated to reflect the inclusion of CT slurry volumes reported by Syncrude Aurora North, in addition to the CT beach deposit.

Similar to 2017, Syncrude reported that production of CT was reduced so more sand could be placed in Aurora East Pit North-West (AEPN-W) to accelerate construction (by infilling with solids) of the base for

the future Fort Hill dump expansion. More information has been requested in order for the AER to complete its technical review of this matter.

Syncrude reported an estimated change in fluid tailings volume inventory as a result of consolidation of 0.9 Mm^3 , which is 0.2 Mm^3 less than the volume predicted in its Aurora North tailings management plan.

8.3.3 Treatment Operation and Continuous Improvement

Syncrude Aurora North altered its target SFR from 4:1 in 2017 to a range that is between 3:1 and 5:1 in 2018. Syncrude Aurora North did not provide rationale for the change. As a result, the AER has requested information to assess the implications to RTR criteria, RTR trajectory, or the effect to its fluid tailings profiles. Syncrude Aurora North reported that the CT plant did not perform at the target range. In 2018, it reported an average SFR, of 2.7:1, which is lower than the 3.9:1 reported in 2017. Syncrude has been asked to clarify this.

Syncrude Aurora North reported that it will continue to follow the existing CT operating guidelines. However, it also reported that it is conducting additional sampling to better understand why its sample data does not appear to be proportionally representative of the plant input streams. Syncrude Aurora North reported that inputs to CT production will continue to be closely monitored, including FFT density and wet gypsum density. Clarification has been requested from Syncrude in order for the AER to complete its technical review of this matter.

8.3.4 Technological Innovation in Fluid Tailings Treatment

Technological innovation in fluid tailings management for Syncrude Aurora North is conducted at the Mildred Lake site. See section 8.2.4 for details.

8.3.5 Regulatory and Management Actions

On December 18, 2018, Syncrude submitted a tailings treatment plan alternatives plan in compliance with clauses 9 and 10 of its approval. The AER considered the submission incomplete because it did not include adequate information to meet the requirements of section 9.8.2 of *Directive 085*, which states that water-capped fluid tailings technology may be used to generate the inventory forecast, provided that the fluid tailings management plan includes an alternative technology option.

The AER initiated further compliance review of the submission that resulted in the AER issuing a notice of noncompliance to Syncrude on February 9, 2019, requiring that it take corrective action, meet with the AER to discuss an action plan, and correct the noncompliance. On March 28, 2019, Syncrude submitted its revised fluid tailings treatment technology alternatives plan to bring it back into compliance. The AER has requested more information on this matter from Syncrude and is awaiting a response.

8.3.6 Measurement System Audit Results

Syncrude Aurora North submitted its proposed measurement system plan in December 2018, which is currently under assessment by the AER. As a result, Syncrude Aurora North's measurement system was not audited in 2018. Once the measurement system plan assessment is complete, audits will occur as required.

8.4 Canadian Natural Upgrading Limited – Muskeg River Mine

CNUL's Muskeg River Mine (CNUL-MRM) reported five active tailings deposits on site: the external tailings facility (ETF); south expansion area (SEA); in-pit cell 1 (IPC1); in-pit cell 2 (IPC2), which consists of IPC2A and IPC2B; and in-pit cell 3 (IPC3).

CNUL-MRM's primary method of treatment for its fluid tailings is the co-deposition of TT, TSRU, and CST with the occasional mixture of whole tailings (WT), which CNUL-MRM refers to as creating a north pool deposit (NPD). In this year's report, CNUL-MRM also refers to NPD-type deposits as mixed deposits.

IPC1 currently acts as a clarification pond by accepting water transfers from ETF, IPC2, and IPC3 before water is transferred to the recycle water pond (RCW). IPC1 contains NPD-type deposits and some CST beaches.

IPC3 also contains both an NPD-type deposit and CST beaches along the south and west perimeters. Volumes reported for IPC3 reflect only the portion of beach considered an NPD-type deposit.

IPC2 is the only deposit formed without TSRU and is identified as a CT deposit in CNUL-MRM's approved tailings management plan.

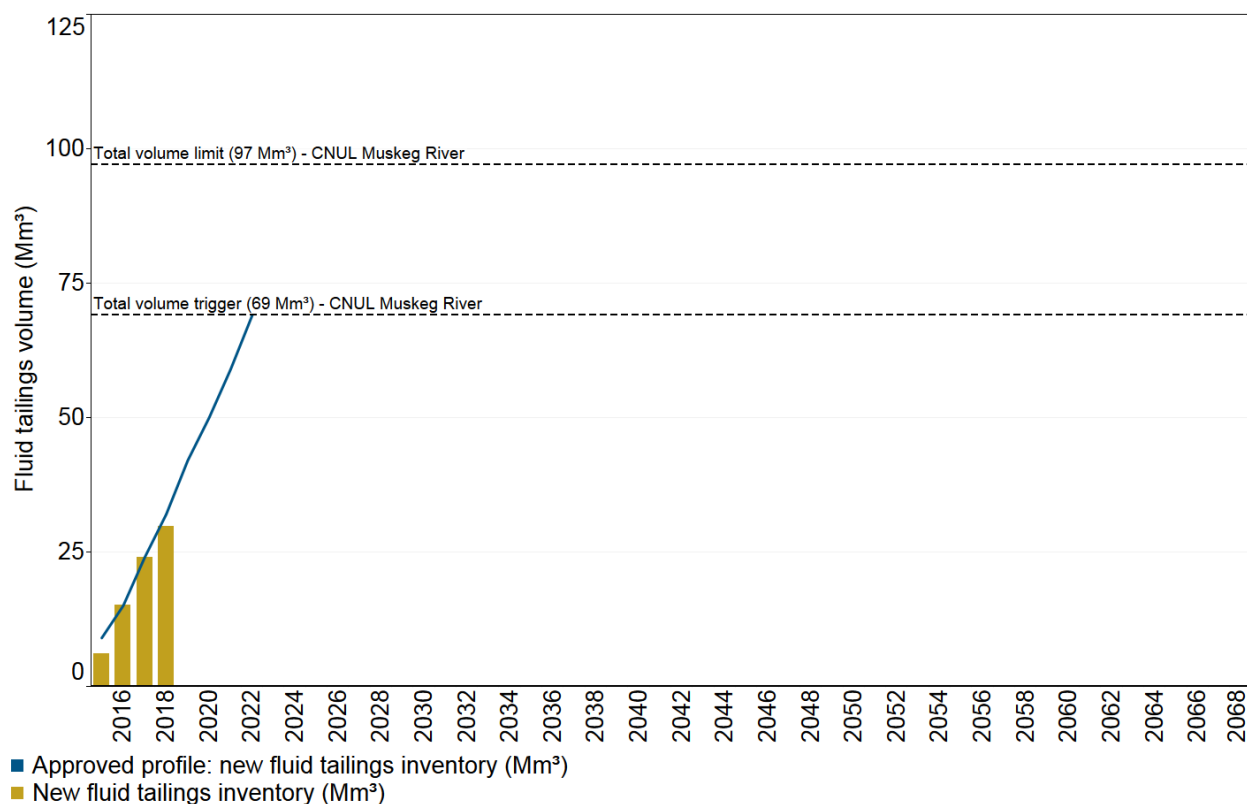
Overall, CNUL-MRM reports being compliant with the fluid tailings profiles approved on May 23, 2018.

8.4.1 Fluid Tailings

CNUL-MRM reported a total fluid tailings volume inventory (new and legacy fluid tailings combined) of 121.7 Mm³ in 2018. CNUL-MRM reported 29.7 Mm³ new fluid tailings inventory and 92 Mm³ legacy fluid tailings inventory in 2018. The AER was unable to assess the treated tailings volumes reported as having met RTR criteria because CNUL-MRM did not indicate the volume of NPD-type deposits that achieved RTR in its report. The AER has requested clarification on this matter from CNUL-MRM. Fluid tailings volumes will be evaluated and the RTR status will be assessed and reported on once RTR criteria are established and measurement system plans are assessed. CNUL-MRM's legacy fluid tailings profile is only approved until 2023, pending an amendment application from CNUL.

8.4.1.1 New Fluid Tailings

CNUL–MRM reported 29.7 Mm³ of new tailings inventory in 2018 (see figure 11). However, CNUL–MRM did not mention how the volume was calculated. The AER has requested that CNUL–MRM clarify how it derived its fluid tailings volume. CNUL–MRM has a total volume trigger of 69 Mm³ and a total volume limit of 97 Mm³ for new fluid tailings in its tailings management approval. Based on data from CNUL–MRM, it did not exceed its total volume trigger or total volume limit for new fluid tailings in 2018 and did not exceed its new fluid tailings profile between 2015 and 2018.

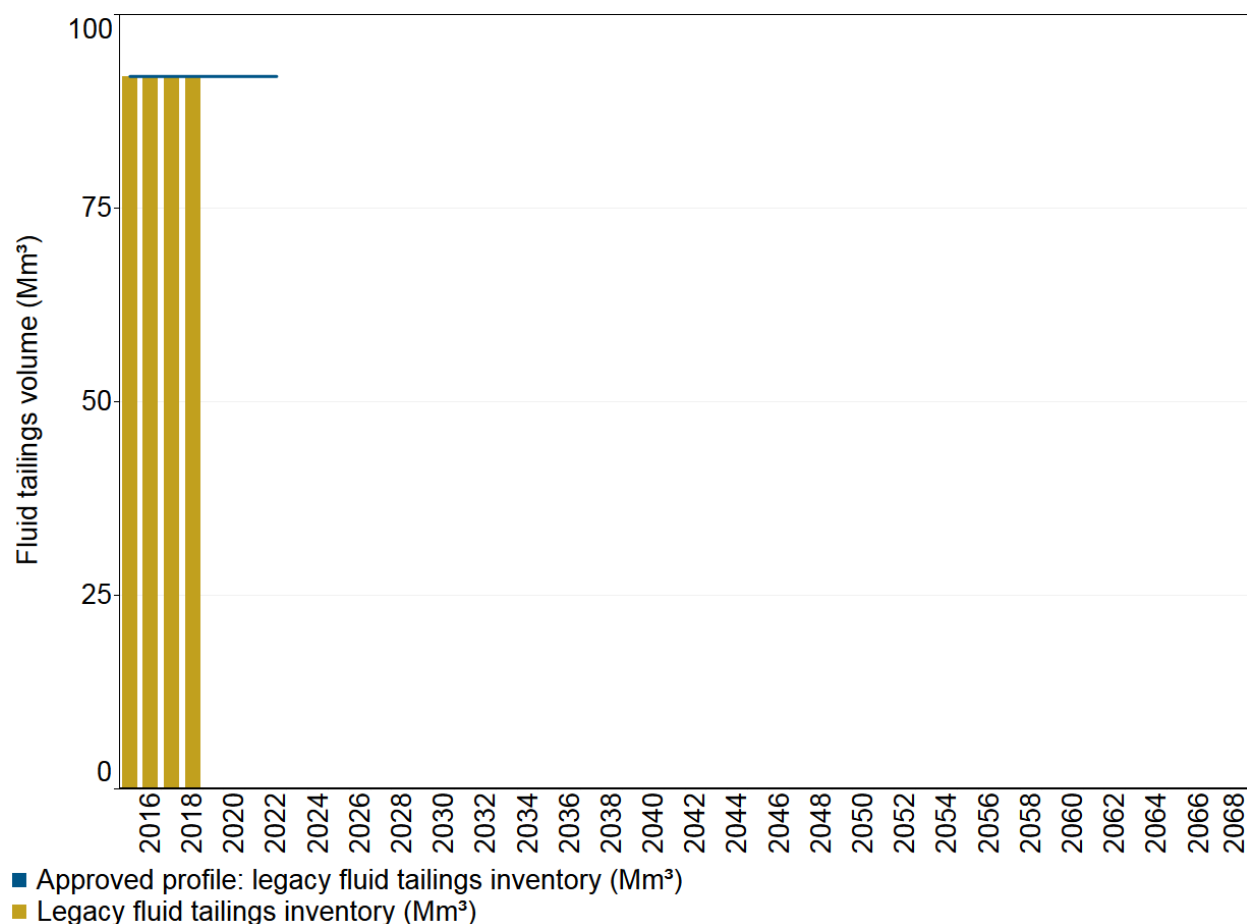


Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 11. New fluid tailings for CNUL Muskeg River Mine, 2015 to 2018

8.4.1.2 Legacy Fluid Tailings

CNUL–MRM reported 92 Mm³ of legacy fluid tailings inventory in 2018, which is below its legacy fluid tailings profile (see figure 12). CNUL–MRM did not report any changes to its legacy fluid tailings inventory volumes in 2018, which is consistent with its approved legacy fluid tailings profile. CNUL–MRM claims it is aligned with its expected legacy fluid tailings volume.



Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 12. Legacy fluid tailings for CNUL-MRM, 2015 to 2018

8.4.2 Volume of Treated Fluid Tailings by Technology

The primary technology used at the CNUL-MRM site for fluid tailings management during the 2018 reporting period was a mixture of TT, CST, TSRU, and WT deposited in the ETF to create an NPD-type deposit. CNUL-MRM reported depositing a total volume of 45.1 Mm³ into the IPC3 and zero volumes in the ETF. Table 3 shows the reported breakdown of the fluid tailings mixture deposited in IPC3 and table 4 shows the reported deposit performance for IPC3.

Table 3. Fluid tailings deposited in IPC3 at CNUL-MRM, 2018

Fluid tailings treatment	Deposit	Volume deposited (Mm³)
CST	IPC3	11.5
TT	IPC3	11.6
TSRU	IPC3	22.0
Total		45.1

Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes provided in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Table 4. Deposit performance for the IPC3 deposit at CNUL–MRM

Treatment	Deposition date	Estimated deposit volume (Mm ³)	Average solids content (%) ^a
Mixed deposit	2016 to June 23, 2017	2.1	69.5
Mixed deposit	June 23, 2017, to June 19, 2018	8.9	60.5
Total		11.0	–

^a Geotechnical solids content, including bitumen.

Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes provided in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

CNUL–MRM did not report any activity for its NPD deposit on the ETF. In table 2 of its 2018 report, CNUL–MRM reported 4.6 Mm³ of NPD-type deposit to have achieved RTR status in 2017. CNUL–MRM also reported a total of 94.5 Mm³ of NPD type deposit in the ETF to have achieved RTR status with an SFR of 2.26. CNUL–MRM indicated the deposit to have achieved RTR status in 2017 for the entire north pool area only. CNUL–MRM reported an estimated deposit volume of 8.9 Mm³ of NPD-type deposit with an average solids content of 60.5 per cent.

CNUL–MRM also reported TT deposition in IPC2 in 2018. CNUL–MRM reported that 11.4 Mm³ of slurry was sent to IPC2 in 2018. It had an average solids content of 18.6 per cent at the end of the year. CNUL–MRM reported that 0.8 Mm³ of TT has achieved its RTR criteria, with an average solids content of 75.3 per cent.

Based on the data presented above, it is not possible to calculate 2018 year-end volumes for the amount of fluid tailings treated. Clarification on this data has been requested from CNUL–MRM.

CNUL–MRM is only approved to use thickener with a co-deposition of TT with TSRU, WT, and CST to form an NPD-type deposit. A TT deposit was not approved in the 2016 tailing management plan approval; a change from a CT deposit to a TT deposit in IPC2 would require a re-evaluation of the tailings management plan. CNUL–MRM's tailings management plan approval indicated that CNUL–MRM was supposed to treat 8.5 Mm³ of CT in 2017 and 8.1 Mm³ in 2018. Further, cell 2's RTR criteria and trajectory for CT was not accepted, and CNUL–MRM is required to provide a consolidation model and updated RTR criteria and RTR trajectory for cell 2.

8.4.3 Treatment Operation and Continuous Improvement

The tailings treatment technology of choice at CNUL–MRM is the use of a thickener to create TT. CNUL–MRM co-deposits TT with TSRU tailings, WT, and CST to form NPD-type deposits, which CNUL refers to as a mixed deposit. In addition, as part of its 2016 tailings management plan approval, CNUL–MRM was to use CT until the end of 2018 upon completion of cell 2.

As mentioned before, the AER expected CNUL to treat a certain volume of tailings through CT in 2018. However, CT was not created in 2018. The AER is requesting further clarification and may require CNUL to submit an amendment application as a result of this deviation from its tailings management plan. Other follow-up actions may be required.

With respect to the NPD-type deposit, the AER has noticed an increase within CNUL–MRM’s IPC3 mixed-deposit performance. CNUL–MRM has increased its claimed treatment volume for the NPD-type deposit from its previous year. However, the AER was unable to verify the volume that achieved RTR status because CNUL–MRM continues to average its solids content measurements to report the volumes in its deposit. The AER has denied the use of average solids content in CNUL–MRM’s tailings management plan approval and decision report. The use of average solids content limits the ability to assess risks and liabilities for underperforming treated tailings and the effect on a deposit’s performance toward the targeted ecosites and evaluate against CNUL–MRM’s approved RTR criteria.

Use of average solids content is not considered acceptable because it does not identify variations in tailings characteristics across a deposit, particularly 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 toward the targeted ecosites. The AER has requested clarification on the performance of NPD-type deposits to date.

8.4.4 Technological Innovation in Fluid Tailings Treatment

CNUL–MRM reported continued refinement of its tailings technologies and deposition strategies. Tailings research is also used in the development of CNUL’s tailings management plans, which enables CNUL–MRM to explore continuous improvement. The following efforts were made to improve the state of tailings management throughout this reporting period at CNUL–MRM:

- tailings consolidation casing experimental pilot project (TCCEPP)
- chemical amendment of fluid fine tailings
- soft deposit capping-atmospheric fines drying test cell capping
- end-of-pipe tailings treatment
- Geotube pilot program

Details of each of the above efforts are found in CNUL–MRM’s report.

8.4.5 Regulatory and Management Actions

CNUL–MRM received its tailings management approval and decision report on May 23, 2018. As a result, CNUL–MRM was required to submit a number of submissions for clarification, verification, and requirements to ensure that it is on trajectory in meeting its overall outcome goals.

- CNUL submitted its treatment capacity plan on December 19, 2018. In response, the AER has requested clarification about the information CNUL–MRM provided. The AER granted the requested extension to September 30, 2019, to provide the requested information.
- CNUL submitted its MRM and JPM tailings capping research plan on September 28, 2018. This submission is under review by the AER.
- CNUL requested a change in chemical use in its tailings treatment in 2018. The AER allowed for this to be piloted. This encompasses laboratory-based research projects and pilot programs focused on in-line flocculation and corresponding instrumentation and control (I&C) system for automation of the process: tailings are mixed with polymer flocculants inline with instrumentation to control the flocculated material quality.

Overall, in 2018 CNUL–MRM was still in its early stages of adjustment to its new tailings management plan approval and conditions. In order to allow for flexibility and operational efficiency, many conditions within the approval allow for some time for development and improvement of approved technologies and deposits. Therefore, there were not many requirements for the remainder of 2018.

8.4.6 Measurement System Audit Results

CNUL–MRM submitted its proposed measurement system plan in November 2018 and it is currently under assessment by the AER. As a result, CNUL–MRM’s measurement system was not audited in 2018.

8.5 Canadian Natural Upgrading Limited – Jackpine Mine

CNUL Jackpine Mine (CNUL–JPM) reported only two active tailings areas. Tailings are stored in the ETF and fluid cell 1 (FC1).

CNUL–JPM’s primary selected method of treatment for its fluid tailings is the co-deposition of TT and CST, which CNUL–JPM commonly refers to as creating a mixed deposit (different from CNUL–MRM’s NPD-type deposit) and the use of centrifuge.

Overall, CNUL–JPM reports that it is compliant with its profiles. However, the AER has requested clarification of CNUL–JPM’s accounting of fluid tailings volumes. CNUL–JPM also reported a reduction in fluid tailings volume inventories between 2017 and 2018. The AER has also requested further clarification on how that was achieved in 2018.

CNUL–JPM reported treating more fluid tailings than it generated between 2017 and 2018. CNUL–JPM did not provide a rationale or explanation for differences between reported volumes in its 2018 report and its 2017 report. The AER has requested clarification of this inconsistency.

Lastly, CNUL–JPM did not specify the exact volume of treated fluid tailings reported to have met RTR criteria. The AER has requested further clarification on this matter.

8.5.1 Fluid Tailings

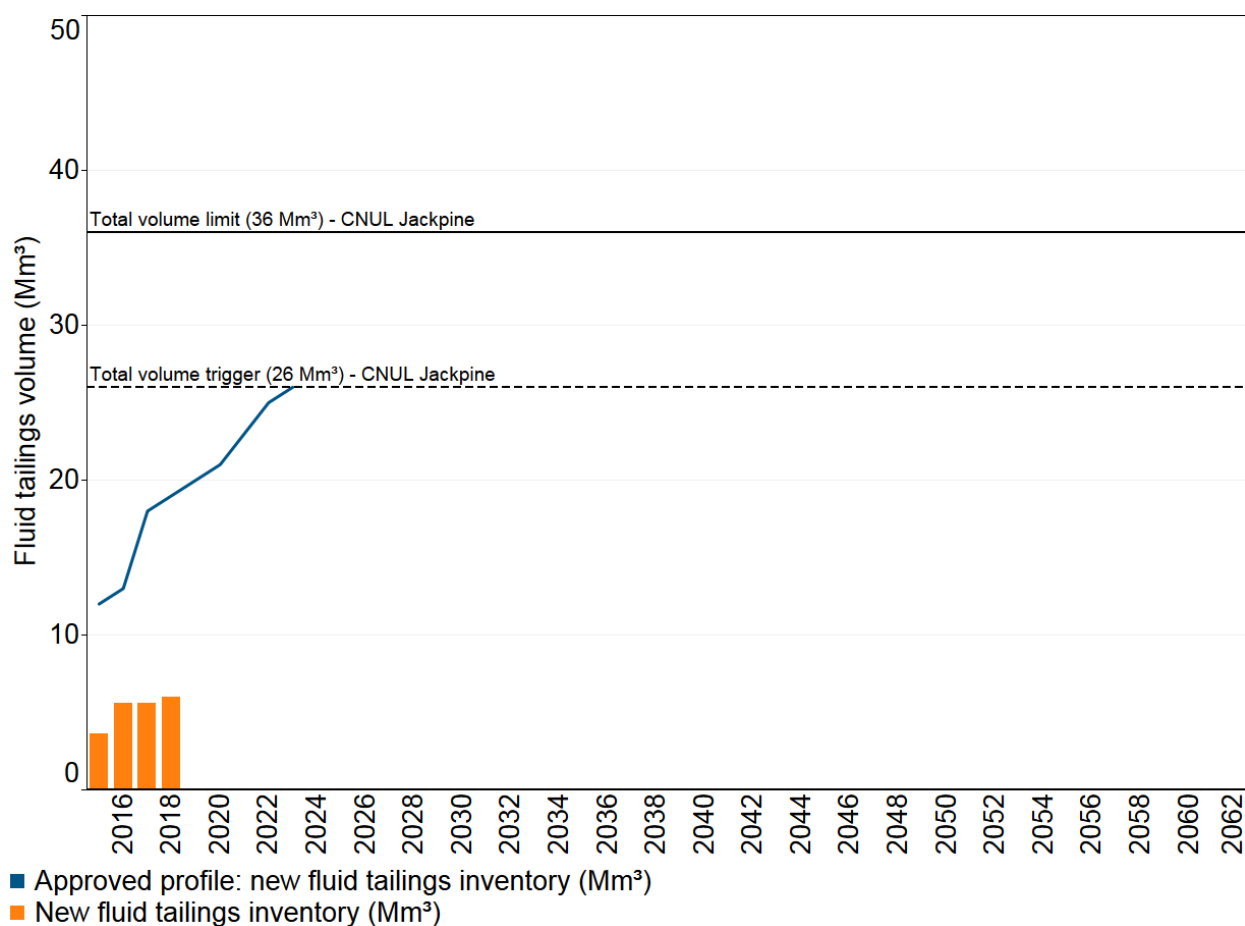
CNUL–JPM reported 28.0 Mm³ of total fluid tailings inventory (new and legacy fluid tailings combined) in 2018. CNUL–JPM reported 6.0 Mm³ of new fluid tailings inventory and 22 Mm³ of legacy fluid tailings inventory in 2018. The majority of CNUL–JPM’s active tailings ponds were on the ETF and FC1.

Fluid tailings volumes will be evaluated and the RTR status will be assessed and reported on once RTR criteria in *OSCA* approvals are established and measurement system plans are assessed. CNUL–JPM’s legacy fluid tailings profile is only approved until 2023, pending an amendment application from CNUL.

8.5.1.1 New Fluid Tailings

CNUL–JPM reported 6.0 Mm³ of new fluid tailings inventory in 2018 (see figure 13). CNUL–JPM has a total volume trigger of 26 Mm³ and a total volume limit of 36 Mm³ for new fluid tailings in its tailings management approval. Based on the data submitted by CNUL–JPM in the fluid tailings report for 2018, CNUL–JPM did not exceed its total volume trigger or total volume limit for new fluid tailings in 2018 and did not exceed its new fluid tailings profile between 2015 and 2018.

However, CNUL did not indicate how the volume was calculated. The AER has requested clarification on this volume.

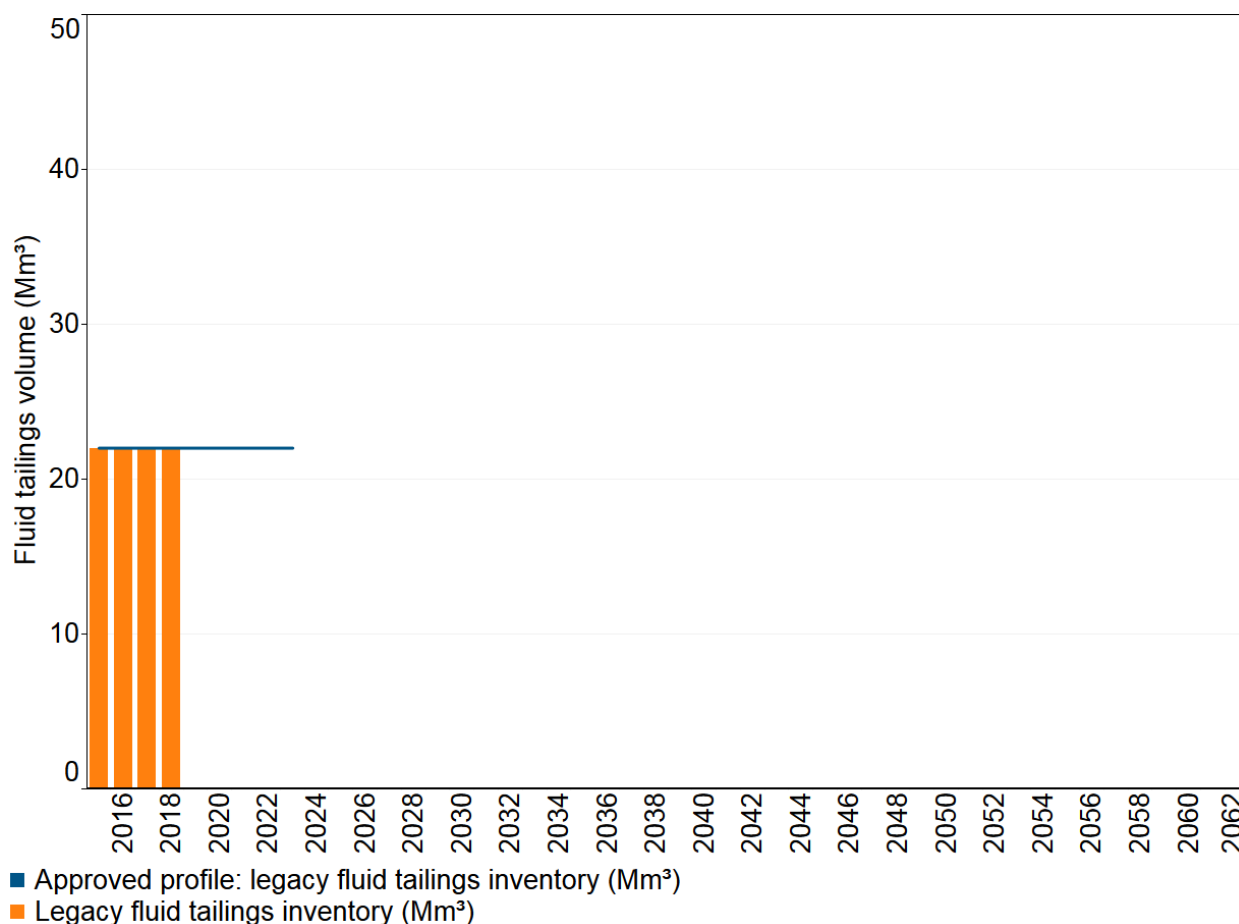


Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 13. New fluid tailings for CNUL-JPM, 2015 to 2018

8.5.1.2 Legacy Fluid Tailings

CNUL-JPM reported 22 Mm³ of legacy fluid tailings inventory in 2018, which is below its legacy fluid tailings profile (see figure 14). CNUL-JPM did not claim any change in its legacy fluid tailings volumes for 2018. According to its profile, no legacy tailings will be treated and the legacy volume will remain unchanged until 2027.



Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 14. Legacy fluid tailings for CNUL-JPM, 2015 to 2018

8.5.2 Volume of Treated Fluid Tailings by Technology

The two primary technologies used at the CNUL-JPM site for fluid tailings management during the 2018 reporting period were mixed deposit (TT and CST) in ETF and centrifuge technologies. CNUL-JPM reported that it deposited a total volume of 16.4 Mm³ of TT in DDA1. CNUL-JPM reported that TT obtained an average solid content of 12.2 per cent, but did not provide the measurements of the mixed deposit for achievement of the approved tailings management plan's RTR criteria and trajectory.

CNUL-JPM reported 2.2 Mm³ of centrifuge produce was deposited in DDA1 with an estimated average solids content 45.7 per cent. RTR criteria were not approved for centrifuge cake deposits.

Volumes claimed to have achieved RTR criteria through centrifuge at CNUL-JPM will not be removed from its fluid tailings inventory: for both previously deposited centrifuge tailings and centrifuge tailings that are deposited in the future as per the decision report issued in 2018 (AER [Decision 20180523B: Canadian Natural Upgrading Limited; Application for Jackpine Mine Tailings Management Plan](#)).

8.5.3 Treatment Operation and Continuous Improvement

CNUL–JPM uses both a thickener and centrifuge technology for its fluid tailings treatment. Thickened tailings slurry and treated tailings from the centrifuge operation are deposited at two fixed locations in the northwest corner of DDA1. CST deposited into this centrifuge deposit is also mixed with centrifuge product, resulting in a deposit containing some zones of CST bands. CNUL–JPM reported that the TT deposit formed during the reporting period had an average solids content of 74.7 per cent and that the deposit formed in DDA 1 had an average solids content of 45 per cent.

Overall, CNUL–JPM indicates that they have performed better than required in its approved tailings management plans. The AER has requested clarification on the performance of its technology and the volumes submitted for the 2018 reporting year.

8.5.4 Technological Innovation in Fluid Tailings Treatment

CNUL–JPM reported five field tests and projects in its 2018 report. The various projects include tests conducted at different scales (e.g., lab, pilot, and commercial scale) and different time scales (e.g., months and years) in order to validate the numerical modelling used in the analysis and design of tailings deposition and reclamation strategies. Research projects undertaken are designed to provide information to allow the selection of tailings technologies for commercial implementation and the formation and development of fluid tailings management plans. Pilots and research projects conducted at CNUL–JPM included:

- chemical amendment of fluid fine tailings
- modified atmospheric fines drying (MAFD)
- deep cohesive deposits
- soft deposit capping centrifuge cake test cell capping
- fluid fine tailings pressure filtration pilot

8.5.5 Regulatory and Management Actions

CNUL–JPM received its tailings management approval and decision report on May 23, 2018. As a result, CNUL–JPM was required to provide a number of submissions for clarification, verification, and requirements as a result of the decision on its tailings management plan from the AER to ensure that they are on track in meeting its overall outcome goals.

- As per clause 23 of CNUL–JPM’s approval 9756H, CNUL has a condition to provide an updated mine plan. CNUL–JPM’s proposed end-of-mine life of 2105 in its tailings management plan was unauthorized. CNUL–JPM’s application did not include sufficient information to support the change, such as an updated mine plan and life-of-mine closure plan. CNUL–JPM requested a one year extension to submit its updated mine plan, the new due date for the updated mined plan is now

September 30, 2019. The AER granted the extension with the expectation that CNUL–JPM will address the AER’s concerns on alignment of the tailings management plan with the life-of-mine plan or life-of-mine closure plan and consistency with targeted reclamation outcomes.

- As per clause 41 of CNUL–JPM’s approval 9756H, CNUL–JPM has a condition to provide RTR criteria for deposits containing centrifuge tailings by September 30, 2018. CNUL–JPM complied and provided its proposed RTR criteria to the AER on September 28, 2018. CNUL–JPM submitted an update to its RTR criteria proposal on December 7, 2018, providing additional clarifications and addressing the AER’s concerns. The AER is working with CNUL to resolve these issues. The major concerns remaining to be addressed are:
 - the acceptability of using of average solids content for deposits
 - the acceptability of outcomes
 - the ability to track performance

Overall, CNUL–JPM is still in its early stages of its newly approved tailings management plan conditions in 2018. In order to allow for flexibility and operational efficiency, the approval allows time for development and adjustment. The AER is working with CNUL–JPM to resolve uncertainties.

8.5.6 Measurement System Audit Results

CNUL–JPM submitted its proposed measurement system plan in November 2018 and it is currently under assessment by the AER. As a result, CNUL–MRM’s measurement system was not audited in 2018.

8.6 Canadian Natural Resources Limited – Horizon

CNRL Horizon’s approval was issued on December 18, 2017. CNRL Horizon reported commissioning a fifth NST train in 2018 in accordance with its production expansion plan. At the end of 2018, CNRL Horizon was also operating two naphtha recovery unit (NRU) lines, with carbon dioxide being injected into NST and NRU lines.

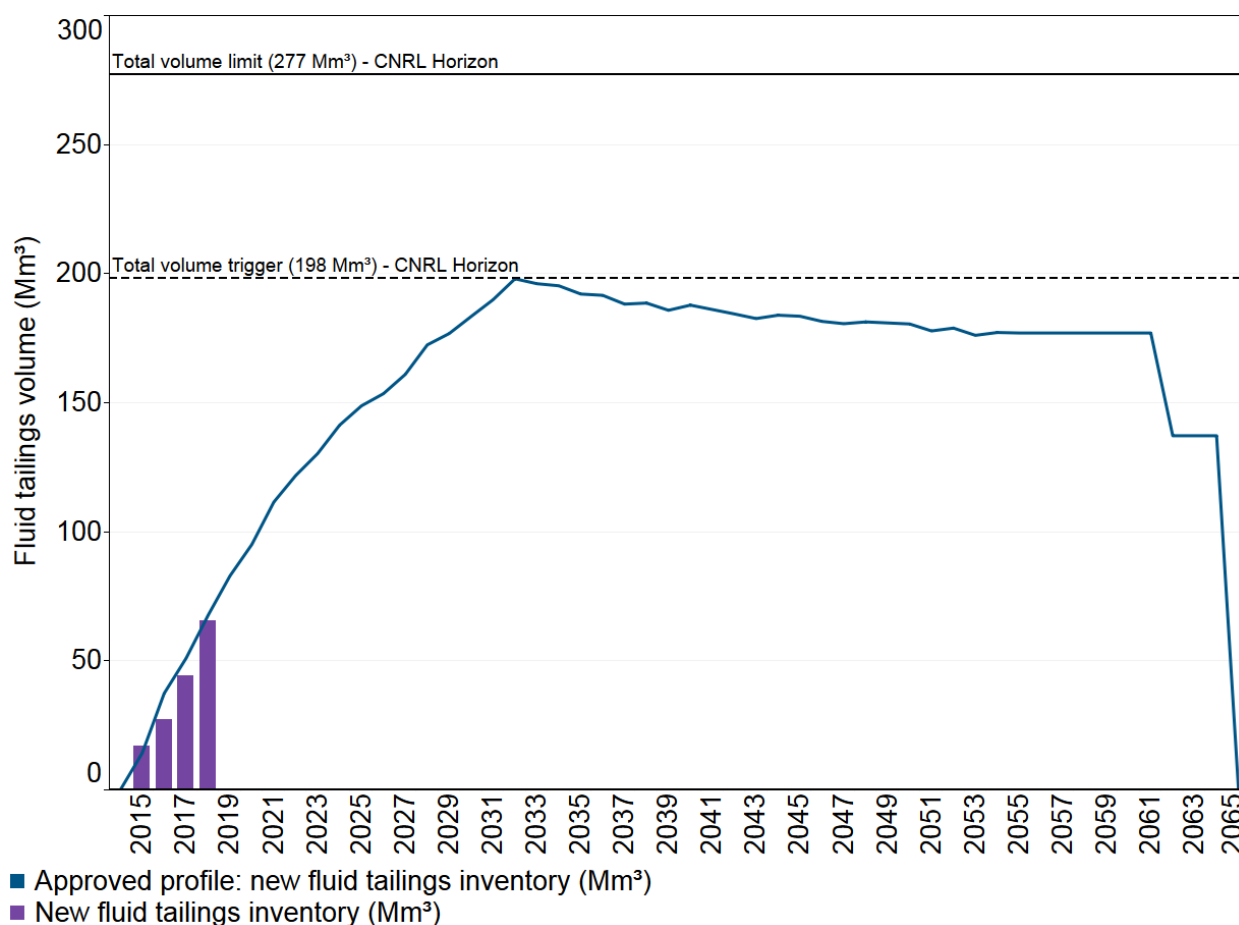
8.6.1 Fluid Tailings

CNRL Horizon reported that fluid tailings volumes are accumulating as predicted in its tailings management plan. CNRL Horizon reported 131.8 Mm³ of total fluid tailings inventory (new and legacy fluid tailings combined) for 2018, up from 110.6 Mm³ in 2017. CNRL Horizon modified its previously reported volumes of fluid tailings inventory to 83.0 Mm³ in 2015, 93.3 Mm³ in 2016, and 110.6 Mm³ in 2017. CNRL Horizon also modified its previously reported change in new fluid tailings inventory volumes to 16.8 Mm³ in 2015, 10.3 Mm³ in 2016, and 17.3 Mm³ in 2017. CNRL Horizon did not provide rationale for these volume changes. As a result, the AER has requested clarification from CNRL Horizon in order for the AER to complete its technical review.

Fluid tailings volumes will be evaluated and the RTR status will be assessed and reported on once RTR criteria in *OSCA* approvals are established and measurement system plans are assessed.

8.6.1.1 New Fluid Tailings

CNRL Horizon reported 65.6 Mm³ of new fluid tailings inventory in 2018 (see figure 15). CNRL Horizon has a total volume trigger of 198 Mm³ and a total volume limit of 277 Mm³ for new fluid tailings in its tailings management approval. Since exceeding its approved new fluid tailings profile in 2015, CNRL's new fluid tailings volumes have been below its approved profile and have not exceeded its total volume trigger and total volume limit for new fluid tailings.

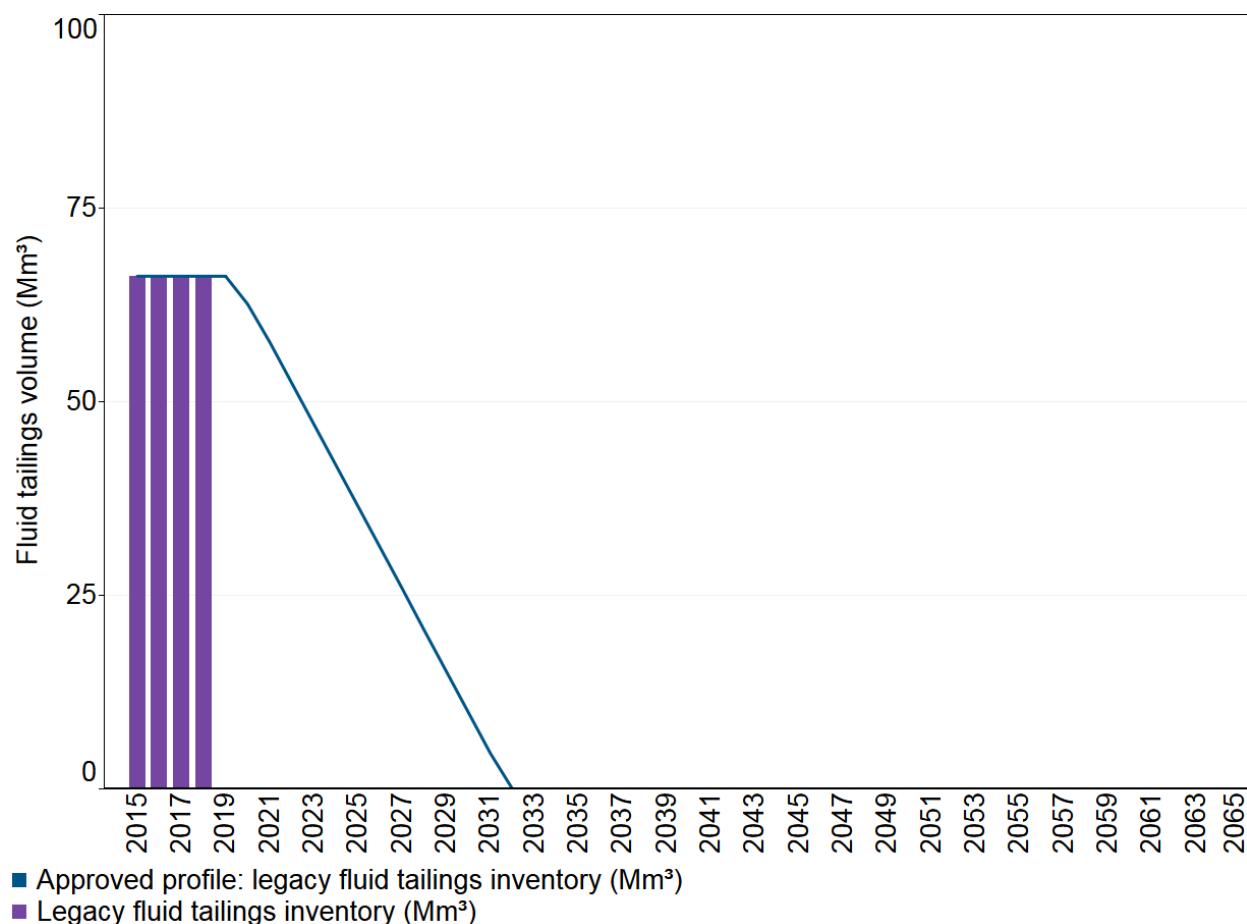


Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 15. New fluid tailings for CNRL Horizon, 2015 to 2018

8.6.2 Legacy Fluid Tailings

CNRL Horizon reported a legacy fluid tailings volume of 66.2 Mm³ in 2018, indicating no reduction in legacy fluid tailings since 2015 (see figure 16). CNRL Horizon was within its approved legacy fluid tailings profile between 2015 and 2018.



Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 16. Legacy fluid tailings for CNRL Horizon, 2015 to 2018

8.6.3 Volume of Treated Fluid Tailings by Technology

Treated tailings from NST and NRU technologies were placed in external tailings facility/dedicated disposal area 1 (ETF/DDA1). CNRL Horizon did not report treated volumes of fluid tailings using NST technology in 2018, stating that NST deposited during the current reporting period is deemed to be on an RTR trajectory. CNRL Horizon also did not report its volume of froth fluid tailings using NRU technology. Clarification has been requested by the AER in order for the AER to complete its technical review of this matter.

CNRL did not report the volume of NST material that was estimated to meet RTR criteria. Instead, it reported that it has no fluid tailings considered to have reached RTR status during this reporting period. The AER has requested clarification in order for the AER to complete its technical review of this matter.

8.6.4 Treatment Operation and Continuous Improvement

CNRL Horizon reported a decrease in NST on-specification run time compared with 2017. However, CNRL Horizon also reported that performance of NST technology did not deviate from its fluid tailings management plan, and that its technology continues to follow the ramp-up performance path approved by the AER. CNRL Horizon reported an on-specification run time target of 85 per cent for its NST plant generation before 2023 and reported an average on-specification run time of 56 per cent in 2018, down from 70 per cent in 2017. The AER has requested clarification from CNRL Horizon in order to understand these comments and to complete its technical review of CNRL Horizon's report.

CNRL Horizon reported that an undefined volume of deposited fluid tailings was on an RTR trajectory. However, CNRL did not provide sufficient evidence for the AER to verify CNRL's reported performance. The AER has requested clarification on this matter.

CNRL Horizon identified a series of process changes for continuous improvement:

- Thickeners: CNRL Horizon changed polymer suppliers to try to improve flocculent performance and higher NST density, which should result in higher fines capture.
- Thickener and cyclones: CNRL Horizon optimized the range of operating conditions of the secondary cyclone to try to improve flow and solids classification, which should result in higher fines capture.

8.6.5 Technological Innovation in Fluid Tailings Treatment

CNRL Horizon did not report any new strategies targeting technological innovation in fluid tailings treatment in 2018. CNRL Horizon reported a continuation of the following innovations that it implemented in 2017:

- NST enhancement (estimated deployment is now 2019; delayed by a year),
- improvement of FT spiking (estimated deployment delayed and is now undefined),
- in-pit extraction (estimated deployment is now 2023; delayed by a year), and
- NRU treatment (estimated deployment is now 2023; delayed by a year).

Semi-in-situ mature fine tailings (MFT) treatment was removed in 2018 from CNRL's summary of technologies under development.

8.6.6 Regulatory and Management Actions

Three amendments were made to CNRL's approval 9752 in 2018:

- In July 2018, CNRL was approved for a 14-month delay for reporting pursuant to its MFT reduction mine plan results, and a reduction in reporting frequency from quarterly to annually.
- In July 2018, CNRL was approved for a one year extension to submit a flux, settlement, and consolidation model that is representative of ETF/DDA1.
- In December 2018, CNRL was approved to extend its MFT reduction mine plan program to September 2022.

8.6.7 Measurement System Audit Results

CNRL Horizon submitted its proposed measurement system plan in June 2018. It is currently under assessment by the AER. As a result, CNRL Horizon's management system was not audited in 2018.

8.7 Imperial Oil Limited–Kearl

Imperial–Kearl reported that the only active tailings deposit is its external tailings area (ETA), which is split into the west ETA (WETA) and the east ETA (EETA). The EETA contains the approved area where Imperial–Kearl is to place its treated tailings (called the thickened tailings (TT) panel). In 2018, coarse sand tailings (CST), flotation tailings (FLT) and TSRU tailings from Kearl plant 1 (K1) continued discharging into the WETA. The CST from Kearl plant 2 (K2) were discharged into the EETA. The FLT and TSRU tailings from K2 continued discharging into the same areas of the WETA as K1 streams.

Imperial–Kearl's primary fines treatment technology is the production of thickened tailings that are produced by flocculating FLT and fluid tailings in the thickeners and re-flocculating the stream using chemical injection (secondary chemical treatment) before it is discharged to the TT panels.

Overall, Imperial–Kearl reported that it is compliant with its fluid tailings profiles. Fluid tailings volumes will be evaluated and the RTR status will be assessed and reported on once RTR criteria are established and measurement system plans are assessed. However, the AER acknowledges Imperial–Kearl's progress on its thickener and thickened tailings product.

Imperial–Kearl is in its early stages of operation and the AER acknowledges that Imperial–Kearl requires more time to verify its tailings treatment technology and deposit performance.

8.7.1 Fluid Tailings

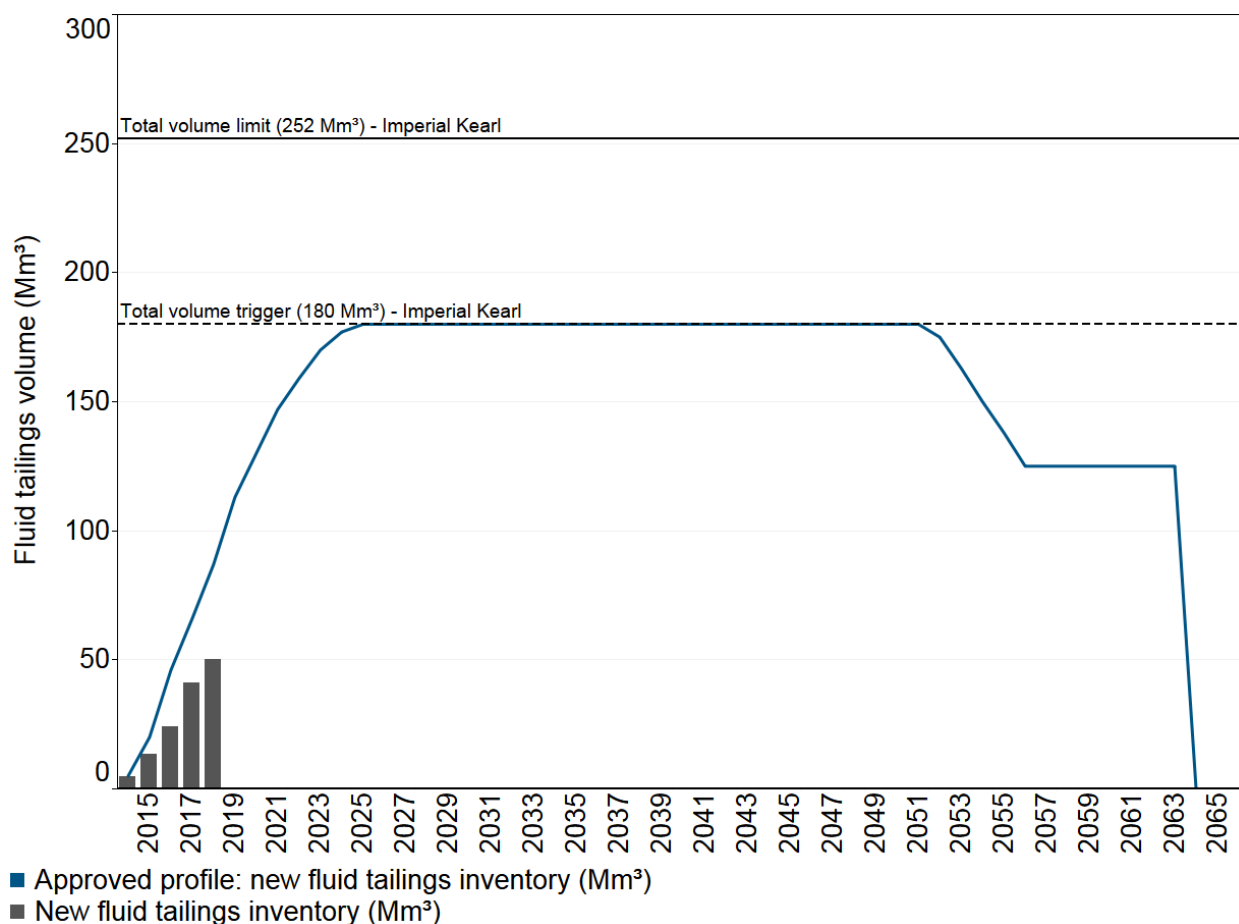
Imperial–Kearl only has new fluid tailings on site and no legacy fluid tailings.

Imperial–Kearl reported 8.0 Mm³ of TT at the end of the reporting period and about 6.0 Mm³ was reported to meet its approved RTR criteria. Fluid tailings volumes will be evaluated and the RTR status

will be assessed and reported on once RTR criteria are established and measurement system plans are assessed.

8.7.1.1 New Fluid Tailings

Imperial–Kearl reported 51.0 Mm³ of new fluid tailings inventory in 2018 (see figure 17), which did not include volumes claimed to have reached RTR criteria. Imperial–Kearl had a total volume trigger of 180 Mm³ and a total volume limit of 252 Mm³ in its tailings management approval. Based on the data provided, Imperial–Kearl did not exceed its total volume trigger or total volume limit for new fluid tailings in 2018 and it was within its new fluid tailings profile between 2014 and 2018.



Note: The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Figure 17. New fluid tailings for Imperial–Kearl, 2014 to 2018

8.7.1.2 Legacy Fluid Tailings

Imperial–Kearl does not have any legacy fluid tailings because all fluid tailings on site are considered new fluid tailings.

8.7.2 Volume of Treated Fluid Tailings by Technology

Imperial–Kearl reported producing 8.7 Mm³ of TT in 2018 and is claiming 6.0 Mm³ of TT as having achieved its approved RTR criteria. Imperial–Kearl only used TT treatment on site.

8.7.3 Treatment Operation and Continuous Improvement

Over the 2018 reporting period, Imperial–Kearl reported that the TT deposit is performing as expected with some variations across the deposit. Imperial–Kearl believes that this variation may, in part, be due to the mechanical reliability challenges encountered within the Imperial–Kearl’s fine tailings treatment (KFTT) system and is being further investigated. Imperial–Kearl reported increasing its understanding of the system as performance continues to improve; however, despite these variations, Imperial–Kearl claims that to date, about 70 per cent of the deposit (by volume) has met RTR criteria.

In 2018, Imperial–Kearl’s reported that its continuous improvement initiatives have been mainly focused on enhancing the overall TT deposit and operational improvements so that they can sustain the current performance of fluid tailings from the KFTT facility. The following list is a summary of areas of continuous improvement activities at Imperial–Kearl:

- FLT feed variability
- FLT feed reliability
- plugging of fluid tailings pumps reducing availability
- pipeline location challenges
- accelerated wear of underflow pumps
- equipment suitability and sparing challenges
- vibration in second chemical injection system

The focus at Imperial–Kearl is still on maintaining its thickeners to operate reliably for 2018.

8.7.4 Technological Innovation in Fluid Tailings Treatment

In 2018, Imperial began exploring improvements to fluid tailings treatment in pilot projects and tests. Imperial submitted an application to the AER on August 3, 2018, requesting authorization to conduct in-line flocculation of FFT at Kearl in the ETA in three phases. This trial used existing facilities and the same chemical from its KFTT process. The proposed first phase of the trial was to extract fluid tailings from the WETA and treat it using the existing secondary chemical injection as an in-line flocculation system. The flocculated material would then be deposited in thin layers within the EETA between the east divider dyke and the east perimeter dyke outside of the TT panels. This would allow for continued fines treatment if the primary fines treatment process (KFTT) was down. Imperial–Kearl plans to conduct the

in-line flocculation phase 2 trial between June 2019 and October 2019 to treat fluid tailings dredged from the TT panels with three chemicals and deposit into cells located along the south ridge of the EETA.

Imperial-Kearl is following what it stated in its tailings management plan. Imperial-Kearl is in the early stages of operation and the AER acknowledges that Imperial-Kearl requires more time to verify its tailings treatment technology and deposit performance.

8.7.5 Regulatory and Management Actions

Imperial-Kearl's tailings management plan was approved on July 16, 2018, and Imperial-Kearl has been compliant in submitting all of its mandated submissions in 2018. No management actions were taken or initiated during the reporting period.

8.7.6 Measurement System Audit Results

Imperial-Kearl submitted its proposed measurement system plan in January 30, 2019, and it is currently under assessment by the AER. As a result, Imperial-Kearl's measurement system was not audited in 2018. Once the measurement system plan assessment is complete, audits will occur as required.

9 Summary

Tailings management under *Directive 085* continued in 2018. It's the second year of operators submitting tailings management plans to the AER for review. Beginning with the 2018 reporting year, full *Directive 085* reporting was required from operators. By the end of 2018, six of eight tailings management plans were approved.

The total volume of fluid tailings (new and legacy tailings combined) on oil sands mine sites in the Athabasca oil sands region has increased between 2014 and 2018, as reported by the individual operators and as expected based on the tailings profiles approved in operators' tailings management plans. The regional volume of water in tailings ponds decreased slightly between 2014 and 2017. It then increased between 2017 and 2018. This occurred with an overall increase in bitumen production and more mines becoming operational.

Following measurement system plans assessments, future reports of treated fluid tailings volumes described as meeting the RTR status will be assessed and reported on. The AER notes that changes to fluid tailings volume inventories may result from reviews of reported data. Requests for clarification or additional data have been issued to operators for more information and explanations necessary to validate reported results.

Based on the volumes reported in 2018 annual reports submitted by operators, all of the operators' fluid tailings volumes were within their approved new and legacy profiles and below their new fluid tailings total volume triggers and total volume limits. Where information was insufficient for the AER to verify

operators' data or analyses, the AER issued requests for clarification or additional data. Responses to these requests were not received before the release of this report. Responses may lead to changes in reported data or analyses from previous years, and will be reflected in the 2019 report.

Operators continue to report on improvements in tailings treatment technologies, pilot new technologies, and work on developing new technologies to treat fluid tailings. The AER will review and evaluate technologies and deposit designs that show promise for treating and reducing fluid tailings volumes. Based on operating conditions, future submissions and applications to the AER are expected from the operators on

- updated tailings management plans,
- research and monitoring information that resolves outstanding risks and uncertainties about reclaiming treated fluid tailings deposits (including settlement, capping, and capping material availability),
- justification for RTR criteria and trajectories proposed for the demonstrated fluid tailings treatment technologies that will allow operators to achieve their targeted range of ecosites,
- justification that fluid tailings inventory profile requirements can be met, and
- a feasible alternative to water capping at sites wherever it has been proposed as a treatment.

The AER and Government of Alberta review the TMF, *Directive 085*, and operator tailings management plans every five years. Operator *EPEA* approvals are required to be renewed every 10 years. These review timelines ensure that updates and changes based on changes to policy and performance can be made.

10 Future Reports

The AER will continue public reporting and will ensure the transparency of fluid tailings monitoring data received from operators. Once all operators' tailings management plans are approved, future AER reports on tailings management will

- summarize the evaluation of operators' tailings performance reports,
- highlight any regulatory actions taken,
- evaluate regional performance against the TMF's outcomes and objectives,
- identify operators that are performing well and those that need to make improvements (in accordance with *Directive 085*), and
- incorporate a summary evaluation of environmental effects and reclamation performance reporting that may include references to other required reports (e.g., *EPEA* reports) and linkages to *EPEA* and reclamation regulation.

Appendix 1 Tailings Site Field Review Summaries

- Summary of the AER 2018 Tailings Field Review for Syncrude Aurora North
- Summary of the AER 2018 Tailings Field Review for Syncrude Mildred Lake
- Summary of the AER 2018 Tailings Field Review for Suncor
- Summary of the AER 2018 Tailings Field Review for CNRL Horizon
- Summary of the AER 2018 Tailings Field Review for Imperial–Kearl



Summary of the AER 2018 Tailings Field Review

Syncrude Canada Limited

Aurora North

OSCA Approval No. 10781

EPEA Approval No. 26-02

Calgary Head Office
Suite 1000, 250 - 5 Street SW
Calgary, Alberta T2P 0R4
Canada

www.aer.ca

Date

June 18, 2018

Purpose

Observe high priority tailings facilities and the tailings testing progress.

The inspector's findings from this visit are independent, will be followed upon separately.

Participants

Alberta Energy Regulator:

Tailings Engineers: Tara Wang, Rod Godwaldt, Jim Jordan

Field Inspector: Aruna Baker

Syncrude:

Technical and Operations Personnel

Background

Syncrude uses composite tailings (CT) to manage fluid tailings on Aurora North site. The CT production started in 2014.

Aurora Settling Basin (ASB)

ASB is located in the southeast corner of the Aurora North lease area. The ASB was the initial tailings placement area at the Aurora North site since start up in 2000. The facility currently provides storage for coarse tailings, flotation tailings, fluid fine tailings, recycle water and cyclone overflow from the CT plant. Recycle water from in-pit is pumped into ASB via fluid transfer systems in both AEPN-E and AEPS. The ASB is the source of recycle water for plant operations and FFT supply for the CT Plant.

Aurora East Pit North – West (AEPN-W)

AEPN-W is the second in-pit tailings placement area at the Aurora North site and is located in the northwest corner of the East Pit mining area. Coarse tailings placement in the AEPN-W facility began in October, 2011.

AEPN-W will be filled with coarse tailings sand to 300m elevation and forms the base of the future Fort Hills Dump expansion. As the AEPN-W is designed as a solids storage area, minimal fluid tailings inventory is maintained within the deposit. The fluids are transferred out of the deposit via a trench which connects AEPN-W to AEPN-E. As Dyke 1 North is constructed, the trench is re-established to allow flow-through.

Aurora East Pit North – East (AEPN-E)

AEPN-E facility is located in the northeast corner of the East Pit mining area, northwest of the Aurora Settling Basin. AEPN-E was the first in-pit tailings placement area at the Aurora North site. Coarse tailings deposition began in May, 2010. CT deposition into AEPN-E commenced in 2014. Fluids from AEPN-W are transferred into the deposit via a trench which connects to AEPN-E. A barge is located in the East side of AEPN-E to transfer RCW to the ASB. The barge is semi-fixed to a ramp and is raised incrementally as the pond level rises.

Aurora East Pit South (AEPS)

AEPS facility is located west of the Aurora Settling Basin. CT deposition in AEPS commenced in December 2014. There are three lines which can transport CT to the AEPS deposit where it is deposited sub-aerially. A fluid transfer system is in place in the southeast corner of AEPS to transfer RCW to the ASB.

There is no reclamation of tailings deposits yet at Aurora North site.

Tailings technology development for Aurora North is combined with Syncrude's Mildred Lake.

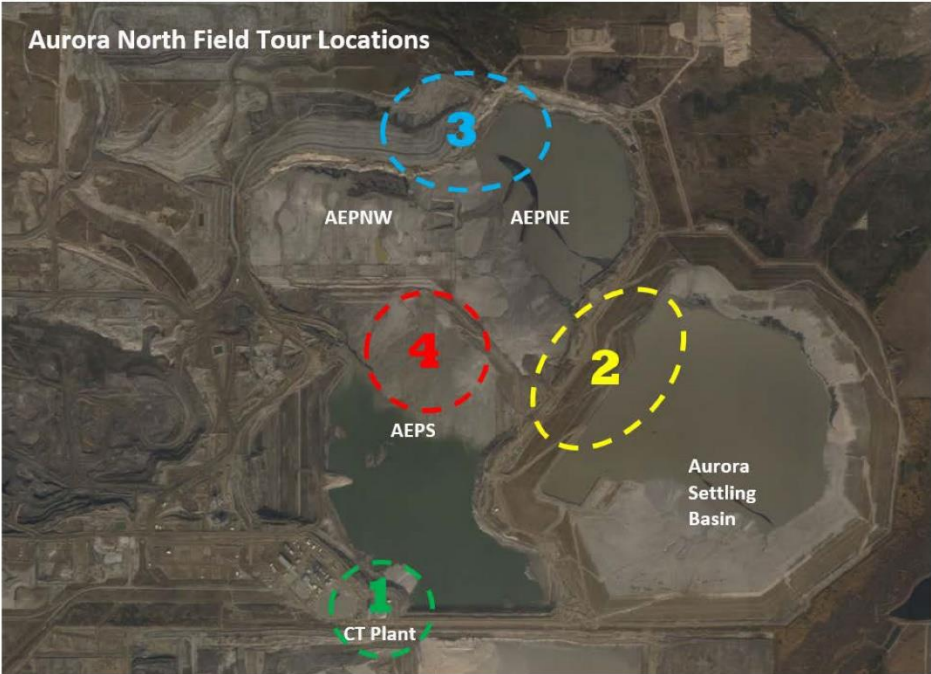
The next reports on tailings technology development and reclamation research are expected to be submitted to the AER by April 30, 2019.

Agenda and Field Review Notes

Item	Agenda	Map	Observation / heard
1	CT Plant	CT Plant (Location 1)	Continued operation
2	CT Plant – FT feed	ASB (Location 2)	Continued operation
3	AEPN-W progress	AEPN-W (Location 3)	Coarse tailings placement in AEPN-W is continuing
4	CT Deposit	AEPS (Location 4)	CT placement in progress

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514

AN site visit locations



Photos



CT plant – Gypsum addition



CT production – MFT feed from ASB

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514



CT deposit – AEPS beach



Summary of the AER 2018 Tailings Field Review

Syncrude Canada Limited

Mildred Lake

OSCA Approval No. 8573

EPEA Approval No. 26-02

Calgary Head Office
Suite 1000, 250 – 5 Street SW
Calgary, Alberta T2P 0R4
Canada

www.aer.ca

Date

June 19, 2018

Purpose

Observe high priority tailings facilities and the tailings testing progress.

The inspector's findings from this visit are independent, will be followed upon separately.

Participants

Alberta Energy Regulator:

Tailings Engineer: Tara Wang, Rod Godwaldt, Jim Jordan

Field Inspector: Aruna Baker

Syncrude:

Technical and Operations Personnel

Background

Syncrude uses two technologies to treat fluid tailings on the Mildred Lake site: composite tailings (CT) and FFT centrifuging. The first CT deposit, East in Pit (EIP), which started in the late 1990s, is progressing towards reclamation — the remaining volume of fluid tailings is being moved out and the deposit is getting capped by tailings sand and progressing for further reclamation activities. Reclamation and closure research testing has been carried out in the north end of EIP, including the Sandhill Fen and Kingfisher areas.

Syncrude operated fluid tailings centrifuge demonstration plant between 2012 and 2015, before the commercial centrifuge plant started its operation in 2015. The centrifuged cake from demonstrate plant was placed thin lift in the waste dump 1 (W1) area. The cake from commercial plant started placement in the mined out pits tens of meters deep. North Mine South Pit –East (NMSPE) is the first centrifuged cake deep deposit. Ongoing research regarding the centrifuged cake deep deposit includes: the consolidation behavior, trafficability, and factors impacting the reclamation and closure.

In addition to CT and FFT centrifuging, Syncrude has commenced the first commercial-scale demonstration of the water capped fluid tailings technology on Mildred Lake site. The Base Mine Lake

consists of mined out oil sands pit filled with fluid tailings has been capped by water. The monitoring is in progress.

As a potential alternative technology, Syncrude tested accelerated dewatering, also called rim ditching, technology in 2009 (i.e. ADW Phase 1). The testing cell from phase 1 is still under monitoring. Syncrude received approval for ADW phase 2 in 2017 and ADW Phase 3 in 2018 to enhance deposit dewatering and consolidation.

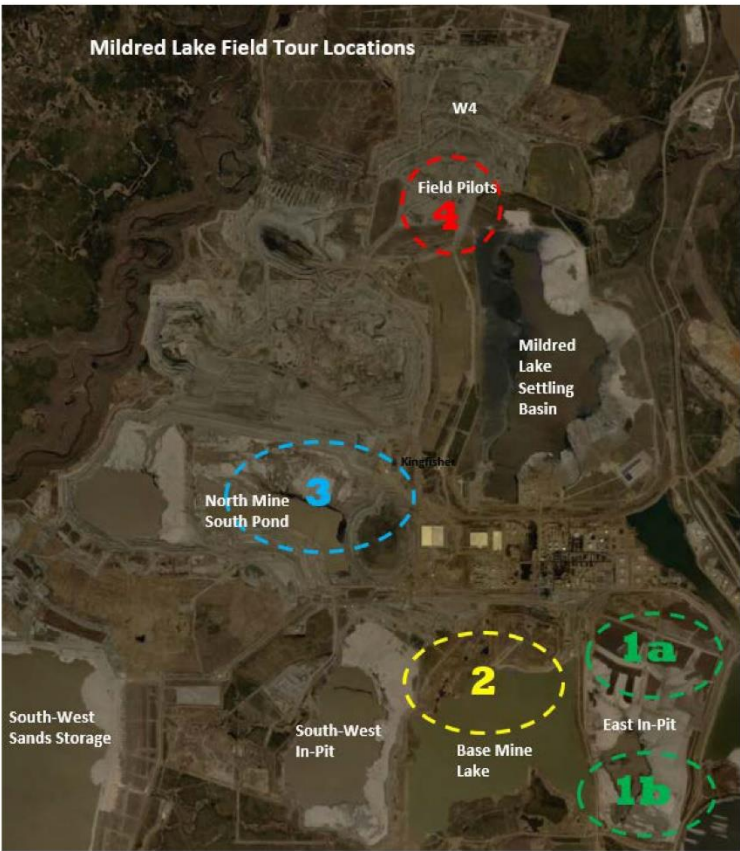
The tailings technology testing update is expected to be included in the annual tailings performance reports. The reclamation update is included in the annual reclamation progress tracking reports. The next reports are expected to be submitted to the AER by April 30, 2019.

Agenda and Field Review Notes

Item	Agenda	Tailings deposit	Observation / heard
1	CT deposit reclamation progress	EIP (Location 1a)	Over 200ha rec soil placed last winter season (Kingfisher area and North and east portions of deposit).
2	CT deposit capping	EIP (Location 1b)	Active sand capping in progress towards its final elevation. More area in EIP has been capped since last visit (September 2017).
3	Water capped fluid tailings demonstration	Base Mine Lake (Location 2)	The latest BML monitoring results indicate that the shoreline erosion and stability is as expected, FFT is consolidating as expected (water cap has increased to ~ 11m), oxygen saturation in the water is increasing, water quality is improving, water toxicity is improving and turbidity is reduced. Efforts to remove hydrocarbons within the lake are ongoing. Coke cell from North to BML has been reclaimed, channel connects to BML is complete. Monitoring ongoing.
4	Centrifuge cake deep deposit placement	NMWP-E (Location 3)	Centrifuged cake placement in progress.
5	Research – Accelerated Dewatering Phase 2 and 3 Field Test	W4 (Location 4)	Tailings placement in two Phase 2 cells completed in 2017; monitoring ongoing. Two Phase 3 testing cells have been prepared for tailings placement. Testing ongoing.

inquiries 1-855-297-8311
24-hour emergency 1-800-222-6514

ML site visit locations



inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514

Photos



EIP – Kingfisher area



EIP- Reclamation soil placement progressing



EIP – Sand capping progressing



BML – channel from reclaimed coke cell to BML



W4 ADW Phase 2 – Testing cell filled



W4 ADW Phase 3 – Testing cell prepared



Summary of the AER 2018 Tailings Field Review

Suncor Energy Inc.

Base Plant

OSCA Approval No. 8535N

EPEA Approval No. 94-02-18

Calgary Head Office
Suite 1000, 250 - 5 Street SW
Calgary, Alberta T2P 0R4
Canada

www.aer.ca

Date

June 21, 2018

Purpose

Observe high priority tailings facilities and the tailings testing progress.

The inspector's findings from this visit are independent, will be followed upon separately.

Participants

Alberta Energy Regulator:

Tailings Engineers: Tara Wang, Jim Jordan, Annoy Roy (Student)

Field Inspector: Sheena Nixon

Suncor:

Technical and Operations Personnel :

Natasha Bouliane	Acting Manager EH&S Environment & Regulatory, Strategy & Operations
Mitch Holte	Director Mine Planning and Closure
Rodney Guest	Manager Closure & Water Strategic Technology Development
Doug Lacey	Director Tailings Engineering
Jessica LeBlanc	Advisor – Wildlife
Jeff Slade	Superintendent Operations - ADW
Roger Ashfield	Manager Projects - Tailings
Richard Clark	Project Engineer - Tailings
Jacob Mellett	Health & Safety Advisor - Tailings

Agenda and Field Review Notes

TIME	LOCATION
9:00 am	Arrive at Main Gate <ul style="list-style-type: none"> ➤ Suncor staff to meet the AER staff at Main Gate ➤ Receive visitor passes (arranged by Natasha) ➤ Depart for East Tailings Complex (bus waiting by glass shelter through security)
9:30 am	Arrive at East Tailings Complex: (2nd Floor Meeting Room) <ul style="list-style-type: none"> ➤ Introductions – AER, Suncor ➤ Overview of where we are going – with map/air photo ➤ PPE Check (tool crib for missing PPE at SBMC) ➤ Safety / FLHA prior to departure ➤ Depart for Heli-Pad to meet Phoenix Helicopter at 10:00
10:10	Depart East Tailings Complex by bus for Heli-pad
10:30 am	Meet Helicopter and depart for aerial tour of Millennium Mine (MD9, ADW – polymer tanks & screen tanks, DDA3) <ul style="list-style-type: none"> ➤ Pre-load safety brief – Phoenix Helicopters ➤ Point out major infrastructure for ADW ➤ Discuss purpose and details of DDA3 ➤ MD9 explanation with focus on co-disposal area
11:30 am	Heli-Pad to Demo Pit Lake <ul style="list-style-type: none"> ➤ Disembark from helicopter and make way by bus to DPL ➤ Foot tour of DPL with overview from Rodney
12:30 pm	Depart Demo Pit Lake for ADW Screen Tank Area <ul style="list-style-type: none"> ➤ Eat bag lunch on bus
1:00 pm	ADW Field Tour (access permitting) <ol style="list-style-type: none"> 1. Meet Operations personnel (Jeff Slade) 2. Proceed with ADW site tour
3:00 pm	Adjourn discussions and depart for Suncor Energy Security Gate <ul style="list-style-type: none"> ➤ Bus returns guests to Security Gate
3:30 pm	Suncor Security Gate <ul style="list-style-type: none"> ➤ Guests return to their vehicles

inquiries 1-855-297-8311
24-hour emergency 1-800-222-6514

Overview Map of site visit



inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514



Figure 1 - Suncor DPL view from air

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514



Figure 2 - Typical drying Cells @ Suncor DDA1 (using TRO technology) ~900m length

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514



Figure 3 - Suncor MD9 - typical haul road access construction

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514



Figure 4 - Suncor MD9 - typical haul road access construction

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514

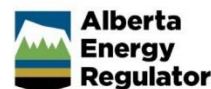


Figure 5 - Suncor DDA3 Pit Bottom

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514



Figure 6 - Suncor Pond 8B pumping & debris management system (for treating Fluid Tailings with PASS technology)



Summary of the AER 2016 Regulatory Tailings Field Visit

Canadian Natural Resources Ltd.
Horizon Site
OSCA Approval No. 9752
EPEA Approval No. 00149968-01-00

Calgary Head Office
Suite 1000, 250 - 5 Street SW
Calgary, Alberta T2P 0R4
Canada

www.aer.ca

Date

Site visit: August 21, 2018

Report generated: September 28, 2018

Purpose

To observe high-priority tailings facilities and the progress of tailings testing.

The inspector's findings from this visit are independent and will be followed up on separately.

Participants

Alberta Energy Regulator:

Authorizations Staff: Tara Wang, Rod Godwaldt, Doug Koroluk, Edward Zeng

Field inspectors: Cynthia Estrop, Virginia Hughes, Annoy Roy

Alberta Environment and Parks:

Land policy: Zvonko Burkus, Ashley Meek

Canadian Natural Resources Limited (CNRL):

Technical and operations personnel

Background

IPEP: CNRL has authorization for a 500 t/hr pilot, the In-Pit Extraction Process (IPEP), described as an innovative low-impact bitumen extraction and tailings treatment process utilizing screw conveyors, dewatering screens and centrifuges to generate dry, stackable tailings. Results from the test are expected to be included in the annual tailings performance reports. AER staff toured the IPEP facility, handled IPEP tailings that were 4 days old, then visited the deposition site at an in-pit dump.

Dyke 21: The TMP mine/tailings plan includes the construction of a set of perimeter dykes for the first in-pit deposit, DDA2. Construction has begun on Dyke 21, spanning the eastern side of the containment. AER staff toured the northern edge of the dyke, where the dyke is abutting original ground at the pit limit.

Coke pour berms: CNRL has authorization to create three berms, 400 m long x 50 m wide x 5 m high, on the beach of the ETF/DDA1 in order to extend the beach length and increase the total material placed

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514

within the structure. AER staff visited one of the sites at which a berm will be constructed in the fall of 2018.

NST Plant: CNRL's approved tailings treatment technology is non-segregating tailings. These tailings are created blending coarse sand with flocculent and a fines stream. Performance of the plant is monitored using an extensive set of sampling and measurement tools. AER staff toured the plant in which the NST is made.

Agenda and Field Review Notes

Item	Agenda	Tailings deposit	Observation / heard
1	IPEP pilot	IPEP and inpit dump	IPEP project successful to date. Potential for dry tailings based on decreased sand removal during extraction phase (ie. no PSV). Some saturated tailings still present in dump.
2	Dyke 21 tie-in to original ground	Future DDA2	Dyke construction progressing as per design and schedule
3	Dyke 10 / ETF	DDA1	Locations for testing coke pour berms appeared normal with low geotechnical and environmental risks
4	NST plant	N/A	Tour of NST plant. Nothing of note.
5			

inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514

Horizon Site Visit Locations



inquiries 1-855-297-8311
24-hour
emergency 1-800-222-6514

Photos



Conveyor to IPEP facility



IPEP Tailings



IPEP tailings in inpit dump



Summary of the AER 2018 Tailings Field Review

Imperial Oil Resource Ltd.

Kearl Mine Site

OSCA Approval No. 1089H

Calgary Head Office
Suite 1000, 250 – 5 Street SW
Calgary, Alberta T2P 0R4
Canada

www.aer.ca

Date

August 29, 2018

Purpose

Observe high priority tailings facilities and the tailings testing progress.

Participants

Alberta Energy Regulator:

Tailings Engineers: Eric Chiu, Annie Jian, Andre Bachteram

Field Inspector: Barbra Saunders

Imperial:

Technical and Operations Personnel

Background

Imperial uses thickened tailings (TT) with secondary chemical treatment to manage fluid tailings on Kearl Mine site in its East External Tailings Area (EETA). The TT production started in 2016.

External Tailings Facility (ETA)

ETA is located in the northern section of the Imperial Oil lease area. The ETA is the initial tailings placement area at the Kearl mine site since start up in 2013. The facility currently provides storage for coarse tailings, TSRU tailings, thickened tailings, and recycle water. The ETA is separated in to two sections, one called East ETA and the other West ETA.

East External Tailings Area (EETA)

EETA section of the ETA where they will only store on spec TT. They are deposited in these TT cells located south east of the ETA. They stagger the TT deposition. As per Imperial's TMP, they will only place on spec TT in the EETA, while off spec will be dumped in the West ETA.

West External Tailing Area(WETA)

WETA is meant for only placement of CST, TSRU, and off spec TT from time to time.

inquiries 1-855-297-8311
 24-hour
 emergency 1-800-222-6514

The ETA is its only tailings deposition area at the moment, as they continue to develop the mine. Once they have moved over a certain point, they will transform the input area into its next tailings deposit, which they call In Tailings Area 1 (ITA 1).

Deposition of tailings into ITA1 is planned to commence in 2023. In the meantime, the ETA will continue to build up to reach its design elevation.

Agenda and Map of Site Visit

Time	Map #	Activity	Lead
9:30 – 10:00		AER arrival to Kearl site Check in at security Travel to AC 3	Jennifer Scott
10:00 – 10:30		Introductions Safety Procedures Tour Overview Dress in PPE	Mitch
10:30 – 10:45		Depart in pickup trucks	Barry and Lee
10:45 – 11:15	2	Secondary Chemical Injection site	Wei
11:15 – 11:45	3	East ETA – TT panels	Lyle, Scott, Mitch
11:45 – 12:15	4	West ETA – SE corner (TSRU)	Lyle, Scott, Mitch
12:15 – 12:30		Travel to Treatment Wetland	
12:30 – 1:15	5	OSPW treatment wetland pilot	Asfaw, Alex
1:15 – 1:30		Travel back to AC 3	
1:30 – 2:15		Lunch and close out in AC 3	Scott, Jenn
2:15 – 2:30		Escort AER off Kearl site	Scott

Conclusion:

Overall, very good tour to observe the overall progress Imperial has had on its operation and technology performance. Very positive on its progress and work. SMEs were especially pleased to see progress made in the Pilot Treatment Wetland facility and its progress. Staff is positive about the work.



Calgary Head Office
Suite 1000, 250 - 5 Street SW
Calgary, Alberta T2P 0R4
Canada

www.aer.ca

Imperial



Appendix 2 Fluid Tailings Volume Data

Project	Pond	2014 (Mm ³)	2015 (Mm ³)	2016 (Mm ³)	2017 (Mm ³)	2018 (Mm ³)
Suncor	Pond 1A	10.1	10.1	10.1	10.1	10.4
	Pond 2/3	38.3	35.0	30.7	32.7	33.6
	Pond 5	18.4	18.4	20.2	–	–
	Pond 6	35.2	34.5	35.0	35.5	36.5
	Pond 7	68.9	69.9	74.5	74.2	73.8
	DDA1 (Pond 8A)	0.3	0.3	0.0	–	–
	DDA3	–	–	–	–	–
	Pond 8B	38.5	38.9	36.8	38.9	20.9
	South tailings pond (STP)	101.0	105.0	105.4	105.7	95.8
	Sand dump 8 (SD8)	3.4	4.0	3.7	3.2	2.3
	Total	314.1	316.1	316.4	300.3	273.3
Syncrude Mildred Lake	Mildred Lake settling basin (MLSB)	177.6	168.1	167.5	141.5	141.2
	Southwest sand storage (SWSS)	71.0	80.9	94.2	112.5	116.3
	West in pit (WIP, i.e. Base Mine Lake)	182.6	182.6	177.4	175.1	172.9
	East in pit (EIP)	3.3	1.7	1.4	2.0	1.3
	Southwest in pit junior (SWIP Jr.)	n/a	n/a	n/a	n/a	n/a
	Southwest in pit major (SWIP Major)	33.7	39.4	35.5	37.2	43.6
	North Mine south pit west major (NMSPW Major)	1.4	3.6	16.0	16.2	18.1
	North Mine South Pit East (NMSPE)	n/a	n/a	3.4	4.3	7.3
	North Mine South Pit east deep cake (NMSPE Deep Cake)	n/a	n/a	5.8	13.3	13.9
	Total	469.6	476.3	501.2	502.1	514.6
Syncrude Aurora North	Aurora settling basin (ASB)	83.1	77.6	74.7	72.3	70.4
	Aurora east pit northeast (AEPN-E)	27.5	38.7	43.5	51.1	50.2
	Aurora east pit northwest (AEPN-W)	2.4	3.1	2.1	0.3	0.0
	Aurora east pit south (AEPS)	n/a	8.4	10.9	13.2	12.6
	Total	113.0	127.9	131.2	136.9	133.2
CNUL Muskeg River Mine	External tailings facility (ETF)	62.4	63.7	58.3	57.9	51.7
	South expansion area (SEA)	0.5	0.8	1.5	1.3	0.2
	In pit cell 1 (IPC1)	23.0	24.3	32.8	31.5	31.4
	In pit cell 2A (IPC2A)	n/a	n/a	6.8	7.7	26.5
	In pit cell 2B (IPC2B)	2.1	5.6	9.5	12.5	–
	In pit cell 3 (IPC3)	n/a	n/a	0.8	5.7	11.9
	Total	88.0	94.4	109.7	116.6	121.7
CNUL Jackpine Mine	Dedicated disposal area 1 (DDA1)	6.8	12.0	7.8	11.7	12.8
	Sand cell 1 (SC1)	12.8	10.6	11.2	9.4	8.6
	Sand cell 2 (SC2)	n/a	1.0	2.4	5.7	5.2
	Fluid cell 1 (FC1)	n/a	n/a	2.8	1.6	1.4
	Total	19.6	23.6	24.2	28.4	28.0
CNRL Horizon	External tailings area (ETA)	66.2	82.1	99.5	114.5	131.8

Project	Pond	2014 (Mm ³)	2015 (Mm ³)	2016 (Mm ³)	2017 (Mm ³)	2018 (Mm ³)
	Total	66.2	82.1	99.5	114.5	131.8
Imperial Kearn	External tailings area west (ETA-W)	4.7	13.6	24.1	39.3	46.5
	External tailings area east (ETA-E)	n/a	NEGL	NEGL	0.4	1.0
	West thickened tailings (TT) panel	n/a	n/a	NEGL	0.8	1.5
	East TT panel	n/a	n/a	NEGL	0.5	1.1
	Total	4.7	13.6	24.1	41.0	50.1
Industry total		1075.2	1134.0	1206.3	1239.8	1252.7

N/A: Not applicable

NEGL: Negligible.

Tailings volume totals in this table may not match the company reports due to rounding. Data provided by operators in their tailings management reports were only to one decimal place.

Tailings volumes for 2017 year-end are estimates based mid-year survey data and estimates based on production from end of surveys to 2017 year-end, except for Suncor.

Syncrude Mildred Lake and Aurora North volumes for 2018 are as reported and not year- end projections as for other operators.

The AER continues to assess measurement system plans submitted by operators. As a result, the tailings volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings volumes and assessment of meeting RTR criteria.

Appendix 3 Water Volume Data

Project	Pond	2014 (Mm ³)	2015 (Mm ³)	2016 (Mm ³)	2017 (Mm ³)	2018 (Mm ³)
Suncor	Pond 1A	2.1	2.1	2.5	2.5	2.2
	Pond 2/3	5.0	2.6	4.8	1.9	2.1
	Pond 5	n/a	n/a	0.0	0.0	0.0
	Pond 6	6.0	6.9	6.9	5.7	7.1
	Pond 7	49.3	40.4	41.7	37.1	42.7
	DDA1 (Pond 8A)	n/a	n/a	0.1	0.0	0.0
	DDA3	–	–	–	8.1	8.2
	Pond 8B	43.3	39.1	42.3	30.8	28.6
	South tailings pond (STP)	19.0	13.7	17.6	24.4	26.2
	Sand dump 8 (SD8)	1.5	1.5	3.4	0.9	1.7
	Total	126.2	106.3	119.3	111.4	118.8
Syncrude Mildred Lake	Mildred Lake settling basin (MLSB)	5.6	10.8	3.4	7.5	8.3
	Southwest sand storage (SWSS)	34.0	42.6	47.5	48.4	43.9
	West in pit (WIP, i.e. Base Mine Lake)	57.4	55.7	60.2	63.6	67.1
	East in pit (EIP)	0.2	0.5	1.2	0.7	0.0
	Southwest in pit junior (SWIP Jr.)	n/a	n/a	n/a	n/a	n/a
	Southwest in pit major (SWIP Major)	14.0	13.9	20.9	19.2	14.6
	North mine south pit west major (NMSPW Major)	15.3	14.7	2.5	0.6	6.2
	North mine south pit east (NMSPE)	n/a	n/a	1.7	4.1	7.4
	North mine south pit east deep cake (NMSPE Deep Cake)	n/a	n/a	0.0	0.0	0.0
	Total	126.5	138.2	137.4	144.1	147.5
Syncrude Aurora North	Aurora settling basin (ASB)	50.5	38.9	40.1	37.9	43.2
	Aurora east pit northeast (AEPN-E)	20.0	7.5	0.1	1.6	4.8
	Aurora east pit northwest (AEPN-W)	0.3	0.8	0.1	0.0	0.0
	Aurora east pit south (AEPS)	1.0	28.3	27.7	21.4	27.4
	Total	71.8	75.5	68.0	60.9	75.4
CNUL Muskeg River Mine	External tailings facility (ETF)	2.8	1.7	0.5	0.3	0.0
	South expansion area (SEA)	0.4	0.1	0.4	0.8	0.2
	In pit cell 1 (IPC1)	4.6	6.4	8.4	7.9	9.6
	In pit cell 2A (IPC2A)	n/a	n/a	0.3	1.0	8.4
	In pit cell 2B (IPC2B)	2.0	0.7	2.1	4.2	–
	In pit cell 3 (IPC3)	n/a	n/a	1.6	2.1	2.4
	Total	9.8	8.9	13.3	16.3	20.6
CNUL Jackpine Mine	Dedicated disposal area 1 (DDA1)	0.4	0.0	0.1	0.4	0.0
	Sand cell 1 (SC1)	17.0	10.1	6.4	4.9	7.1
	Sand cell 2 (SC2)	2.4	4.9	3.6	0.5	2.2
	Fluid cell 1 (FC1)	n/a	n/a	0.7	6.4	6.7
	Total	19.8	15.0	10.8	12.2	16.0
CNRL Horizon external tailings area (ETA)		33.0	30.0	33.0	28.2	31.1

Project	Pond	2014 (Mm ³)	2015 (Mm ³)	2016 (Mm ³)	2017 (Mm ³)	2018 (Mm ³)
	Total	33.0	30.0	33.0	28.2	31.1
	External tailings area west (ETA-W)	21.3	27.4	18.4	17.3	18.0
	External tailings area east (ETA-E)	n/a	0.3	0.8	1.7	0.5
Imperial-Kearl	West thickened tailings (TT) panel	n/a	n/a	0.5	0.4	0.1
	East TT panel	n/a	n/a	0.2	0.3	0.1
	Total	21.3	27.7	19.9	19.7	18.7
Industry total		408.4	401.6	401.7	392.8	428.1

N/A: Not applicable.

Water volume totals in this table may not match the company reports due to rounding. Data provided by operators in their tailings management reports were only to one decimal place.

The AER continues to assess measurement system plans submitted by operators. As a result, the water volumes in this report are presented as reported by industry and are subject to change upon further review of fluid tailings and water volumes.