

Tailings Plan Review

**An Assessment of Oil Sands Company Submissions
for Compliance with ERCB Directive 074: Tailings
Performance Criteria and Requirements
for Oil Sands Mining Schemes**



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*Tailings Plan Review — An Assessment of Oil Sands Company Submissions for Compliance with
ERCB Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining
Schemes*

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Executive Summary

Oil sands mining operations produce significant quantities of liquid waste materials called tailings. While oil sands companies are expected to reclaim liquid tailings, there has been poor performance to date in addressing this long-term liability. The large inventory of liquid tailings requiring long-term containment has therefore been growing, which has been causing growing concerns for the public and regulators.

In 2009 Alberta Energy and Resources Conservation Board (ERCB) released new rules to regulate the reclamation of tailings waste. Oil sands companies were required to submit tailings management plans by September 30, 2009, in accordance with *Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes*.

Directive 074 is concerned with the removal of fines, mineral solids with particle sizes equal to or less than 40 microns, which persist in tailings fluid for long periods. It is also concerned with the “trafficability” of these fine tailings, in other words how much weight the tailings can bear once they have been deposited in reclamation areas and the water has been given a chance to drain out or evaporate. Directive 074 sets rules for the quantity of fine particles that must be captured and the strength those tailings must have, all within defined time periods.

There is phase-in sequence approach to the fluid tailings reduction performance criteria set out by the ERCB. The following sequence is expressed in percentage of total fines in the tailings feed that must report to the dedicated disposal areas (DDAs):

- 20% from July 1, 2010, to June 30, 2011
- 30% from July 1, 2011, to June 30, 2012
- 50% from July 1, 2012, to June 30, 2013, and annually thereafter

The ERCB specifies that the material deposited each year must have a certain load-bearing strength within one year of deposition. The deposit must also be ready for reclamation within five years after active deposition has ceased, and at that time the deposits need to meet a more stringent requirement for how much weight they can bear. The first compliance reports for Directive 074 must be submitted by September 30, 2011, and then annually thereafter. If there is material that does not meet the ERCB’s specified strength requirements it will not count towards the fines reduction target for that company.

The plans that were submitted by oil sands companies to the ERCB varied in the quantity of information they provided and in the meeting the reporting requirements identified by the ERCB. Plans ranged from 24 pages to 124 pages in length. The terms used for different types of tailings and technologies also varied across the reports, with each company having slightly different terminology to mean the same thing. This variability made the plans challenging to compare.

Nine tailings management plans were submitted by six different companies. Of these nine plans, only two — the Fort Hills Energy mine and the Suncor Millennium/North Steepbank mine — indicate that their operations will be in full compliance with Directive 074. Our review concludes

that all other plans will not comply with Directive 074 requirements for the timing of capturing the allotted percentage of fine tailings. Some of the companies did not provide evidence of how they would meet the trafficability requirements of Directive 074.

Oil Sands Operation	Submission meets fine particle capture requirements	Submission meets trafficability requirements
CNRL: Horizon	No	No
Imperial: Kearl	No	No
Shell: Muskeg River	No	No
Shell: Jackpine	No	No
Fort Hills Energy: Fort Hills	Yes	Yes
Suncor: Millennium and North Steepbank	Yes	Yes
Syncrude: Mildred Lake	No	No
Syncrude: Aurora North	No	No
Syncrude: Aurora South	No	No

Given that seven out of nine proposed tailings management strategies do not meet the requirements of Directive 074, it is essential to determine how the ERCB proposes to regulate non-compliant companies, or even if these plans will be accepted by the regulator. How much flexibility the ERCB allows companies that have submitted inadequate plans is a critical unresolved issue. The ERCB has jurisdiction to enforce the requirements of the directive under *Directive 019: ERCB Compliance Assurance—Enforcement*. Enforcement options include suspension of oil sands operations.

1. Overview of Directive 074

1.1 What Are Tailings?

In the oil sands mining process, water and additives are used to extract the bitumen from oil sands material. This process results in a tailings stream that is discharged into a pond where it is expected that solids will settle and water will be recycled. Coarse solids settle rapidly, while the fine solids remain suspended in the pond.¹ These fine solids, otherwise referred to as mature fine tailings (MFT) are currently the reason that tailings ponds cannot be reclaimed. For the purpose of the directive, fines are defined as mineral particles equal or less than 44 µm (0.044 mm) in size.

Currently, the principal means of consolidating fluid tailings at existing oil sands operations is through consolidated tailings (CT) technology.² Within the CT process, fluid fine tailings are mixed with coarse sand and a chemical agent to form a non-segregating mixture with the intent of reclaiming to a solid deposit.³ Transforming CT into a solid landscape has been challenging, and producing CT to specifications has not always been achievable. There is recognition that other technologies may be required to reach the final solid landscapes desired for reclamation purposes. Current plans include putting remaining fluid fine tailings into end pit lakes, although this technology has yet to be proven on a commercial scale.⁴

1.2 Introduction to the Directive

Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes, was released on February 3, 2009 by the Energy and Resources Conservation Board (ERCB).⁵ While oil sands companies with mineable operations have proposed to convert their fluid tailings into deposits that would be trafficable and reclaimable in their project applications, these targets have not been met, resulting in large amounts of fluid tailings on the landscape.⁶ The large

¹ ERCB, "Backgrounder on Draft Directive: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes (2009), page 1.

² ERCB, "Backgrounder on Draft Directive: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes (2009), page 1.

³ ERCB, "Backgrounder on Draft Directive: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes (2009), page 1.

⁴ ERCB, "Backgrounder on Draft Directive: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes (2009), page 1.

⁵ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes," (2009), page 1, <http://www.ercb.ca/docs/documents/directives/Directive074.pdf>.

⁶ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes," (2009), page 2.

inventory of liquid tailings requiring long-term containment has therefore been growing,⁷ which has been causing growing concerns for the public and regulators.

1.3 Purpose of the Directive

The key purpose of Directive 074 is to regulate tailings in the oil sands and to reduce the volume of fluid fine tailings that are produced. The ERCB wants to hold mineable oil sands operators accountable for the tailings being produced during the bitumen extraction process by setting time-lines for the reduction in the amount of fluid tailings being produced by extracting fine particles and creating ‘trafficable surfaces’ with the fines that are recovered from the extraction process.⁸ To obtain these ‘trafficable surfaces’, deposits that have been created through consolidation, drying, drainage and or capping must have a minimum shear strength. Companies were required to submit a tailings management plan to the ERCB on September 30, 2009, to show how they intend to meet the directive’s requirements.⁹

1.4 Requirements to Meet Directive

The actions required by operators in order to comply with Directive 074 are the following:

- reduce fluid tailings by capturing fines in the dedicated disposal areas (DDAs) and to form and manage those DDAs properly
- submit a DDA plan to the ERCB
- submit compliance reports for the DDAs (annually)
- submit tailings plans and pond status reports (annually)¹⁰

The first compliance reports must be submitted by September 30, 2011, and then annually thereafter.

1.5 Dedicated Disposal Areas (DDA)

A dedicated disposal area (DDA) is defined by the ERCB as “an area dedicated solely to the deposition of captured fines using a technology or a suite of technologies. The material deposited each year must achieve a minimum undrained shear strength of 5 kPa [kilopascals] within one year of deposition.”¹¹

⁷ ERCB “Backgrounder on Draft Directive: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes (2009), page 1.

⁸ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes," page 2.

⁹ The ERCB along with Alberta Environment (AENV) and the Sustainable Resources Department (SRD) are the provincial regulators of the oil sands industry in Alberta. These three regulators have a memorandum of understanding outlining the responsibilities of each agency with regard to the various aspects of oil sands management.

¹⁰ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes," page 4.

¹¹ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes," Appendix A, page 7. A kilopascal is a unit of pressure (force per area).

Operators must provide a DDA plan to the ERCB two years prior to the construction of the DDA, although it is recognized that this timing may vary for existing operators. The DDA plan must include dates for construction, use, closure, capping and formation of trafficable deposits.¹² To obtain a trafficable deposit, the material deposited in the previous year must have a minimum undrained shear strength of 5 kPa. If it does not meet this criterion, the material must be removed or remediated¹³ and it will not count towards the company's fines reduction target for that year.¹⁴ Furthermore, the deposit in the DDA must be ready for reclamation within five years after active deposition has ceased, and at that time the shear strength must be 10 kPa.¹⁵

The ERCB allows companies to phase-in the implementation of the proportion of fluid tailings that must be sent to DDAs. The percentage of total fines in the tailings feed that must report to the DDAs is:

- 20% from July 1, 2010, to June 30, 2011
- 30% from July 1, 2011, to June 30, 2012
- 50% from July 1, 2012, to June 30, 2013, and annually thereafter¹⁶

This percentage is in addition to the fines which will be captured in coarse sand deposits which are used to build dikes and beaches.

Companies are required to inform the ERCB of their progress in quarterly and annual reports.

The following table, which shows the schedule for filing plans and reports, is taken directly from Directive 074:¹⁷

Fines capture progress reports	Quarterly—three reports 45 days after the end of each calendar quarter starting in Q3-2010, i.e., November 15, February 15, and May 15
Fines capture—annual compliance report	August 15 of each year starting in 2011
DDA plan	2 years prior to construction or as approved for existing operators
DDA—annual compliance report	September 30 of each year starting in 2011
Tailings plan integrated with annual mine plan—annual	September 30 of each year starting in 2009
Fluid tailings pond—annual status reports	September 30 of each year starting in 2011

¹² ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 4.

¹³ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 5.

¹⁴ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 5.

¹⁵ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 5.

¹⁶ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 4.

¹⁷ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 14.

1.6 Tailings Management Plans

The ERCB does not prescribe how companies must meet its targets for tailings management and reclamation. They are able to use different technologies to avoid or reduce the accumulation of fluid fine tailings.¹⁸ Each company explains which technologies it intends to use in their tailings management plans.

The Tailings Management Plans which the companies submitted to the ERCB in September 2009, contain the initial plans, but Directive 074 requires companies to continue to submit an annual tailings management plan. Each year, these plans must outline the annual tailings projections for the next ten years and then give five-year projections until the end of the mining project.¹⁹

The tailings management plans must include a lot of detailed predictions, not only about the tailings (including the site-wide fluid fine tailings inventory), but about the expected quality of the ore and the proportion of fines, sand and bitumen in the ore. A company has to indicate the number of barrels of bitumen it expects to produce each year from 2010 onwards. A full list of the requirements is given in Appendix E to Directive 074, which is copied as an appendix in this report. Some information from the first tailings management plans is given in Chapter 3, below.

Companies must satisfy the ERCB that the plan for tailings management will achieve compliance with the directive. If significant changes are made to the approval tailings management plan in order to comply with directive 074, the ERCB may require an application for amendment to the approval for the specific project in question.²⁰

The directive does not prescribe how companies must meet the targets set out for tailings reclamation. It is therefore up to the operators to decide how to meet the directive criteria, and they are able to use different technologies to reduce the accumulation of fluid fine tailings.²¹

¹⁸ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 2.

¹⁹ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 11.

²⁰ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 3.

²¹ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." page 2.

2. Tailings Management Plan Summaries

2.1 Canadian Natural Resources Limited

2.1.1 Horizon Oil Sands Project

2.1.1.1 Description

The Canadian Natural Resources Limited (CNRL) Horizon project was approved in 2004.²² Phase 1 started operations in 2008 and the company aimed to reach full capacity of 110,000 bbl synthetic crude oil (SCO)/day in 2009.²³ Phases 2 and 3 were also approved and in 2007 CNRL has a goal of producing 232,000 bbl SCO/day by 2017.²⁴ The company has divided the 2nd and 3rd phases of the project into four “tranches”. Much of the Tranche 2 work will be completed in 2010, but Tranches 3 and 4 are awaiting approval from the CNRL Board, and this includes the Non-segregated Tailings Plant targeted for completion in 2015.²⁵

The original plan and approval were based on 98% non-segregating tailings (NST) from start-up, using thickeners, with 2% of tailings from the naphtha recovery unit.²⁶ The tailings were to be placed in an external tailings pond (Pond 1) for about the first ten years and then in-pit. 2005 discussions with the ERCB and AENV prompted CNRL to revise the project plans and delay the installation of the non-segregating tailings (NST) plant and tailings thickeners.²⁷ All tailings are currently being directed to Pond 1 which will be monitored to determine the volume of fines being captured.²⁸

CNRL plans to develop non-segregating tailings (NST), to enable compliance with Directive 074 at a later date, but is currently examining two technology options.

²² ERCB. *Energy and Utilities Board Decision 2004-005 Canadian Natural Resources Limited Application for an Oil Sands Mine, Bitumen Extraction Plant, and Bitumen Upgrading Plant in the Fort McMurray Area*, Joint Panel Report, January 2004, <http://www.ercb.ca/docs/documents/decisions/2004/2004-005.pdf>.

²³ Canadian Natural Resources Ltd., (CNRL). *Canadian Natural Resources Limited Announces 2009 Budget*, news release, November 6, 2008, page 6, http://www.cnrl.com/client/news/544/550/1106_budget2009.pdf.

²⁴ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 4, https://www3.eub.gov.ab.ca/eub/dds/iar_query/ApplicationAttachments.aspx?AppNumber=1626022.

²⁵ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 3, https://www3.eub.gov.ab.ca/eub/dds/iar_query/ApplicationAttachments.aspx?AppNumber=1626022.

²⁶ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 1.

²⁷ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 3.

²⁸ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, pages 2 and 3. See also Appendix 3. Preliminary /technical Specifications for Tailings Pond Monitoring.

Option 1: “Technology Option 1 is to implement NST operations as soon as possible, with a target of 2015 for NST plant operations and a target fines capture of 85%. The balance of fines capture would be accomplished with MFT dewatering using organic polymer and CO₂ addition, deposited in a DDA immediately west of Pond 1, with a target fines capture exceeding 15%. Once the technology is successfully operating, the target date for compliance with the annual overall fines capture required by the Directive is 2015 and the target date for compliance with the cumulative fines capture is 2025.”²⁹

Option 2: “Technology Option 2 would defer the NST plant until it was required for warm process water recycle at Tranche 4 rates (232,000 bbls SCO/day). Polymer and CO₂ treated MFT dewatering facilities would be expanded to capture greater than 50% of the fines with a target operations date of 2015. Pond 1 would be operated as a conventional tailings pond, with continued CO₂ treatment of segregating tailings. Both annual and cumulative fines capture targets will be identical to Technology Option 1.”³⁰

CNRL promises to inform the ERCB of which option is selected in its September 2010 tailings management plan.³¹

CNRL lists alternatives which could be considered if their plan for dewatering with an organic polymer and CO₂ are unsatisfactory, including modification of the Horizon process to allow production of CT as well as NST.³²

CNRL points out that:

- The Horizon operation is just starting and a sufficient volume of fluid fine tailings at sufficient density must be developed so that dredging is practical for MFT collection and treatment using polymer and CO₂. It will take about 2.5 years for fluid fines to settle to 30% solids by weight.³³
- The target date for the first DDA is 2015.³⁴

Figure 2 from the CNRL submission (below) compares the Fluid Fine Tailings inventory (assuming CNRL adopts Technology Option 1) with the ERCB requirements. It shows CNRL’s fluid fine tailings inventory will exceed the ERCB Cumulative Allowable Fluid Fines in the early years. CNRL plans an average fines capture of approximately 110% from 2016 to 2029, to reduce the fluid fine tailings inventory accumulated until 2015.³⁵

²⁹ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 5.

³⁰ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 5.

³¹ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 8.

³² CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 11.

³³ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 8.

³⁴ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, page 8.

³⁵ CNRL, *2009 Horizon Tailings Management Plan*, September 30, 2009, pages 8–9.

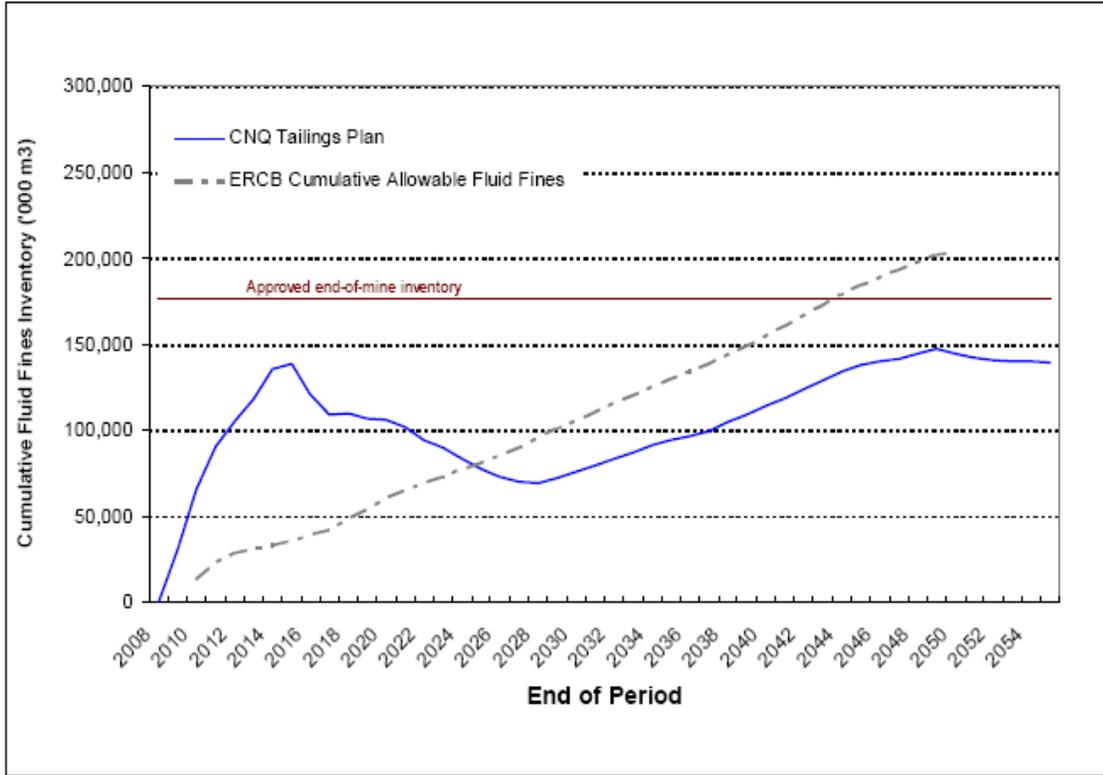


Figure 2 Fluid Fine Tailings Inventory

2.1.1.2 Compliance

CNRL’s Tailings Management Plan shows that the operation will not comply with Directive 074 because the target for the project’s first Dedicated Disposal Area is not until 2015, whereas the Directive requires fines capture to start in 2011, with 50% of fines going to a DDA by 2013. CNRL claims they will not implement the requirements of Directive 074 until 2025, which does not meet the timelines set by the ERCB.

2.2 Imperial Oil Resources

2.2.1 Kearl Oil Sands Project

2.2.1.1 Description

The Kearl oil sands project is due to start operations in 2012, with a second phase expected to double production when it comes on-line in 2014.³⁶ The Imperial Kearl project does not plan to meet the approved 345,000 bpd production rate until additional facilities are added to the project in 2020, and therefore their tailings management plan deals only with the bitumen production rate of 260,000 bpd. Imperial indicates that it will take 5-6 years to begin MFT treatment after start-up of the project, and therefore in the initial 5-6 years, all tailings will be stored in an

³⁶ Imperial Oil Resources, *Kearl Oil Sands 2009 Annual Tailings Plan Submission*, page 1.

external tailings area.³⁷ This time will allow for the build-up of sufficient MFT inventory for steady state dredge output, which Imperial will then process, perhaps using thin lift placement.³⁸ The process of thickening the froth treatment tailings (from the tailings solvent recovery unit) will occur when the MFT processing starts up.³⁹

Although Imperial has indicated for the purpose of their submission that they will use MFT thin lift drying, they have not finally decided which of several technologies to use for the treatment of fines.⁴⁰ In the original tailings plan composite tailings would not have been produced until sufficient in-pit space was available for disposal. A change in mining may allow the first in pit dedicated disposal area (DDA) to start operations until 2018.⁴¹ Imperial is currently performing laboratory and pilot scale testing for fine treatment technologies.⁴²

The technologies that Imperial is currently assessing include:

- Early implementation of the CT process
- MFT thin lift drying/freeze thaw
- MFT centrifuge
- Thickened tailings⁴³

2.2.1.2 Compliance

The Imperial Kearn tailings management plan is not compliant with Directive 074. Although a dedicated disposal area is planned, it will not be in place until 2018 and there is no indication when it will be reclaimed or become trafficable. Imperial originally believed that implementing the consolidated tailings process in 2023 would meet the intent of the directive, however the ERCB indicated that this would not meet the timeline of the directive.⁴⁴ As a result, Imperial is evaluating other technologies.

Imperial indicates that the use of MFT thin lift drying and a separate process to handle the fines from the tailings solvent recovery unit, could potentially capture 76–87% of cumulative fines by 2023, and states that “The Kearn project believes that this approach to fine tailings management meets the Directive.”⁴⁵ The reason Imperial believes that this plan meets the directive despite the time delay is their interpretation of section 3 of the directive, that recognizes the need for flexibility in implementation of fine tailings management systems.⁴⁶

³⁷ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, page 1.

³⁸ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, pages 1 and 7.

³⁹ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, page 1.

⁴⁰ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, pages 8–12. On pages 1, 11 and 12, Imperial refers to the use of MFT thin lift drying for the purpose of their tailings management plan submission, but on page 8 it is clear that they are still reviewing their technology options.

⁴¹ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, page 12.

⁴² Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, page 1.

⁴³ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, page 9.

⁴⁴ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, page 8.

⁴⁵ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, page 12.

⁴⁶ Imperial Oil Resources, *Kearn Oil Sands 2009 Annual Tailings Plan Submission*, page 11.

2.3 Shell

2.3.1 Shell Canada Muskeg River Mine

2.3.1.1 Description

The Muskeg River Mine (MRM) started its operation in 2002 and phase 1 has a production rate of 150,000 bpd. The approved Muskeg River Mine Expansion is scheduled to begin operations in 2010 and is expected to have a production rate of 120,000 bpd.⁴⁷ The tailings management plan submitted for MRM considered the average bitumen production of 150,000 bpd of bitumen for MRM. The plan also includes the management of fine tailings from bitumen froth produced at the Jackpine Mine facility which are to be transferred for processing through expanded MRM froth treatment facilities.⁴⁸

The Muskeg River Mine plan involves production of composite tailings (CT) in the initial phases of developing a dedicated disposal area (DDA), which is expected to start at the end of 2010 or in 2011.⁴⁹ This will ultimately produce a trafficable deposit. Shell intends to focus on the production of CT until 2018. Composite tailings are formed by combining coarse sand tails and mature fine tailings.

The CT facility will be designed and constructed with intent of 2010/2011 start up. “This will present a significant challenge to complete construction and start-up these facilities to meet a 2010 timeframe for continuous operation.”⁵⁰

Shell argues that “CT is considered by Shell to be the only commercially viable technology and the equipment required to incorporate CT technology into the MRM facilities is readily available. Shell will continue to study alternative technologies and anticipates the implementation of NST in the longer term.”⁵¹ Shell notes that “...development and implementation of new technologies at commercial scale provides a degree of uncertainty that may impact the timing and performance of the proposed fine tailings management schemes.”⁵²

Non-Segregating Tailings (NST) would provide the potential to create a tailings stream composed of coarse and fine tailings directly from the processing facility.⁵³ However in Shell’s opinion, this technology needs time in order to test its viability and performance at a commercial scale.⁵⁴ There is a plan to replace CT with NST in 2019 and Shell then expects to meet the requirements of the directive

Shell notes that “...prior to implementation of NST, there may be a shortfall of in-pit storage capacity to meet the requirements of the directive with respect to the required percentage of fine

⁴⁷ Simon Dyer et al., "Under-Mining the Environment," (Drayton Valley: The Pembina Institute, 2008). page 5.

⁴⁸ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 3.

⁴⁹ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 6.

⁵⁰ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 3.

⁵¹ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 6.

⁵² Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 3.

⁵³ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 4.

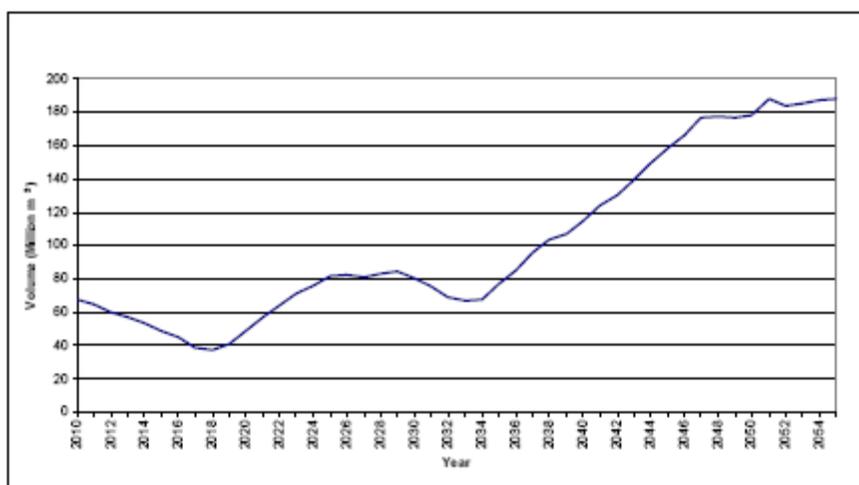
⁵⁴ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 4.

tailings sequestration.”⁵⁵ Technologies to supplement composite tailings, such as atmospheric fines drying, are being considered for use if there is a shortfall in in-pit storage capacity.⁵⁶

Shell includes a plan for forming a Dedicated Disposal Area (DDA), in compliance with Directive 074, and the first DDA is due to be complete in 2018 and the area is scheduled to have a trafficable surface by 2025.⁵⁷ Shell says there will be coarse sand tailings deposition from 2019 to 2020, which would meet the portion of the Directive that states that a trafficable surface must be ready for reclamation within 5 years after active deposition has ceased.⁵⁸ The ERCB does not however define “active deposition”, so it is not clear if it can include the sand capping as well as the CT deposition.

Despite the plans to capture more fines, the total volume will increase over the life of the project. In 2010, Shell expects to produce approximately 67.6 million cubic metres of fluid tailings. This is expected to increase to 188 Mm³ by 2065-69, as shown in Figure 2-6 from the Muskeg River submission (below).⁵⁹

Figure 2-6 Site-wide tabulation illustration of fluid tailings inventory



2.3.1.2 Compliance

The Shell Canada Muskeg River Mine Tailings Management Plan does not comply with all aspects of Directive 074. Shell will not meet the targets outlined by the Directive until 2019 but only assuming the successful introduction of NST. Shell hopes to have its first DDA shortly after the date required by Directive 074. However, prior to the implementation of Non Segregated Tailings technology, there may be a shortfall of in-pit storage capacity, and this may prevent the operation from meeting the fine tailings capture requirements. The first DDA with a trafficable surface is expected to occur at the Muskeg River Mine site in 2025. Shell is investigating other potential fine tailings treatments such as atmospheric drying of fines.

⁵⁵ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 4.

⁵⁶ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 4.

⁵⁷ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 1, page 9.

⁵⁸ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 1, page 9.

⁵⁹ Shell Canada Ltd., *Muskeg River Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 33.

2.3.2 Shell Albian Jackpine Mine

2.3.2.1 Description

The Jackpine Mine is scheduled to start operations in 2010.

Shell Albian expects that there will be problems with meeting ERCB Directive 074.⁶⁰ They expect to fall short of requirements with respect to the required percentage of fines sequestration. The company is therefore looking into supplemental technologies such as atmospheric fines drying to attempt to make up for this shortfall.

In Phase 1 the company will use an external tailings deposition area, i.e. a pond, for the deposition of coarse sand tails, thickened tails, whole tailings (produced when upsets occur in the tailings circuit) and thin fine tails (generated when fines segregate during the deposition of all tailings streams). In fact, the company admits that although it has chosen the thickened tailings (TT) process to sequester fines over the short term,

“The TT deposit will not achieve the full long-term fines sequestration requirements of the directive, however initiatives are underway to optimize fines capture in the TT deposit, and investigate supplemental fines capture methods such as atmospheric fines drying.”⁶¹

Non segregating tailings (NST) will be used for in pit tailings operations, starting in 2027. The NST will be produced by mixing thickened tailings, coarse dewatered sand, mature fine tailings from a fluid tailings cell and gypsum (which will prevent segregation of the mixture).⁶² “Upon implementation of NST, JPM will be compliant with the D-074 fine sequestration targets.”⁶³ (i.e., from 2027).

Figure 2-6 from the Jackpine submission (below) shows how the volume of fluid fine tailings is expected to increase over much of the project life.

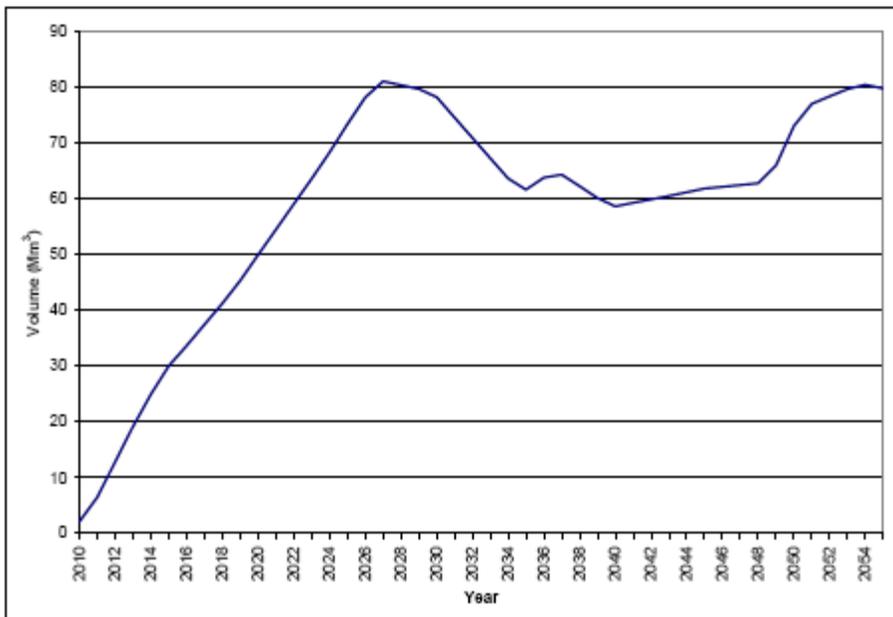
⁶⁰ Shell Canada Ltd., *Jackpine Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 4.

⁶¹ Shell Canada Ltd., *Jackpine Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 7.

⁶² Shell Canada Ltd., *Jackpine Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 7.

⁶³ Shell Canada Ltd., *Jackpine Mine: Tailings Management Plan*, September 30, 2009, Section 2, page 7.

Figure 2-6 Site-wide tabulation illustration of fluid tailings inventory



It appears that the first sand capping of an in pit tailings cell will not start until 2035.⁶⁴ MFT transfer and completion of NST production is expected to continue until 2055, when work will start on the creation of a trafficable surface.

2.3.2.2 Compliance

The Shell Jackpine Mine Tailings Management Plan shows that the operation is not planning on being compliant with Directive 074. Shell suggests they will not meet the Directive 074 requirements until 2027 with respect to tailings capture. The volume of fine tailings declines in 2027 once non-segregated technology is introduced, but the total volume of fines is shown to increase again as the Jackpine operation expands.

Although sand capping of thickened tailings deposits will start in 2035, the creation of a trafficable deposit will not commence until 2055.

2.4 Fort Hills Energy Corporation

2.4.1 Fort Hills Oil Sands Project

2.4.1.1 Description

The Fort Hills mine was originally a project of Petro-Canada Oil Sands Inc., UTS Energy Corporation, Teck Cominco Ltd, and Fort Hills Energy Corporation. Since Petro-Canada has

⁶⁴ Shell Canada Ltd., *Jackpine Mine: Tailings Management Plan, September 30, 2009*, Section 2, pages 7 and 8, Table 1.1: Timeline Summary. This is for JPM DDA1.

recently merged with Suncor, Suncor submitted the tailings management plans for this joint project.

The tailings management plan submitted for the Fort Hills mine is based on development activities commencing in 2012, with production estimated to start in the third quarter of 2014 at a rate of 156,000 barrels bitumen per day cumulatively with two streams.⁶⁵

The operators of Fort Hills mine intend to meet the directive by using thin lift drying technology in the DDAs to manage fluid fine tailings and dry fine tailings to the point where they are trafficable and reclaimable.⁶⁶ Fines from the coarse sand tailings stream, the thickened tailings stream and the tailings solvent recovery unit are expected to partially segregate from the slurry as they are deposited into its corresponding storage facility.⁶⁷ The fluid fine tailings component in each of the tailings storage facilities will later be dredged and pumped in the non-winter months to a DDA where they will be deposited in thin lifts and with time they are expected to partially dry and gain geotechnical strength.⁶⁸

The current design for fine fluid tailing drying does not include additional chemicals, however if it is required to achieve plan targets it could be included in provisions of the ultimate project design.⁶⁹ The Fort Hills operators also foresee that there may be situations where the fines material may be off-specifications from the Directive requirements due to weather events, erosion, or loss of strength in certain parts of the DDAs.⁷⁰ In order to deal with this, off-specification material will be mixed with underlying drier material or the pour zone in question will be avoided on its next scheduled deposition cycle.⁷¹

The thickened tailings operations are expected to commence six months after startup and the MFT drying area operations 18 months after plant startup, although the plan does recognize that this is dependent on sufficient fine fluid tailings (FFT) in the dredging area.⁷²

Figure 1-6 from the Fort Hills submission (below) illustrates fines capture by type over time in the Fort Hills project.

⁶⁵ New Technology Magazine. "Suncor Submits Fort Hills Oilsands Tailings Plans". Published October 9, 2009. Accessed October 28, 2009 at: http://www.nickles.com/ntm/extra.asp?article=NTM2009_O90000.html.

⁶⁶ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 1-1.

⁶⁷ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 1-1.

⁶⁸ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 1-1.

⁶⁹ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 1-2.

⁷⁰ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 15-32.

⁷¹ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 15-32.

⁷² Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 1-2.

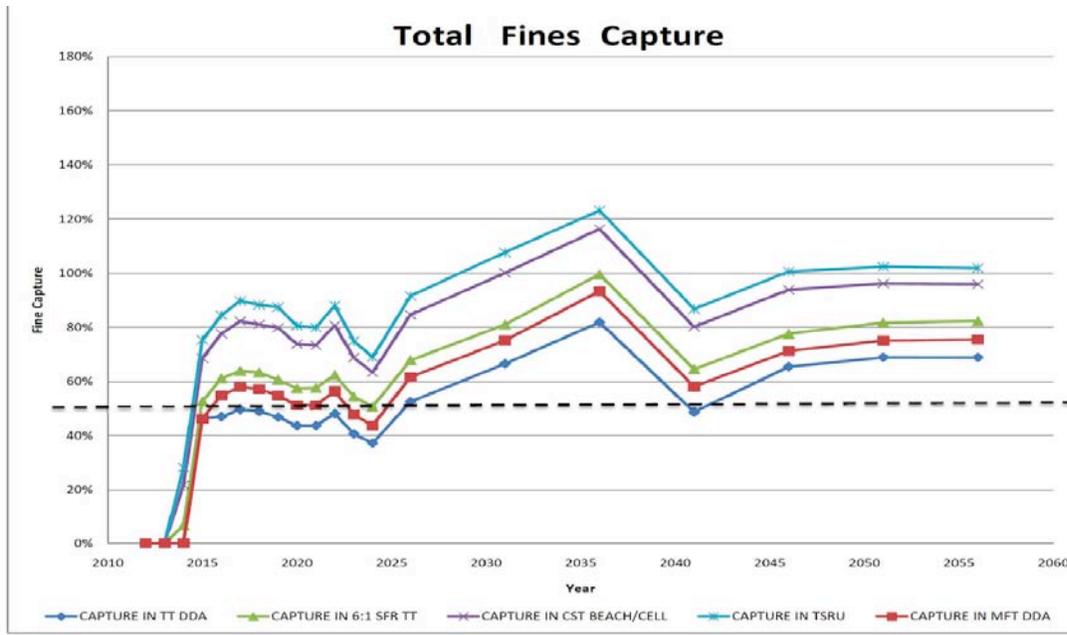


FIG 1-6

Figure 1-7 from the Fort Hills submission (below) shows the cumulative volume of fines over the lifetime of the project. The DDA drying area increases after 2029, when in pit areas become available,⁷³ and about six years after mine closure the plan indicates that there will be no residual fluid fine tailings.

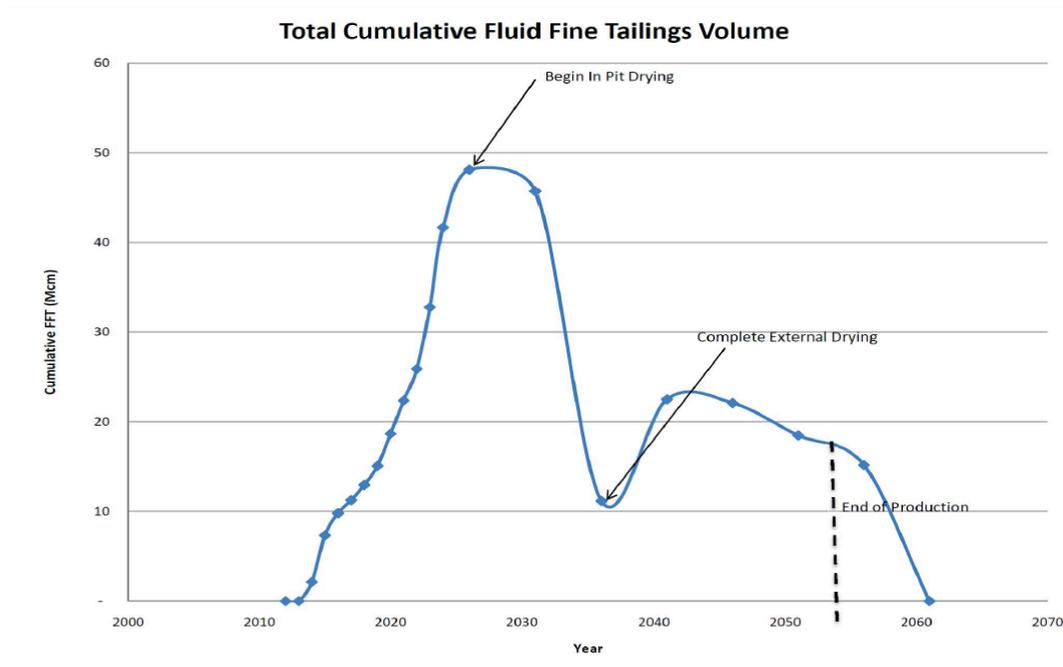


FIG 1-7

⁷³ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 1-2.

2.4.1.2 Compliance

The Fort Hills project intends to be compliant with the ERCB Directive 074. The DDAs in this project plan to capture 55% of the total fines in the initial 10-12 years of production. This means that with additional fines capture in dykes and beaches, the total fines capture will be approximately 85%.⁷⁴ Starting in 2029, when in pit DDAs become available the total volume of fluid fine tailings decreases and there should be no remaining fluid fine tailings by 2060.⁷⁵

Fort Hills has modified its earlier plans in order to comply with Directive 074 and expect that the fines captured in the drying area DDAs will be reclaimable within 5 years of the end of active deposition.

2.5 Suncor

2.5.1 Lease 86/17 and Millennium

2.5.1.1 Description

Suncor has two mining and production streams:

- Millennium Mine
- North Steepbank Mine⁷⁶

Because the company has been operating for a significant time, it already has large tailings ponds containing mature fine tailings and has been capturing MFT to create consolidated tailings (CT).⁷⁷

When Suncor submitted plans in accordance with ERCB Directive 074, it indicated important changes to its Tailings Management Plan.⁷⁸ The company announced that in future it would use Mature Fine Tailings Drying instead of CT technology. Suncor believes that this change in technology will enable Suncor to be in compliance with Directive 074, while also attempting to improve the fines capture in trafficable deposits, reduce overburden material shortfalls, facilitate progressive reclamation and reduce residual MFT transfer to pit lakes.⁷⁹ Suncor also expects that this change in technology will save money with regards to tailings management.⁸⁰

⁷⁴ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 1-2.

⁷⁵ Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan, page 1-2.

⁷⁶ Strategy West, *Existing and Proposed Canadian Commercial Oil Sands Projects* (August 2009), page 4, Athabasca Mining Projects, http://www.strategywest.com/downloads/StratWest_OSProjects_200908.pdf. The extension for this mine was granted in 2006 and it is due to start up in 2010.

⁷⁷ Suncor refers to consolidated tailings, but it seems that they are similar to composite tailings created by Shell and Syncrude, etc.

⁷⁸ Suncor Energy Inc., *Annual Tailings Management Plan, As Per Clause 14a from Approval #8535 and Directive 074 – Appendix E, Part 1*, September, 2009, https://www3.eub.gov.ab.ca/eub/dds/iar_query/ApplicationAttachments.aspx?AppNumber=1626039. This document is subsequently referred to as Suncor Energy Inc., *Annual Tailings Management Plan, Part 1*, September 30, 2009.

⁷⁹ Suncor Energy Inc., *Annual Tailings Management Plan, Part 1*, September 30, 2009, page 2-3.

⁸⁰ Suncor Energy Inc., *Annual Tailings Management Plan, Part 1*, September 30, 2009, page 2-3.

Suncor submitted a comprehensive application for tailings reduction operations to the ERCB in October, 2009.⁸¹

Suncor plans to process MFT by using drying assisted with the use of a polymer flocculent.⁸² Extraction tailings will be deposited into in-pit beaching areas enclosed by berm structures where sand will trap portions of the fine tailings while the remaining fines will be suspended in water in the form of thin fine tailings.⁸³ The thin fine tailings will then be transferred to MFT settling ponds where they will receive a polymer additive in the MFT drying process.⁸⁴ This MFT with polymer additive will then be deposited in thin layers over sloped beach areas (DDAs).⁸⁵ Freeze-thaw processes and the polymer MFT will then help recover a portion of the water, and the rest of the water will evaporate or remain in the resulting deposit.⁸⁶ The resulting MFT drying produces a clay product that can be reclaimed in place or be placed in mine dumps. The rate of fines consumption will therefore depend on the process performance and the total area dedicated to drying.⁸⁷

According to Suncor's tailings management plan, each DDA will occupy an area of 80 hectares and will be able to dry 4 m³ of MFT per m² drying area per year.⁸⁸

Suncor expects that this process will result in a legacy volume of end of mine fine tailings of 75 Mm³ versus the 108 Mm³ that would have resulted from the previous CT technology.⁸⁹ The area of the Suncor end-pit lake will also be reduced from 14 km² to 8.4 km².⁹⁰

Suncor provides a simplified overview on the process on a video on their website.⁹¹

Suncor applied for field testing of the new process for Tailings Reduction Operations in March 2009, which was granted, and subject to regulatory approval for the October 2009 application, plans full scale commercial application of the process in June 2010.⁹²

⁸¹ Suncor Energy Inc., *Application for Tailings Reduction Operations*, October 15, 2009. This application is available on the ERCB website under Application # 1626702, at:

https://www3.eub.gov.ab.ca/eub/dds/iar_query/ApplicationAttachments.aspx?AppNumber=1626702.

⁸² Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 3.

⁸³ Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 3.

⁸⁴ Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 3.

⁸⁵ Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 3.

⁸⁶ Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 3.

⁸⁷ Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 3.

⁸⁸ Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 35.

⁸⁹ Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, pages 3 and 4.

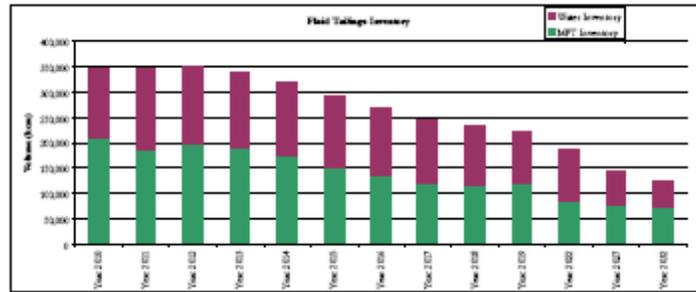
⁹⁰ Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 20, Table 1.3.

⁹¹ <http://www.suncor.com/en/newsroom/2625.aspx?id=3233>.

⁹² Suncor Energy Inc., *Annual Tailings Management Plan*, Part 1, September 30, 2009, page 3.

Figure 11.1 from the Suncor submission (below) shows the decline of fluid tailings over time in

Figure 11.1 Fluid Tailings Inventory



the Suncor operation:

2.5.1.2 Compliance

Suncor is planning to be compliant with Directive 074. Suncor has made major modifications to their tailings management plans in order to meet the Directive requirements and, subject to the approval of their October 2009 application for Tailings Reduction Operations, will be operating dedicated drying areas from July 2010.

The company expects to be compliant with Directive 074 according to the tailings management plan that they submitted to the ERCB for 18 of their 22 years of operations planning. Table 11.2 from the Suncor submission (below) clearly sets out the Directive 074 Compliance Schedule. From 2029 the company is out of compliance as all the MFT in Pond 7 has been treated, but MFT drying is matched with new MFT formation.

Table 11.2 : Directive 074 Compliance Schedule

Period	Tailings Directive 074 compliance (% fines in the feed captured by TRO)	Comments
July 2010 - June 2011	36.3%	Above compliance required 20%
July 2011 - June 2012	48.8%	Above compliance required 30%
July 2012 - June 2013	54.9%	Above compliance required 50%
July 2013 - June 2014	65.3%	Above compliance required 50%
July 2014 - June 2015	71.9%	Above compliance required 50%
July 2015 - June 2016	73.3%	Above compliance required 50%
July 2016 - June 2017	76.2%	Above compliance required 50%
July 2017 - June 2018	72.6%	Above compliance required 50%
July 2018 - June 2019	44.7%	Below compliance (50%). Ceased drying operations on DDA1 for following reasons (a) Give mine sufficient time to plan and prepare for future mining (b) A minimum of 3m of MFT thickness is maintained in STP for reliable barge operation
July 2019 - June 2020	54.7%	Above compliance(50%). Established drying operations on SDS as soon as beaches are available (in January 2020) to dry MFT from Pond 7
July 2020 - June 2021	70.7%	Above compliance required 50%
July 2021 - June 2022	73.9%	Above compliance required 50%
July 2022 - June 2023	63.9%	Above compliance required 50%
July 2023 - June 2024	59.3%	Above compliance required 50%
July 2024 - June 2025	62.1%	Above compliance required 50%
July 2025 - June 2026	57.3%	Above compliance required 50%
July 2026 - June 2027	51.8%	Above compliance required 50%
July 2027 - June 2028	50.8%	Above compliance required 50%
July 2028 - June 2029	50.1%	Above compliance required 50%
July 2029 - June 2030	46.3%	Below Compliance (50%). Ceased MFTD operation on SDS. All MFT in Pond 7 treated
July 2030 - June 2031	43.1%	Below Compliance (50%). MFT drying from STP is matched with new MFT formation
July 2031 - June 2032	46.0%	Below compliance

⁽⁶⁾ percent of fines in ore feed captured by TRO. On average TRO is expected to consume 56.5% of the fines in ore feed over the life of Millennium Mine (2010 to 2032).

The company has reported operational difficulties in producing on-specification consolidated tailings (CT), and also recognized that there is insufficient sand for production of more CT. They are therefore trying to address these issues by changing their approach to fine tailings

management through the use of different technology. As noted above, a new application for the Tailings Reduction Operations (TRO) have been submitted to the ERCB.

It is interesting to note that while Suncor plans to end the use of consolidated tailings technology, some other companies plan to use similar composite tailings technology, which results in plans not consistent with the requirements of Directive 074.

2.6 Syncrude

2.6.1 Syncrude Tailings Management Plans

Syncrude is the largest producer in the oil sands,⁹³ operating the Mildred Lake and Aurora North mines. The Mildred Lake Facility started operation in 1978,⁹⁴ and the Aurora mine was approved in 1997. The Aurora South mine is currently in the development and design stage, with start-up planned for 2016.

Bitumen is extracted using warm water and froth treatment.⁹⁵ Bitumen froth from the Aurora North project is piped to the Mildred Lake site for froth treatment.⁹⁶ Thus fines from the froth treatment appear in the Mildred Lake tables.

2.6.2 Mildred Lake

2.6.2.1 Description

Syncrude has been producing composite tailings since 2000 and the company plans to continue with CT production.⁹⁷ The CT is formed by combining the densified coarse tailings stream from the cyclone underflow, with mature fine tailings and gypsum.⁹⁸ The water that flows out when CT is deposited is low in solids. After deposition the CT drains and is capped using coarse tailings sand to create a trafficable surface for reclamation.

In addition, Syncrude is proposing to centrifuge mature fine tailings at Mildred Lake to reduce the MFT inventory and produce a soft, clay-like solid termed “centrifuge cake”, which will be capped with sand and reclaimed as a dry landscape feature.⁹⁹ A commercial scale demonstration

⁹³ Syncrude. *Our Record Fact Book*, <http://www.syncrude.ca/users/folder.asp?FolderID=5959>. Web site accessed October 16, 2009.

⁹⁴ ERCB. EUB Decision 97-13: Application by Syncrude for the Aurora Mine.1997, page 2.

⁹⁵ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Mildred Lake*, September 30, 2009, page 1.

⁹⁶ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora North*, September 30, 2009, page 1.

⁹⁷ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora North*, September 30, 2009, page 4.

⁹⁸ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Mildred Lake*, September 30, 2009, page 4.

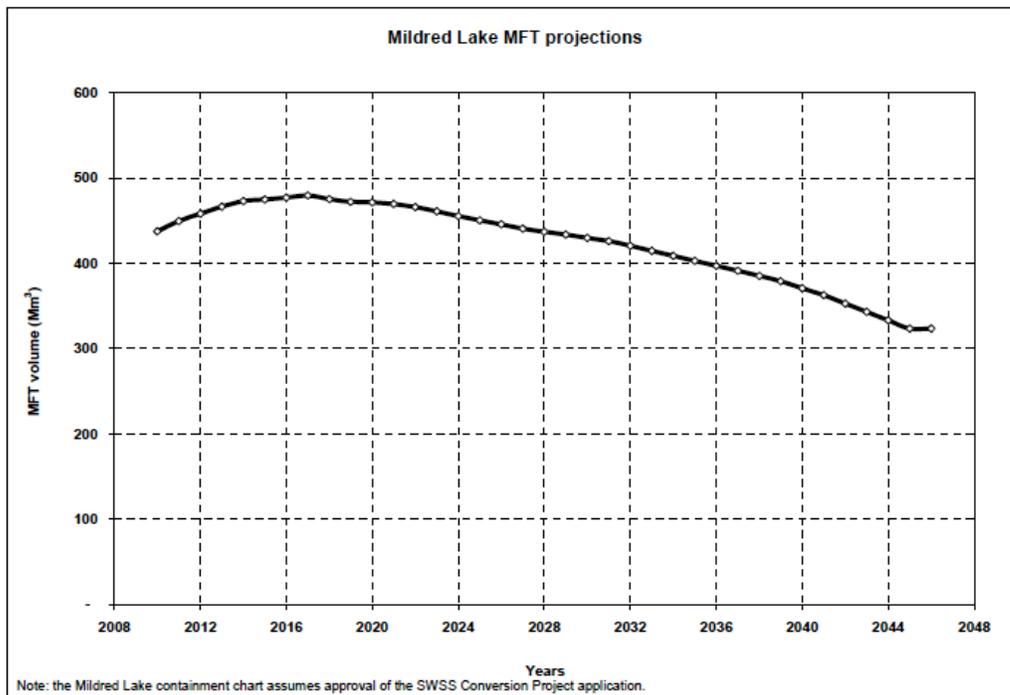
⁹⁹ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Mildred Lake*, September 30, 2009, page 4.

project is scheduled to start in 2012, followed by the first phase of commercial plant in 2015, with a further increase in capacity in 2018.

“The use of MFT centrifuging technology in addition to CT will allow Syncrude to reduce MFT inventories at end of mine life to levels contemplated in the approved C& R plan.”¹⁰⁰

Syncrude plans to rely on two end pit lakes for the remaining MFT when the project ends. Figure 2.3 from the Mildred Lake submission (below) shows the fluid inventory for the Mildred Lake project.¹⁰¹ The MFT Inventory Curve is based on the continued use of CT and the staged introduction of MFT centrifuging technology.¹⁰² The company expects to reduce its current MFT inventory of 437 million m³ to 323 million m³ by the end of operations.¹⁰³

Figure 2.3 MFT Inventory Curve



The company is currently evaluating options for creating DDAs.¹⁰⁴

¹⁰⁰ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Mildred Lake*, September 30, 2009, page 9.

¹⁰¹ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Mildred Lake*, September 30, 2009, page 9.

¹⁰² Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Mildred Lake*, September 30, 2009, page 9.

¹⁰³ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Mildred Lake*, September 30, 2009, page 17, Table 3.3. See also page 29, Table 4.3, Tailings Disposal Schedule, which shows the Tailings Material Balance; and pages 34–37, for the Side Wide Material Balance.

¹⁰⁴ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora North*, September 30, 2009, page 6.

2.6.2.2 Compliance

Syncrude is not planning on being compliant with Directive 074 for their Mildred Lake Project. The company expects to capture 50% of fines, but not until 2015, several years after it is required by the ERCB in Directive 074.¹⁰⁵ The company also expects that its use of CT and production of centrifuge cake will reduce its current tailings inventory. There is only one reference to trafficable deposits in the tailings management plan for this project, and it is not clear how the DDAs will be reclaimed into trafficable surfaces.

2.6.3 Aurora North

2.6.3.1 Description

At Aurora North, tailings are currently stored in the out-of-pit settling basin and production of composite tailings is scheduled to begin in 2013.¹⁰⁶ There are plans to introduce other fines management technology to supplement the composite tailings, starting in 2018. The 2009 plan predictions are based on the use of thickened tailings, but Syncrude is still evaluating possible technologies, which might include centrifuged MFT and MFT dewatering.¹⁰⁷ There will be several DDAs according to the Aurora North plan, and formation of trafficable deposits in the first DDA will happen as soon as possible, although no date is specified.¹⁰⁸

Syncrude expects to capture more than 50% of fines produced in composite tailings and thickened tails, starting in 2014.¹⁰⁹ This proportion increases when thickened tailings are introduced in 2018, but in five later years (in period to 2039) the proportion of fines captured is expected to fall below the 50% level. The tailings volumes in this table are the final deposit volumes.

Despite the capture of fines, the volume of MFT is expected to continually increase over the life of the project, as can be seen in Figure 2.3 from the Aurora North submission (below).¹¹⁰

¹⁰⁵ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Mildred Lake, September 30, 2009*, page 17.

¹⁰⁶ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora North, September 30, 2009*, page 4.

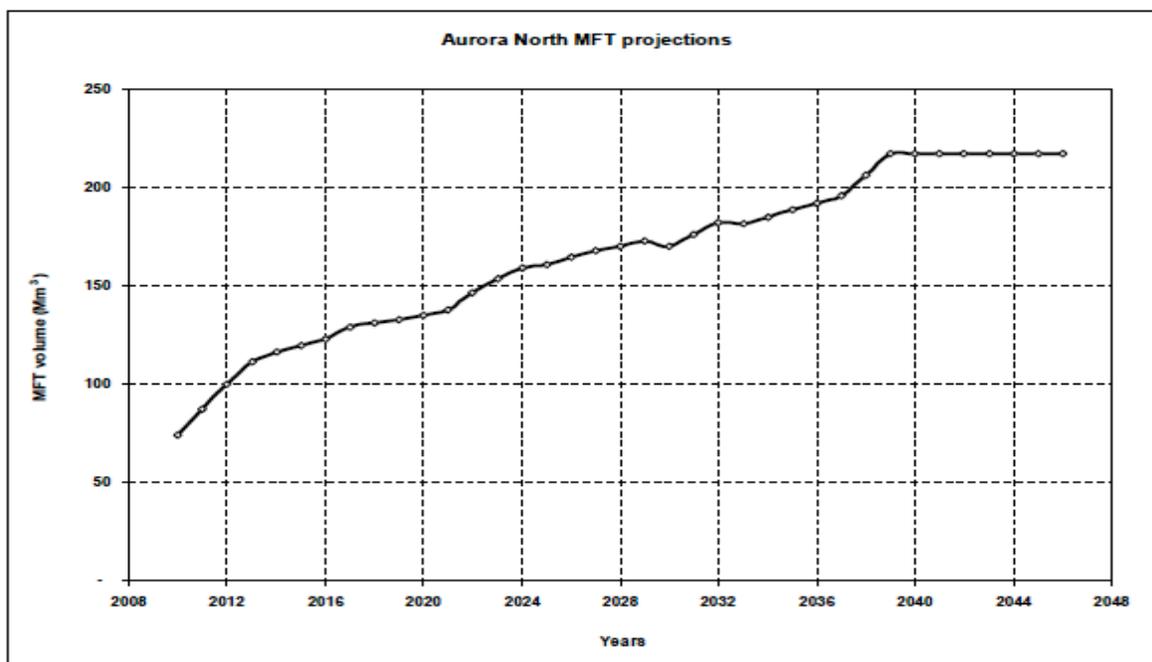
¹⁰⁷ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora North, September 30, 2009*, pages 4 and 8 of 39. For additional information see pages 15 and 30 for Tables 3.3 and 4.3, which indicate, respectively, the Aurora North tailings production summary and tailings disposal schedules. The site-wide materials balance for fines is shown on page 37, Table 5.2.

¹⁰⁸ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora North, September 30, 2009*, page 6.

¹⁰⁹ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora North, September 30, 2009*, page 15, Table 3.3, columns on fines capture.

¹¹⁰ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora North, September 30, 2009*, page 8.

Figure 2.3 MFT Inventory Curve



2.6.3.2 Compliance

Syncrude’s Aurora North Project is not planning on being compliant with Directive 074. In the Aurora North plan, Syncrude shows that more than 50% of fines will be captured in composite tailings, in 2014, two years after the deadline for Directive 074 requires it to be done. There is no discussion of when sites will be suitable for reclamation or even when the deposits will become trafficable in the tailings management plan. According to Syncrude, the plans will reduce the rate of fine tailings accumulation, but fines will still accumulate over the course of the project. The final plan is to place these legacy tailings into end pit lakes.

2.6.4 Aurora South

2.6.4.1 Description

Although Syncrude’s Aurora South Project is still in the development and design stages, the project is expected to start up in 2016.¹¹¹ A detailed project update will be provided to the ERCB in Q4 of 2009.¹¹² Syncrude mentions that opportunities are currently under consideration that could result in changes to future tailings plans. These include changes to mining rates in the

¹¹¹ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora South*, September 30, 2009, page 1.

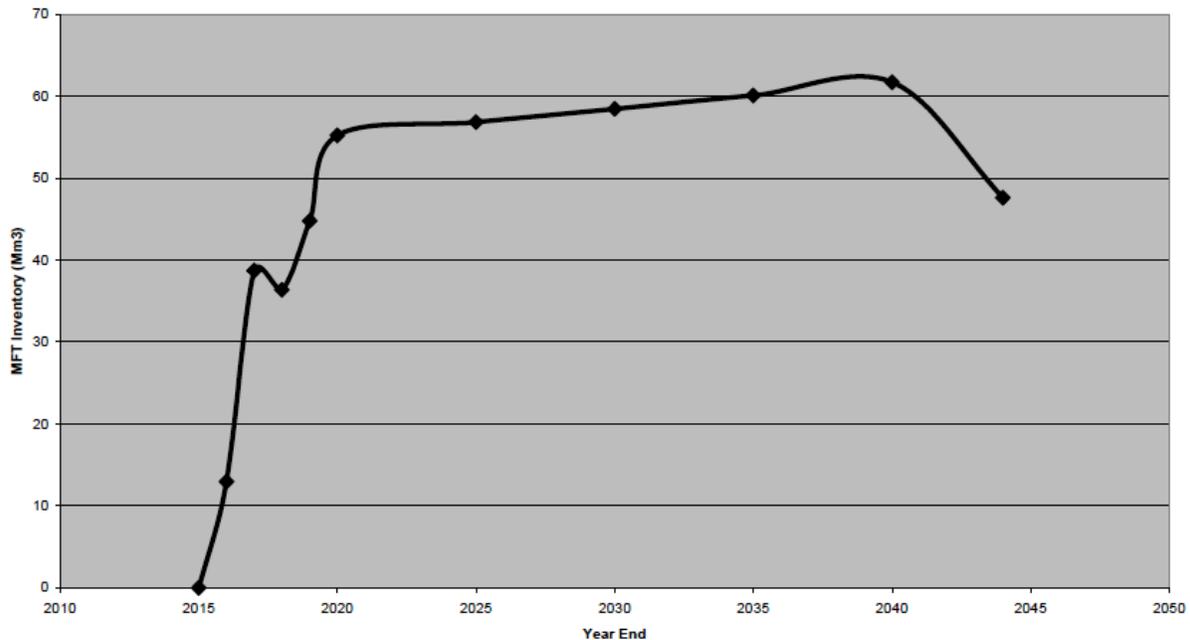
¹¹² Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora South*, September 30, 2009, page 1.

Aurora North Mine in 2015, a change in the mining to TV:BIP limits¹¹³ and the potential integration of Mildred Lake Mine and Aurora North Mine projects.¹¹⁴

The Aurora South project is proposing to use MFT centrifuging technology as the primary fines management technology.¹¹⁵ The residual MFT at the end of the process will be capped with water in an end pit lake.¹¹⁶

Figure 2.1 from the Aurora South submission (below) shows the cumulative MFT inventory for the Aurora South Project, which increases over much of the project life.

Figure 2.1 MFT Inventory Curve



There are several other tables in the plan, but they are presumably tentative. Table 3.3 in the submission shows the tailings production summary for the project including the percentage of fines from the original feed that will be sent for processing on an annual basis.¹¹⁷ This is at or above 50% capture rates for only 9 years of the project’s 28 year life span Legacy fine tailings will go into an end pit lake at the end of the mine’s life.

¹¹³ TV:BIP is the ratio of Total volume to bitumen in place.

¹¹⁴ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora South*, September 30, 2009, page 3.

¹¹⁵ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora South*, September 30, 2009, page 2.

¹¹⁶ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora South*, September 30, 2009, page 2.

¹¹⁷ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora South*, September 30, 2009, page 6.

2.6.4.2 Compliance

The current plan does not appear to be compliant with Directive 074. Syncrude does not state whether or not they will be in compliance with Directive 074 in the tailings management plan provided, but it appears that the current plan is not yet compliant, as in many years the proportion of fines being consumed in centrifuge cake is slightly under 50% (and averages 48%).¹¹⁸ Syncrude states it will provide a supplementary report to the ERCB in Q4 of 2009, which may include changes to all their mining projects.¹¹⁹ The Syncrude Aurora South plan contains substantially less information than other plans.

¹¹⁸ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora South*, September 30, 2009, page 6, Table 3.3.

¹¹⁹ Syncrude Canada Ltd., *2009 Annual Tailings Plan Submission Syncrude Aurora South*, September 30, 2009, page 3.

3. Compliance

Directive 074 contains many different requirements with which each company is expected to comply. However, Directive 074 is quite specific on two criteria: a company must meet the targets for fines capture and it must ensure that the deposits are trafficable according to a prescribed schedule.

The following table summarizes the extent to which those requirements appear to be met in each company’s plans.

Oil Sands Operation	Meeting DDA Timelines for Fines Capture (Sec. 4.1)		Meeting Criteria for DDA Trafficable Deposits (Sec. 4.3)	
	Yes/No	Details	Yes/No	Details
CNRL: Horizon	No ¹²⁰	Aims to meet cumulative fines capture requirements by 2025. DDA will not be in place until 2015. ¹²¹ Says no commercially proven method for fluid tailings dewatering exists. ¹²²	No	No timelines specified. ¹²³
Imperial: Kearl	No	Aims to meet fines capture requirement by 2023. ¹²⁴	No	Not indicated.
Shell: Muskeg River	No	Unlikely to meet 2010 timeline for start-up of CT ¹²⁵ or required performance. ¹²⁶	No	Cell 1 to be trafficable by 2025.
Shell: Jackpine	No	The DDA area is a cell for thickened tailings in the external tailings facility. ¹²⁷ Deposition to continue until 2027. Thickened tailings not meeting directive requirements. ¹²⁸ Non-segregating tailings in-pit will not start until 2027.	No	Start date for trafficable surface not until 2055. ¹²⁹

¹²⁰ CNRL Plan, page 7. “Canadian Natural is unable to establish Dedicated Disposal Areas (DDA) and the fines capture in accordance with the dates specified in the Directive.” Target operable date for DDA is 2015, with higher fines capture 2016-2029 to reduce inventory obtained prior to 2015. (page 8).

¹²¹ CNRL Plan, page 8. See also pages 12–13.

¹²² CNRL Plan, page 7.

¹²³ CNRL Plan, page 10 says that NST will meet trafficability requirements – but no details.

¹²⁴ Imperial Oil Resources, *Kearl Oil Sands 2009 Annual Tailings Plan Submission*, page 12.

¹²⁵ Shell Muskeg, Section 2, page 3. Start-up expected 2010-2011.

¹²⁶ Shell Muskeg, Section 2, page 3. states “... implementation of new technologies at commercial scale provides a degree of uncertainty that may impact the timing and performance of the proposed fine tailings management scheme.” Still needs to test NST at commercial scale. “Prior to implementation of NST, there may be a shortfall of in-pit storage capacity to meet the requirements of the directive with respect to the required percentage of fine tailings sequestration.” Section 2, page 4. Also considering atmospheric fines drying to supplement CT (page 4).

¹²⁷ Shell Jackpine, Section 1, page 2 of 15.

¹²⁸ Shell Jackpine, Section 2, page 7.

Compliance

Oil Sands Operation	Meeting DDA Timelines for Fines Capture (Sec. 4.1)		Meeting Criteria for DDA Trafficable Deposits (Sec. 4.3)	
	Yes	No	Yes	No
Fort Hills Energy: Fort Hills	Yes	DDAs to capture 55% of total fines on average in first 10 to 12 years. ¹³⁰	Yes	Expects to meet requirements. ¹³¹
Suncor: Millennium and North Steepbank	Yes	Expects to exceed Directive 074 requirements for 18 of the 22 years. ¹³²	Yes	Revising its tailings management process in an effort to attain Directive 074 requirements for trafficability. ¹³³
Syncrude: Mildred Lake	No	Plans to introduce centrifuge tailings to complement CT, but first commercial phase does not start until 2015. ¹³⁴ Currently evaluating options for DDAs. ¹³⁵ Will not meet requirements in early years, but expects to reduce total volume of legacy tailings. ¹³⁶	No	No details on trafficable deposits. ¹³⁷
Syncrude: Aurora North	No	More than 50% of fines will be captured in composite tailings, in 2014, two years after the deadline for Directive 074 requires it to be done and in many (but not all) subsequent years. ¹³⁸ Currently evaluating options for DDAs.	No	No information on trafficable deposits.

¹²⁹ Shell Jackpine, Section 2, page 7 states: “The TT [thickened tailings] deposit will not achieve the full long-term fines sequestration requirements of the directive, however initiatives are underway to optimize fines capture in the TT deposit, and investigate supplemental fines capture methods such as atmospheric fines drying.”

¹³⁰ Fort Hills, page 1-2.

¹³¹ Fort Hills, page 1-2.

¹³² Suncor Millennium Plan. Table 11.2 clearly sets out the Directive 074 Compliance Schedule. Suncor expects to meet the ERCB schedule most of time and has explained its deviations. It will be below compliance from 2029 to 2032 as all MFT in Pond 7 is treated. MFT drying is matched with new MFT formation.

¹³³ Suncor Millennium Plan, pages 3–4. States that depending on the sand to fines ratio, CT may support reclamation activities in 5 to 10 years after deposition. While CT can form a trafficable deposit, Suncor has experienced difficulties in achieving consistent production of on-spec CT. Also, as coarse material needed for dykes, lack of capacity to reduce legacy MFT. New plans aim at 50% of fines capture in sand beaches and 50% through MFT drying.

¹³⁴ Syncrude Mildred Lake, pages 4 and 5.

¹³⁵ Syncrude Mildred Lake, page 6.

¹³⁶ Syncrude Mildred Lake, page 17 of 39. See Table 3.3 Fines Capture column for annual % to be captured. Will capture over 50% of fines in feed in CT and CMFT from 2015 Site-wide Material Balance, Fines Management, page 36 of 39, shows 221 Mt fines in suspension in 2046 (c.f. peak of 308 Mt in 2017).

¹³⁷ Syncrude Mildred Lake, page 4 of 39 is only reference to “trafficable”. Just states that CT drains relatively rapidly and can be capped using coarse tailings. No timelines.

¹³⁸ Syncrude Aurora North, page 15, Table 3.3.

Compliance

Oil Sands Operation	Meeting DDA Timelines for Fines Capture (Sec. 4.1)		Meeting Criteria for DDA Trafficable Deposits (Sec. 4.3)	
Syncrude: Aurora South	No	It appears that, on average, slightly less than 50% of fines will be captured using the centrifuge cake process, ¹³⁹ but plans are still being developed.	No	Not Indicated.

¹³⁹ Syncrude Aurora South plan, page 6.

According to our assessment only two of the plans — Fort Hills Energy mine and Suncor Millennium/North Steepbank are compliant with Directive 074.

Many companies rely on the fact that the ERCB has indicated there may be some flexibility in meeting the requirements of Directive 074 within Section 3 of the Directive which states: “*The ERCB recognizes that fluid tailings management is developing and that operators may need flexibility to apply technologies and techniques that best suit the circumstances of particular projects. The ERCB will consider submissions of operators and will determine project-specific requirements related to the directive.*”

Given that 7 out of 9 operations have submitted plans that do not meet the requirements of Directive 074 for its initial timelines, it is essential to determine how the ERCB proposes to regulate non-compliant companies, or even if these plans will be accepted by the regulator. How much flexibility the ERCB allows companies who will not be in compliance with Directive 074 is a critical unresolved issue. Given the weak track record of tailings management to date in the oil sands industry, it is essential that the rules are adequately enforced. The ERCB has jurisdiction to enforce the requirements of the Directive under *Directive 019: ERCB Compliance Assurance—Enforcement*. Enforcement options include suspension of oil sands operations.

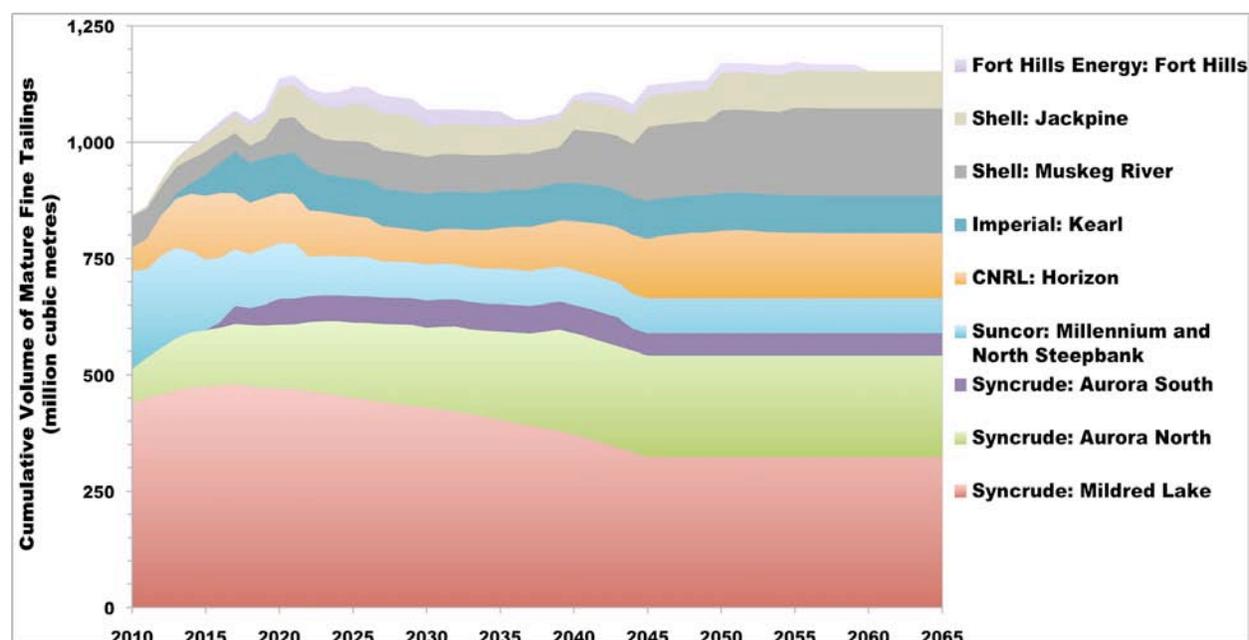
Several companies have not yet indicated timelines for the creation of trafficable deposits. Also, it is still uncertain as to whether the trafficable surfaces created with the tailings will be a suitable substrate for revegetation due to the high salt content that they will likely have.¹⁴⁰

¹⁴⁰ Riley Brandt, “Tarsands tailings will grow despite new rules,” Newspaper article published by FFWD, October 15, 2009.

4. Appendix

The ERCB reports that current tailings volumes on the landscape total 720 million m³.¹⁴¹ Calculations by the Pembina Institute and Water Matters suggest a cumulative increase in fluid fine tailings/mature fine tailings based on company submissions.

According to the company submissions, volume of FFT/MFT will grow 30% from 843 million m³ in 2010 to over 1.1 billion m³ in 2020. By 2065, the volume of tailings will still be over 1.1 billion m³ by 2065.



Data sources for cumulative MFT volumes:

Oil Sands Operation	Source
Fort Hills Energy: Fort Hills	Fort Hills Energy Corporation. 2009. ERCB Directive 074 Annual Tailings Management Plan. Table 8.1.
Shell: Jackpine	Shell Albian Sands. 2009. Jackpine Mine ERCB Directive 074 Submission. Table 2-8, page 34.
Shell: Muskeg River	Shell Canada. 2009. Muskeg River Mine ERCB Directive 074 Submission. Table 2-8, page 32.
Imperial: Kearl	Imperial Oil Resources. 2009. Kearl Oil Sands Project 2009 Annual

¹⁴¹ http://www.ercb.ca/portal/server.pt/gateway/PTARGS_0_0_303_263_0_43/http%3B/ercbContent/publishedcontent/publish/ercb_home/news/news_releases/2008/nr2008_14.aspx

	Tailings Plan Submission. Table 9, page 12.
CNRL: Horizon	Canadian Natural Resources Ltd. 2009 Horizon Tailings Management Plan.10-RTP-TA-0001, Revision 0. Figure 2, page 9.
Suncor: Millenium and North Steepbank	Suncor Energy Inc. — Oil Sands. 2009. Part I. ERCB Directive 074 Annual Tailings Management Plan. Table 11.1, page 43.
Syncrude: Aurora South	Syncrude Canada Ltd. 2009 Annual Tailings Plan Submission Syncrude Aurora South (Lease 31). 2009 Directive 074 Submission: Aurora South. Table 3.3, page 6.
Syncrude: Aurora North	Syncrude Canada Ltd. 2009 Annual Tailings Plan Submission - Syncrude Aurora North (Leases 10, 12 and 34). 2009 Directive 074 Submission: Aurora North. Table 3.3, page 15.
Syncrude: Mildred Lake	Syncrude Canada Ltd. 2009 Annual Tailings Plan Submission Syncrude Mildred Lake (Leases 17 and 21). 2009 Directive 074 Submission: Mildred Lake. Table 3.3, page 17.

Under Directive 074 there is an annual tailings management plan requirement. These annual plans, outlining the tailings projections for five year intervals are to be submitted by September 30 each year (the first plan must however project for the first 10 years).¹⁴²

According to Directive 074 this plan must include the following:¹⁴³

- 1) a description of the tailings management plan and any deviations from the approved tailings plan for the entire mine scheme;
- 2) a process flow diagram for the scheme’s tailings operations;
- 3) a mineable oil sands reserves table for the life of the mine scheme that includes mine total waste, overburden, and interburden, and ore quantity, bitumen grade, fines, sand, and water (as a weight per cent of the ore), and recovered barrels of bitumen;
- 4) a production forecast table for the life of the mine scheme by time period, including mined total waste, mined ore, bitumen grade, and recovered barrels of bitumen, and total tailings production by type;
- 5) a table of waste material (overburden and interburden) classified by geologic formation (Holocene, Pleistocene, Clearwater, McMurray, etc.) with associated volume and weight, type and per cent of material suitable for tailings impoundment construction, and the amount projected for use in tailings impoundment construction;
- 6) a table that schedules the source and destination of waste material by mass and volume, classifying material type by structure, the material types—overburden, interburden, crusher rejects (or oversize), and tailings—used for structures, destination area, including DDAs,

¹⁴² ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." Page 11.

¹⁴³ ERCB, "Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes." Page 11-12.

external and in-pit waste disposal areas, external and in-pit tailings impoundment structures, and external and in-pit tailings areas;

7) a starting baseline for all structures, including the present elevation of each waste material type within each structure;

8) a construction schedule, volume, and projected life span for each tailings impoundment structure;

9) an illustration of fluid tailings impoundment and DDA capacity versus the associated storage requirements;

10) destination and description of each tailings type by structure, including mass, volume, and components (water, fines, sand, and bitumen, as a per cent of the ore);

11) a site-wide tabulation and illustration of fluid tailings inventory;

12) site-wide sand, fines, and water balance;

13) mine scheme development maps by reporting period, and a text description of the major development activities as illustrated on each map;

14) a summary of tailings water chemistry, seepage water chemistry, and seepage water rates into the groundwater from reports of groundwater and tailings monitoring programs provided to AENV;

15) a description of the process for remediation or rehandling of segregated fines within the DDAs within one year of segregation;

16) planning assumptions and criteria used to support the tailings management plan, such as fines distribution in the ore body, tailings stream-specific gravities, tailings consolidation curves, tailings deposition angles, and tailings impoundment design and construction criteria; and

17) any other information that the ERCB requires.