Summary

Tailings, A Lasting Oil Sands Legacy
**Front cover:** Aerial view of Syncrude Aurora mine and tailings lake north of Fort McMurray, Alberta, Canada. Oil sands mining over the past four decades has produced a vast and growing legacy of toxic liquid tailings. © Jiri Rezac / WWF-UK

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WWF is one of the world's most experienced independent conservation organizations, with over 5 million supporters and a global Network active in more than 100 countries. WWF’s mission is to stop the degradation of the planet’s natural environment and to build a future in which humans live in harmony with nature, by: conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.
With 170 billion barrels of established reserves, Alberta’s oil sands are the second largest oil reserve in the world after Saudi Arabia’s. Bitumen mining and extraction have produced wealth for some but they also incur a vast and growing liability from the liquid tailings.

About 4,800 square kilometers of land in Northern Alberta are slated to be mined for bitumen. Only about 12.5% or 602 square kilometers has been mined so far but more than a quarter (170 square kilometers) of the area mined is covered by liquid tailings in long-term storage behind dikes.

Bitumen is extracted from the mined ore using hot water and caustic soda. This produces a liquid tailings waste that is comprised of sand, water, fine clay particles, residual bitumen and other contaminants. The coarse sand settles out from the tailings relatively quickly; the fine clay particles pose a greater problem in managing tailings. Some of the fine particles settle out from the tailings over two or three years to leave behind a fluid waste known as mature fine tailings or “MFT” which retains between 30% and 45% fine particles by weight. Further settling takes a long time – perhaps centuries. MFT represents a liability because it is too toxic to be released to the aquatic environment and too fluid to serve as a substrate for dry land reclamation.

MFT has been accumulating since the first commercial oil sands mine opened in 1967. Today, more than 840 million cubic metres of waste MFT are stored on the landscape in what is commonly referred to as tailings ponds. Some of these ponds occupy as much as 30 square kilometers which make them far larger than what we commonly think of as ponds so we will refer to them from here on in as tailings lakes. More than 1.5 barrels of MFT are produced for every barrel of bitumen. Hence we calculate that the inventory of MFT will grow by 66 million cubic metres as a result of 2008 bitumen production and by another 72 million cubic metres from the amount of bitumen produced in 2009. To put these numbers into perspective, the volume of the Toronto SkyDome (now Rogers Centre) is 1.6 million cubic metres and that of the Great Pyramid of Giza about 2.5 million cubic metres. Last year’s growth in tailings alone would fill 45 SkyDomes or more than 28 Great Pyramids. Alberta regulators have projected that the inventory of MFT waste could reach 2.4 billion cubic metres by 2040, a figure that could be seriously underestimated given the rates of MFT growth in recent years.
Mature fine tailings are toxic. The dikes that contain the fluid tailings leak into groundwater and have the potential to fail. Tailings lakes also emit methane, a greenhouse gas that contributes to climate change.

As previously mentioned, MFT cannot be released to the aquatic environment because it contains toxic contaminants – naphthenic acids, polycyclic aromatic hydrocarbons, metals, salts and residual bitumen – and silt that remains suspended for a long time.

Tailings dikes leak, a fact that has led the industry to construct ditches around the dike perimeters to collect the escaping fluids so they can be pumped back into the lakes. Not all leakage is captured by the collection systems, some makes its way into groundwater and from there into the Athabasca River.

The tailings dikes that tower above the landscape are constructed from native sands. Foundation and slope instabilities in the dikes have been noted in the past. People living in communities downstream of the oil sands are concerned about the potential for human and ecosystem harm should a catastrophic breach occur in any of the many dikes. In 2009, both the Dene First Nation and the City of Yellowknife issued proclamations calling for, among other measures, contingency plans in the event of dike failure.

Methane, a potent greenhouse gas, is emitted from the stored MFT as it ages. One researcher has found that the daily amount of methane that has been bubbling up since the early 1990s from just one of Syncrude’s tailings lakes is equivalent to the methane produced by half a million cows.
The Energy Resources Conservation Board (ERCB), the Alberta regulator responsible for tailings management, has expressed concern over the growing tailings footprint, primarily because the lakes interfere with the recovery of underlying bitumen. Mine operators, in their applications for new mines and mine expansions over the years, have pledged to meet self-imposed targets for reclaiming fluid tailings but have failed to meet their commitments.

In 2009, the ERCB issued a directive that set regulatory targets intended to slow tailings growth. Mine operators were required to submit tailings plans laying out how they would meet the targets. Most of the plans submitted by the operators in the fall of 2009 failed to meet the ERCB targets. Instead of imposing penalties for non-compliance, the ERCB has allowed delays in meeting the stipulated targets and has authorized Syncrude to construct another tailings storage lake and Suncor to increase the storage capacity of another. Such authorized increases in tailings storage capacity counter the intent of the directive.

The tailings liability that has grown under lax and unenforced regulations has prompted Alberta’s premier to say that the problem will be remedied, yet such political promises are backed neither by firm timelines nor effective regulations and enforcement.

It’s clear after more than forty years of tailings growth and accumulation that the Alberta government has failed to hold mine operators accountable for remedying the liability they have created. It’s equally clear from the backpedalling on the regulator’s tailings directive that substantive movement towards more responsible tailings management is not yet in sight.

"The Alberta Government has not enforced the requirements of its fledgling tailings directive."
Through an airplane window’s glare, the Athabasca River is seen flowing past Tar Island, home to Canada’s first oil sands tailings lake. In September 2010, Suncor celebrated the surface reclamation of ‘Pond 1’; however, this was achieved only after the accumulated MFT were transferred out of the tailings lake.
Although regulations have been ineffective in addressing oil sands tailings, the oil sands industry has long promised that technological innovation would resolve its tailings problems. Research and development efforts over the past two decades have identified some technologies that hold promise in the struggle to reclaim fluid tailings. Industry investment in and adoption of such technology to date has not slowed the growth nor reduced the accumulated volume to any significant degree.

The mining industry has proposed both wet and dry reclamation processes for incorporating MFT into a final landscape once the bitumen is mined out. Dry reclamation would turn fluid tailings into solid deposits in a terrestrial final landscape while wet reclamation would enable the industry to place its MFT in fluid form into mined out pits and cover the toxic waste with water to form manmade lakes.

The following paragraphs outline some of the tailings reclamation technologies that are currently in use.

**Dry Reclamation**

Dry reclamation attempts over the past decade have been primarily centred around technology known as consolidated tailings (CT). Suncor implemented CT operations in 1995, Syncrude followed suit in 2000. The CT process combines MFT with sand and gypsum which binds the sand to the fine clay particles in the MFT. The consolidated waste is then placed into a deposit where water is released over time to, in theory, eventually make the deposit solid enough to support land reclamation activities.

The technology has failed to live up to expectations. A minimum ratio of sand to MFT is required to create trafficable deposits but there are competing uses for a finite amount of sand. CT operations have been unable to keep pace with the volume of tailings produced. Suncor and Syncrude have been diverting sand to build higher dikes and more tailings lakes to contain the ever growing inventory of MFT. As a result, only about 10% of the area currently covered in tailings on Syncrude and Suncor leases is occupied by CT deposits and some of the deposits are substandard. Parts of the deposits are soft and must be capped with scarce sand or petroleum coke to adequately support reclamation activities. The historically low rates of CT production and the
inadequacy of the deposits demonstrate that CT technology cannot cope with the scale of the MFT problem.

Suncor has decided to retire its CT operations by 2011 and will implement a new technology, MFT drying, in an attempt to reduce the company’s inventory of MFT. With the new process, Suncor’s MFT is mixed with a flocculant (a chemical agent that causes small particles in a liquid mixture to aggregate) and spread in relatively thin layers over large surface areas to dry. Some water is released and runs off as the small particles in the MFT clump together under influence of the flocculant. Additional water is removed from the MFT through evaporation. Suncor has predicted its drying technology will, by 2032, have turned more than 600 million cubic metres of MFT into deposits capable of supporting foot and vehicle traffic. The new technology shows promise for reducing fluid tailings inventories but the long term performance of MFT drying technology remains unproven. Suncor is at least implementing a potential replacement for the older CT technology.

Syncrude, in contrast, continues to employ CT as the primary technology to remediate its MFT inventory. Despite having produced only 50 million cubic metres of CT over nine years of using the technology at Mildred Lake, Syncrude has promised the ERCB that it will create more than 900 million cubic metres of CT at the Aurora North mine between 2013 and 2038. This would require an average annual production rate more than six times Syncrude’s historical annual rate of CT production.

To augment its CT production, Syncrude has said it will experiment with new technology that removes water from MFT through the use of centrifuges. With its centrifuging trial and subsequent operations at Mildred Lake, Syncrude hopes to process another 170 million cubic metres of MFT into solid deposits between 2013 and 2032. The promise of new centrifuging technology and the optimistic projections for CT operations at Aurora North will not, however, reclaim all of Syncrude’s projected inventory of MFT. The corporation plans to use wet reclamation to dispose of a substantial surplus of MFT in end pit lakes.

More than four decades of mining have passed and the oil sands industry is still struggling to find tailings reclamation technology able to cope effectively with the vast amounts of mature fine tailings produced every year.

511

millions of cubic metres of MFT that Syncrude currently has stored in tailings lakes

183

millions of Canadian dollars held by the Alberta government as security for Syncrude mine reclamation
The flurry of new tailings technology currently being implemented in response to the ERCB directive is long overdue but it is important to reinforce that this technology remains unproven. The effectiveness of new tailings technology must be considered in the context of a historical record that has, over a decade and a half, disproved the value of CT, once the darling of dry tailings remediation technology.

**Wet Reclamation With End Pit Lakes**

Base Mine Lake (BML) at Syncrude’s Mildred Lake mine will become the first oil sands end pit lake (EPL). BML is intended to demonstrate the feasibility of EPLs as a means to permanently dispose of MFT under water in man-made lakes. Expected to be ready by 2012 for the start of at least a decade of evaluation, BML will contain more than 200 million cubic metres of MFT capped with 40 million cubic metres of water.

EPLs come with significant concerns and uncertainties. Regulators have been clear that EPLs must be natural, fully functional, self sustaining ecosystems that support a diversity of species, despite the large volumes of toxic MFT destined for disposal beneath the water. Research conducted on small test ponds over the years has shown that contaminants from the MFT will negatively impact various species required to establish a viable food web. Research and modeling to date have been unable to determine if bioremediation in EPLs can produce conditions for healthy aquatic communities and, if so, how long it will take. The many unaddressed concerns have left doubt among regulators and stakeholders that EPLs will be a viable option for disposing of MFT in a final reclaimed landscape.

Because EPLs are the lowest-cost option for disposing of MFT, they are currently included in the reclamation plans of every oil sands mine operator, even though the ERCB has only approved the plans conditional upon the success of the full-scale demonstration EPL. Despite the condition imposed, the ERCB has not required mine operators to provide alternative plans for reclamation should Syncrude’s demonstration EPL fail to produce desired results.

Bottom photo: Freshly mined oil sands. Approximately 2 tonnes of ore must be mined to produce each barrel of bitumen. 1.5 barrels of toxic mature fine tailings are produced for every barrel of bitumen extracted from the mined ore.
The top priority of oil sands mine operators over the years has been to maximize bitumen production. This is to be expected given that bitumen is a source of marketable products for the industry. Alberta’s regulators have demonstrated their reluctance to impose reclamation requirements that might interfere with bitumen production. While regrettable and short-sighted, this is not unexpected considering royalties, jobs and other benefits – along with costs and impacts – also accrue with increased production. As a result, over the past four decades mine operators have failed to reclaim tailings at a rate that would keep pace with the growth in MFT. This failure has created a toxic environmental liability that will require substantial resources to remedy.

Alberta’s Auditor General has repeatedly reported that the government holds inadequate security to ensure that land destroyed by oil sands mines will eventually be reclaimed. The amount of security held in the Alberta Government’s Environmental Protection and Security Fund, the fund intended to ensure oil sands mines are reclaimed, validates the Auditor General’s observations. As of March 2009, the fund held just $820.5 million in security to ensure that 602 square kilometers of mined oil sands land, including the 840 million cubic metres of MFT currently stored on the landscape, would be reclaimed.

The full amount of security held, applied solely to addressing the tailings liability, would provide less than one dollar to remediate each cubic metre of MFT. The little information that is publicly available indicates operating costs for remediating MFT could reach almost $5 per cubic metre depending upon the technology used.

The Alberta Government holds insufficient security to ensure mature fine tailings are eventually reclaimed in solid deposits.
Four decades of tailings growth will not be remedied overnight but a concerted effort with appropriate timelines and resources could eventually eliminate the problem.

The Alberta government should require mine operators to reclaim MFT into dry deposits before allowing them to produce more of the waste. Mine operators should be on a schedule of aggressive increases in reclamation rates relative to extraction. Since 1.5 barrels of MFT are produced for every barrel of bitumen extracted, mine operators should be required to reclaim that amount of MFT in advance of being permitted to extract the next barrel of bitumen. While this reasonable and minimal production restriction would not reduce the amount of MFT currently stored on the landscape, it would stop the continued rapid growth of the toxic substance. By tying permitted bitumen extraction rates to tailings reclamation performance, the Alberta government could motivate mine operators to at least prevent the tailings problem from growing out of control.

Regrettably, the ERCB, in failing to enforce its tailings regulation, has created a situation where continued inaction on tailings reclamation appears inevitable. Until the industry is forced to accept responsibility for the liability it has created, it is unrealistic to expect that the next four decades of tailings management in the Alberta oil sands will be any different than the last four decades. Urgent, clear and effective government leadership is needed to prevent the MFT inventory from continuing to grow and to avoid passing the toxic legacy along to future generations.

The amount of MFT currently stored in tailings lakes, 25,000 litres for every Canadian, is staggering. The enormity of this toxic legacy and the fact that it is still growing are clear indicators that the industry has thus far failed to find a sustainable way to treat its voluminous waste. The Alberta government should enforce its regulations to curtail the growth of MFT on the landscape and enact further regulations to drive the industry to drastically reduce the legacy of MFT waste within a reasonable timeframe. The Alberta government also needs, as advised by its Auditor General, to obtain sufficient security from the industry to ensure that the financial and environmental liabilities that come with MFT are not passed to the public.
Top photo: Aerial view of the Shell Albian tailings lake north of Fort McMurray, Alberta, Canada. In addition to the residual bitumen, visible in the image, tailings lakes contain other toxic contaminants including: naphthenic acids, polycyclic aromatic hydrocarbons, metals and salts.

Bottom photo: Syncrude’s Aurora North tailings lake in the oil sands area of Alberta, Canada. Tailings dikes are constructed from sand, left over from the extraction process. Foundation and slope instabilities have been noted in the past.
## OIL SANDS TAILINGS BY THE NUMBERS

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>43</strong></td>
<td>number of years over which oil sands tailings have been growing</td>
</tr>
<tr>
<td><strong>18</strong></td>
<td>number of tailings lakes scattered among the oil sands mines</td>
</tr>
<tr>
<td><strong>170</strong></td>
<td>square kilometers covered by mine tailings in the Athabasca oil sands</td>
</tr>
<tr>
<td><strong>28</strong></td>
<td>percentage of mined areas currently covered in tailings</td>
</tr>
<tr>
<td><strong>1.5</strong></td>
<td>barrels of mature fine tailings produced for every barrel of bitumen extracted</td>
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<tr>
<td><strong>66</strong></td>
<td>millions of cubic metres of MFT that will accrue as a result of 2008 bitumen production</td>
</tr>
<tr>
<td><strong>72</strong></td>
<td>millions of cubic metres of MFT that were added to oil sands tailings lakes in 2009</td>
</tr>
<tr>
<td><strong>840</strong></td>
<td>millions of cubic metres of MFT currently stored behind tailings dikes in Northern Alberta</td>
</tr>
<tr>
<td><strong>1,119</strong></td>
<td>millions of cubic metres of MFT that mine operators are proposing to dispose of in end pit lakes</td>
</tr>
<tr>
<td><strong>821</strong></td>
<td>millions of Canadian dollars held by the Alberta government as security to reclaim all oil sands mines</td>
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<tr>
<td><strong>511</strong></td>
<td>millions of cubic metres of MFT that Syncrude currently has stored in tailings lakes</td>
</tr>
<tr>
<td><strong>183</strong></td>
<td>millions of Canadian dollars held by the Alberta government as security for Syncrude mine reclamation</td>
</tr>
<tr>
<td><strong>60</strong></td>
<td>percentage of the entire oil sands MFT inventory held by Syncrude</td>
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<tr>
<td><strong>606</strong></td>
<td>millions of cubic metres of MFT that Syncrude wants to dispose of in end pit lakes</td>
</tr>
<tr>
<td><strong>1,100</strong></td>
<td>millions of Canadian dollars it could cost to centrifuge Syncrude's current MFT inventory</td>
</tr>
<tr>
<td><strong>2,400</strong></td>
<td>millions of cubic metres of MFT that could be stored behind tailings dikes by 2040</td>
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BML  
**Base Mine Lake.** Syncrude’s demonstration EPL at the company’s Mildred Lake Mine. The success or failure of BML will determine if the concept of capping MFT with fresh water will be a viable tailings reclamation strategy.

CT  
**Consolidated Tailings;** also known as Composite Tailings. A process that adds gypsum and sand to MFT to bind the fine particles in the MFT to the heavier sand particles. When placed into a deposit, the resulting product releases water to form a surface solid enough to be reclaimed. CT also refers to the product of the process.

EPL  
**End Pit Lake.** The result of a tailings reclamation strategy that would put MFT into a mined out pit and cover it with a water cap.

ERCB  
**Energy Resources Conservation Board.** The Alberta government authority that regulates oil sands mines.

MFT  
**Mature Fine Tailings.** A waste product from oil sands mining consisting primarily of water, fine clay particles, residual bitumen and toxic contaminants.
WWF in Numbers

1961
WWF was founded in 1961

+100
WWF is in over 100 countries, on 5 continents

+5
WWF has over 5 million supporters

+ 5,000
WWF has over 5,000 staff worldwide

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