Summary of 2013 Tailings Technology Development and Commercialization Workshop

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April 2013

Oil Sands Research and Information Network

The Oil Sands Research and Information Network (OSRIN) is a university-based, independent organization that compiles, interprets and analyses available knowledge about managing the environmental impacts to landscapes and water impacted by oil sands mining and gets that knowledge into the hands of those who can use it to drive breakthrough improvements in regulations and practices. OSRIN is a project of the University of Alberta's School of Energy and the Environment (SEE). OSRIN was launched with a start-up grant of $4.5 million from Alberta Environment and a $250,000 grant from the Canada School of Energy and Environment Ltd.

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- **Industry** with ready access to an integrated view of research that will help them make and execute reclamation plans – a view that crosses disciplines and organizational boundaries

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Citation

This report may be cited as:

Mian, H., N. Fassina, A. Mukherjee, A. Fair and C.B. Powter, 2013. *Summary of 2013 Tailings Technology Development and Commercialization Workshop*. Oil Sands Research and Information Network, University of Alberta, School of Energy and the Environment, Edmonton, Alberta. OSRIN Report No. TR-32. 69 pp.

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REPORT SUMMARY

NAIT-CGCE, NAIT School of Sustainable Building and Environmental Management, and the NAIT JR Shaw School of Business, in collaboration with COSIA, AIEES, and the Oil Sands Research and Information Network (OSRIN), held a technology innovation workshop on March 19, 2013 at the NAIT campus to open the dialogue between oil sands industry, academia, research and development organizations, and third-party innovators. The workshop, titled 2013 Tailings Technology Development and Commercialization: Big Ideas from Small Places, was attended by approximately 130 people from SMEs, government, industry and academia.

The following common themes arose during the presentations:

- There is considerable public scrutiny and concern about oil sands tailings-related environmental challenges
- Technology development and deployment is key to solving the tailings challenge in a sustainable manner
- There is no single technology solution for tailings disposal– a suite of technologies will be required
- For a technology to be considered suitable it must provide net environmental benefits (e.g., must be evaluated in the context of impacts on solids, liquids, GHG) and be economic (i.e., a systems perspective)
- Technologies must be deployed more quickly than in the past
- There is a need for an entity or organization that can provide a bridge between SMEs, third-party technology developers, and the oil sands companies

The workshop was a first step towards tailings technology development and commercialization. More events may be planned, some specifically focused on bringing the technology developers together and understanding their technologies. The 2nd Tailings Technology and Development Commercialization Workshop will be planned for 2014 in collaboration with all the partners. There may be an opportunity to share some results on SME and third-party vendor technologies within the 2014 workshop.

ACKNOWLEDGEMENTS

The Oil Sands Research and Information Network (OSRIN), School of Energy and the Environment (SEE), University of Alberta provided funding for this project along with NAIT Centre for Green Chemistry and Engineering (CGCE) and COSIA Tailings EPA.

1 INTRODUCTION

On August 28, 2012, Canada's Oil Sands Innovation Alliance (COSIA) along with Alberta Innovates – Energy and Environment Solutions (AI-EES), published an oil sands tailings technology deployment roadmap and action plan[1] ("Tailings Technology Roadmap"). The report identified a number of potential candidate solution technologies and has grouped them into various classes. COSIA anticipates that a number of existing and new technologies will need to be pre-screened, validated, and further developed before being considered for a pilot and/or commercial application at oil sands operations.

The NAIT Centre for Green Chemistry and Engineering (CGCE), under the leadership of the Ledcor Group Applied Research Chair in Oil Sands Environmental Sustainability, enables solutions developed by third-party innovators and small and medium enterprises (SMEs) to be screened, validated, scaled-up, and integrated within a systems-based approach to complex mineable oil sands tailings management challenges. Such a systems-based perspective is crucial to ensure that solutions in one area of complex oil sands operations do not create problems elsewhere in the process. A collaborative approach is essential to bridge the gap between SMEs and the oil sands industry to develop solutions in a timely and cost-effective manner, while reducing risk and time to market[2].

The CGCE realizes that a number of third-party inventors and small companies with potential solutions may have challenges in accessing and speaking to the right people within oil sands companies. The CGCE also realizes that oil sands operators need SMEs to have a minimum set of information available before they can engage in meaningful discussions on adopting technologies. The technologies are at various levels of development. Some of the SMEs may have conceptual schemes having little or no experimental testing, others may have developed and tested their technologies and may be ready for pilot testing, and still other technologies may well be suited for commercial application. However, each of these technologies will need to be evaluated and graded to ensure that they could make it to the next level of development/application, and be picked up by the COSIA member companies.

To accomplish this, NAIT-CGCE, NAIT School of Sustainable Building and Environmental Management, and the NAIT JR Shaw School of Business, in collaboration with COSIA, AIEES, and the Oil Sands Research and Information Network (OSRIN), held a technology innovation workshop on March 19, 2013 at the NAIT campus to open the dialogue between oil sands industry, academia, research and development organizations, and third-party innovators. The workshop, titled 2013 Tailings Technology Development and Commercialization: Big Ideas

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[1] See Sobkowicz, J., 2012. Oil sands tailings technology deployment roadmaps. Project Report Volume 1 - Project summary. Alberta Innovates - Energy and Environment Solutions, Edmonton, Alberta. 60 pp. plus appendices. http://www.ai-ees.ca/media/7375/1906-project_summary_report.pdf

[2] See for example the series of reports by Geoff Dembicki in The Tyee (March 2013) on SME efforts to break into the oil sands industry – http://www.osrin.ualberta.ca/Resources/WhatsNew/2013/March/Cleantechfirmswantashotatfixingoilsands.aspx

from Small Places, was attended by approximately 130 people from SMEs, government, industry and academia.

It is expected that as a result of the workshop some protocols may emerge, e.g., steps that need to be taken at the early stage of technology innovation before engaging the oil sands operators, an open line of communication with the oil sands industry, and a clear path forward for SMEs.

1.1 Terminology used in this Report

In the workshop a variety of phrases were used to describe the people/entities that develop technologies, including: small and medium enterprises (SMEs), technology developers, third-party vendors, and technology innovators. For the purposes of this report the term small and medium enterprises (SMEs) will be used generically to describe any of these people/entities.

The term *technology* or *technologies* is used to include a range of equipment, processes, chemicals, and treatments that may be applied to solve the tailings problem.

Additional definitions and acronyms are provided in Section 7.

1.2 Report Organization

Section 2 of the report provides a summary of the highlights from each of the workshop presentations plus the associated Question and Answer sessions. Section 3 covers the panel presentations and the Question and Answer session. Section 4 summarizes the questions raised during the market place discussions.

The Appendices contain the workshop agenda, list of attendees and the PowerPoint presentations.

2 PRESENTATIONS AND DISCUSSIONS

Attendees were welcomed by NAIT's President and CEO Dr. Glenn Feltham who explained the role of NAIT, and in particular the Centre for Green Chemistry and Engineering (CGCE), in developing economic, timely and environmentally-sustainable solutions for industry. One of the key things NAIT offers industry and SMEs when compared to other research institutions and organizations is that the Intellectual Property (IP) remains with the industry or SME.

The following common themes arose during the presentations:

- There is considerable public scrutiny and concern about oil sands tailings-related environmental challenges
- Technology development and deployment is key to solving the tailings challenge in a sustainable manner
- There is no single technology solution for tailings disposal– a suite of technologies will be required

- For a technology to be considered suitable it must provide net environmental benefits (e.g., must be evaluated in the context of impacts on solids, liquids, GHG) and be economic (i.e., a systems perspective)
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2.1 Government Perspective – Roger Ramcharita, Alberta Environment and Sustainable Resource Development

Roger outlined Alberta Environment and Sustainable Resource Development's progress on the four pillars of their Progressive Reclamation Strategy[3]: the Mine Financial Security Program, the Reclamation Certification program, transparent reporting of reclamation progress through the Oil Sands Information Portal, and the Tailings Management Framework. The Tailings Management Framework will be ready for public and industry consultation later this year. It will address both legacy tailings (fluid tailings that were not addressed by ERCB Directive 074) and ongoing production of tailings.

Tailings disposal solutions will be technology-based, must be cost-effective and must be chosen based on the net environmental benefit they provide – that is, the optimal solution will provide a balance between achieving tailings goals (solids and liquids) and impacts on water, land and GHG emissions. Achieving the optimal solution may require that trade-offs be considered.

The provincial government supports technology development and deployment through the Alberta Innovates system.

2.1.1 *Questions*

Q: What teeth does Directive 074 have if a company fails to meet targets?
A: The ERCB is serious about enforcing Directive 074 and has a variety of tools available. The results of the ERCB reviews of oil sands operator's 2013 tailings management plans will be available soon. See Terry Abel's presentation for more details.

Q: What are the timelines for implementation of the Tailings Management Framework?
A: The current plan calls for consultation later this year and implementation in fall/winter 2013.

Q: What mechanisms are there to allow technology developers to show industry what can be done?
A: Alan Fair will address this in his presentation.

[3] See http://environment.alberta.ca/03387.html

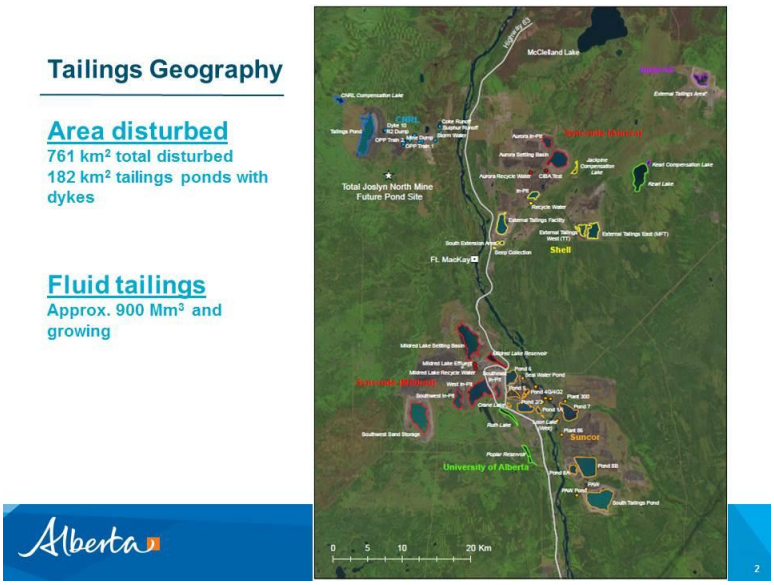

Figure 1: Tailings Pond Locations.

2.2 COSIA Updates – Joy Romero, CNRL

Joy noted the importance of holding the event in collaboration with the JR Shaw Business Centre as it is critical to demonstrate the link between technology and business.

Industry has acknowledged that collaboration on environmental issues such as tailings management is a much better way to develop and implement technology. The creation of Canada's Oil Sands Innovation Alliance (COSIA) is seen as a benefit to SMEs because it collapses a number of individual and collective efforts into a single entity with whom SMEs and regulators can interact.

Joy described the operating system and structure of COSIA and its Environmental Priority Areas (EPAs) with an emphasis on the Tailings EPA (covered in more detail in Alan Fair's presentation). She described the project execution mechanism (called Joint Industry Projects – JIPs) and also how IP and use rights would be addressed.

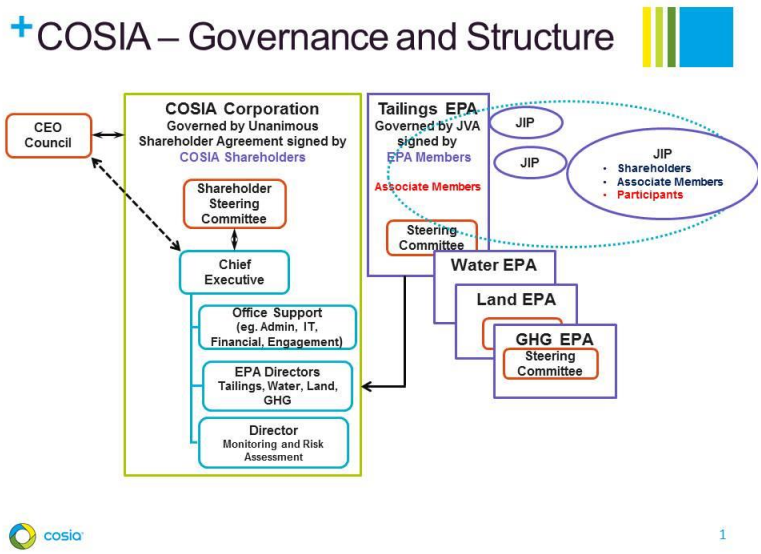

Figure 2: COSIA Governance and Structure

2.2.1 *Questions*

Q: What does "use rights" mean and does the SME have rights?
A: The advantage of COSIA for SMEs is a single entry point to all the oil sands players and the agreement that all the players will have access to the technology (use rights) but that the SME would enter into negotiations with each company on the details of actual implementation of their technology on a given mine site.

Q: Is it correct to characterize the relationship as one where the SME holds the technology but now has access to multiple customers at once?
A: Yes. COSIA is not out to get the technology (IP) but rather to gain the ability to use the technology based on a mutually agreed upon business model. Having said that, SMEs must be realistic about the value of their technology and the costs it will add to the industry and adjust their expectations accordingly.

Q: What happens to the use rights if COSIA only puts up some of the costs for a project?
A: This would be addressed in the JIP contractual agreements.

Q: What happens with previous work or knowledge developed under past projects?
A: COSIA went back over work done in various groups such as the Oil Sands Tailings Consortium (OSTC) over the past five years and everything on tailings research and development has been shared. In some cases companies also brought forward work done on their own or with others outside of OSTC.

2.3 Regulatory Perspective – Terry Abel, ERCB

Terry noted the oil sands industry has come a long way from an experimental concept to a full-blown industry and the same progression is now underway for tailings technologies.

Terry described the regulatory framework under which the ERCB manages oil sands developments including the important role Directive 074 is playing in the management of tailings. The Board will be updating Directive 074 in the coming year.

Where appropriate, the Board is increasingly using a performance-based regulatory approach in which they establish clear performance expectations and allow industry to determine the best technical approach to meet the requirements having regard for the unique aspects of their particular development.

The Board plays a key role in providing an interface between SMEs and the oil sands industry. One way they do this is by allowing SMEs to share information with the regulator and conduct demonstration projects on a confidential basis to assist innovators in the development and protection of their IP.

Terry stated that we are past the time of waiting for solutions – we need applied solutions at the commercial scale now. This includes looking for solutions from outside the sector and beyond our borders. He also noted that SMEs should understand that it is not just holistic approaches to tailings management that are required – there are many opportunities for improvements to existing management approaches that their innovations might support. Their technologies may also have application in other parts of the operations.

2.3.1 *Questions*

Q: What updates are there on the water-capping proposals of industry?
A: The large-scale demonstration of this technology was given conditional approval back in 1994. Syncrude will be starting to fill Base Mine Lake this year and monitoring will begin. The government is working with industry to develop methods and analytical requirements to prove whether or not the technology is successful. For more information on oil sands end pit lakes see the report by the Cumulative Environmental Management Association (Hrynyshyn 2012).

Q: Can you comment on Suncor's TRO (Tailings Reduction Operations) and Pond 5 coke capping projects in the context of Directive 074?
A: TRO meets the objectives of Directive 074. The Pond 5 work is targeting legacy tailings and is therefore outside the scope of the Directive.

2.4 Tailings Technology Roadmap Overview and Oil Sands Industry Challenges – Alan Fair, Director, COSIA Tailings EPA

Alan acknowledged the efforts of NAIT in moving technologies forward and indicated this was a key reason why COSIA is providing funding to NAIT.

The industry has spent over $550M on tailings research and development work over the last eight years, including about $45M in 2012. Companies are making significant expenditures at the operational-scale as well – for example, $1.2B by Suncor on TRO and $1.9B by Syncrude on centrifuging.

The Tailings Technology Roadmap project evaluated 549 individual technologies, condensed those down to 48 technology "types" and then identified 9 priority technology suites as being

ready for next stage evaluations. About 1/3 are at the commercial stage, 1/3 are at the development stage and 1/3 are at the research stage.

The COSIA Tailings EPA has developed a Technology Development Workflow (Figure 3) and Technology Check Sheet to allow SMEs to describe their technology and provide relevant data that will allow industry to determine if and how to undertake further assessment. A certain level of information must be provided on a non-confidential basis to allow the review process to start. Technologies must take into account the needs of the bitumen processing plant and be cost-effective.

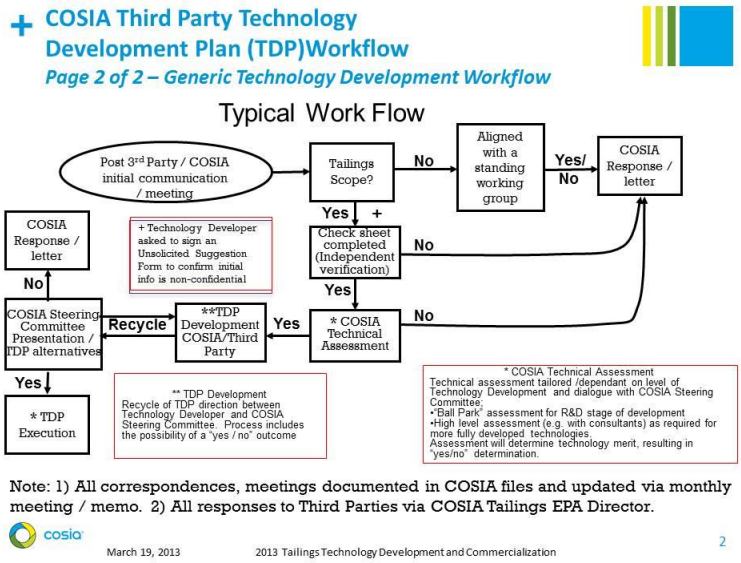

Figure 3: Technology Development Plan Workflow.

2.4.1 *Questions*

Q: Can you define what you mean by "cost-effective" or "low-cost"?
A: It will depend, but a ball park value might be $1 to $3 per barrel of synthetic crude produced. Historically the thinking would have been less than $1/bbl.

Q: While an SME may be willing to provide the information you have described there are still concerns about losing IP or rights. What can you tell us to alleviate these concerns?
A: COSIA doesn't want to own the rights to the technology. Rather they want to ensure all companies have access to the data and have the right to use the technology under commercial terms agreed to by the technology provider, which would be negotiated on a company-by-company basis (outside of COSIA).

2.5 Government Funding – Lisa Marquardson, Natural Sciences and Engineering Research Council of Canada

Lisa outlined the various funding mechanisms that NSERC offers with particular emphasis on those available to colleges like NAIT.

2.5.1 *Questions*

Q: How can private companies learn about and access expertise?
A: NSERC provides a "match-making" role to link people across the country.

3 PANEL SESSION

A four member panel representing various facets of technology development was asked to provide some general thoughts and then took questions from the floor.

3.1 Oil Sands Tailings Management – Richard Nelson, Alberta Innovates – Energy and Environment Solutions

Alberta Innovates – Energy and Environment Solutions invests in research and technology with industry and international collaborators. Rick described the AI-EES funding application process.

The Tailings Technology Roadmap was a collaborative project to identify the current state of knowledge about existing tailings technologies and to identify those that are promising enough to warrant immediate evaluation effort.

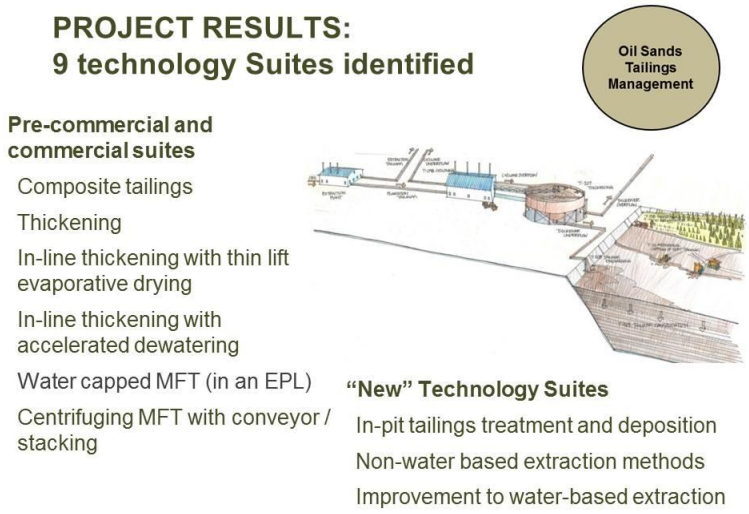

Figure 4: Technology Suites Identified in the Tailings Technology Roadmap

3.2 Oil Sands Environmental Sustainability Initiative – Haneef Mian, NAIT

NAIT-CGCE focuses on working with SMEs, third-party vendors, and COSIA Tailings EPA to screen, verify, validate, and further develop technologies, and to bridge the gap between the SMEs and industry. The CGCE also acknowledges that there is a need for cost effective real world sustainable solutions and that technological solutions have to make both an environmental and business sense. CGCE focuses on short-term (three months to one year) applied research projects. They are obtaining a suite of state-of-the-art analytical equipment to allow for the necessary testing of the technologies. They are also trying to get a variety of business (SMEs, and third-party larger organizations and technology developers) to coordinate their technologies to develop integrated solutions for the oil sands industry. This work is aimed at a System's Approach such that solutions in one part of the oil sands system do not negatively impact the other parts.

NAITs vision is to be responsive to the industry needs. The core benefits to NAIT are the ability to provide student learning opportunities and increase faculty engagement with industry. NAIT leaves the IP with the SME – this is a key differentiator from other research institutions.

NAIT evaluates technologies on a Technology Readiness Level chart or a Stage-Gate chart, to assist SMEs in understanding the information required by industry and to identify the types of analytical work required (Figure 5). CGCE is ensuring that feedback on technologies is provided to the oil sands industry as a third-party arm length organization.

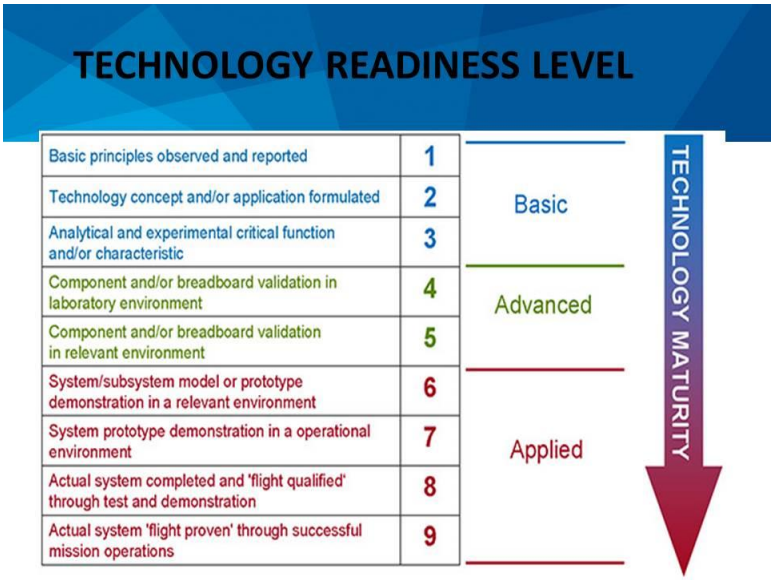

Figure 5: Technology Readiness Level Categories.

3.3 A Personal Perspective on Technology Development in the Oil Sands – Randy Mikula, Kalium Inc.

Work is required to test new technologies and to optimize old ones (the hurdle for success and acceptability changes over time). Randy acknowledged the need for an organization that will work on applied solution driven research, and the importance of the CGCE to conduct applied solution driven research. The technology evaluation process needs to promote successful technologies but have a clear but polite NO for those technologies that are not appropriate. SMEs need to understand the industry and their specific process and economic constraints.

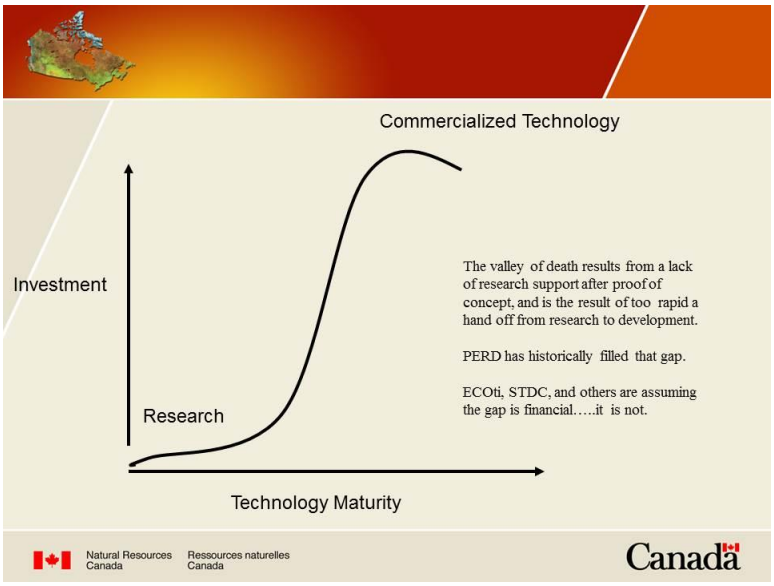

Figure 6: The Research and Development Valley of Death

3.4 Funding Technology – Myles McDougall, PetroJet

The kind of work, the long timelines and the level of funding required for developing oil sands tailings technologies is very difficult for angel investors and/or venture capitalists. Myles outlined the various sources of funding that may be tapped by SMEs and indicated that the most problematic area (known as the funding gap) is the space between when you finish using your own funds and those of "family, friends and fools" and the time when venture capitalists kick in – generally seen as $500K to $5M to $10M.

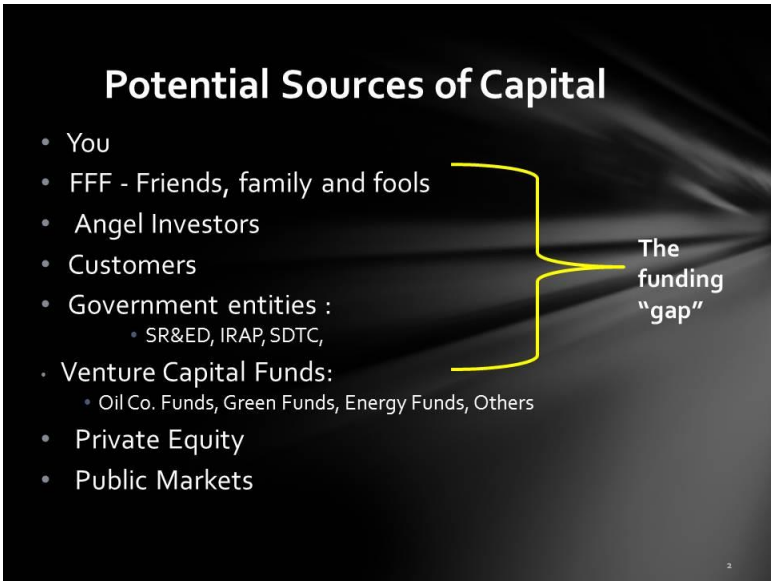

Figure 7: Potential Sources of Capital

As a result of the long timelines it is likely that government funds will be required (they generally represent more "patient capital"). Also recognize that projects with long timelines run into natural cycles – business, government, regulatory, commodity – that may completely change the value of a technology.

SMEs need to recognize that funders are not going to be as passionate about your idea as you are – investors are in it to make money. SMEs need to be very clear about their value proposition and be able to clearly articulate it. They need to have a business plan and know what they are selling – IP, product, service, company, etc.

A venture capitalist may select 1 out of every 100 business plans and expect that out of every 10 businesses they invest in that 7 will not do well, 2 will limp along and 1 will be a homerun. As a result they will need all the projects to be worth 10x their initial investment to be able make their money back. As a result the SME has to be willing to give up what it takes to provide that 10x cushion.

3.5 Questions

More of a comment about the value CGCE brings: focused and dedicated workforce; simple and quick legal agreements; quick results; and low overhead. CGCE moves at the industry pace.

Q: The COSIA workflow chart looks very much like a deal flow chart. What practical advice can we offer SMEs?
A: Understand the business plan, value, timelines and funding sources. Make sure the technology is technically viable. Understand how the solution fits into the existing industry processes (the "pots and pans").
A: Solution has to make business sense, be cost-effective and be a real-world solution.
A: Have to know it works.

A: You have to know how to work with a large, bureaucratic organization and understand how to deal with both short-term and long-term goals of the organization.

Q: Does government screen ideas the way Alan outlined COSIA's process?
A: Yes.
A: Not always, politics do enter into the picture.
A: It is important to note that some investors will not invest if there is or has been government funding. The reason is they ask "wasn't it viable on its own business merits"?

Q: Does it matter if you are a single-product entity or a multi-product company?
A: Companies generally have multiple revenue generating products therefore they can afford to support development costs for a new product.
A: Agree but the intent of the Tailings Technology Roadmap was to evaluate a range of technologies and move the ones with potential forward. Therefore there is a need for "compassionate capital" to help move these forward – in essence the technology should be viewed as a "public good".

Q: If government invests to develop and support policy and legislation and industry invests to make money under current and future policy regimes isn't there a danger when the policy regime lags technology and environmental needs?
A: Agree that the lag is a concern but we need to move forward as best we can rather than dwell on it. Government is no better than anyone else at predicting the future.
A: Note that the government got criticism for supporting programs like AOSTRA because government should not be in business development.
A: Also important to note that the industry has not always been a profit centre. There is a role for government because environmental measures are a cost to industry.

4 MARKET PLACE SUMMARY

Representatives from several organizations that can provide support to SMEs were available to provide information and answer questions. The organizations present were:

- Alberta Innovates – Energy and Environment Solutions
- Alberta Innovates – Technology Futures
- Beckman Coulter
- COSIA Tailings EPA
- National Research Council – Industrial Research Assistance Program
- Natural Sciences and Engineering Research Council of Canada
- Northern Alberta Institute of Technology – Centre for Green Chemistry and Engineering

The following common themes arose during those discussions:

- Who are you and what do you do?

- How can we access your services?
- How can we access your funding? How much do you provide, when, how and for what?
- Where in the technology development process do you fit – research, demonstration, deployment?
- What are the boundaries of each of the COSIA Environmental Priority Areas (especially Tailings, Water and GHG) so we know who to approach with our technology?
- Are we serious this time about moving innovative technologies into the industry? What are the best mechanisms to push consideration and adoption of technologies?

These themes can be summarized into two key needs:

- SMEs need more information about available support services. A number of the organizations in the Market Place had handouts and websites which is a good start. This forum was a big help.
- SMEs need to see that their efforts have the potential to be rewarded. Perhaps one option to address this would be to communicate examples of SME technologies that have been incorporated into the industry. An additional step would be to communicate examples of SME technologies that have entered the technology review process and how they have been fairly assessed using the processes adopted by COSIA.

5 NEXT STEPS

The workshop was a first step towards tailings technology development and commercialization. More events may be planned, some specifically focused on bringing the technology developers together and understanding their technologies. The 2nd Tailings Technology and Development Commercialization Workshop will be planned for 2014 in collaboration with all the partners. There may be an opportunity to share some results on SME and third-party vendor technologies within the 2014 workshop.

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Environment Solutions, Edmonton, Alberta. 116 pp. plus appendices. http://www.ai-ees.ca/media/7369/1906-component_4_report.pdf

6.2 Relevant Oil Sands Websites

Alberta Energy – Oil Sands

Alberta Environment and Sustainable Resource Development – Oil Sands Information Portal

Alberta Innovates – Energy and Environment Solutions

Alberta Innovates – Technology Futures – Oil Sands Sample Bank

CANMETEnergy – Natural Resources Canada oil sands research facility at Devon

Energy Resources Conservation Board – Oil Sands

Energy Resources Conservation Board – Directive 074

Canada's Oil Sands Innovation Alliance

Oil Sands Environmental Management Bibliography (use search terms tailings, tailings treatment, tailings water and/or wastewater / wastewater treatment)

Oil Sands Research and Information Network

University of Alberta – Oil Sands Tailings Research Facility (OSTRF)

6.3 Relevant SME Websites

Alberta Enterprise and Advanced Education – Western Economic Partnership Agreement

Alberta Innovates – Alberta Regional Innovation Network

Business Link – Government of Alberta and Government of Canada

Canada Foundation for Innovation

Government of Alberta – FAQ for Alberta Business

National Research Council – Industrial Research Assistance Program

Natural Sciences and Engineering Research Council of Canada – Partnerships

NovaNAIT – Applied Research

Public Works and Government Services Canada – Office of Small and Medium Enterprises

TEC Edmonton

Western Economic Diversification Canada

7 GLOSSARY

The first volume of the Tailings Technology Deployment Roadmap reports (Sobkowicz 2012a) contains a set of definitions for various types and stages of technology development used in the Roadmap.

The BGC tailings technology report provides definitions for oil sands tailings and tailings treatment (BGC Engineering Inc. 2010a).

OSRIN's glossary provides a wide range of terms and acronyms related to environmental management of oil sands (OSRIN 2010).

7.1 Terms

Angel Investor

An angel investor or angel (also known as a business angel or informal investor) is an affluent individual who provides capital for a business start-up, usually in exchange for convertible debt or ownership equity. A small but increasing number of angel investors organize themselves into angel groups or angel networks to share research and pool their investment capital, as well as to provide advice to their portfolio companies (Wikipedia).

Intellectual Property (IP)

A legal concept which refers to creations of the mind for which exclusive rights are recognized. Under intellectual property law, owners are granted certain exclusive rights to a variety of intangible assets, such as musical, literary, and artistic works; discoveries and inventions; and words, phrases, symbols, and designs (Wikipedia).

Legacy Tailings

Tailings contained in ponds that were generated before the implementation of the Energy Resources Conservation Board's Directive 074. Directive 074 addresses the generation of new tailings whereas Alberta Environment and Sustainable Resource Development's proposed Tailings Management Framework will address both legacy and new tailings.

Small- and Medium-Size Business

There are various ways to classify size of a business including number of employees, sales, and gross or net revenue. Industry Canada uses the number of employees to determine size class (http://www.ic.gc.ca/eic/site/cis-sic.nsf/eng/h_00012.html):

- Micro – less than 5
- Small – 5 to less than 50 for goods-producing firms and 100 for service-producing firms
- Medium – 50/100 to less than 500

Use Rights

The right, but not obligation, of individuals in a group (in this case COSIA) to use a process, technology, chemical developed by another person. The inventor or developer of the process, technology or chemical enters into an agreement with each of the parties interested in using the process, technology or chemical.

Venture Capital

Financial capital provided to early-stage, high-potential, high risk, growth startup companies. The venture capital fund makes money by owning equity in the companies it invests in, which usually have a novel technology or business model in high technology industries, such as biotechnology, IT, software, etc. (Wikipedia).

7.2 Acronyms

AESRD	Alberta Environment and Sustainable Resource Development
AIEES	Alberta Innovates – Energy and Environment Solutions
CGCE	Centre for Green Chemistry and Engineering (NAIT)
COSIA	Canada's Oil Sands Innovation Alliance
EPA	Environmental Priority Area (COSIA)
ERCB	Energy Resources Conservation Board
GHG	Greenhouse Gas
IP	Intellectual Property
JIP	Joint Industry Project (COSIA)
JVA	Joint Venture Agreement (COSIA)
MFT	Mature Fine Tailings
NAIT	Northern Alberta Institute of Technology
OSRIN	Oil Sands Research and Information Network
OSTC	Oil Sands Tailings Consortium
SEE	School of Energy and the Environment
SME	Small and Medium Enterprise(s)
TDP	Technology Development Plan (COSIA Tailings EPA)
TMF	Tailings Management Framework (AESRD)
TRO	Tailings Reduction Operations

APPENDIX 1: Workshop Agenda

7:30 - 8:30	Registration and Breakfast
8:30 - 8:45	Opening Remarks – Dr. Glenn Feltham, President & CEO, NAIT
8:45 - 9:00	Government Perspective – Shannon Flint, Assistant Deputy Minister, Policy Division
9:00 - 9:30	COSIA Updates – Joy Romero, CNRL
9:30 - 9:45	Coffee Break
9:45 - 10:15	Regulatory Perspective – Terry Abel, ERCB
10:15 - 11:00	Tailings Technology Roadmap Overview and Oil Sands Industry Challenges – Alan Fair, Director, COSIA Tailings EPA
11:00 - 12:00	Market Place: Booths By: • Government Support: AIEES, IRAP, NSERC • Applied Research Support – NAIT CGCE, AITF • COSIA Tailings EPA and Water EPA • Beckman Coulter
12:00 - 1:15	Lunch
1:15 - 2:15	Panel Presentations. Moderator: Dr. Neil Fassina, Dean, JR School of Business • Rick Nelson – AIEES • Dr. Haneef Mian – Ledcor Chair & Director CGCE • Randy Mikula – Kalium Inc. • Myles McDougall – Angel Investor
2:15 – 2:45	Panel Questions
2:45 – 3:00	NSERC Government Funding – Lisa Marquardson
3:00 - 3:20	Coffee Break
3:20 - 4:10	Feedback from Market Place – Chris Powter, Executive Director, OSRIN
4:10 pm	Closing Remarks and Next Steps – Dr. Haneef Mian, Ledcor Chair & Director CGCE

APPENDIX 2: List of Attendees

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APPENDIX 3: Workshop Presentations

Workshop Presentations

Tailings and Policy Government Perspective – Roger Ramcharita, Alberta Environment and Sustainable Resource Development

COSIA - Canada's Oil Sands Innovation Alliance – Joy Romero, CNRL

Tailings and Technology: A Regulatory Perspective – Terry Abel, ERCB

Tailings Technology Roadmap Overview and Oil Sands Industry Challenges – Alan Fair, Executive Director, COSIA Tailings EPA

College and Community Innovation (CCI) Program – Lisa Marquardson, Natural Sciences and Engineering Research Council of Canada

Panel Session

Oil Sands Tailings Management – Rick Nelson – AIEES

Oil Sands Environmental Sustainability Initiative – Dr. Haneef Mian – Ledcor Chair & Director CGCE

A Personal Perspective on Technology Development in the Oil Sands – Randy Mikula, Kalium Inc.

Funding Technology – Myles McDougall – PetroJet

Alberta Government

Tailings and Policy Government Perspective

Roger Ramcharita
Executive Director, Clean Energy Policy
Alberta Environment and Sustainable Resource Development

March 19, 2013

Progressive Reclamation Strategy

- The Progressive Reclamation Strategy is a suite of enhanced reclamation initiatives to ensure reclamation occurs faster and with greater transparency.
- The Strategy consists of the following initiatives:
  - Reclamation Security: Mine Financial Security Program (MFSP)
  - Reclamation Certification Program
  - Enhanced and Transparent Reclamation Public Reporting (Oil Sands Information Portal), and
  - Tailings Management Framework

Alberta

Reclamation of Mineable Oil Sands

- The following elements of the progressive reclamation strategy have been completed
  - Mine Financial Security Program
  - Performance Measurement and Reporting (Oil Sands Information Portal)
  - Reclamation Certification
- The following elements are in progress
  - Acknowledgement of Progressive Reclamation
  - Tailings Management Framework

Alberta

Issues with Tailings Management

- Tailings management remains one of the most difficult environmental challenges.
- Concerns about:
  - Large and increasing footprint of tailings ponds
  - Challenges regarding reclamation success
  - Increasing financial and environmental liability
  - Risks to Wildlife
- Development and implementation of new technologies to reclaim tailings ponds takes time, however there are demands for immediate action.
- There are currently more than 182 square kilometers of tailings ponds in Alberta.

Alberta

Tailings Geography

Area disturbed

761 km² total disturbed
182 km² tailings ponds with dykes

Fluid tailings

Approx. 900 Mm³ and growing

Alberta

Tailings Technology's Importance

- Managing and reclaiming tailings in the oil sands is highly dependent on technology
  - Critical to tailings reclamation success.
  - Many potentially successful technologies are still in the development and field trial stages
  - Optimization of current technologies is also important

Alberta

Some Tailings Technology Considerations

- Need to be cost effective
  - Develop cost-effective solutions that promote progressive and low risk reclamation of tailings
- Must consider other environmental effects (e.g. GHG, water, land use)
  - Net environmental impact of tailings management technologies, e.g. intensive tailings reclamation methods may result in higher environmental impacts in other areas, such as higher energy use or larger overall terrestrial footprints

Alberta

Technology Development Support

- The Government has a research and innovation system that includes:
  - The "Alberta Innovates" research and innovation system, e.g. Alberta Innovates-Energy and Environment Solutions, Alberta Innovates-Technology Futures
  - Research Capacity Planning
    - Approach for coordination and identification of research priorities for the provincially-funded research and innovation system
    - Support research capacity at Alberta's post-secondary institutions

Alberta

Oil Sands Technology Development Support

- Government continues to support innovation and research on tailings
- Government funding of research has included:
  - $25-million research partnership between the University and the Helmholtz Association of German Research Centres focusing on cleaner energy production with an emphasis on the oil sands
  - $4.5 million to the School of Energy and the Environment at the University of Alberta to support oil sands reclamation research, including OSRIN
  - Financial support to technology and/or process initiatives with a tailings focus through the Energy Innovation Fund and Innovative Energy Technologies Program
- Other opportunities:
  - CCEMC Fund
  - In-kind support

Alberta

Tailings Technology Roadmap and Action Plan

- Developed by Alberta Innovates-Energy and Environment Solutions and industry, in collaboration with other government departments
- Released in August 2012
- Assessed hundreds of technologies
- Identified knowledge and research gaps
- Summarized technologies and combinations for reduced impact of tailings
- Goal: define the optimum pathway(s) for industry to achieving successful reclamation of tailings

Alberta

Current Management of Tailings

Managing Tailings Today
- Groundwater monitoring and seepage capture systems
- Strong technical review for any new tailings facility
- Directive 074 – faster reclamation; less fluid tailings

Vision for the Future
- First tailings pond reclaimed in 2010
- Zero growth in tailings
- Reclaim legacy tailings

New management strategies and technologies will greatly reduce the size and lifespan of tailings ponds.

Alberta

Current Management of Tailings

- Two key methods of regulation are:
  - Environmental Protection and Enhancement Act (EPEA) requirements
  - Directive 074

- EPEA Requirements for Reclamation
  - Ensure land used for industrial activities is reclaimed in an environmentally sound manner
  - Sets out duties of operators towards conservation and reclamation, including that of tailings ponds
  - Approvals include requirements for reclamation such as Mine Reclamation Plans and Life of Mine Closure Plans

Alberta

Current Management of Tailings

- *Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes*
  - Issued in February 2009 by the ERCB
  - Timelines for operators to process fluid tailings and to reduce growth in fluid tailings
    - Between 2012 & 2016, companies must implement plans that reduce growth in fluid tailings

Alberta

Tailings Management Framework

- Development of a Tailings Management Framework is a commitment in the Lower Athabasca Regional Plan
- Framework is currently under development
- Purpose of Framework:
  - provide assurance that tailings ponds produced from oil sands mining are returned to productive, sustainable public lands as quickly as possible in consideration of environmental and economic outcomes.
  - Address all fluid tailings, including legacy inventories of tailings
- Builds on Energy Resources Conservation Board Directive 074 which deals with new tailings but doesn't address existing tailings

Alberta

Tailings Management Framework - Development

- Will establish limits and triggers for the volume of fluid tailings, regionally and for individual facilities
- Will establish requirements for reclamation of tailings, including at the end of mine life
- Will include the principle of considering the environmental net effects of tailings and the technologies used to treat them
- It will establish outcomes to be achieved rather than state the technologies needed to meet those outcomes

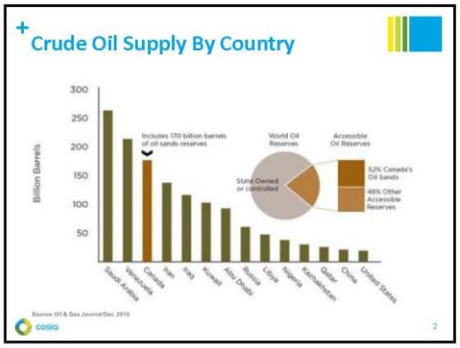
Alberta

Questions?

Alberta

Government of Alberta


cosia
Canada's Oil Sands Innovation Alliance
XXXXX, 2013


Crude Oil Supply By Country
Billion Barrels
300
250
200
150
100
50
Includes 170 billion barrels of oil sands reserves
World Oil Reserves
Accessible Oil Reserves
State Owned or controlled
52% Canada's Oil Sands
48% Other Accessible Reserves
Saudi Arabia
Venezuela
Canada
Iran
Iraq
Kuwait
Abu Dhabi
Russia
Libya
Nigeria
Kazakhstan
Qatar
China
United States
Source: Oil & Gas Journal Dec. 2010
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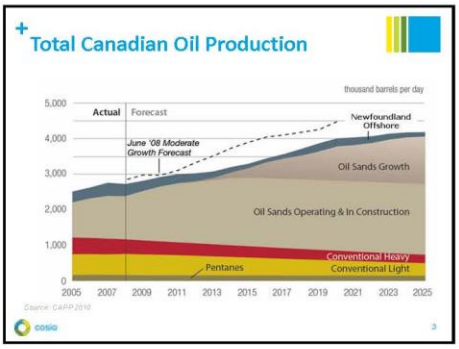
Total Canadian Oil Production
thousand barrels per day
5,000
4,000
3,000
2,000
1,000
0
Actual
Forecast
June '08 Moderate Growth Forecast
Newfoundland Offshore
Oil Sands Growth
Oil Sands Operating & In Construction
Conventional Heavy
Conventional Light
Pentanes
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025
Source: CAPP 2010
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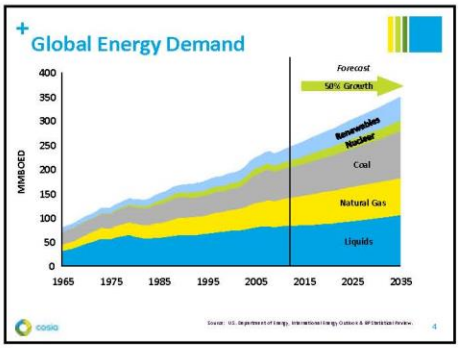
Global Energy Demand
Forecast
58% Growth
MMBOED
400
350
300
250
200
150
100
50
0
Renewables Nuclear
Coal
Natural Gas
Liquids
1965
1975
1985
1995
2005
2015
2025
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cosia
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Context

- Energy demand to remain high
- Renewables making gains but traditional energy sources will be important for some time
- Continuous improvement of environmental performance in traditional sectors is important contribution

cosia 5

Journey Towards COSIA

- Company expectations
- Predecessor organizations
- Industry understanding that collaboration works

- COSIA = the collaborative hub to drive performance
- Remain competitors, collaborate on environmental innovation
- Announced on March 1, 2012

cosia 6

Our Vision is to enable responsible and sustainable growth of Canada's Oil Sands while delivering accelerated improvement in environmental performance through collaborative action and innovation.

COSIA Companies:

- BP Canada Energy Company
- Canadian Natural Resources Limited
- Cenovus Canada Inc
- CNOOC Canada Ltd
- ConocoPhillips Canada Resources Corp
- Devon Canada Corporation
- Imperial Oil
- Nexen Inc
- Shell Canada Energy
- Statoil Canada Ltd
- Suncor Energy Inc
- Syncrude Canada Ltd
- Teck Resources Ltd
- Total E&P Canada Ltd

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Environmental Priority Areas (EPAs)

- Water
- Land
- GHGs
- Tailings

- Monitoring
  - Single industry focal point for technical issues for environmental monitoring system

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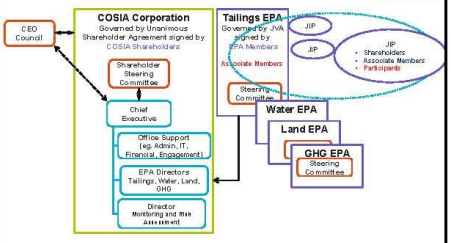
How is COSIA Different?

- Leadership
  - CEOs signed Charter
- Line of Sight
  - Goals and reporting
- Leverage
  - Overarching collaborative hub, companies retain ownership but share environmental innovation, remain fierce competitors
- Linkages
  - Best Ideas

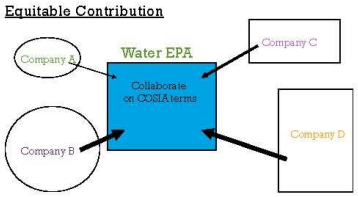
COSIA – Governance and Structure



How Can You Participate?

- Shareholder
  - Oil Sands producing company, sign Charter, fund COSIA
- Associate Member
  - Annual Fee
  - Other companies, organizations that endorse the COSIA vision can contribute to strategic planning, Joint Implementation Project (JIP) development, JIP execution, goal attainment
- Joint Implementation Project (JIP) Participant
  - Company, organization or individual that participates in a JIP
  - Does not require Associate Membership

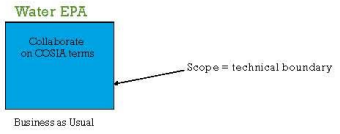
Key COSIA Concepts



After equitable contribution, company is vested
(has use rights for all innovation in scope in Canadian oil sands)

Key COSIA Concepts

Scoping



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More Information

www.cosia.ca

info@cosia.ca

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Tailings and Technology: A Regulatory Perspective

Terry Abel, Executive Manager, Oil Sands and Coal Branch
Energy Resources Conservation Board

March 2013

Outline

- Energy regulation
- Innovation
- Importance of collaboration
- Directive 074: Tailings Performance Criteria and Requirements
- Performance and progress
- Evolution of Directive 074

Energy Regulation

- Responsible development
- Effective and efficient regulation that achieves
  - Public safety
  - Environmental protection
  - Energy resource conservation
- Protect Albertans from exposure to long-term liability
- Focus on controlling risks and solving problems

Performance-Based Regulation

- Regulation sets performance criteria
- Operators develop plans to achieve it
- ERCB comments on effectiveness of plans
- Operator responsible for performance

Innovation

Regulatory incentive for innovation

One problem: a suite of solutions

Rapid commercial deployment of technology to solve problems

Strongest contribution when separated from policy discussions

Collaboration

Two heads are better than one

Colleagues within the sector
- Dialogue
- Share information
- Build on strengths

Fresh ideas and perspectives from other sectors
- Engage others to help solve problems
- Avoid creating intentional and unintentional barriers

Directive 074: Tailings Performance Criteria and Requirements

First step: Slow the growing volume of fluid tailings

Long-term outcomes:
- Minimize or eliminate:
  - long-term storage of fluid tailings in the reclamation landscape
  - external tailings disposal areas
  - stored process-affected water
  - resource sterilization

Progressive reclamation

Regulatory Requirements

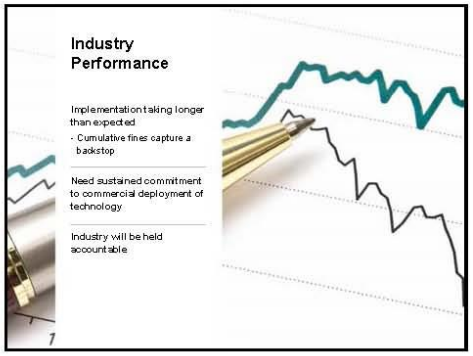
Capture fines and deposit in a dedicated disposal area

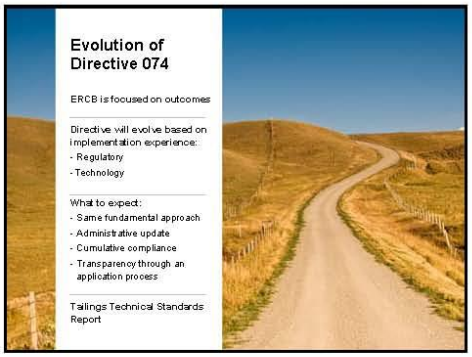
Minimum undrained shear strength of 5 kPa within one year of deposition

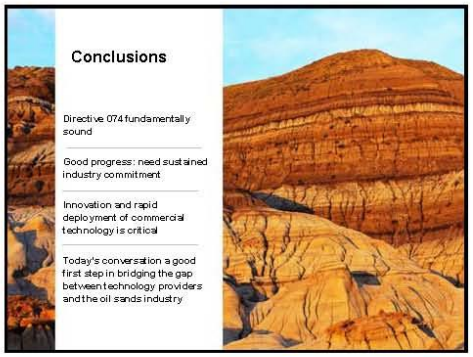
Ready for reclamation within five years after active deposition has ceased

Fines capture a percentage of fines in feed


Positive Progress
Change in industry attitude and activity
- Prioritizing tailings management and integrating with mine planning and bitumen production
- Successful commercial implementation of technologies
- Significant capital investment to honour historical commitments
- Sharing intellectual property
- Learning
Operator plans for new tailings ponds cancelled
Designs of existing ponds optimized


Industry Performance
Implementation taking longer than expected
- Cumulative fines capture a backstop
Need sustained commitment to commercial deployment of technology
Industry will be held accountable
1


Evolution of Directive 074
ERCB is focused on outcomes
Directive will evolve based on implementation experience:
- Regulatory
- Technology
What to expect:
- Same fundamental approach
- Administrative update
- Cumulative compliance
- Transparency through an application process
Tailings Technical Standards Report


Conclusions
Directive 074 fundamentally sound
Good progress: need sustained industry commitment
Innovation and rapid deployment of commercial technology is critical
Today's conversation a good first step in bridging the gap between technology providers and the oil sands industry


Questions?
www.ercb.ca

COSIA

2013 Tailings Technology Development and Commercialization Workshop

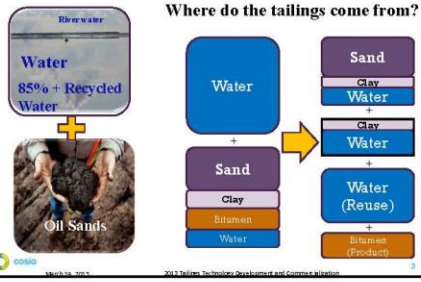
Shaw Theatre, NAIT Main Campus
March 13, 2013
Alan Fair

1

Oil Sand Tailings Challenges

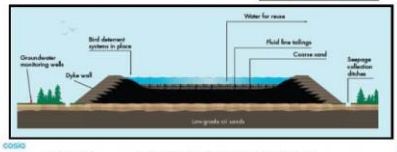
Oil Sands Processing

Where do the tailings come from?



Oil Sand Tailings – what are they?

- Mixture of remaining water and solids following bitumen extraction process
- Composed of water, sand, silt, clay, small amounts of hydrocarbon (bitumen, solvent, and asphaltenes)
- A necessary part of production in excavation of oil sands and removal of bitumen



Fluid Fine Tailings (aka MFT)

"Conventional" MFT (Shell)
~ 30wt% solids, 85% water by volume

'Thick' MFT (Shell)
~ 45wt% solids

'Thick' MFT (Syncrude)
~ 50wt% solids

Tailings Challenges

Surface area impact
Reclamation confidence and pace
Water quality
Groundwater protection
Wildlife protection

Over $550M has been spent across industry on tailings research and development over the past 8 years

Challenges: Finding solutions that effectively optimize both environmental and cost performance:

- Dewatering the fluid fine tailings
- Treatment of the remaining process-affected water
- Reclamation of the tailings disposal areas (both terrestrial and aquatic)

Aerial view of tailings facilities - 170 km ,

Tailings Roadmap Study

A Collaborative Initiative

Alberta Innovates Energy and Environment Solutions

OSTC
TOTAL
Canadian Natural
Syncrude
Teck
SUNCOR
Esso Imperial Oil

Government of Alberta Energy
Government of Alberta Environment
ERCB
Natural Resources Canada

Project Scope

- In 2011, AI-EES & the OSTC awarded a contract to the Consortium of Tailings Management Consultants (CTMC) to produce "The Technology Deployment Roadmap and Action Plan for 'End-to-End' Solutions for Oil Sands Tailings."
- The CTMC summarized and assessed 549 technologies and produced a set of roadmaps for the most promising of these technologies & suites.
- The final report was completed in June 2012.

The Study had 4 Components

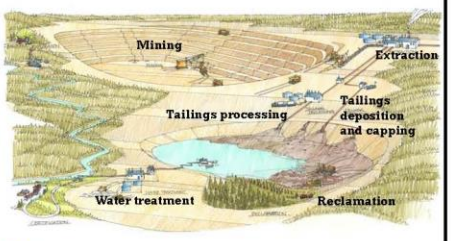
Component 1 - Compile state of practice, describe existing technology suites, & compile full list of technologies

Component 2 - Develop assessment criteria

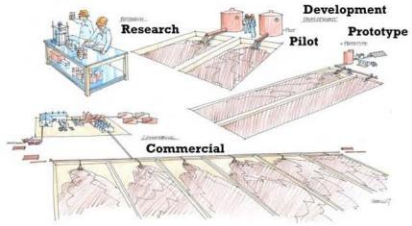
Component 3 - Evaluate opportunities, technologies, identify data gaps

Component 4 - Highlight & prioritize technologies through a development roadmap

Definition of Technology Categories



Stage of Development



Tailings Roadmap Study

- The Study identified 549 technologies with potential use for oil sands.
  - Included 89 vendor technologies
  - Reduced to 101 unique technologies (plus technology variations and enhancements)

Category	Commercial	Prototype	Pilot		Research		Total
			Industry	Third-party	Industry	Third-party	
Mining	1		1				2
Extraction	1		3	1	2	5	12
Tailings Processing	5	4	6	4	4	6	29
Deposition & Capping	9 (1)*	3	9		6	2 (1)*	31
Water Treatment	3 (6)*		8		2		19
Reclamation	4	1	1	1		1	8
TOTAL	30	8	28	6	14	15	101

TRS Vol. 2, Table 2.1

*Numbers in parentheses represent technologies not currently being investigated for oils sands but used in other mining areas

Tailings Roadmap Study

Follow-up

Follow-up Action Plan for 48 Highlighted Technologies

- 16 Technologies are included in current or planned OSTC/COSIA projects
- 14 Technologies will be considered by Technical Working Groups
- 8 Technologies will be considered by OSTC/Member companies
- 8 Technologies are out of the current scope of the OSTC/COSIA Tailings EPA
- 2 Bitumen Recovery Technologies will be evaluated through a joint industry AI-EES initiative

COSIA Third Party Technology Development Workflow

Page 1 of 2 - Overview

1. Third Party Technology Developers are typically;
   - Individual Technology provider;
   - Vendor; or;
   - R&D Organization e.g., University
2. Initial contact between Third Party / COSIA representative(s), whether by written communication or via meeting has to be on a non-confidential basis. As well, once technology is developed, all member companies must have the ability to obtain use rights, with commercial terms determined on an individual company basis outside of COSIA.

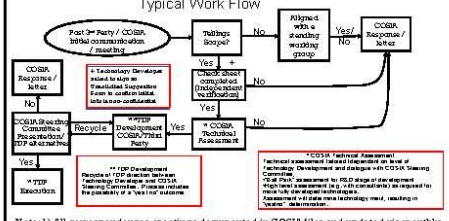
   Objectives of the introductory communications are ;
   - Third Party provides an overview of technology, work completed to date – initial data, Business Plan, IP status, list of public documents, etc.
   - COSIA provides its Tailings Mandate (role) and brief overview of: COSIA membership, operational scale, review how technologies are developed (Workflow Diagram, Technology Checksheet) and provides advice/guidance to facilitate technology development.

- Notes:
  Allowances can be made for topic specific confidentiality agreements (NDA).
  All correspondences and meeting minutes will be documented and circulated in monthly memo / stored in COSIA files.

COSIA Third Party Technology Development Plan (TDP)Workflow

Page 2 of 2 – Generic Technology Development Workflow

Typical Work Flow



Note: 1) All correspondences, meetings documented in COSIA files and updated via monthly meeting / memo. 2) All responses to Third Parties via COSIA Tailings EPA Director.

Looking Forward… *What is Important?*

1. Longer term (before or at mine closure)
   - Establishment of a stable closure landscape that directs surface water off the lease into established streams, and supports desired end land use objectives.
   - "Stable" means resistant to natural processes, self-healing after natural erosion, and with a self-sustaining, native vegetation cover.
2. Shorter term (a limited timeframe after completing deposition)
   - "Reclaim" the ground surface – place a cover to support access & plant growth.
3. Pursue solutions that make sense and fit the conditions and operating realities on each lease.
4. Use technically and environmentally effective and low-cost methods for the reclamation of oil sand tailings deposits.
5. Oil sands operators are accountable to regulators for:
   - Meeting the above objectives
   - Submitting plans that contain measurable performance goals,
   - Measuring performance, reporting performance, and
   - Taking action to improve performance when it doesn't meet plans.

Final Comments

- Industry is committed to:
  - Sharing the information necessary to progress the development of oil sand tailings technologies
  - Working with AI-EES, government and Third Party Technology Developers to develop and implement tailings technologies that will ensure that oil sand tailings are successfully reclaimed on a timely basis.
  - The Tailings Roadmap Study report can be accessed at: www.cosia.ca & www.ai-ees.ca

Questions?

PHOTO courtesy of Suncor Energy Inc.

Agenda

- Overview of the CCI Program
- Innovation Enhancement grants
- Applied Research and Development grants
- Industrial Research Chairs for Colleges
- College-University Idea to Innovation grants
- Questions

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CCI Overview

The College and Community Innovation (CCI) Program is managed by NSERC in collaboration with the Canadian Institutes of Health Research (CIHR) and Social Sciences and Humanities Research Council of Canada (SSHRC).

CCI program is open to proposals across the spectrum of natural and social sciences, engineering, humanities and/or health

NSERC CRSNG
Social Sciences and Humanities Research Council of Canada
Conseil de recherches en sciences humaines du Canada
CIHR IRSC
Canada

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CCI Overview – Objectives

- Increase innovation at the community and/or regional level by enabling Canadian colleges to strengthen their capacity to work with local companies, particularly SMEs
- Support applied research and collaborations that facilitate commercialization, as well as technology transfer, adaptation and adoption of new technologies

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CCI Overview

- Who can be recognized as a partner?
  - Businesses, colleges, hospitals, public utilities, associations and government agencies can be eligible partners. Universities, and other organizations may also participate in the proposed activities and projects as collaborators.
- Who is eligible to apply?
  - An employee of the college, preferably an administrator or a manager who has experience in managing grants of a value equivalent to the amount for which the application is being made.

Innovation Enhancement Grants (IE)

- IE Grants provide funding to colleges on a competitive basis to enhance applied research capacity and carry out applied research and technology transfer activities in collaboration with, and to the benefit of, companies.
- Grants focus on a college's area of recognized expertise, meets local or regional needs and builds capacity for increase economic development in the community.

IE Grant Overview

- Funding Levels:
  - Entry-Level IE Grants
    - Funds: up to $100K per year for 2 years)
  - Five-Year IE Grants
    - Funds: up to $500K per year for years 1-3, up to $400,000 for years 4-5)
  - **Eligible** costs include:
    - Direct costs of applied research / technology, knowledge transfer/outreach activities, networking;
    - Operating and equipment (up to 20%)
    - Indirect costs – overhead and administration (up to 20%)

Applied Research and Development Grant (ARD)

- The ARD provides support for Canadian companies to undertake well-defined applied R&D projects at colleges
  - Applicants can apply at any time—***no deadlines***
  - Projects range in duration and value
  - Projects will be selected based on:
    - Technical merit
    - Applied research competence
    - Potential for innovation impact
    - Private-sector support
    - Contribution to the training of students
    - Benefit to Canada

ARD Overview

Three levels of grants:

1. Up to $25K (six months)
   - Requires a new relationship, private sector partner contribution,
   - internal review, 4-6 week target
2. Up to $75K / year, up to 3 years:
   - Private sector partner(s) contribute 1/3 of project costs in cash and/or in-kind
   - External peer review
3. Projects between $75K and 150k per year, up to 3 years:
   - Private sector partner(s) contribute ½ of project costs in cash and/or in-kind
   - External peer review and committee review

CCI Pilot Grants

Technology Access Centre grants (TAC)

The goal of the TACs are to enhance the ability of companies, particularly SMEs, to become more productive and innovative by enabling them to readily access college expertise, technology and equipment. This access to college capabilities is intended to enhance the productivity, competitiveness and innovation of the participating SMEs. (pilot in progress)

Industrial Research Chairs for Colleges (IRCC)

- IRCC supports applied research leaders and the development of business focused applied research programs at colleges.
- Chairs are established for 5 year terms, range in value from $100K - $200K annually
- Selection Criteria:
  - Suitability of Candidate
  - Benefits to College
  - Institutional Support
  - Quality of the Proposal
  - Private Sector Support
  - Contribution to Education and Development

IRCC Overview

- Eligible expenses include:
  - Chairholder salary plus benefits
  - Faculty course load reduction, research staff, and students
  - Equipment and Overhead (up to 20% of grant each)
  - Other (Operating costs, material, project travel, etc.)
- Eligible partners must contribute an amount equal to the IRCC grant in cash and/or in-kind contributions
  - 40% of 5 year total must be committed by eligible partners at time of application
  - cash not mandatory for first 5 year term only

College-University Idea to Innovation (CU-I2I)

- CU-I2I aims to develop and strengthen research links between colleges, universities and businesses to accelerate the development of promising technologies and promote their commercialization into the Canadian marketplace.
- Must have at least one participant of each: College, University, eligible company partner(s).
- Applicant can be College or University. The other institution will be the co-applicant.
- Grants will be transferred to applicant institution. Applicant institution will then transfer funds to co-applicant institution in accordance with the application budget.

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CU-I2I Overview

- Grants can be up to $250K annually
- Duration of grants can be up to 3 years
- Eligible expenditures include:
  - Faculty course load reduction (college only), technical/research assistants, postdoctoral fellows (university only) and students
  - Equipment (up to 20% of grant)
  - Overhead (up to 20% of grant for college only)
  - Other (Operating costs, material, project travel, etc.)

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CU-I2I Overview

- Company partner contributions can be matched at a maximum level of 1:1 for both the college and the university participants
  - e.g. if the company partner contribution is $100,000, NSERC will leverage this contribution for a maximum of $100,000 for the college participants and $100,000 for the university participants
- Grants to either institution do not need to be equal
- Distribution of funds can vary from year to year
- Maximum grant to College or University is $125K

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CU-I2I Overview

- Selection Criteria
  - Technical Merit
  - Synergies from the College-University Collaboration
  - Team Expertise
  - Innovation, Tech Transfer, and Commercial Benefit potential
  - Private-Sector Support
  - Contribution to the Training of students/talent
  - Benefit to Canada

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Questions

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Alberta Innovates Energy and Environment Solutions

Oil Sands Tailings Management

Oil Sands Tailings Management

Richard Nelson
Program Director, Oil Sands Tailings

Presentation to the NAIT 2013 Tailings Technology Development and Commercialization Workshop
March 19, 2013 Edmonton

Alberta Innovates – Energy and Environment Solutions (AI-EES)

Who we are?

One of four Alberta Innovates corporations

Technology arm of the Alberta Government in energy and environment

What we do?

Position Alberta for the future in energy and environment:

- Identify, evaluate, select technologies and partners
- Invest in research & technology with industry & international collaborators

Alberta Innovates Energy and Environment Solutions

2

AI-EES Strategic Priorities

Oil Sands Tailings Management

Oil Sands Tailings Management

Research

- Centre for Oil Sands Innovation (COSI)
- NSERC Industry Chair in Oil Sands Tailings Water Management (UofA)

Technology Development and Assessment

- Oil Sands Tailings Technology Roadmap
  - Eliminate Tailings Generation
  - HC recovery from tailings
  - High Solids content water based tailings
  - Progressive Reclamation

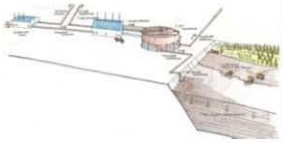
Tailings Technology Roadmap

- Government and industry collaboration
- 549 technologies identified with potential use for oil sands
- Reduced to 101 unique technologies
- 9 technology pathways identified
- Examples: centrifuge, thin-lift and air drying (TRO)

PROJECT RESULTS: 9 technology Suites identified

Pre-commercial and commercial suites

- Composite tailings
- Thickening
- In-line thickening with thin lift evaporative drying
- In-line thickening with accelerated dewatering
- Water capped MFT (in an EPL)
- Centrifuging MFT with conveyor / stacking



"New" Technology Suites

- In-pit tailings treatment and deposition
- Non-water based extraction methods
- Improvement to water-based extraction

Recommendations

Operations / management

- Review water management practices and opportunities
- Remove roadblocks between companies
- Examine regional opportunities for waste treatment, including solids, fines, water and byproducts

Recommendations

Technology assessment

- Implement a formal assessment framework for new technologies
- Standardize testing methods
- Evaluate the range of chemical amendments

Development

Evaluate methods to reduce the mass of fines delivered to extraction by mining operations

Evaluate the potential for creating separate extraction processes for high fines and low fines ore streams

Revisit retort-based and solvent-based extraction methods

Revisit the processing of froth tailings to reduce its potential environmental impacts

High Solids Content Tailings

Technology	Key Attributes	Current Status	Future Positioning
Centrifuged MFT with Conveyor/ Stacking	• Low risk and technically manageable • The product will meet D-074 criteria. • The deposit still contains hydrocarbons (limits placement to deeper than1.5 m)	• Syncrude is leading the implementation ($1.5B in their commercial tailings program) – scheduled to be operational by 2015. • Suncor/ Shell are also examining the use of centrifuges.	Improvement Opportunities: • MFT dredge • Performance of deposit AI-EES' Assessment: • Syncrude investment suggests that this technology is ready for commercial use.

High Solids Content Tailings

Technology	Key Attributes	Current Status	Future Positioning
In-line Thickening with Thin Lift Drying (e.g.TRO)	• This process can increase solid content from 30% to 60% in a few weeks. • The technology can meet D-074 requirements • Requires a large amount of polymer and a large area for deposition • Its performance is weather dependent and winter operation is limited. • Deposit still contains residual bitumen/diluent	• Suncor's TRO is a commercial process • Can require considerable rehandling	*Improvement Opportunities:* • Alternative discharge processes to reduce land requirements • Use of Freeze-Thaw during winter. *AI-EES' Assessment:* • Suncor is commercially committed to the process • This technology is commercially viable

High Solids Content Tailings

Technology	Key Attributes	Current Status	Future Positioning
Thickeners	• Improves solids content from between 10 and 20% up to 45 to 55%. • Thickening is aided by the use of flocculants. • Water from the thickener overflow recycled to extraction. • Deposit still contains residual bitumen/diluent	• Shell is the main operator with a tailings thickener. IOL Kearl Lake and CNRL will soon be using thickeners as part of their operations.	*Improvement Opportunities:* • Increase solids content, • Improve pumping methods • Improve discharge methods • Trafficability and strength issues

Alternative Extraction and Recovery

Technology	Key Attributes	Current Status	Future Positioning
Non-Water Based Extraction of Tailings	Retort Technology: • Production of dry tailings as part of the mineral content of a retorted oil sands. • Very high bitumen recovery can be achieved along with partial upgrading of the bitumen. • The waste coke is re-used as fuel. Solvent Technology: • Production of dry tailings that is hydrocarbon free.	• The retort technology is commercial for shale oil and has been pilot tested with oil sands almost 20 years ago. • To date, the largest oil sands retort tests are at 10 tonnes/hr. • The solvent process is at the lab testing stage and no field studies have been reported publically. • Solvent requires finely crushed Oil Sand ore for effective extraction.	***AI-EES' Assessment*** • The industry might explore non-water based extraction technologies in the context of selective mining (separation of fines rich ores from the fines poor ores). • The use of selective mining could significantly minimize tailings output from the operation. • Feasibility studies

Progressive Reclamation

Technology	Key Attributes	Current Status	Future Positioning
In Pit Tailings Treatment	• Large reduction in the size of land needed for tailings containment. • Significantly reduce the time necessary for reclamation. • Increases the amount of recycle water for extraction.	• Mobile crushing and extraction technology has not been demonstrated or proven on oil sands. • Will require the initial tailings deposition to occur out of pit until the pit bottom has been reached.	***AI-EES' Assessment*** • The industry will examine in-pit technologies in the context of hot water extraction. • This technology suite is intended for fresh fluid tailings not legacy MFT. • Field studies and assessments of several deposits including EPLs

AI-EES Application & Monitoring Guidelines

Application Process	Project Monitoring
Must further AI-EES strategy	Steering Committee oversight
Provide grants & contributions	Technical direction & learning
Cost-Sharing	Information-sharing
No Intellectual Property ownership	Make final report public (after a short confidentiality period)

Applications: An Open Process

1. ***Apply at any time:*** **Contact AI-EES technical staff and discuss your proposed project; project must be technical, innovative and strategic**
2. ***Pre-Application:*** **If your proposed project is considered promising and within the AI-EES mandate, you will be invited to submit a "pre-application", which will undergo internal evaluation**
3. ***Full-ProGrid (FPP) Application:*** **Based on the results of the internal evaluation, you may be invited to submit a FPP**
4. ***AI-EES Board Decision:*** **Our industry-led Board makes the final funding decision**

Evaluation Criteria

A: The Innovation	B: The Quality	C: The Impact
Technology Opportunity	Work Plan, Budget & Deliverables	Economic Benefits
Competitive Analysis	Excellence of the Project Team	Environmental Performance
Commercialization Potential	Funding Commitments	Climate Change Benefits
Risk Analysis & Mitigation		Building Innovation Capacity

Oil Sands Environmental Sustainability Initiative

NAIT

Haneef Mian, M.Sc., Ph.D., P.Eng. MBA

Ledcor Group Applied Research Chair in Oil Sands Environmental Sustainability
Director – Centre for Green Chemistry and Engineering (CGCE)

March 19, 2013

Outline

- About NAIT
- Applied Research at NAIT
- Centre for Green Chemistry and Engineering (CGCE)
- Tailings Technology Development, End-to-End
- Concluding Remarks

Overview of NAIT

- **Alberta's 3rd Largest Post-Secondary Institution**
  - NAIT serves approximately **80,000** customers each year.
  - Employer of **3,100** dedicated staff.

Overview of NAIT

Hands-On Learning & Technical Education

NAIT's five academic schools, together with the Department of Continuing Education, provide learners with career-focused education opportunities in virtually every sector within our economy.

- JR Shaw School of Business
- School of Health Sciences
- School of Trades
- School of Information Communication and Engineering Technologies
- School of Sustainable Building and Environmental Management

Ledcor Group - Applied Research Chair in Oil Sands Environmental Sustainability

- In place November 15, 2010
- Established with a $1.5 million endowment from Ledcor Group, matched by the Province, to lead NAIT's first applied research initiative
- Influenced by Industry – Chair Advisory Council
  - Mike Krayacich – VP Oil Sands and In situ Technical & Reliability (Chair)
  - Eddy Isaacs – CEO Al EES
  - Don Breen - President Ledcor Industrial
  - Ryan Bischoff – BNG Engineering
  - David Carpenter– VP Academic and Applied Research, NAIT
  - Forrest Tittle - Dean SSBEM

Centre for Green Chemistry and Engineering (CGCE) at NAIT

- **Established under the direction of Ledcor Chair through NSERC, CFI and NAIT Funding**
  - NSERC CCI-IE ($2.5 Million)
  - CFI ($2 M)
  - NAIT ($2.5M)
- **Focused on sustainable R&D – e.g. end-to-end tailings.**

CGCE Applied Research Focus

- Applied Research focus on oil sands technology development;
- Applied research aligned with areas of strength and academic programming;
- Focus on outcomes - utilizing academic knowledge to produce meaningful outputs for industry;
- Support economic growth of SMEs and businesses;
- Complimenting research at other institutes;
- **DON'T WAIT - PLAN, DO, FAIL FAST, CHECK AND IMPROVE**

If you always do what you always did, you will always get what you always got [Albert Einstein]

U of R sues over 'misappropriated' CO2 technology, CBC News

MARCH 11, 2013

University countersued by firms from Sas[illegible]nd South Korea, Geoff Leo CBC

The University of Regina is suing two [illegible]mes alleging the firms have unjustly claimed exclusive right[illegible]ate technology developed at the institution and are refusi[illegible]

In 2005 the u[illegible]n agreement with Regina-based HTC Purenergy, providing [illegible]n the non-exclusive right to commercialize the university's carbon o[illegible]nology. HTC went on to sub-license that technology to another company, [illegible]an, which is based in South Korea.....contd.

http://www.cbc.ca/news/canada/saskatchewan/story/2013/03/15/sk-lawsuit-u-of-regina-1303.html

CGCE - FLEXIBLE IP POLICY

CGCE - Applied Research Focus (cont.)

- Through engagement with SMEs and 3rd Party Innovators, advance generation of technology and new ideas through
  - Technology verification
  - Validation and further development
  - Prototypes
  - Scale up & demonstration
- Complement through collaboration with…
  - Universities
  - Research Consortia
  - Industry

Our Niche - Bridging the Gap

- Filling a recognized gap in the system.
- Small companies lack resources to handle wide range of tests, data collection and analysis.
- Small companies with potential solutions may have challenges in accessing and speaking to the right people within oil sands operations.
- Oil sands operators face challenges, as a large company, in trying to work with small companies.
- Through training, education and technology development, NAIT is and will asssist companies that would otherwise have difficulties meeting the standards required as a large, publicly-traded operator.

Our Niche - Bridging the Gap (cont.)

- Collaborative approach used to bridge the gap between SME and third party technology providers, and oil sands industry to develop solutions in a time and cost-effective manner, while reducing risk and time to market.
- Technology incubation services
- Ensure to compliment the work that other researchers and the industry is carrying on
- Ensure that best mechanisms exist to transfer knowledge on the viability of various technologies back to the industry.

Students and Faculty Engagement

- **Bring applied research expertise to the class, and enhance the curriculum**
  - Students: engaged through co-op, summer opportunities, in-class faculty supervised projects, and applied research Capstone Projects.
  - Faculty: a large pool of full-time faculty engaged through course downloads on a project by project basis – multidisciplinary teams

CGCE - South Edmonton Research Park Facility

- NAIT's first dedicated space for applied research:
  - 3000 sq ft, state-of-the-art wet chemistry lab.
  - 3000 sq. ft. engineering lab
- Provides a base for:
  - Industry collaborative projects.

Innovation Driver - Tailings

- Innovation need comes from business needs,
- Innovation need also comes from external threats, or regulatory changes (Directive 074)
- We must, align innovation strategy with business strategy

Tailings Technology Roadmap Study

- The Study identified 549 technologies with potential use for oil sands.
  - Included 89 vendor technologies

Category	Commercial	Prototype	Pilot		Research		Total
			Industry	Third-party	Industry	Third-party	
Mining	1		1				2
Extraction	1		3	1	2	5	12
Tailings Processing	5	4	6	4	4	6	29
Deposition & Capping	9 (1)*	3	9		6	2 (1)*	31
Water Treatment	3 (0)*		8		2		19
Reclamation	4	1	1	1		1	8
TOTAL	30	8	28	6	14	15	101

*Numbers in parentheses represent technologies not currently being investigated for oils sands but used in other mining areas.

TRS Vol. 2, Table 2.1

Slide Adapted from AIEC'S public document

Collaborations – COSIA Tailings EPA & Others

- Collaborating to screen, verify, and validate technologies;
  - Technologies identified by COSIA Tailings EPA Experts
- Use Technology Readiness Level (TRL) or Stage-Gate Approach
- Feedback - provided to COSIA Tailings EPA
- Depending on the level of technology readiness decisions made on next steps by COSIA Tailings EPA

Engaged with a number of other partners through NSERC Funding, or Fee-for-Service arrangements

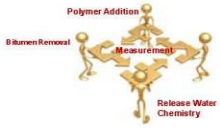
TECHNOLOGY READINESS LEVEL

Basic principles observed and reported	1	Basic
Technology concept and/or application formulated	2	
Analytical and experimental critical function and/or characteristic	3	
Component and/or breadboard validation in laboratory environment	4	Advanced
Component and/or breadboard validation in relevant environment	5	
System/subsystem model or prototype demonstration in a relevant environment	6	
System prototype demonstration in a operational environment	7	Applied
Actual system completed and 'flight qualified' through test and demonstration	8	
Actual system 'flight proven' through successful mission operations	9	

TECHNOLOGY MATURITY

Screen, Verify, Validate, & Scale Up Tailings Treatment Technologies

- **Technologies A, B and C:** bench scale, batch, validation and improvement, testing, includes bitumen removal and treatment, polymer addition, dewatering, and consolidation studies
- A number of collaborative agreements have to be in place



OUTCOMES

- **Suite of Cost-Effective Proven Sustainable Technologies:** for End-to-End Tailings Management
- **Systems Approach** - ensure that technology development in one part of the system does not negatively impact others parts

Existing Team

- Dr. Haneef Mian, Ledcor Chair & Director CGCE
- Dr. Don Scott, Geotechnical Engineer (Project basis)
- Ehsan Abazari (Ph.D. Candidate), Geotechnical Engineer
- Dr. Ron Currie, Analytical Chemist
- Dr. Sukhdeep Bansal, Organic Chemist
- Ed, Barone, Chemist, Senior Faculty Researcher
- Dr. Bei Zhao, Chemical Engineer
- Mr. David Christiansen, Instrumentation Tech
- Ms. Tasha Ritchie, Chemical Technologist
- Ms. Binbin Zhang – Recent graduate (Biological technology)
- Ms. Amy Mukherjee – Business Officer
- Suncor Fellow in Oil Sands Environmental Sustainability – $250K
- Ms. Shena Tyliszczak, Admin Support
- High interest from other faculty and instructors – mobilized on a need basis

Funding Strategy

- Leveraging Endowment funds with other available sources
  - NSERC CCI/CFI
  - NSERC ARD Grants
  - NSERC Industrial Chairs for College Grants (IRCC)
  - NSERC College University Idea to Innovation (NSERC CU I2I) Grants
  - Applied Research Fee-for-Service Projects

NAIT's Commitment

- CGCE (6000 sq. ft) has been developed at the Edmonton Research Park.
- CGCE fully supported by NAIT's Applied Research Support Services and Enterprise Development Department (novaNAIT).
- NAIT supports all legal, human resources, finance, information technology, promotional, business development, curriculum development, and related needs through our existing divisions.

Acknowledgments

- **Ledcor Industrial**
- **NSERC**
- **CFI**
- **COSIA – Tailings EPA**

A PERSONAL PERSPECTIVE ON TECHNOLOGY DEVELOPMENT IN THE OIL SANDS INDUSTRY

Randy Mikula
KALIUM RESEARCH

Canadian Oil Sands

The area occupied by the circle is approximately 400,000km², and the area of the oil sands resource (in white) is approximately 141,000km². Currently land disturbance due to oil sands development is about 600km², with tailings containment about 180km².

BACKGROUND:

The need for testing and evaluating new concepts

Who should do the evaluation

Who should pay for the evaluation

Know the difference between industry interest and a politically correct "don't waste my time"……..where can technology developers go to ask questions?

I HAVE SOLVED THE OIL SANDS PROBLEM!

What problem?

Usually the understanding of industry interests or challenges are gleaned from the popular press.

Know your industry, use common sense.

The Oil Sands Sludge Story

"Oil Sands tailings take between five hundred and one thousand years to settle and consolidate…..maybe never"

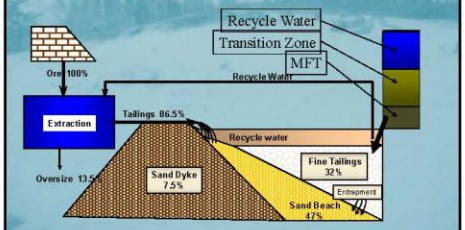
Crazy statements like this make it seem like the oil sands industry is out of control, but what does this statement really mean?

It does not mean that the tailings do not settle at all…..it means that they do not consolidate to the point where they can easily be reclaimed. This is a significant distinction.

oilsands@shaw.ca

KALIUM Research

The sand tailings are used to build the containment for the fine tailings and the recycle water



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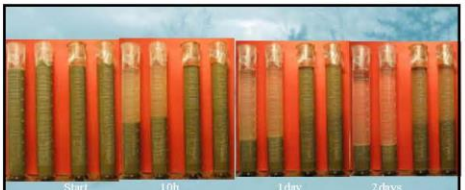
KALIUM Research



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KALIUM Research

2 Days

Thin Fine Tailings 10% solids

MFT analog 30% solids

So What!

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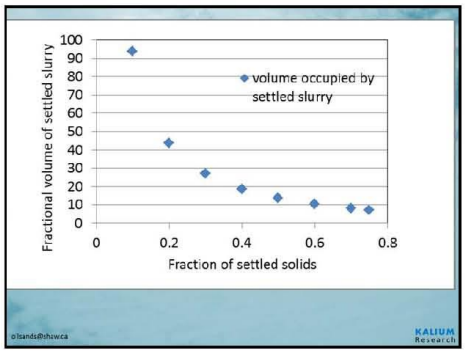
KALIUM Research


Fractional volume of settled slurry
100
90
80
70
60
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
Fraction of settled solids
volume occupied by settled slurry
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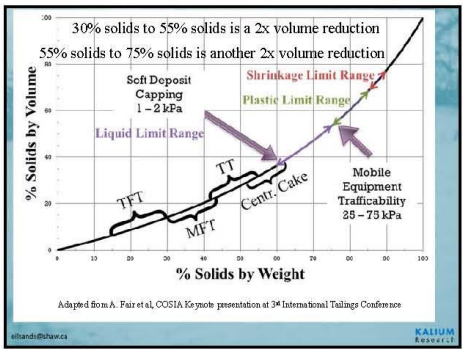
KALIUM Research


30% solids to 55% solids is a 2x volume reduction
55% solids to 75% solids is another 2x volume reduction
% Solids by Volume
Soft Deposit Capping 1 – 2 kPa
Shrinkage Limit Range
Plastic Limit Range
Liquid Limit Range
TT
Centr. Cake
TFT
MFT
Mobile Equipment Trafficability 25 – 75 kPa
% Solids by Weight
Adapted from A. Fair et al, COSIA Keynote presentation at 3rd International Tailings Conference
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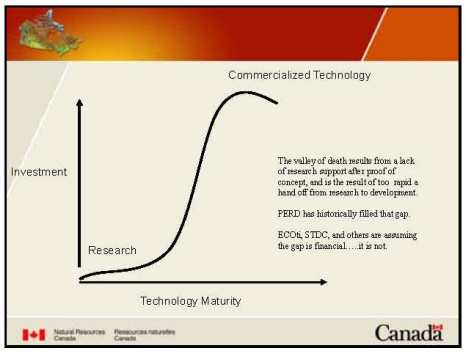
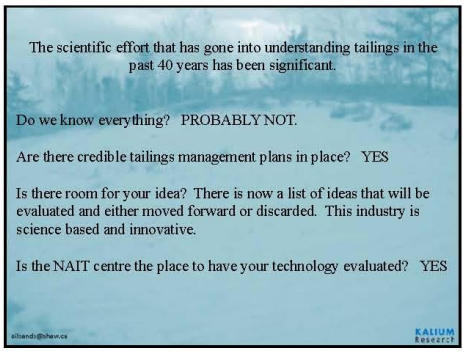
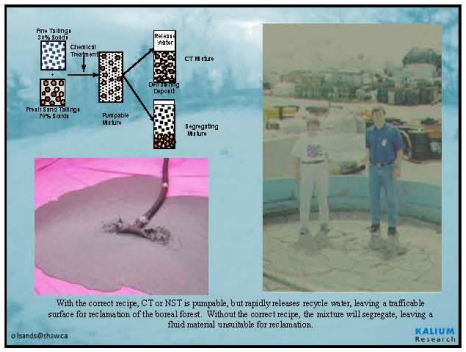
KALIUM Research


Commercialized Technology
Investment
Research
The valley of death results from a lack of research support after proof of concept, and is the result of too rapid a hand off from research to development.
PERD has historically filled that gap.
ECOs, STDC, and others are assuming the gap is financial. . . .it is not.
Technology Maturity
Natural Resources Canada
Ressources naturelles Canada
Canada


The scientific effort that has gone into understanding tailings in the past 40 years has been significant.
Do we know everything? PROBABLY NOT.
Are there credible tailings management plans in place? YES
Is there room for your idea? There is now a list of ideas that will be evaluated and either moved forward or discarded. This industry is science based and innovative.
Is the NAIT centre the place to have your technology evaluated? YES
oilsands@shaw.ca
KALIUM Research


Fine Tailings
Chemical
Treatment
Release
Water
CT Mixture
Consolidated
Deposit
Fine/Coarse Tailings
Pumpable
Mixture
Segregating
Mixture
With the correct recipe, CT or NST is pumpable, but rapidly releases recycle water, leaving a trafficable surface for reclamation of the boreal forest. Without the correct recipe, the mixture will segregate, leaving a fluid material unsuitable for reclamation.
olsands@shawca
KALIUM
Research

Potential Sources of Capital

- You
- FFF - Friends, family and fools
- Angel Investors
- Customers
- Government entities :
  - SR&ED, IRAP, SDTC,
- Venture Capital Funds:
  - Oil Co. Funds, Green Funds, Energy Funds, Others
- Private Equity
- Public Markets

The funding "gap"

What is your value proposition?

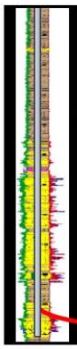
- Clear, concise and understandable
- What is the pain that you can solve?
- Idealistic notions are not enough

What is your Business plan?

- All elements: marketing, operations, continuing R&D, management & personnel, Financing
- Cash flow projections
- Realistic timelines
- What is the earnings model?

Who is assuming the risk?

- Unrealistic expectations of value
- Unrealistic expectations of timing
- what is the real value of your IP?
- The longer the timeframe, the greater the risk.



What is your value proposition?

- Clear, concise and understandable
- What is the pain that you can solve?
- Idealistic notions are not enough

REACH YOUR RESERVOIR POTENTIAL

LIST OF OSRIN REPORTS

OSRIN reports are available on the University of Alberta's Education & Research Archive at https://era.library.ualberta.ca/public/view/community/uuid:81b7dcc7-78f7-4adf-a703-6688b82090f5. The Technical Report (TR) series documents results of OSRIN funded projects. The Staff Reports (SR) series represent work done by OSRIN staff.

OSRIN Technical Reports – http://hdl.handle.net/10402/era.17507

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Cruz-Martinez, L. and J.E.G. Smits, 2012. *Potential to Use Animals as Monitors of Ecosystem Health in the Oil Sands Region*. OSRIN Report No. TR-18. 52 pp.

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Dixon, R., M. Maier, A. Sandilya and T. Schneider, 2012. *Qualifying Environmental Trusts as Financial Security for Oil Sands Reclamation Liabilities*. OSRIN Report No. TR-24. 32 pp.

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Alberta Innovates – Technology Futures, 2012. *Investigating a Knowledge Exchange Network for the Reclamation Community*. OSRIN Report No. TR-26. 42 pp.

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Davies, J., B. Eaton and D. Humphries, 2012. *Microcosm Evaluation of Community Level Physiological Profiling in Oil Sands Process Affected Water*. OSRIN Report No. TR-28. 33 pp.

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Pyper, M. and T. Vinge, 2013. *A Visual Guide to Handling Woody Materials for Forested Land Reclamation*. OSRIN Report No. TR-31. 10 pp.

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Rooney Productions, 2012. *Assessment Methods for Oil Sands Reclamation Marshes*. OSRIN Video No. V-1. 20 minutes. Also available on the University of Alberta You Tube Channel (recommended approach).

Rooney Productions, 2012. *Assessment Methods for Oil Sands Reclamation Marshes*. OSRIN Video No. V-1. Nine-part mobile device version. Also available on the University of Alberta You Tube Channel (link to Part 1 - recommended approach).

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