Tailings
2016 IOSTC
We are Tailings
Associate Members

INDUSTRY
- BASF
- FPInnovations
- GE
- SNF Floerger
- BGC
- Golden Associates
- Caterpillar
- IBM
- CEDA
- Maxxam
- TITANIUM Corporation
- Ch2M
- WorleyParsons
- Natural Resources Canada

HUBS
- Secure Energy Services
- Alberta Innovates Technology Futures
- Coevok Innovations
- Innovate Calgary
- INNOVATE CALGARY
- LOCKNorth
- MaRS Innovation
- CMC Research Institutes
- TECTERRA

ACADEMIC INSTITUTIONS
- Athabasca University
- NAIT
- SAIT
- University of Calgary
- University of Alberta
- University of Waterloo
- University of Lethbridge
- MaRS Innovation
Innovation in Action – E-TAP

Environmental Technology Assessment Portal

Anyone can submit an idea for assessment.
Results

TO DATE:

Technology Sharing
- 936 technologies costing $1.33 billion to develop

Active Projects
- 276 projects = $680 million

IN 2016

New Projects in 2016
- 76 new = $219M to develop

Completed Projects
- 119 projects

Shared
- 113 technologies = $111M to develop
Tailings Aspiration

We will strive to...

“Transform tailings from waste into a resource that speeds land and water reclamation.”
Tailings Opportunity Areas & Gaps

Tailings in Pit Lakes

**Technology Fundamentals**
- Clay Chemistry impacts on permeability and consolidation of fines-dominated deposits
- Modelling to improve predictions of commercial deposit consolidation
- In situ treatment of fluid tailings in pit lakes

**Technology Optimization and Commercialization**
- Impact of froth treatment diluent on tailings
- Optimize flocculant / coagulant suite and dosage to improve aggregate settling performance for TT, FFT, and NS1/CT deposits
- Impact of residual fines on slurry filtration and consolidation

**Tailings Treatment Optimization to Improve / Predict Mine Water Capture**
- Assessment of Environmental Net Effects (ENE)
- Optimizing existing tailings treatment technologies
- Commercially ready online instrumentation

**Collection, Transportation, and Depositional Flow**
- Impacts of shear and chemical dosage on dewatering and segregation
- Applied rheology and effects of pipeline shear

**Improving Deposit Performance**
- Atmospheric drying of fine-grained tailings deposits
- Consolidation enhancement and adaptive management
- Freeze-Thaw effects on consolidation
- Capping of tailings deposits

**Depositional Flow of non-Newtonian slurries**
- Harvesting FFT

**COSIA EPA members will strive to transform tailings from waste into a resource that speeds land and water reclamation.**
2016 Tailings Project Portfolio

PROJECT PORTFOLIO

164 Contributed technologies (32 obtained in 2016)
$705M Cost to develop technologies ($41 million in 2016)
75 Current (active) projects (33 obtained for 2016)
$319M Cost for current projects ($185.5 million in 2016)
164 Completed projects (32 completed in 2016)
$705M Cost for completed technologies ($41 million in 2016)

ACTIVE PROJECT PORTFOLIO BY ‘D’ PHASE

- DISCOVER: Scientific research. Early translation to applied R&D. Application is speculative.
- DEVELOP: System validation with testing in a relevant environment.
- DEPLOY: System prototype at/near scale. Field demonstration. Integration into existing system.

- DISCOVER: 58%
- DEVELOP: 12%
- DESIGN: 15%
- DEPLOY: 15%
2016 Tailings Achievements

- Renewal of the Tailings JVA for 2016 - 2021
- Major revisions of Opportunity Areas and Gaps
- Renewal of four-year NSERC CRD at Carleton University on long-term dewatering of amended oil sands fine tailings
- Ongoing tailings research collaboration with IOSI at University of Alberta with twelve projects completed in the last year
- First commercial deployment of non-segregating tailings (NST) technology (Canadian Natural)
- Second commercial deployment of high-rate tailings thickener (Imperial)
- Increased level of collaboration among COSIA tailings members
Key Focus Areas - Capping and Reclamation

- Gradual evolution of tailings research and pilots over the last 10 years from tailings treatment technology to performance of tailings deposits over time and capping / reclamation methods

- Capping
  - facilitates physical access to the deposits for the purpose of placing reclamation materials
  - provides separation between underlying tailings materials and overlying reclamation materials
  - serves a beneficial role accelerating deposit consolidation

- Operators have successfully capped commercial-scale sand-dominated deposits like CT (NST) and sand beaches

- Current focus is optimizing capping of fines-dominated deposits where there is significant post-placement settlement
Key Focus Areas - Environmental Net Effects (ENE)

- Important to assess and understand the long-term environmental impacts of new tailings technologies.
- Operators are not interested in solving one environmental problem while making other environmental areas worse.
- Similar approach to ENE tools developed for Water and GHG.
- Assess long-term impact on GHG generation, land disturbance, water inventory, relative capital and operating costs.
- Long-term impacts of tailings management options are highly dependant on lease conditions.
Studies continue to support that sequestering tailings in pit lakes is an environmentally effective means of reclaiming tailings.

There are 35 pit lakes currently planned for the region.

Researching treatment of fluid tailings prior to placing in pit lakes to:

- Increase storage efficiency through densification
- Minimize the impact of tailings on the water column.
- Minimize GHG formation.
Key Focus Areas – Commercially Ready On-Line Instrumentation

- Real-time, on-line or at-line analyzers to control tailings treatment processes and consistently produce tailings deposits that meet specifications

- Key characteristics include bitumen content, clay content, density, segregation/dewatering potential, Sands-to-Fines Ratio (SFR), floc size, PSD, rheology, electrical and hydraulic conductivity, yield stress

- Currently most tailings treatment processes rely on
  - Subjective assessments of deposit quality from visual observations to provide process control feedback
  - Annual pond surveys to assess effectiveness of previous years’ tailings operations

- Members are currently piloting analyzers that measure most of the key tailings characteristics
Key Focus Areas - Modelling to Improve Predictions of Commercial Deposit Consolidation

- Members already have models to predict the consolidation and performance trajectory of most deposit types, but recognize there is room for improvement.

- Tailings Directive D085 requires operators to ensure that new tailings are Ready to Reclaim (RTR) within ten years of end of mine life and:
  - RTR performance criteria are tracking to the expected trajectory.
  - For each deposit type, suitable indicators will be monitored and indicate the expected trajectory.

- There are twelve active projects where at least part of the scope includes improved modeling of consolidation behaviour.
Project highlights for 2016

- Tailings consolidation columns (Shell)
- Evaluation of on-line in-pipe K40 analyzer (Shell)
- Permanent Aquatic Storage Structure for MFT (Suncor)
- Non-segregating tailings (NST) deployment (Canadian Natural)
- Applied Process Innovation Center (APIC) (Canadian Natural)
- Co-mixing of fluid fine tailings and overburden (Syncrude)
Tailings consolidation columns

- Evaluate performance of new flocculants and assess long-term consolidation behaviours of centrifuge cake (analogue to deep fines-dominated deposits)
- Eight columns, each 10 metres tall by three metres in diameter filled with centrifuged FFT and flocculated FFT using a number of different polymer types.
- Environmental Benefits: increased confidence with deep, fines-dominated deposits that substantially reduces environmental footprint
- Business Benefits: Improved long-term planning that will ensure final landform objectives are met at commercial scale in a cost-effective manner.
Evaluation of on-line in-pipe K40 analyzer

- Potassium-40 (K40) commonly found in clays present in oil sands ore and tailings.
- Evaluate K40 analyzer as an online / real-time tool to quantify clay minerals in FFT, to improve the real-time process control for tailings treatment.
- Environmental Benefits: improved process control of tailings treatment processes ensuring deposits will consistently meet specifications
- Business Benefits: improved process control of tailings treatment processes reduces costs
Permanent Aquatic Storage Structure for MFT

- Treating fluid fine tailings (FFT) prior to deposition in an aquatic landform to increase storage efficiency, minimize the impact on the water column, minimize GHG

- Stage 1 – 3 completed including bench scale testing and laboratory continuous pilot.

- Next stage is a large field test of the technology in 2017

- Environmental Benefits: treated FFT in pit lakes has a very low environmental footprint compared to other alternatives. Deposit would be “Ready for Reclamation” to a lake shortly after closure.

- Business Benefits: better management of FFT inventory with better quality water available for recycle. Lower cost than other FFT treatment options.
Non-segregating tailings (NST) deployment

First commercial deployment of NST technology

By dewatering the coarse tailings fraction using cyclones, the fine fraction using a thickener then recombining the streams, most of the fines in the ore are captured in the sand beach of the tailings pond

Environmental Benefits: smaller footprint, lower GHG intensity (warm water recycle), lower water use intensity, “Ready for Reclamation” sooner

Business Benefits: better management of FFT inventory by avoiding creation of FFT, lower costs.
Applied Process Innovation Center (APIC)

- 3,600-square-foot research facility to speed the movement of promising technologies from the lab to commercial deployment.
- Tests since June 2015 include enhanced fines capture in NST, thickener operations optimization and re-flocculation of tailings for Imperial and testing a volute screw press with U of A.
- **Environmental Benefits:** rapid testing and deployment of tailings technologies that reduce environmental footprint.
- **Business Benefits:** optimized treatment and deposition processes, reducing costs.
Co-mixing of fluid fine tailings and overburden

- Evaluation of mixing dry overburden with fluid fine tailings (FFT) to trap the FFT in overburden void spaces.

- Field tests in 2014-15 involved mixing on a conveyor belt at four different moisture levels then depositing in test cells.

- Co-mixing is a robust technology for capturing FFT resulting in a trafficable surface that can be reclaimed sooner than using other treatment methods.

- **Environmental Benefits:** smaller tailings footprint, “Ready for Reclamation” sooner.

- **Business Benefits:** Use of overburden, a readily available material, may help lower cost and improve tailings treatment and reclamation efficiency.
SUMMARY

- Tailings technology priorities have evolved significantly over the past few years
- COSIA member collaboration is increasing
- Significant increase in commercial deployment of technologies
- Continued interest in new technologies that both improve environmental performance and reduce costs.
COSIA Upcoming Events

INNOVATION SUMMIT 2017
MAR 21–22
CALGARY ALBERTA