2016
PROJECT PORTFOLIO

STEADILY TRANSFORMATIVE
TABLE OF CONTENTS

FOREWORD: Dan Wicklum 2

TARGETING SOLUTIONS: Opportunity Areas and Gaps 3

GREENHOUSE GASES 13

LAND 23

WATER 33

TAILINGS 43

ABOUT COSIA 52
FOREWORD

Not that long ago, heavier than air flight was thought to be impossible. Now it’s difficult to picture a world with no planes and no ability to transport people and goods quickly around the world.

Building on this idea of innovation solving the world’s great challenges, to me the concept of a low-carbon energy future is not just possible, it’s inevitable. When the world’s best minds focus on solving important challenges, good things happen.

We rarely talk about COSIA without using two words – collaboration and innovation. As far as we know, COSIA members are pushing the paradigm of sharing technology further than any other sector in the world, by coming together as collaborators in innovation to solve environmental problems and decrease costs. We also know our success is dependent on leveraging partners and leaders in the global innovation community, including our 40 Associate Members, and leading thinkers in industry, government, academia and the wider public.

We often think of innovation on a continuum. On one end, it’s important to have a deliberate effort on technologies that will yield quick progress – and our efforts are driving a great array of meaningful, but incremental improvement projects ranging from enhancing cogeneration of heat and power, to increasing waste heat recovery, and exploring new ways to accelerate reclamation of mine tailings. If you stack up many incremental improvements you have real, substantive progress.

On the other end, companies are undertaking unconventional projects with the potential to create breakthrough technologies, such as the development of molten carbonate fuel cell technology that would capture CO2 while generating clean electricity, and the NRG COSIA Carbon XPRIZE that is motivating teams from around the world to uncover technologies capable of transforming CO2 into valuable, useful products.

Measuring progress is important and we track progress in two ways. One is effort – the amount of dollars invested, the number of projects launched and completed, or the number of technologies shared inside of COSIA. Then there’s outcome. An important test on the work we do is whether knowledge gets used and technologies are implemented. To date, our members have made 347 implementation decisions on the technologies developed and shared through COSIA.

Another important reality is that when you are innovating in the natural world, there are real limitations dictated by the laws of nature. We don’t think of these as constraints, but as the boundaries that define the area within which we have room for creativity.

When I look at the people that work inside of COSIA, whether they’re an engineer or scientist for a company or COSIA staff, or an Associate Member leader or innovator, every single one of these people are interested in making a difference, and harnessing each other’s knowledge to realize outcomes that will benefit, not just their organization, but the province, Canada and the world. They represent, perfectly, the spirit, passion, creativity and promise that take us from problems to solutions.

In Canada’s oil sands, we are fortunate to have some of the world’s best minds partnering with the COSIA companies. As Canada strives to shape and implement a national approach to climate change, we are developing and testing cutting-edge technologies, and leading in a true innovation-based economy by building on the global resource advantage we have with our oil sands.

Facing problems head-on, bringing together different perspectives, backgrounds, educations and world views, keeps us continuously renewing and positioning Canada as a global economic and environmental leader in a quickly changing world.

DAN WICKLUM, CEO
TARGETING SOLUTIONS: OPPORTUNITY AREAS AND GAPS

While innovation in the oil sands sector has come an impressively long way in a very short time, demonstrating incredible creativity and cutting-edge engineering and science, the innovation timelines for long-cycle infrastructure sectors like oil sands don’t always match the perceptions created by other high-tech industries.

In an industry where the time to advance physical infrastructure is often measured in decades, COSIA quietly works the tension, helping to shorten timelines through its active collaboration and open innovation model.

We know that focusing a challenge, bringing the many and the brightest minds together to face that challenge, propels us towards solution. To deliver progress against our goals, COSIA members work together, drawing on and combining each other’s technology expertise and innovation to identify what we want to accomplish - identifying opportunity areas and gaps as the difference from where we are, to where we want to be in the future, and then launching projects to close the gaps.

This approach drives a vast array of incremental improvement projects, but at the same time, members are undertaking higher risk, unconventional projects with the potential to create breakthrough technologies.

Through COSIA’s open sourcing approach to identifying solutions, technologies that may have been created for purposes other than oil sands are looked at for their potential to close gaps in the oil sands. And anyone, from large innovation hubs and multi-nationals to garage inventors, can submit an idea for consideration through COSIA’s Environmental Technology Assessment Portal (E-TAP).

Projects include everything from contributed knowledge or technology that can be shared and adapted, to literature studies, to workshops that bring together subject matter experts, to developing computer programs, databases and associated data analysis processes, to applied research from lab-scale to field pilots. The involvement of industry experts, vendors and suppliers, innovators and inventors, technology developers, academic researchers, and government scientists and representatives, in addition to the experience and knowledge transferred from other industries, positions COSIA as a world hub for innovation in oil sands.

Inside of COSIA we have a portfolio of projects across our four Environmental Priority Areas (EPAs) – GHGs, Land, Water and Tailings. Inside each priority area we make very deliberate investment decisions from concept of idea to development, demonstration, deployment and commercialization, and we have technologies at all those different stages.

COSIA has devised bubble diagrams for each of the EPAs, presented on the following pages, that help visualize the broad range and highly interconnected nature of the opportunity areas and gaps where our work is focused. These bubble diagrams give an appreciation for how structured COSIA’s research approach is – and how our work is clearly focused on targeted solutions.

PROJECT PORTFOLIO OVERVIEW

936 Contributed technologies (113 obtained in 2016)
$1.33B Cost to develop technologies ($111 million in 2016)
276 Current (active) projects (76 obtained for 2016)
$680M Cost for current projects ($219 million in 2016)
347 Completed projects (119 completed in 2016)
$818M Cost for completed technologies ($111 million in 2016)
COSIA EPA members will strive to produce oil with lower greenhouse gas emissions than other sources of oil.
COSIA 2016 PROJECT PORTFOLIO

PROJECT PORTFOLIO

- 154 Contributed technologies (18 obtained in 2016)
- $208M Cost to develop technologies ($21.5 million in 2016)
- 12 Current (active) projects (7 obtained for 2016)
- $15M Cost for current projects ($5.6 million in 2016)
- 42 Completed projects (18 completed in 2016)
- $25M Cost for completed technologies ($21.5 million in 2016)

ACTIVE PROJECT PORTFOLIO BY ‘D’ PHASE

- 25% DEPLOY
- 42% DISCOVER
- 25% DEVELOP
- 8% DESIGN

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.

COSIA 2016 PROJECT PORTFOLIO

MINING & EXTRACTION

MOBILE FLEET

- Low/No Carbon Alternatives to Diesel Fuel
- Optimize Fleet Utilization and Design
- Mine Fleet Engine Efficiency Improvements
- Regional Fleet Sharing

FUGITIVE EMISSIONS

- Quantifying Area Fugitive Emissions
- Reduce Fugitive Emissions From Tailings Ponds
- Reduce Fugitive Emissions from the Mine Face

MATERIALS HANDLING

- Optimize Ore Handling and Quantify Benefits
- Optimize Other Materials Handling Techniques
- Existing and Novel Tailings Handling

IN SITU ENERGY EFFICIENCY

MINING & EXTRACTION

- ELECTRIFICATION with Low/No Carbon Fuels
- Existing and Novel Tailings Handling

FUGITIVE EMISSIONS

- REDUCING Electric Demand
- LOW/NO Carbon Alternatives to Diesel Fuel
- Optimize Fleet Utilization and Design

MATERIALS HANDLING

- OPTIMIZING Water/Energy Balance
- OPTIMIZING Facility Energy Integration

Retrofitting Existing Steam Generation Technology
Alternatives for Optimizing Hot Water Production

Optimized Steam Generation and use in Extraction and Froth Treatment

Process Improvements and Alternative Technologies to Reduce Energy Use

Reduce Fugitive Emissions From Tailings Ponds
Reduce Fugitive Emissions from the Mine Face

MINING & EXTRACTION MOBILE FLEET

IN SITU STEAM DEMAND REDUCTION

CROSS CUTTING LOW CARBON HEAT AND POWER

EPA members will strive to produce oil with lower greenhouse gas emissions than other sources of oil.

GREENHOUSE GASES

CO2/LP

ACTIVE PROJECT PORTFOLIO BY ‘D’ PHASE

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COSIA EPA members will strive to be world leaders in land management, restoring the land and preserving biodiversity of plants and animals.
Developing Tailings Reclamation Strategies

Reduce Commercial Footprint Intensity

PROGRESSIVE RECLAMATION

Identify Best Management Practices

Front End Planning Methods for Front End Planning and Integrated Land Management Optimization of Planning for Exploration Footprint

Watershed Modeling

Establishment of Functional Wetlands

Establishment of Functional Compensation and End Pit Lakes

Establishment of Functional Wildlife Habitat

Establishment of Functional Uplands

Off-Lease Ecological Function Restoration

EFFECTIVE RESTORATION

Caribou Captive Breeding and Reintroduction

Caribou Predator Exclosure Fencing

Bison Research

Other Issues of Biodiversity Concern

Wildlife Corridors

Caribou Habitat Restoration

SPECIES OF MANAGEMENT CONCERN

Captive Breeding and Reintroduction

PROJECT PORTFOLIO

387 Contributed technologies
(22 obtained in 2016)

$135M Cost to develop technologies
(≈$3 million in 2016)

126 Current (active) projects
(7 obtained for 2016)

$80M Cost for current projects
(≈$1.8 million in 2016)

60 Completed projects
(22 completed in 2016)

$20M Cost for completed technologies
(≈$3 million in 2016)

ACTIVE PROJECT PORTFOLIO BY ‘D’ PHASE

21% DEPLOY

30% DISCOVER

30% DEVELOP

19% DESIGN

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.
WATER OPPORTUNITY AREAS AND GAPS

COSIA EPA members will strive to be world leaders in water management, producing Canadian energy with no adverse impact on water.
COSIA 2016 PROJECT PORTFOLIO

PROJECT PORTFOLIO

- 231 Contributed technologies (47 obtained in 2016)
- $277M Cost to develop technologies ($45.6 million in 2016)
- 63 Current (active) projects (29 obtained for 2016)
- $266M Cost for current projects ($25.7 million in 2016)
- 81 Completed projects (47 completed in 2016)
- $68M Cost for completed technologies ($45.6 million in 2016)

ACTIVE PROJECT PORTFOLIO BY ‘D’ PHASE

- 33% DISCOVER
- 27% DEVELOP
- 27% DESIGN
- 13% DEPLOY

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

- Water Criteria
- Environment Effects Monitoring
- Scale-Up
- Adaptive Techniques
- Acceptable Configurations

DEVELOP

- MINING PIT LAKES
  - Biological and Water Quality Factors
  - Identify Performance Boundaries
  - Improve Water Use

DESIGN

- MINING SITE-WIDE WATER MANAGEMENT
  - Recovery Improvements

DEPLOY

- IN SITU WATER RECOVERY FROM FLUE GAS
  - Recovery Improvements

- MINING WATER RETURN
  - Receiving Water Criteria
  - Environment Effects Monitoring
  - Better Active Treatment Technologies
  - Passive Treatment Technologies
COSIA EPA members will strive to transform tailings from waste into a resource that speeds land and water reclamation.
IMPROVING DEPOSIT PERFORMANCE

- Capping of tailings deposits
- Atmospheric drying of fines-dominated tailings deposits
- Consolidation enhancement and adaptive management
- Freeze-Thaw effects on consolidation
- Co-deposition of tailings streams

COLLECTION, TRANSPORTATION AND DEPOSITIONAL FLOW

- Harvesting FFT
- Impacts of shear and chemical dosage on dewatering and segregation
- Applied rheology and effects of pipeline shear

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

- 58% DISCOVER
- 15% DEVELOP
- 12% DEPLOY
- 15% DESIGN

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.
Environmental Priority Area

Greenhouse Gases

We will strive to produce oil with lower greenhouse gas emissions than other sources of oil.
# TAILINGS SOLVENT RECOVERY UNIT
## HEAT RECOVERY PHASE II

### PROJECT DESCRIPTION

In the bitumen extraction process associated with surface mining, heat is lost to the tailings from froth treatment. The objective of this project is to adapt existing heat exchanger technology to the froth treatment process, which will result in the recovery and transfer of waste heat. This in turn allows the recycle water stream to be pre-heated before going back to the hot water heaters. The recovery of heat in that stream reduces natural gas consumption and results in lower greenhouse gas (GHG) emissions intensity.

In Phase I, Shell heat transfer experts worked with several vendors to screen potential technologies. Two small Alfa Laval Spiral Plate type Heat Exchangers (SPHE) with commercial plate spacing (gaps) were tested at the Saskatchewan Research Council in 2015 using a tailings sample supplied by Shell. The study provided high confidence in predicting heat transfer rates and high confidence that erosion of the exchanger surface will occur.

The primary aim of the Phase II research is to assess the function of the SPHE in an operational environment, including the challenge of dealing with large particles in the tailings, and to develop the scale-up potential by testing with multiple gap sizes.

### OPPORTUNITY AREA:
#### ENERGY EFFICIENCY

**LEAD COMPANY:** Shell  
**OTHER PARTICIPANTS:** Saskatchewan Research Council

### POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- If this technology can be proven at a commercial scale and deployed, overall energy efficiency improvements would be expected, thereby reducing net GHG emissions.

### BUSINESS BENEFITS

- Improved process efficiency.  
- Reduced natural gas consumption.  
- Lower operating costs.

If this technology can be proven at a **commercial scale** and deployed, overall energy efficiency improvements would be expected, thereby **reducing** net GHG emissions.
COSIA IN SPACE: SATELLITE MONITORING OF AREA FUGITIVE EMISSIONS

PROJECT DESCRIPTION

COSIA is literally going out of this world to achieve its vision of accelerating the pace of environmental performance improvement in Canada’s oil sands.

Oil sands mining operators are required to conduct annual measurements of carbon dioxide (CO₂) and methane emissions from tailings ponds and mine faces, known as “fugitive emissions,” which make up a significant part of a mine’s total emissions. All emissions are reported to the provincial government.

The current measurement method involves a flux chamber, a large hood floated on the surface of a pond or set on the mine face to capture and measure emissions. Operators then estimate the total emissions from the mine face or tailings pond. Although this method is approved by the Alberta government for estimating emissions, it has significant disadvantages including high uncertainty (in the range 20 to 50 per cent), high costs and relatively high safety risk.

This project’s partners are working with GHGSat, a global emissions monitoring company based in Quebec, to investigate the use of satellite technology to obtain more accurate and frequent measurements of fugitive greenhouse gas (GHG) emissions.

The project will develop a modelling system that will use GHGSat’s innovative satellite technology to measure emissions in the atmosphere above two tailings ponds and one mine face. The emissions rates will be calculated based on those measurements and will be compared with more conventional technology measurements, including the flux chamber method.

The satellite launched on June 22, 2016 and will remain in orbit for at least one year. It will circuit above Alberta’s oil sands mining operations once every two weeks. Provided that the conditions are clear enough, the satellite will conduct concentration measurements and transmit them back to Earth. The data will then be plugged into the model to determine emissions levels from the targeted tailings ponds and mine face. Attempts will be made to conduct measurements on the ground at the same time for comparison.

This demonstration project has received financial support from Sustainable Development Technology Canada, the Boeing Company, LOOKNorth and the Canadian Space Agency. GHGSat will also be supported by Ramboll Environ, a global consulting firm with specific expertise in dispersion modelling.

OPPORTUNITY AREA: FUGITIVE EMISSIONS

LEAD COMPANY: Imperial
OTHER PARTICIPANTS: Canadian Natural, Shell, Suncor; GHGSat, Environ

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• The technology being tested could replace the current method, improving accuracy of the estimates and potentially increasing measurement frequency.
• With an improved methodology for measuring fugitive emissions, COSIA can begin to look at emissions reduction technologies and confirm their effectiveness.

BUSINESS BENEFITS

• Satellite technology could be adopted as the industry standard for fugitive emissions measurement.
• The project also has the benefit of avoiding safety risks and costs associated with ground-based measurement.
EVALUATING MOLTEN CARBONATE FUEL CELLS FOR CARBON CAPTURE

PROJECT DESCRIPTION

Oil sands facilities burn natural gas to generate heat, steam and electricity needed for operations. Natural gas combustion creates carbon dioxide (CO₂), a greenhouse gas (GHG) that can be captured and purified. One capture method is to use molten carbonate fuel cells (MCFCs – see sidebar), which also generate electricity – so using MCFCs could reduce carbon capture cost, relative to alternatives. Water can also be produced from this process, providing another benefit to oil sands operations. In addition, MCFCs reduce nitrogen oxides (NOₓ) emissions and do not use amine solvents.

In 2015, Cenovus, Shell and Devon carried out pre-FEED work (front-end engineering and design) associated with installing and operating a 200-kilowatt pilot MCFC project at the University of Calgary’s cogeneration plant. In 2016, together with additional oil sands operators, another project was initiated for pre-FEED work. This is for a larger 1.4-megawatt pilot project, to be installed and operated at an oil sands facility.

The purpose of the pre-FEED study is to determine the scope and cost of a pilot project. Depending on the outcome of the pre-FEED, a decision will be made to advance to a pilot demonstration. The technology could capture 70 to 90 per cent of CO₂ emissions while generating up to 1.4 megawatts of power.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Post-combustion capture of CO₂ from flue gases can reduce the GHG emissions intensity of oil sands operations and provide electricity for on-site use or export to the Alberta grid.

• MCFC technology can capture CO₂ from boilers and process heaters. Captured CO₂ could be stored or used for enhanced oil recovery applications depending on which site is selected for the pilot.

• Water from combustion can be captured and used at oil sands facilities, displacing other make-up water sources.

• NOₓ emissions can be reduced.

MOLTEN CARBONATE FUEL CELLS

A fuel cell converts chemical energy from a fuel (in this case, natural gas) into heat and electricity through an electrochemical process. MCFCs are one type of fuel cell that operates at high temperatures to produce electricity and steam. They contain an anode, a cathode and a molten electrolyte salt layer. The flow of electrons from anode to cathode through an external circuit produces electricity. MCFCs have been used in commercial power generation since the 1990s.
INTERACTIVE FLOWSHEET MODEL

PROJECT DESCRIPTION

This project delivered the first version of a web-based interactive model to perform mass and energy balances at the block flow diagram level for any in situ central processing facility. Starting with one of the model’s templates, the user can add or remove components to model operations such as carbon capture, CO₂ compression, different boiler configurations, etc. The model calculates key performance indicators such as fuel consumption, greenhouse gas emissions, make-up water consumption, water disposal rate, water recycle, heat rejected to stacks and glycol air coolers.

The current version of the flowsheet model includes the components of an in situ facility and a few generic modules for carbon capture, CO₂ compression, flue gas condensation and air separation. The tool also features some high-level economic assessments. Users can easily quantify the benefits of different technologies they may wish to add to existing facilities or design into new facilities.

This is a web-based application available to all COSIA members and Associate Members. The tool is secure, as the server does not store any company confidential information – all simulation files are saved locally by the user.

The interactive flowsheet provides opportunities to assess the potential impact of various inputs on plant performance.

OPPORTUNITY AREA:
LOW CARBON HEAT AND POWER

LEAD COMPANY: Nexen
OTHER PARTICIPANTS: BP, Devon, Suncor; Process Ecology

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS
• Using better tools to screen new technologies will help engineers to assess and prioritize lower emissions technologies on a facility level, leading to faster deployment and reduced emissions intensity.

BUSINESS BENEFITS
• An effective tool for engaging the innovation community improves the probability that promising technologies will be identified and deployed faster.
OIL SANDS MINE AND EXTRACTION REFERENCE FACILITY

PROJECT DESCRIPTION

This project will develop a static, representative oil sands reference facility that will enable multiple studies to facilitate the evaluation of greenhouse gas (GHG) emissions reduction opportunities on a common basis. The project will also support prospective technology developers to better frame and quantify the GHG reduction benefits of their technology. The project’s deliverable is a static block mass and energy flow for a typical oil sands mine.

The diagrams will include a material (block flow diagram) and heat/energy (energy flow diagram) balance for four scenarios in total—two mine resource scenarios (representing a range of fines content, waste:ore ratio, and ore grade), each considering naphthenic froth treatment and paraffinic froth treatment. Specific scenarios will be determined by COSIA.

The reference facility will be based on Alberta Energy Regulator (AER) regulatory requirements. The battery limits and design basis would be the same for all scenarios, including the mine face, a bitumen product ready for pipeline transport, outflow to tailings, and tailings ponds. The boundary would exclude any upgrading or tailings treatment. Scenarios will include heat recovery, once-through steam generation, and cogeneration applications including quantifying exported power.

An effective tool for engaging the innovation community improves the probability that promising technologies will be identified and deployed faster.

OPPORTUNITY AREA:
LOW CARBON HEAT AND POWER

LEAD: COSIA EPA

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Using better tools to assess new technologies is expected to lead to deployment of technologies that help improve energy efficiency and reduce emissions intensity.

BUSINESS BENEFITS

• An effective tool for engaging the innovation community improves the probability that promising technologies will be identified and deployed faster.
CO₂ RECOVERY UNIT IN HORIZON H₂ PLANT

PROJECT DESCRIPTION

Canadian Natural's Horizon oil sands development includes surface mining, bitumen extraction, and on-site bitumen upgrading with associated infrastructure to produce high quality synthetic crude oil. Canadian Natural is constructing a commercial-scale carbon dioxide (CO₂) capture / recovery facility within the upgrader’s hydrogen (H₂) plant. The technology is based on a state-of-the-art activated amine solvent system and has the capacity to capture 430,000 tonnes per year of CO₂ – equivalent to removing emissions from 77,000 cars, and supplying the required CO₂ for Horizon’s tailings management process. The facility is expected to be completed by the end of 2016.

The objective of this COSIA project is to share information from the detailed engineering design of the recovery unit, including:

- Process description.
- CO₂ capture unit gas feed and CO₂ product conditions, compositions and flow rates.
- Heat and mass balances.
- Utility summaries and design conditions.
- Plant performance.
- Waste characterization and execution strategy.

OPPORTUNITY AREA:
CARBON CAPTURE, STORAGE AND CONVERSION

LEAD COMPANY: Canadian Natural

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Successful CO₂ capture can reduce the overall carbon footprint while potentially generating material useful in other on-site processes or available for sale.

BUSINESS BENEFITS

- The cost of CO₂ capture is significant. Evaluating and sharing information on CO₂ capture technologies in a collaborative manner expedites the potential for further innovation specifically focused on oil sands applications that could drive industry towards significantly lower capture costs for oil sands operations.
- Canadian Natural has been purchasing CO₂ for its tailings management. These costs can be reduced through on-site capture and re-use of CO₂.
Steam-assisted gravity drainage (SAGD) operations combust large quantities of natural gas to produce steam. A portion of the heat generated in this process is lost through boiler stacks as high temperature flue gas or as low-grade waste heat from process operations. COSIA is seeking technologies that can capture waste heat and transform it into higher-value heat or electricity.

Stages I and II of this study are complete. Stage I defined a “micro challenge” to seek technological solutions that could be taken to a field trial. Stage II identified two promising technologies:

- AMS Energy Heat Pipe – combustion air or boiler feed water pre-heat (from flue gas).

Stage III includes:

- Engaging engineering consultant(s) to perform pre-feasibility assessment of all technologies.

At the completion of Stage III, one technology may be selected to move forward to a front-end engineering and design (FEED) study.

**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

- If technologies are further developed and deployed, overall energy efficiency improvements would be expected, thereby reducing greenhouse gas emissions.

**BUSINESS BENEFITS**

- Overall energy efficiency improvements could reduce energy and carbon emission levy costs and improve industry competitiveness.
NRG COSIA CARBON XPRIZE

PROJECT DESCRIPTION

The NRG COSIA Carbon XPRIZE challenges the world to re-imagine what we can do with carbon dioxide (CO₂) emissions by advancing the development of technologies that convert CO₂ into valuable products.

This global competition will promote and advance the discovery and development of technologies to take CO₂, widely regarded as a liability, and turn it into a resource. The competition launched on September 29, 2015 and will operate over four and a half years, offering $20 million to the two teams best able to convert CO₂ into a usable product.

The competition is structured with two tracks – one focused on testing technologies at a natural gas power facility, the other on testing technologies at a coal power plant. A prize pool of $10 million is available for each track. There will be a total of three rounds:

• Round 1 (Sept. 29, 2015 to Q3, 2016) consisted of all submissions being assessed for technical and business viability. On July 27, 2016, the official roster of teams was announced, with a total of 47 entries from seven countries.

• Round 2 (Q3 2016 to Q3 2017) will involve a pilot scale competition where two milestone purses of $2.5 million each will be shared equally among up to five finalists in each track.

• Round 3 (Q3 2017 to Q1 2020) will consist of a demonstration-scale competition, where two $7.5 million grand prize purses will be awarded to the winner in each track at the end of Q1 2020.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Developing technologies to convert CO₂ emissions from oil sands operations into valuable, useful products.

• Accelerating CO₂ reuse technology development by attracting more resources (intellectual and financial) to address excess CO₂ emissions.

OPPORTUNITY AREA:
CARBON CAPTURE, STORAGE AND CONVERSION

LEAD COMPANY: ConocoPhillips
OTHER PARTICIPANTS: Canadian Natural, Cenovus, Devon, Imperial, Nexen, Shell, Suncor
CO-TITLE SPONSOR: NRG Energy, an integrated wholesale power-generation and retail electricity company in the U.S.
PRIZE DEVELOPMENT/MANAGEMENT: The XPRIZE Foundation, an American non-profit organization

BUSINESS BENEFITS

• First-hand exposure to how open innovation can work to help tackle challenges in the energy sector. This type of collaboration across geographical and sectoral boundaries will become more integral to research and development efforts in the future.

• Accelerate CO₂ re-use technology development from low-technology readiness to commercial-ready.
Environmental Priority Area

Land
We will strive to be world leaders in land management, restoring the land and preserving biodiversity of plants and animals
AMPHTIBIOUS VEHICLES AND OTHER ALTERNATIVE RESTORATION EQUIPMENT

PROJECT DESCRIPTION

Muskeg, a swamp-like boreal environment that’s wet, peaty and difficult to access, dominates much of northeastern Alberta. Industrial activities over the past 40 years have fragmented the boreal forest, leaving legacy disturbances such as seismic lines and winter roads. A common obstacle to restoring this land is that it’s often inaccessible because the muskeg is too spongy and wet. Typically, restoration can only be completed during a brief period in winter when the ground is frozen, allowing equipment access.

Using amphibious vehicles — machines that can drive on land and float on water — offers a potential solution that would improve equipment access to muskeg sites and extend the restoration work period.

This project explores using extremely low ground-pressure and amphibious equipment to perform habitat restoration activities in muskeg areas during warmer seasonal conditions. Amphibious vehicles can operate on dry land, muskeg and even in water. Equipped with an extra-large undercarriage filled with air, similar to pontoons, these vehicles can safely navigate muskeg terrain.

The project builds on an earlier joint industry project (JIP) carried out by Cenovus and partners ConocoPhillips and Devon, which reviewed potential existing equipment and performed a site test of multiple candidate vehicles to assess the potential benefits of using this amphibious equipment.

Cenovus and partners ConocoPhillips, Devon and Nexen are now further evaluating the use of the amphibious equipment as well as other alternative restoration equipment types and methods through a large-scale operational trial. Within this trial, JIP participants will evaluate the use of a tree spade on an amphibious trackhoe to live transplant trees, and their understory plant community, from undisturbed forest onto the areas being restored. It is hoped that this will dramatically speed up the return to forest cover and restore habitat more quickly. Also being evaluated in this trial are implements that can be dragged across the soil surface to create surface roughness in order to increase survival of planted trees and encourage natural regeneration of trees and shrubs. If successful, these dragged implements may be much faster than the current soil mounding techniques being utilized. This trial will be completed in the fall of 2016.

OPPORTUNITY AREA:
EFFECTIVE RESTORATION

LEAD COMPANY: Cenovus
PARTICIPANTS: ConocoPhillips, Devon, Nexen

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Amphibious vehicles do not compress the soil and are much less likely to leave ruts or get stuck, reducing the overall environmental footprint. Vehicles tested in November 2015 were able to cross streams without causing stream bank damage or stirring up sediment.
- Amphibious vehicles may have the ability to restore more than twice the land area per day compared to standard machines, and can potentially greatly extend the traditional midwinter operating season.
- Amphibious vehicles may improve restoration success. In the traditional two-month winter work period, the effectiveness of restoration treatments such as mounding and stem bending is reduced due to hard frozen ground. Additionally, survival rates of live transplanted and planted trees may be lower in winter.
- Improved linear disturbance restoration may help reduce use of these corridors by predators and prey. Restoration of these features may ultimately reduce caribou predation.

BUSINESS BENEFITS

- Deploying amphibious vehicles is a first for oil sands restoration activities and may be a game-changer in improving the rate of restoration, allowing work to be conducted in any season with better outcomes and lower costs.

One of the amphibious vehicles crossing wet terrain during the pilot in November 2015.
ACOUSTIC WILDLIFE DATA RESEARCH AND DEVELOPMENT

PROJECT DESCRIPTION

Acoustic recording units (ARUs) are an emerging technology. These devices record vocalizations and analyze the recordings to determine the presence of rare or hard-to-detect species, primarily birds and amphibians. Because ARUs are automated, use of this technology increases data reliability, reduces costs associated with performing field surveys, and allows ongoing wildlife monitoring in remote and difficult terrain.

ARUs have been deployed by several COSIA member companies across their development sites. However, there is no centralized hub to manage the large volume of digital data being collected. This project will create an online computer system to manage, process and disseminate acoustic data from ARUs. The system will compile ARU data collected by various oil sands companies into an online repository so it can be efficiently analyzed and stored. Data and protocols will be made available to the public for potential citizen science or inclusion in community-based monitoring programs.

The project is also designed to address a number of issues related to ARU use, including:

- Optimal volume of data to be collected and analyzed.
- Optimal spatial distribution of ARUs.
- Temporal scheduling of data collection (daily and seasonally).
- File compression standards for archival purposes.

The system will disseminate results in a number of ways, including species identification as summary tables and/or written reports. A primary benefit of the system will be the creation of a data entry interface that will standardize data capture in a consistent manner, allowing deeper analyses of combined data sets.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Building an efficient and coordinated system will greatly improve efficiencies, data quality, and application for environmental management.
- Improved accuracy of wildlife monitoring.

OPPORTUNITY AREA:
SPECIES OF CONCERN, OPTIMIZATION OF PLANNING

LEAD COMPANY: Devon

OTHER PARTICIPANTS: ConocoPhillips, Shell, Suncor; Alberta Biodiversity Monitoring Institute (ABMI), University of Alberta

BUSINESS BENEFITS

- Lower monitoring costs and improved personnel safety.

An acoustic recording unit mounted on a tree.
WORKSHOP: AN EXPLORATION OF CONSERVATION BREEDING AND TRANSLOCATION TOOLS TO INCREASE WILD CARIBOU POPULATIONS

PROJECT DESCRIPTION

Woodland caribou populations are declining and caribou are listed as “threatened” federally under the Species At Risk Act and provincially in many jurisdictions including Alberta. Unsustainable predation levels, primarily on young calves, is widely recognized as the primary cause. In 2012, Environment Canada released its Boreal Caribou Recovery Strategy, which aims to stop current population declines, increase individual herd populations, and improve habitat condition. Provinces are charged with creating plans to meet these recovery objectives.

This project entailed the planning, organization and delivery of a multi-stakeholder workshop on caribou population augmentation tools. The event was hosted by the Calgary Zoo and facilitated by the IUCN, a global organization that supports scientific research and develops partnerships to foster nature conservation and species recovery.

This workshop was held in January 2016, and was attended by experts from the energy sector, provincial and federal governments, environmental non-government organizations, academia, and zoo organizations. Participants focused on brainstorming, building relationships, and problem solving via an established IUCN process. The workshop had five specific objectives:

- Understand regulator, stakeholder and others’ positions on caribou population augmentation tools.
- Share experiences in caribou conservation breeding techniques and tools, building on experiences within Canada and internationally.
- Assess and evaluate the merits of the full range of conservation breeding and translocation techniques.
- Discuss risk assessment and prioritization criteria for potential caribou ranges that may benefit from conservation breeding and/or translocations.
- Determine funding/partner agencies and models to deliver long-term projects for specific feasibility studies in areas that are most likely to yield success.

By the end of the workshop, there was a consensus-based conclusion that intensive population management tools play a role in caribou recovery, alongside other habitat-based tools. Among the strategies assessed, two variations of predator exclosure fencing were ranked highest when all objectives were considered together.

The intended follow-up will be the creation of strategic collaborations to investigate in detail the feasibility of conservation breeding and/or translocations for specific areas or herds.

OPPORTUNITY AREA:

SPECIES OF CONCERN

LEAD COMPANY: Devon

OTHER PARTICIPANTS: Canadian Natural, Cenovus, Imperial, Nexen, Suncor, Statoil; MEG Energy, Husky Oil, International Union for Conservation of Nature (IUCN), Calgary Zoo, British Columbia Oil and Gas Research and Innovation Society (BC OGRIS)

POTENTIAL/ACUTAL ENVIRONMENTAL BENEFITS

- Improved understanding of potentially effective tools for caribou population enhancement.

BUSINESS BENEFITS

- The workshop process facilitated disparate stakeholders to work together to find common or shared solutions.
- The workshop considered multiple objectives, including concepts of a working landscape, by applying integrated land management that would allow multiple land uses concurrently with caribou recovery. Not all techniques will necessarily be applicable in all caribou ranges.
- Workshop results provided the basis for the decision by various COSIA member companies to undertake additional ongoing study work on predator exclosure fencing.

Photo Credit: Devon Canada.
ALBERTA BIODIVERSITY CONSERVATION CHAIRS AT THE UNIVERSITY OF ALBERTA

PROJECT DESCRIPTION

Responsible and sustainable growth of Canada’s oil sands requires detailed understanding of the environmental effects of industrial and human activities in the boreal forest, and that industry continues to work to reduce those effects. The Alberta Biodiversity Conservation (ABC) Chairs program is intended to fast-track biodiversity science by providing funding and support to implement on-the-ground research in the boreal forest of northern Alberta. The results of that field research will be knowledge that can be shared across Canada, to be used to avoid or minimize environmental effects across the nation’s boreal forest. Research will also be looking at more rapidly and effectively removing or mitigating impacts where they do occur.

The ABC Chairs program will look at predicting biodiversity responses to human activities and developing restoration methods and tools to recover site biodiversity and landscape processes. For example, one of the research themes will be focused on woodland caribou conservation and monitoring.

POTENTIAL/ACUTAL ENVIRONMENTAL BENEFITS

The environmental benefits of applied research will include improved landscape management through better understanding of the:

- Impacts on biodiversity from human activities.
- Effectiveness of local mitigation strategies.
- Effectiveness of scaling up solutions (cumulative effects).

Additional benefits will be the application of new knowledge to support best management practices, and specific research findings including those focused on supporting caribou conservation.

BUSINESS BENEFITS

- Graduate and post-graduate students – Canada’s next generation of biologists – will have a variety of research opportunities, helping to develop better knowledge and stronger management practices going forward.

OPPORTUNITY AREA:

EFFECTIVE RECLAMATION

LEAD COMPANY: ConocoPhillips

OTHER PARTICIPANTS: Alberta Innovates Bio Solutions, Energy and Environment Solutions, Natural Sciences and Engineering Research Council of Canada (NSERC), University of Alberta

MEET THE CHAIRHOLDERS

The ABC Chairs program includes two Chairs at the University of Alberta:

- **Dr. Stan Boutin** (FRSC) is a Professor in the Department of Biological Sciences and Science Director of the Alberta Biodiversity Monitoring Institute. His current interests include conservation and management of the boreal forest including new strategies for the conservation of woodland caribou. His applied research is designed to allow stakeholders to make ecologically informed land-use decisions.

- **Dr. Scott Nielsen** is an Assistant Professor in Conservation Biology. His current research interests are species distribution and habitat supply modelling; endangered species monitoring and management; conservation planning and reserve design; and landscape ecology.

- The program also supports the work of **Dr. Erin Bayne**, Professor, Biological Sciences, whose research centers on understanding the cumulative ecological impacts of human activities on biodiversity, and cutting edge techniques in wildlife monitoring, survey design, geographic information systems, and habitat modelling. Dr. Bayne is involved with the use of acoustic recording units (ARUs) and he’s a participant in the Land Reclamation International Graduate School (LRIGS) program sponsored by NSERC.
The Forest Watershed and Riparian Disturbance (FORWARD) project is a watershed modelling project designed to improve the reclamation of oil sands developments. Through a consortium of university, government, and industry partners, the overarching goal is to better understand how natural and anthropogenic disturbances influence the dynamics of forest watersheds. The project incorporates existing information about oil sands processes, plus forest dynamics and hydrology, into a watershed-modelling framework.

FORWARD III is comprised of components focusing on soils, vegetation, hydrology, chemical export and the ultimate establishment of biotic communities. The general hypothesis: watersheds that have predictable water quality, chemical export and functioning terrestrial and aquatic features can be reconstructed successfully.

The final academic project report is scheduled for delivery at the end of December 2017.

**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

- Better understanding how natural and anthropogenic disturbances influence the dynamics of forest watersheds to aid in the successful reclamation of watersheds in the oil sands region.
- Development of soil and watershed assessment tools and appropriate bio-indicators that will support reclamation

**BUSINESS BENEFITS**

- The FORWARD III project will provide foundational knowledge to ensure landform and watershed construction meets equivalent capability requirements for reclamation.
NAIT SURMONT BOREAL RECLAMATION PROJECT

PROJECT DESCRIPTION

Interim reclamation provides opportunities for oil sands developers to establish forest vegetation communities on disturbed areas many years in advance of final reclamation, which occurs at the end of project life and is a regulatory requirement. Opportunities exist wherever hydroseeding is a current common practice for temporary reclamation (such as soil stockpiles, along roads, around well pads) or in areas that are no longer required for safe operations of the facility.

The overall project objective is to establish interim reclamation trials to:

- Test the efficacy of novel reclamation approaches.
- Inform final reclamation practices.
- Reduce footprint intensity.

The innovative techniques being tested will provide immediate environmental benefits and will accelerate the final reclamation of the site. In the short term, the project will:

- Reduce commercial footprint.
- Reduce the risk of invasive species establishment.
- Increase plant diversity.
- Stabilize soils.

In the longer term the project will:

- Accumulate organic matter.
- Provide coarse woody material for final reclamation.
- Build a bank of suitable seeds, buds and spores.
- Improve the quality of reclamation soils.
- Increase plant and animal biodiversity.

OPPORTUNITY AREA: EFFECTIVE RECLAMATION

LEAD COMPANY: ConocoPhillips
OTHER PARTICIPANTS: Canadian Forest Service, Natural Resources Canada

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- The project is testing specific reclamation practices that can be readily adopted to cost-effectively mitigate the impacts of industrial development in the boreal forest.

BUSINESS BENEFITS

- By mitigating the impacts of oil sands development sooner, proponents can increase the area considered "temporarily reclaimed."
- Reclamation techniques should be cost neutral or more cost effective when compared to current soil erosion and vegetation management practices.

Coarse woody material placement creates micro-sites that encourage the growth and survival of tree seedlings.
SANDHILL FEN

PROJECT DESCRIPTION

In-pit placement of sand and composite tailings (CT) creates landforms conducive to developing persistent wetland complexes, but presents both a challenge and an opportunity. The challenge is developing suitable reclamation technologies; the opportunity is to advance wetland reclamation. This challenge and opportunity are combined in the Sandhill Fen Research Watershed (SFRW), a large-scale pilot fen wetland research program designed to address two challenges in oil sands reclamation and closure:

- The ability to re-establish fen wetlands.
- Technology and practices for reclamation of soft tailings.

The SFRW is located in Syncrude’s East in Pit – the former east mine – which was actively mined from 1978 until 2000. After completion of mining, this area was backfilled with CT and an area of approximately 50 hectares was reclaimed as the Sandhill Fen Watershed. This area is a combination of upland landforms and a central 17-hectare wetland. The uplands were revegetated using a variety of tree and shrub species. Planting was done at conventional densities, as well as some experimental high-density applications. The wetland was seeded in 2011, with additional native species planted in 2012.

The specific objectives of the SFRW research program are to gain knowledge and provide guidance for future lease development and reclamation. Three key study areas are:

- Understanding nutrient, carbon and water balances.
- Landform design guidance, especially hummock landform technology.
- Wetland reclamation guidance.

Monitoring and research have been active since 2012, including studies on wetland and upland revegetation, wildlife use, invertebrate populations, wetland reclamation prescriptions, peat formation, markers of wetland reclamation success, and water movement, generation and quality. A pilot online metadata and mapping system is part of the SFRW, as a tool for supporting multidisciplinary research. The tool allows researchers access to information about the type and location of data (metadata) being collected by others as part of the program.

OPPORTUNITY AREA: EFFECTIVE RECLAMATION

LEAD COMPANY: Syncrude

OTHER PARTICIPANTS: Shell; University of Alberta, University of Windsor, McMaster University, Carleton University, University of Saskatchewan, Southern Illinois University

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Enhanced understanding of reclamation tools and techniques for reclaiming sand-dominated tailings landforms.
- Developing wetland reclamation best practices for revegetation, including suitable native boreal species lists with information on harvesting, salt tolerances, seed viability and planting success rates.
- Developing wetland reclamation soil placement recommendations, including evaluation of different capping materials – clay, sand, tailings sand, peat.

BUSINESS BENEFITS

- Continuing to define measures of success for wetland reclamation.

The central wetland area of Syncrude’s Sandhill Fen was seeded in 2011 and 2012; the area is now being monitored and studied, including revegetation success and wildlife use.
RECLAMATION GHG LIFE CYCLE ANALYSIS

PROJECT DESCRIPTION

Increased environmental concerns require more sustainable practices in oil sands reclamation. Ecosystems – including oil sands – contain large amount of sequestered carbon, which helps to mitigate climate change. Therefore, maintaining carbon storage, or recovering the land to its original situation, has become an important responsibility. Furthermore, Canadian laws and regulations including Climate Change and Emissions Management Act, Specified Gas Reporting Regulation, and Alberta’s Specified Gas Emitters Regulation, require regulated facilities to measure, report and reduce their annual emissions intensity. Reclamation and carbon analysis is a critical component to form a foundation for establishing carbon emissions mitigation strategies and defining practices to enhance carbon storage during mine planning and reclamation.

This project aims to conduct a carbon cycle analysis of overburden removal and reclamation-associated activities, and to provide potential recommendations for increasing carbon stocks. The analysis will evaluate greenhouse gas (GHG) losses or gains from reclamation activities and areas to support improved understanding of reclamation planning activities and, ultimately, closure landscape designs to minimize GHG losses and maximize carbon sequestration.

The activities include:

- Pre-disturbance ecosystem versus the closure plan.
- Emission differences between forest ecosites, wetland types, and within a reclamation type with age (e.g. aspen forest at five years may differ from an aspen forest at age 30).
- Emission rates from streams and lakes.
- Tree clearing, soil salvage, direct soil placement versus soil stockpiling.
- Landform types (e.g. tailings sand, coke, overburden, etc.).
- Coarse woody debris placement for erosion control.
- Cover crop, fertilization.

OPPORTUNITY AREA:
EFFECTIVE RECLAMATION, CROSS-EPA

LEAD COMPANY: Suncor
OTHER PARTICIPANTS: University of Alberta

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Establish carbon emissions mitigation strategies and define practices to enhance carbon storage.

BUSINESS BENEFITS

- Under the current regulation, sites pay for all carbon emissions detected over process-affected areas like tailings ponds and mines. Using this study to establish a pre-disturbance baseline could help reduce this cost.
- Enhanced reclamation techniques could be used to generate recognized reductions that count toward the GHG reduction obligations.
- This study could be used to inform more realistic estimates of land use change impacts when conducting life cycle assessments of oil sands derived crudes.
Environmental Priority Area

Water

We will strive to be world leaders in water management, producing Canadian energy with no adverse impact on water.
IN SITU BEST PRACTICES WORKING GROUP

PROJECT DESCRIPTION

The In Situ Best Practices Working Group (WG) is an excellent example of collaboration, bringing together oil sands operators to share their practices and technologies and accelerate the dissemination of knowledge and information. The WG organizes annual forums to allow direct interaction between personnel from the various COSIA companies to discuss water-related issues.

The 2015 knowledge-sharing forum presented topics associated with boiler feed water practices, seeded slurry evaporators, an update on process water coolers, state of the technology for membranes, water treatment, and increased steam quality. The 2016 focus is on sharing information on tracking of fouling within steam generators and ion exchanger operational performance. A knowledge-sharing workshop is scheduled for November 2016.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Operational reliability improvements can be directly related to environmental benefits.
• Identify operational and/or technology improvements that can be implemented relatively quickly and will incrementally improve environmental performance.

BUSINESS BENEFITS

• The Best Practices WG allows companies to learn from successes and failures that other members have experienced through day-to-day operation of their facilities. Sharing practical knowledge contributes to lowering the risk associated with the deployment of new practices, and accelerating the pace of such deployment.
• Cost savings are also realized through improved operational performance.

OPPORTUNITY AREA:
SHARING BEST PRACTICES

LEAD COMPANY: ConocoPhillips
OTHER PARTICIPANTS: BP, Canadian Natural, Cenovus, Devon, Imperial, Nexen, Shell, Statoil, Suncor, Teck, Total

MINING-RELATED WATER ISSUES

Water Best Practices WG has two parallel groups – one focused on in situ operations, the other on water issues related to mining. This group, led by Shell, is focused on areas of interest in both upgrading and extraction. Topics include coordinated work on two to three high-priority topics such as improvements in mine water management that can lead to environmental performance improvements, and best practices in water quality sampling and analysis.

This Working Group is an excellent example of collaboration, bringing together oil sands operators to share their practices and technologies and accelerate the dissemination of knowledge and information.
MINE DEPRESSURIZATION WATER MANAGEMENT STUDY

PROJECT DESCRIPTION

COSIA members completed a feasibility study to assess options for the management of saline Basal McMurray groundwater that is depressurized during mine development. The assessment of each option considered application of the principles of water reduce-reuse-recycle-return.

Basal McMurray groundwater naturally seeps into the Athabasca River. One option this study considered was the feasibility of depressurization water treatment and release (or return) to the Athabasca River. Compared to other options that were assessed, the study concluded that the treatment and return of depressurization water to the Athabasca River watershed was preferred based on environmental and economic considerations. The work completed by COSIA for the return option addressed alignment with current regulatory requirements, regional salt management, substance load allocation, technology and sector-based effluent quality objectives.

Near-field modelling of a hypothetical return of high salinity depressurization water to the Athabasca River was undertaken using the Cornell Mixing Zone Expert System (CORMIX). The model was used to characterize the mixing of high salinity depressurization water. It demonstrated that effects to aquatic organisms would not occur downstream of the hypothetical return location and concentrations of the release constituents would be substantially reduced within a very short distance downstream.

COSIA members may need to undertake additional evaluation to understand the applicability of the study results and any constraints related to their specific operations and site-specific basal water chemistry.

OPPORTUNITY AREA:
WATER RETURN, SITE-WIDE WATER MANAGEMENT

PARTICIPANTS: COSIA, Canadian Natural, Imperial, Shell, Suncor, Syncrude, Teck, Total

WHAT IS DEPRESSURIZATION WATER?

Basal McMurray groundwater naturally seeps into the Athabasca River and contributes to the quality and flow in the river. The groundwater has naturally elevated concentrations of sodium chloride and sodium bicarbonate (essentially table salt and baking soda, respectively), which are common constituents released into riverine aquatic environments such as the Athabasca River. Groundwater within overburden and bitumen deposits must be removed prior to mining, to facilitate safe and efficient mine operation.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Enhanced understanding of practical, efficient options for water treatment and management of mine depressurization water.
WATER & ENERGY RECOVERY FROM FLUE GAS SCOPING STUDY (IN SITU)

PROJECT DESCRIPTION

Oil sands boilers and steam generators produce large quantities of hot water vapor within the flue (exhaust) gases that are vented to the environment. If some of this waste heat and water can be recovered, fuel requirements, greenhouse gas (GHG) emissions and makeup water could be reduced. While research on capturing waste heat is being conducted globally, the level of research on technologies that recover both water vapor and a portion of the associated heat from flue gas is less clear. Technologies are evolving continually and, as an industry, producers should be able to identify current commercial opportunity and status of new and emerging technologies which may impact the feasibility of flue water and energy recovery.

In 2016, the COSIA Water Environmental Priority Area (EPA), in partnership with Mitacs, worked with the University of Calgary to complete a technology scan and evaluation of flue gas water and energy recovery technologies. The study identified commercial technologies as well as technologies currently in development that are showing promise to address this opportunity. The technologies were ranked for their applicability to oil sands operations and shortlisted for further study. This work was completed in September 2016.

AI-EES and COSIA are partnering to advance a second stage of work, which will carry out a technologic and economic evaluation of the most promising technologies integrated into in situ and mining operations. This will include evaluation of water and GHG reduction, impact on Criteria Air Contaminants emissions, and capital and operating costs.

OPPORTUNITY AREA:
WATER RECOVERY FROM FLUE GAS

LEAD COMPANY: Canadian Natural
OTHER PARTICIPANTS: BP, Imperial, Shell, Statoil, Suncor; Alberta Innovates - Energy and Environment Solutions (AI-EES)

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS
• Improve water and energy recovery for re-use, reducing requirement for make-up sources and lowering greenhouse gas emissions.
• Decrease land footprint with less infrastructure requirements, such as fewer make-up source wells.

BUSINESS BENEFITS
• Potential for overall less capital expenditures required for new infrastructure

If waste heat and water can be recovered from flue gas, fuel requirements, greenhouse gas emissions, and make-up water could be reduced.
SAIT CHAIR - LAB-SCALE ONCE-THROUGH STEAM GENERATION (IN SITU)

PROJECT DESCRIPTION

The intent of this project is to further understanding of fouling in once-through steam generators (OTSGs), specifically related to boiler feed water (BFW) composition, allowing operators to improve the steam generator reliability.

ConocoPhillips developed a lab-scale OTSG tube ("test loop") to replicate OTSG fouling that is observed at their Surmont facility. The test loop has been operating at their research facility in Bartlesville, Oklahoma for a number of years. The test loop design was contributed to COSIA in 2016. Under this project, a similar OTSG test loop will be installed in collaboration with SAIT Polytechnic in Calgary, to further evaluate OTSG scaling. A suite of tests will be developed to evaluate the effects of operating with various BFW conditions including high silica, high magnesium, high particulate hardness versus dissolved hardness. This equipment can also be used to evaluate the effectiveness of BFW chemical additives.

Project goals include:

• Furthering industry knowledge of preferred OTSG operating conditions.
• Challenging current operating practices and BFW specifications.
• Improving operator response to maximize steam output.
• Testing water from various in situ facilities.
• Sharing knowledge across the industry.
• Teaching SAIT students about steam generation from non-pristine waters.

OPPORTUNITY AREA: STEAM GENERATION

LEAD COMPANY: ConocoPhillips
OTHER PARTICIPANTS: BP, Canadian Natural, Cenovus, Devon, Imperial, Nexen, Shell, Statoil, Suncor, Teck, Total; Alberta Innovates - Energy and Environment Solutions (AI-EES), SAIT Polytechnic, Natural Resources and Engineering Research Council (NSERC)

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Steam generators must be taken offline periodically for cleaning, leading to inefficiencies in the operating facility and requiring incremental re-heating of bitumen reservoirs. This project aims at improving steam generator operation to increase the time between cleanings, and reduce the environmental impact of taking steam generators offline.
• Improving steam quality output from SAGD facilities has tremendous impact on reducing boiler blowdown volumes, while improving water use intensity and reducing greenhouse gas emissions intensity.

BUSINESS BENEFITS

• More efficient, reliable, lower-cost operations.
NATURAL AND ANTHROPOGENIC INPUTS INTO THE ATHABASCA RIVER (MINING)

PROJECT DESCRIPTION

The Athabasca River system receives inputs from both natural and human (anthropogenic) sources. The former includes inputs from groundwater, precipitation, runoff, and tributaries, while the latter includes oil sands development, municipal development, forestry, and gravel mining. Past investigations have identified large natural discharges of water that has naturally contacted bitumen, resulting in natural hydrocarbon contributions to the Athabasca River. This raises questions about the role natural processes play in contaminant loading to the Athabasca system. Recent natural events such as wildfires have likely also increased natural contaminant loadings to the river.

This study seeks to understand all sources of various inputs. The study focus area is the Lower Athabasca region from Fort McMurray to the Firebag River. Objectives of this study include:

• Conduct desk-top and field-based studies to enhance physical, chemical, and biological understanding of the lower Athabasca Study area.
• Assess the relative contribution of salinity, selected trace elements, and dissolved organics to the Athabasca River system from natural and anthropogenic sources.
• Assess the relevance of natural versus anthropogenic contributions in relation to potential impacts, if any, to water quality and biological receptors.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Provide an understanding of natural and anthropogenic impacts on the Athabasca River and its tributaries.
• Provide knowledge and information that can assist government and industry to balance economic development, social well-being, and environmental management and protection.

BUSINESS BENEFITS

• Natural water resources such as surface water, precipitation runoff, and groundwater within oil sands developments are currently stored on site or managed prior to release to the river system. There is potential to expedite progressive reclamation activities by reducing on-site water containment requirements.

OPPORTUNITY AREA:
REGIONAL WATER RESOURCE MANAGEMENT

LEAD COMPANY: Syncrude
OTHER PARTICIPANTS: Canadian Natural, Shell, Suncor, Teck, Total; Alberta Innovates - Energy and Environment Solutions (AI-EES), University of Alberta

COMPLEX INPUTS

Understanding how anthropogenic emissions are influencing the Lower Athabasca River ecosystem must be balanced with an understanding of how natural emissions of similar constituents influence the same system. The landscape is covered by muskeg and underlain by bituminous sands. The complex chemical and biological nature of the problem, the spatial range and remoteness of many sites in this area, and the presence of natural seeps that contribute salts and complex dissolved organic mixtures to the watershed, have contributed to generally poor understanding of natural inputs.
WATER CHEMISTRY EVALUATION OF OIL SANDS PROCESS-AFFECTED WATER (MINING)

PROJECT DESCRIPTION

End-pit lakes (EPLs) are currently a major strategy for long-term remediation of oil sands process water (OSPW). The purpose of this work is to build upon previous work to further understand the chemical constituents that impart toxicity to OSPW, their aquatic persistence, and bioaccumulation potential.

This COSIA project involves strategic, large-scale fractionation of the complex mixture of organic compounds in oil sands process water into sub-fractions, then testing for aquatic toxicity and mode of toxic action using recently developed state-of-the-art analytical chemistry methods developed by researchers at the University of Alberta. This process will then be repeated, taking the most toxic primary fraction(s), and sub-fractionating them into secondary fractions, which will be chemically characterized and tested again for aquatic toxicity and mode of toxic action. In this manner, the source of toxicity can be narrowed. Parallel studies will rank the most bioaccumulative and biopersistent compounds.

POTENTIAL/ACUTAL ENVIRONMENTAL BENEFITS

- Identifying toxic, persistent, and bioaccumulative compounds in oil sands process water will allow development of focused monitoring and water management strategies including expected lake development timeframes.

BUSINESS BENEFITS

- Pit lakes are planned across the oil sands region. Understanding the water chemistry will aid industry and regulators in managing this reclamation technology to help ensure EPLs are suitable features in the closure landscape.

OPPORTUNITY AREA:
CHEMISTRY AND IMPACTS OF PROCESS-AFFECTED WATER, PIT LAKES

LEAD COMPANY: Syncrude
OTHER PARTICIPANTS: University of Alberta, University of Saskatchewan
TREATMENT OF OIL SANDS PROCESS WATER USING TREATMENT WETLANDS (MINING)

PROJECT DESCRIPTION

This is a three-year research project being conducted at South Carolina’s Clemson University to evaluate the efficacy of engineered wetlands to treat oil sands process water (OSPW) for re-use or release. OSPW contains constituents of potential concern (COPCs) that may require treatment prior to being returned to the natural environment. Using an engineered wetland to treat COPCs is a proven technology for other industrial waters, but has not been demonstrated for OSPW or in the northern climate where oil sands operations are located. Clemson University is researching, identifying and designing the wetlands at a proof-of-concept scale. Site implementation is the ultimate objective of this research.

POTENTIAL/ACTIONAL ENVIRONMENTAL BENEFITS

- Developing a potentially effective method to treat water that is primarily passive (i.e. low energy requirements, low GHG emissions) and integrates green infrastructure components into the design.
- Releasing treated OSPW to the environment would reduce the operational footprint associated with large inventories of stored process water, and facilitate faster reclamation.
- Treatment wetlands can be developed to become an integral component of a mine’s final closure and reclamation landscape, supporting biodiversity.

OPPORTUNITY AREA:
CHEMISTRY AND IMPACTS OF PROCESS-AFFECTED WATER, PIT LAKES

LEAD COMPANY: Shell
OTHER PARTICIPANTS: Suncor, Clemson University

BUSINESS BENEFITS

- Because treatment wetlands can be engineered an as integral component of a final closure and reclamation plan, the technology provides dual benefits: an operational water management tool, and final reclamation and closure outcome.
- Research to date indicates the effectiveness of treatment wetlands is high and may be coupled with other technologies to create hybrid water management systems.
- Wetlands have a positive reputation, are moderate in cost, and may assist in storing carbon as a secondary benefit.

Wetland vegetation research into the treatment of oil sands process water.
Photo credit: Clemson University.
CHARACTERIZING AQUATIC TOXICITY OF ACID-EXTRACTABLE ORGANICS – MODELING & PASSIVE SAMPLING APPROACHES (MINING)

PROJECT DESCRIPTION

Acid-extractable organics (AEOs), including naphthenic acids (NA), are a class of compounds in oil sands process water (OSPW) that have been identified as responsible for aquatic toxicity concerns. AEOs are a diverse and complex mixture of constituents that vary in composition and aquatic toxicity, thus complicating development of water quality guidelines. Lack of guidelines and standardized analytical methods currently limit the ability to consistently evaluate the effectiveness of treatment options and potential suitability of OSPW for future discharge to the environment. There is a critical need to develop water quality criteria for these organic chemicals to ensure long-term responsible management of OSPW.

The objective of this work is to evaluate a framework for establishing environmental quality benchmarks for AEOs, which will be used to inform regulatory decision-making with respect to mine water return and restoration goals.

This project applied a mechanistic toxicity model – the Target Lipid Model (TLM) – to evaluate the relationship between the structure of AEO constituents and toxicity. This work demonstrated that toxicity for the types of organic chemicals found in OSPW behaves in a predictable manner. Further, analysis of these data using the TLM provided a basis for characterizing the relative sensitivity of aquatic species exposed to representative AEO and NA chemicals. This provides a strong basis for developing water quality guidelines protective of a variety of aquatic species.

A complementary passive sampling technique was also evaluated as a potential surrogate measurement of the bioavailability of AEO mixtures. The theory is that organic chemicals in the OSPW partition to the passive samplers in proportion to both their abundance and physicochemical properties. This methodology was evaluated using representative compounds and well characterized AEO extracts. The passive sampler based results successfully characterized the aquatic toxicity of the AEO constituents in this study.

The main outcomes of this work are:

- Modelling analysis to relate chemical structure to toxicity of AEO constituents.
- Establishing relative sensitivity of aquatic organics exposed to AEO constituents.
- Demonstrating passive samplers as a convenient surrogate measurement of bio-available AEOs.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- More effective, targeted water treatment and management.
- Reduced reliance on vertebrates for toxicity testing.

BUSINESS BENEFITS

- Project will support potential mine water return by establishing defensible water quality benchmark that will support regulatory applications to enable water managers to treat and discharge process water to the environment.
- Use of passive samplers will significantly reduce the analytical turnaround time requirements from seven days to less than two days.

Ranking of relative sensitivity of aquatic organisms exposed to AEO constituents (●) and other organic chemicals (▲) as determined by the TLM.
Environmental Priority Area

Tailings

We will strive to transform tailings from waste into a resource that speeds land and water reclamation.
TAILINGS CONSOLIDATION CASING EXPERIMENTAL PROJECT PILOT AND 3-METRE GEOCOLUMNS

PROJECT DESCRIPTION

Tailings deposits are either coarse-dominated or fines-dominated. Fines-dominated tailings will be a significant portion of the industry’s tailings deposits that will need to be reclaimed as landforms. Fines-dominated tailings tend to retain water, which makes it difficult to construct durable landforms that maintain their consistency and shape.

Two approaches for dealing with fine tailings that contain large quantities of water are centrifuging to drive the water out, and the addition of flocculant that encourages the fines to aggregate and dewater more quickly.

The laboratory-scale tailings consolidation project is designed to understand the long-term consolidation behaviours of fine fluid tailings (FFT) centrifuge cake, and to evaluate performance of new flocculants.

The lab-based research has been expanded to include a field-scale pilot project that involves eight columns, each 10 metres tall by three metres in diameter. The columns were filled with centrifuged FFT and flocculated FFT using a number of different polymer types. Instruments were installed to monitor geotechnical performance. The columns are an analogue to deep fines-dominated deposits that will be reclaimed as different landform types.

The geotechnical information from these projects will be used to better determine how soon deposits are ready for reclamation. This in turn will enable long-term planning to schedule tailings deposition that will ensure final landform objectives are met at commercial scale.

BUSINESS BENEFITS

• Confidence in meeting closure and reclamation plans and final landform objectives.
• Increased knowledge in the area of cohesive deposit consolidation in oil sands.

OPPORTUNITY AREA:
DEPOSITION AND PLACEMENT

LEAD COMPANY: Shell
OTHER PARTICIPANTS: Suncor

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Provides industry with the basis for decision-making regarding centrifuged FFT placement, capping and drainage management options to create targeted landforms.
• A reasonably scaled deposit provides increased confidence in tailings management that substantially reduces environmental footprint and improves cost efficiency.
• Offers insight into fines-dominated deposit performance variables that, in turn, may initiate new fundamental geotechnical research work.

This field-scale pilot project involves columns that are 10 metres tall by three metres in diameter.
EVALUATION OF ONLINE IN-PIPE K40 ANALYZER

PROJECT DESCRIPTION

Potassium-40 (K40) is commonly found in clays present in oil sands fluid fine tailings (FFT). Gamma ray spectroscopy can be used to quantify concentrations of K40 in tailings without direct sampling. This project is designed to investigate whether K40 spectral intensity can be used as a surrogate to measure the proportion of fines in tailings, which in turn could be used to determine coagulant or flocculent dosages required to treat FFT. This project will evaluate the K40 analyzer as an online / real-time tool to quantify clay minerals in FFT, to improve the real-time process control for tailings treatment and allow ongoing adjustment for optimum tailings treatment.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Improved understanding of tailings treatment leading to more effective flocculation and reclamation.

BUSINESS BENEFITS

• Improved process control and tailings treatment will reduce treatment costs.

OPPORTUNITY AREA:
WATER-SOLIDS SEPARATION PROCESS (FINES)

LEAD COMPANY: Shell

Using an online, real-time analysis tool can result in improved understanding of tailings treatment, leading to more effective flocculation and reclamation.
PERMANENT AQUATIC STORAGE STRUCTURE FOR MATURE FINE TAILINGS

PROJECT DESCRIPTION

The Permanent Aquatic Storage Structure (PASS) project is focused on treating fluid fine tailings (FFT) prior to deposition in an aquatic landform, such that the landform can be reclaimed shortly after mine closure to a lake capable of supporting a vibrant aquatic ecosystem. By recombining tailings and water treatment technologies that have been deployed in the industry over the past 20 years, the PASS treatment process is conceived to accelerate the reduction of FFT, as well as immobilize substances that would be of concern in an end-pit lake. Substances such as residual hydrocarbons, regulated metals, and organic acids are sequestered within the FFT mineral matrix prior to deposition.

The PASS project is being implemented through a staged process:

- Stage 1 - treatment concept selection.
- Stage 2 - bench scale testing.
- Stage 3A - laboratory continuous pilot.
- Stage 3B - field prototype.

Significant progress was made in 2016 with the completion of the Stage 3A laboratory pilot. A field prototype (Stage 3B) will be built in 2017 and monitored over a 15-year period.

BUSINESS BENEFITS

- The rapid FFT volume reduction in-pit enables better management of FFT inventory with better quality water entering the process water loop.

OPPORTUNITY AREA: DEPOSITION AND PLACEMENT (MINING)

LEAD COMPANY: Suncor

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- Placing rapidly settling FFT in-pit, with good release water quality, allows a significant reduction in the disturbed footprint during the mine life. The rapid water release during operation reduces the need for fresh water intake for the bitumen extraction process.
- PASS was developed with mine closure in mind. By immobilizing substances of concern before deposition, the PASS landform would be "Ready for Reclamation" to a lake shortly after closure. Once reclamation is complete, the lake becomes part of the natural landscape.
- Provide logistical guidance on how to optimize the technology so it can be successfully deployed at a commercial scale.

Jackpine spruce seedlings on a Suncor tailings pond.
The continuous improvement of tailings management is an integral component of successful oil sands mining operations. Reducing the size and need for tailings ponds, and accelerating reclamation, are ongoing challenges.

Since 2001, Canadian Natural has been developing the concept of producing non-segregating tailings (NST) as part of their oil sands extraction process at their Horizon oil sands operation. After several research and development projects at lab and pilot scales, full-scale production of NST started in September 2015.

NST are tailings that have been significantly treated (dewatered) to form a homogeneous, semi-cohesive mass when deposited. NST production involves dewatering whole tailings. The process includes cyclones to separate coarse sand, and thickeners to capture and remove water from the fines in the tailings streams prior to recombinant tailings being sent to the tailings pond. The warm water that is recovered is then re-used in the bitumen recovery process. In addition, carbon dioxide (CO₂) is injected into the tailings stream to further assist in fines capture. Purchased CO₂ will soon be replaced by captured CO₂ from the upgrader.

The objective of this project is to achieve commercially feasible NST production, as well as to meet material specifications and regulatory requirements for tailings management and reclamation.

The success of the process will be measured in terms of NST density – higher density indicates that more water has been removed, resulting in a stronger NST and greater fines capture. Another objective of this project is to meet Horizon’s high reclamation criteria.

**POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS**

- Accelerate reclamation of tailings ponds.
- Reduce fluid tailings through increased fines capture.
- Reduce water usage by increasing water recycling.
- Reduce GHG emissions.

**BUSINESS BENEFITS**

- Reduced fluid tailings volumes and accumulation.
- Reuse process water.
- Reduce long-term tailings pond management costs.
COSIA 2016 PROJECT PORTFOLIO

NST DEPOSITION MONITORING

PROJECT DESCRIPTION

Non-segregating tailings (NST) are the primary technology selected by Canadian Natural to minimize production of fluid tailings (FT) at their Horizon oil sands operation. Horizon began transitioning from whole tailings to NST in 2015 and all future tailings produced will be NST. Canadian Natural plans to operate five NST trains by Q1 2017, three of which are currently in operation.

Horizon’s closure and tailings management plan depend on NST consolidation performance. To evaluate that performance, monitoring stations were installed near the vicinity where on-spec NST is poured. The online NST deposition performance monitoring system consists of five poles (installed in the tailings pond in early 2015), each equipped with a power supply, a modem to transmit data, and specialized sensors and instrumentation that collect data about the tailings. The system allows for observations at various depths as the pond fills with tailings.

Data from the monitoring system is combined with information from other sources, such as pond elevation surveys, to obtain readings on the solids content of the deposit. The information is used to indicate when NST is ready to enter a reclaimed state. Quantifying the amount of consolidation and strength gain of the deposit due to downward and upward drainage will be an extremely important element of tailings management planning as Canadian Natural moves forward with this technology.

The objectives of this project are to monitor NST placement, determine consolidation of the deposit over time (NST strength gain, pore pressure and effective stress of the tailings), and monitor NST deposit water content.

OPPORTUNITY AREA:
DEPOSITION AND PLACEMENT

LEAD COMPANY: Canadian Natural

POTENTIAL/ACTUAL BENEFITS

• Monitor NST readiness to accelerate reclamation.
• Provide data for understanding and optimizing tailings performance.
• Improve tailings technologies management.

BUSINESS BENEFITS

The benefits of the NST process include:

• Reduced fluid tailings volumes and accumulation.
• Reduced tailings pond size.
• Reuse process water.
BASE MINE LAKE DEMONSTRATION

PROJECT DESCRIPTION

When an oil sands mine reaches the end of its life, the operator is required to fully reclaim the land to equivalent land use capability. All closure landscapes plans include pit lakes. These features can be used as a method for treating process-affected water, sequestering tailings, and as hydrologically and ecologically sustainable landscape components.

COSIA has projects underway to build scientific knowledge about pit lakes. The first commercial scale demonstration is Syncrude’s Base Mine Lake (BML).

The BML was one of Syncrude’s original mine pits. After the mining operation finished in 1995, Syncrude placed untreated fluid fine tailings (FFT) at the bottom of the mined-out pit. When placement was complete in 2012, the pit contained about 45 metres of this material, as well as approximately five metres of process-affected water on top of the FFT. In 2013, Syncrude added fresh water to bring the level to the final designed elevation.

Extensive monitoring of the BML, supported by in-depth research, will help researchers better understand the processes through which the lake undergoes natural biological development. The data and knowledge will be shared with government, academia and peer industry partners.

The BML project was initially intended to validate water capping of FFT, to demonstrate that:

- The FFT will remain on the bottom and will dewater and densify over time.
- Water quality will improve.
- The lake will be a functioning aquatic feature in the closure landscape.

OPPORTUNITY AREA:
WATER-SOLIDS SEPARATION,
DEPOSITION AND PLACEMENT, CAPPING FOR RECLAMATION

LEAD COMPANY: Syncrude
OTHER PARTICIPANTS: Canadian Natural, Imperial, Shell, Suncor, Teck

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

- The outcome of this demonstration end-pit lake will provide operators with information on the design and operating parameters for their intended pit lakes, including calibrated and validated models that could be applied to a range of design and operational strategies.

BUSINESS BENEFITS

- Ongoing and future research crosses three COSIA EPAs, with collaboration and contribution across the Tailings, Water and Land EPAs.
- Many end-pit lakes are planned for the region. While the majority are likely to contain treated tailings, the BML demonstration provides valuable information on the design and performance of an end pit lake containing untreated (unflocculated) tailings.

Extensive monitoring of Syncrude’s Base Mine Lake, supported by in-depth research and computer modeling, will help researchers understand the lake’s ongoing natural biological development.
CO-MIXING OF FLUID FINE TAILINGS AND OVERBURDEN

PROJECT DESCRIPTION

In surface mining operations, overburden material is removed to expose oil sands ore. This project is evaluating the technique of mixing dry overburden with fluid fine tailings (FFT) in an effort to absorb water from the FFT, essentially trapping FFT in overburden void spaces, resulting in a stable and readily reclaimable deposit. Co-mixing means that very soft or fluid tailings are mixed with a more solid component.

The project will monitor the strength gain of the co-mixed material over time, to determine the mixtures’ geotechnical performance and ability to support various landform designs. The pilot also tested the effectiveness of on-belt mixing.

A field test was conducted in 2014, using FFT with four different moisture levels. The FFT was sprayed directly onto dry overburden on a conveyor belt, and the resulting mixtures were deposited in four separate cells. In 2015 the cells were tested for a number of parameters and a second round of field tests was conducted in the third quarter of 2015.

Testing of the field pilot cells indicates that co-mixing is a robust technology for capturing fines in tailings, resulting in a trafficable surface that can be reclaimed sooner than using other disposal methods. Next steps include:

• Deposit sampling in 2016.
• Test site reclamation in 2016 – capping with subsoil and a layer of peat, and developing a revegetation plan.

OPPORTUNITY AREA:
WATER-SOLIDS SEPARATION, DEPOSITION AND PLACEMENT, CAPPING FOR RECLAMATION

LEAD COMPANY: Syncrude
OTHER PARTICIPANTS: Suncor

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS
• Potential for improved tailings management and faster surface reclamation.

BUSINESS BENEFITS
• Use of overburden, a readily available material, may help lower cost and improve tailings treatment and reclamation efficiency.
COLLABORATION AT CANADIAN NATURAL’S APPLIED PROCESS INNOVATION CENTRE

PROJECT DESCRIPTION

Testing and developing technological and process improvements in tailings management practices requires access to authentic samples, high quality industrial equipment, and knowledgeable personnel. Canadian Natural’s Applied Process Innovation Centre (APIC) is a 3,600-square-foot research facility at Canadian Natural’s Horizon oil sands site. Operational since June 2015, APIC is a dedicated and secure facility with the mandate to investigate, enhance and accelerate the application of promising technologies to a commercial scale.

APIC was designed and equipped to perform a variety of tests and programs including analysis of mixing systems, evaporation and drying analysis, production of non-segregating tailings (NST) for testing, and production of thickened tailings. The facility also facilitates collaboration on research projects not only with industry, but with academia and government as well.

The key word in the test facility’s name is “applied.” The focus is on developing technology that can be moved quickly from the lab and applied in the field. A good example is work on enhanced non-segregating tailings (NST) where the lab is focusing on enhancing fines capture in the NST. A number of products have been identified and a commercial-scale test will be completed in 2016 – less than a one-year turnaround.

APIC is facilitating collaboration on research projects with industry, academia and government. Imperial Oil Limited wanted to conduct targeted research using tailings from its Kearl oil sands operation, and the APIC offered an ideal space (see sidebar). Canadian Natural has also conducted volute screw press testing at the facility, a technology submitted by Dr. Xu at the University of Alberta. This is an exceptional example of how COSIA and member companies are working together to develop and prove technologies that ultimately advance the entire industry’s environmental performance. Shell, Suncor, Syncrude and Teck have also participated in, or made use of, the APIC facility.

POTENTIAL/ACTUAL ENVIRONMENTAL BENEFITS

• Improved understanding of tailings processes and treatments will lead to more efficient operations and should facilitate the eventual reclamation of tailings deposits.

OPPORTUNITY AREA:
ENHANCED DEPOSIT DENSIFICATION

LEAD COMPANY: Canadian Natural
OTHER PARTICIPANTS: Imperial, Shell, Suncor, Syncrude, Teck

BUSINESS BENEFITS

• Exceptional opportunities for collaboration and synergies between Canadian Natural’s test facility and research needs of other member companies.

IMPERIAL OIL RESEARCH AT APIC

Imperial led a Joint Interest Project at APIC from January through March 2016, bringing together its technical expertise with Canadian Natural and Teck researchers to advance tailings management research. Experiments conducted at the facility included:

• Thickener Operation Optimization - poor flocculant dosage control produces poor thickener performance. Process upsets may result in operational deviation such as high bitumen content in thickener feed or high fines feeds, which may affect thickener performance. Understanding the feed variability to a thickener is critical for control strategy development. This project was designed to study flocculant dosage control and thickener performance with varying feed and process parameters, identify critical process parameters and how to monitor them, and study bitumen content impacts on flocculation and thickener performance. The project involves lab-scale feed variability testing and developing an operation strategy with varying feed parameters.

• Re-Flocculation of Kearl Tailings - Imperial identified a number of tests using tailings from their Kearl oil sands operation. Canadian Natural’s APIC provided Imperial a secure location to test at a smaller but representative size to simulate the Kearl tailings treatment facilities. Research results provided insights into the operation of Imperial’s thickener program as well as industry’s first test of a continuously operated second stage flocculation of thickened tailings. This project evaluated flocculation, thickening, shearing, reflocculation and mixing of thickener, and tailings deposition.
ABOUT COSIA

Our Vision: To enable responsible and sustainable growth of Canada’s oil sands while delivering accelerated improvement in environmental performance through collaborative action and innovation.

Canada’s Oil Sands Innovation Alliance (COSIA) is an alliance of oil sands producers focused on accelerating the pace of improvement in environmental performance in Canada’s oil sands through collaborative action and innovation.

The alliance was launched March 1, 2012, when representatives of 13 companies came together in Calgary, Alberta to sign the COSIA charter, signifying their agreement with COSIA’s vision, their support of our alliance’s beliefs and their pledge to uphold the commitments put forward in the charter.

We bring together leading thinkers from industry, government, academia and the wider public to improve measurement, accountability and environmental performance in the oil sands in four priority areas. These four Environmental Priority Areas (EPAs) are tailings, water, land and greenhouse gases.

We accomplish this through a continued focus on collaboration and transparent exchange, by setting environmental performance goals and by reporting publicly on progress towards these goals. Progress towards these goals will be achieved by breaking down barriers to innovation, and by identifying, developing and applying solutions-oriented innovation to the most pressing oil sands environmental challenges.

COSIA has 13 members representing almost 90 per cent of the oil sands production in Canada. COSIA member companies have signed COSIA’s Charter and support the Alliance’s vision.

These companies, by becoming part of COSIA, share experience and intellectual property with other member companies. Through the sharing of innovation and application of these technologies, members accelerate the pace of environmental performance improvement.

COSIA brings companies together to share innovation and intellectual property related to COSIA’s Environmental Priority Areas. Sharing is done in a manner that values and protects corporate technologies, but still provides access for the COSIA companies who can apply and build on these technologies to accelerate environmental performance improvement in their operations.

To date, COSIA member companies have shared 936 distinct technologies and innovations that cost over $1.325 billion to develop. These numbers are increasing as the alliance matures and expands. Through this sharing of innovation and application of new technologies, members can accelerate the pace of environmental performance improvements.

For more on the work being done at COSIA visit our website: cosia.ca.

COSIA has 13 members representing almost 90 per cent of the oil sands production in Canada.