The OSRIN Story: Five Years of Creating and Sharing Oil Sands Environmental Management Knowledge

Oil Sands Research and Information Network

University of Alberta, School of Energy and the Environment

December 2014

Oil Sands Research and Information Network

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

OSRIN provides:

- **Governments** with the independent, objective, and credible information and analysis required to put appropriate regulatory and policy frameworks in place
- **Media, opinion leaders and the general public** with the facts about oil sands development, its environmental and social impacts, and landscape/water reclamation activities – so that public dialogue and policy is informed by solid evidence
- **Industry** with ready access to an integrated view of research that will help them make and execute environmental management plans – a view that crosses disciplines and organizational boundaries

OSRIN recognizes that much research has been done in these areas by a variety of players over 40 years of oil sands development. OSRIN synthesizes this collective knowledge and presents it in a form that allows others to use it to solve pressing problems.

Citation

This report may be cited as:

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Copies of this report may be obtained from OSRIN at osrin@ualberta.ca or through the OSRIN website at http://www.osrin.ualberta.ca/en/OSRINPublications.aspx or directly from the University of Alberta's Education & Research Archive at http://hdl.handle.net/10402/era.17507.

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REPORT SUMMARY

The Oil Sands Research and Information Network (OSRIN) was originally proposed to the Oil Sands Environmental Management Division of Alberta Environment by the School of Energy and the Environment (SEE), University of Alberta in December 2007. The need for OSRIN was described as follows:

> Currently, oil sands research occurs through a vast array of unconnected research groups, universities and funding bodies, both public and private sector. The challenge is thus to develop a structure that will provide coordination where necessary and increase efficiency of the research, while maintaining the entrepreneurial nature and benefits of current academic structures. The proposed network will provide a structure for the allocation of Government of Alberta research funds, to facilitate the leveraging of additional research funds (private sector and other), for integration and leveraging of research activities and for information management and dissemination. This structure will facilitate the management of knowledge transfer in order to ensure that science is progressing from one study to the next and facilitate the implementation of new knowledge in technology and environmental systems.

Alberta Environment and the University signed an agreement in March of 2008 to fund and implement the proposed network. The original term of the agreement was to the end of March 2013, however prudent allocation of funds meant that resources were available to continue beyond this date. As a result, Alberta Environment and Sustainable Resource Development extended the term of the grants until December 31, 2014.

This report summarizes the progress made by OSRIN from 2009 to 2014 in meeting its three mandates:

1. Creating oil sands environmental management knowledge by funding research – the emphasis was to be on mineable oil sands, not in-situ developments
2. Sharing oil sands environmental management information using a variety of different tools, and
3. Networking to help link researchers with funders and other researchers, and to enhance awareness of oil sands environmental management issues

The following achievements reflect OSRIN's efforts at meeting its mandates:

- 80 research projects and workshops funded
- 71 technical reports issued (one additional research report on heavy metals in mammals will be released early in 2015)
- 39,771 downloads of OSRIN technical reports, staff reports and videos
- 17 conferences sponsored

ACKNOWLEDGEMENTS

The Oil Sands Research and Information Network (OSRIN), School of Energy and the Environment (SEE), University of Alberta provided funding for this project.

OSRIN recognizes that its success is largely due to the valued guidance provided by the Board of Directors and the work of its researchers. Together we accomplished a great deal in a short period of time.

EXECUTIVE DIRECTOR'S COMMENTS

With 71 research reports issued, OSRIN contributed a significant amount of new knowledge to the oil sands community over the last 5 years. Our 11 workshops also provided a safe and engaging forum for discussion of a broad range of topics amongst stakeholders from diverse backgrounds.

But the one thing that made us different from all other research-focused entities (and there are lots of them serving the oil sands) was our passion for sharing knowledge with others and our recognition that older knowledge still has considerable value. I was heartened to hear from a number of people during December about how much they valued getting information from us through the Newsletter and our work digitizing older government and industry documents, and how much they were going to miss that service.

In a knowledge-driven sector like the oil sands there is a market for someone to consolidate and transmit easy-to-digest updates on research activities. There also remain a significant number of documents that could be digitized and made available as a public service to increase awareness of the breadth and depth of knowledge that has been gathered about the oil sands region.

1 INTRODUCTION

The Oil Sands Research and Information Network (OSRIN) was originally proposed to the Oil Sands Environmental Management Division of Alberta Environment by the School of Energy and the Environment (SEE), University of Alberta in December 2007. The need for OSRIN was described as follows:

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1.1 OSRIN Mandate

Taking its lead from the need described above, OSRIN identified three mandates:

1. Creating oil sands environmental management knowledge by funding research – the emphasis was to be on mineable oil sands, not in-situ developments
2. Sharing oil sands environmental management information using a variety of different tools, and
3. Networking to help link researchers with funders and other researchers, and to enhance awareness of oil sands environmental management issues

1.2 OSRIN Structure, Strategy and Oversight

OSRIN was intentionally designed as a lean organization to maximize the funds available to deliver its mandate. As a result OSRIN staff included an Executive Director[1] and an

[1] Dr. Stephen Moran was the original OSRIN Executive Director from 2008 to April 2010; Chris Powter was the Executive Director from April 2010 to December 2014.

administrative assistant (initially this was a full time position but was later converted to part-time)[2].

OSRIN spent considerable time in 2008 and 2009 devising a strategic approach to delivering its mandate[3]. OSRIN also established a Board of Directors to provide oversight and guidance on research priorities to SEE and the OSRIN Executive Director. The Board was chaired by the Executive Director of SEE[4]. The Board of Directors consisted of members representing relevant provincial government agencies (Alberta Environment and Sustainable Resource Development, Alberta Energy, Oil Sands Secretariat and Alberta Innovates – Energy and Environment Solutions) and the academic research community (University of Alberta, University of Calgary, Canada School of Energy and Environment Ltd. and NAIT). A full list of OSRIN Board members is provided in Appendix 1.

OSRIN recognized that oil sands environmental management research can be very expensive and can take considerable time to complete, especially if the focus of study includes field collection of data. Given its short time horizon and relatively small budget, OSRIN focused its efforts on smaller budget, short-term projects (Figure 1 shows that the majority of OSRIN-funded projects cost less than $50,000). This meant that most of the projects were targeted to preparation of knowledge synthesis documents (e.g., literature reviews, catalogues or workshops). However OSRIN did take advantage of opportunities to fund early-stage technology- and methodology-development projects, and to partner with other research funders on larger projects.

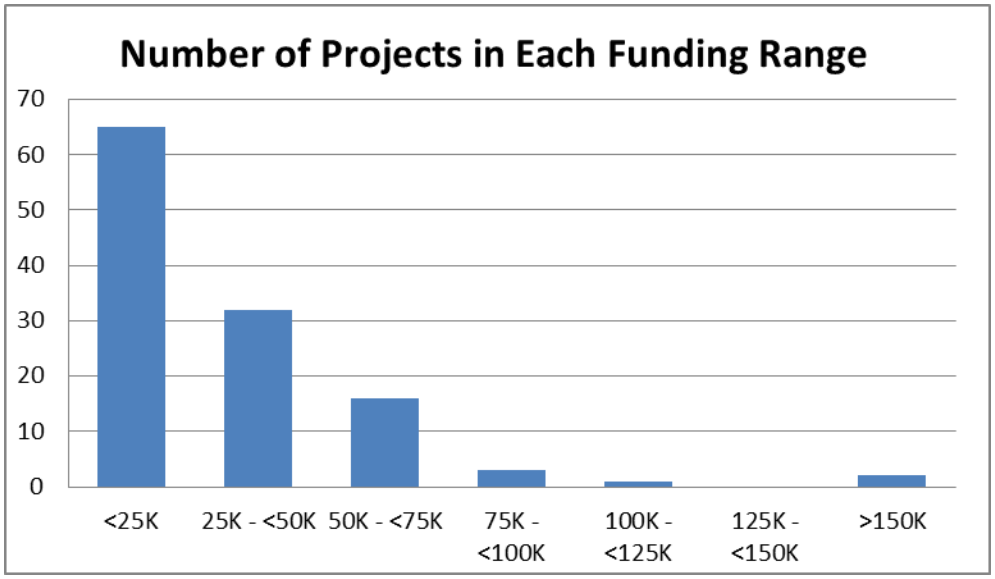

Figure 1. Scale of OSRIN funded projects.

[2] Administrative assistants were: Caroline Simpson, Doug Leung, Barbara LeFort and Tamara Day.

[3] See OSRIN, 2011. OSRIN's Design and Implementation Strategy. OSRIN Report No. SR-7. 10 pp. http://hdl.handle.net/10402/era.23574

[4] Originally Dr. Joseph Doucet and later Dr. Stefan Scherer.

In general, OSRIN took the view that its work would help set the stage for future efforts to be funded by organizations with access to larger pools of funding and longer time horizons.

1.3 Funding

OSRIN received two grants from Alberta Environment: $3,000,000 in FY2008/09 and $1,500,000 in FY2009/10. A $250,000 operating grant was received in FY2009/10 from the Canada School of Energy and Environment Ltd. These grants provide the core funding for delivering OSRIN's mandate.

OSRIN received additional funds in the form of:

- Interest on grant funds ($17,264.78)
- Grant from Sherritt Coal to support a project on use of LFH soil material for reclamation ($10,000)
- Contract income from the Cumulative Environmental Management Association and Alberta Environment ($11,837.50)
- Grant from ConocoPhillips to support a student oil sands tour ($5,000)
- Two donations from Barr Engineering of Calgary ($4,500)

Thus the total budget for OSRIN work was $4,798,602.08. Table 1 shows how OSRIN spent the funds to deliver its mandate.

Table 1: Allocation of funds from 2008 to 2014.

Cost Centre	$ Spent	% of Total $ Spent
Program Funding		
Strategic Design [1]	$138,604.59	2.9
Creating Knowledge [2]	$3,045,868.31	63.5
Sharing Knowledge [3]	$189,978.30	3.9
Overhead		
Payroll [4]	$1,323,667.51	27.6
Overhead [5]	$100,483.37	2.1
TOTAL	$4,798,602.08	

[1] Expenditures to establish OSRIN's structure and strategy, conduct a research and information needs survey, and transition the website to the Alberta Centre for Reclamation and Restoration Ecology

[2] Research project and workshop funding

[3] Conference and student support, website design, bibliography and digitizing historical reports

[4] Staff costs – Executive Director, Administrative Assistant, MBA students working on website design and content

[5] Travel, supplies, services, and other non-project related expenses

1.4 Funding Partners

OSRIN partnered with several agencies to fund research projects. In some cases OSRIN was the lead agency with the partners contributing lesser funding amounts and/or in-kind contributions, and in other cases OSRIN was a contributor to a larger project. In addition, many of the university researchers accessed other grant funds to support their projects.

Partners included:

Alberta Environment and Sustainable Resource Development

Alberta Innovates – Energy and Environment Solutions

Alberta Innovates – Technology Futures

Canada School of Energy and Environment Ltd.

Canada's Oil Sands Innovation Alliance

Canadian Environmental Assessment Agency

ConocoPhillips

Cumulative Environmental Management Association

Environment Canada	Oil Sands Leadership Initiative
Mount Royal University	Sherritt Coal
NAIT Applied Research Center for Oil Sands Sustainability	TECTERRA
Natural Resources Canada	University of Alberta

1.5 OSRIN Highlights

The following achievements reflect OSRIN's efforts at meeting its mandates:

- 80 research projects and workshops funded
- 71 technical reports issued (one additional research report on heavy metals in mammals will be released early in 2015)
- 39,771 downloads of OSRIN technical reports, staff reports and videos
- 17 conferences sponsored

OSRIN was particularly proud to have been ahead of key initiatives led by others. For example:

- Creating a world-class oil sands monitoring system – OSRIN's report was released in 2010 whereas the provincial panel report was released in 2011[5].
- Assessing oil sands tailings technologies – OSRIN's report was released in 2010 whereas the larger and more comprehensive Tailings Technology Deployment Roadmap reports were issued by Alberta Innovates – Energy and Environment Solutions in 2012[6].

OSRIN partnered with the Oil Sands Leadership Initiative on a major project assessing options for shipping tailings water to in-situ sites to replace groundwater sources for makeup water. Our report[7] was one of the early public descriptions of this important initiative.

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[5] See James, D.R. and T. Vold, 2010. Establishing a World Class Public Information and Reporting System for Ecosystems in the Oil Sands Region – Report and Appendices. OSRIN Report No. TR-5. 189 pp. http://hdl.handle.net/10402/era.19093 vs. Alberta Environmental Monitoring Panel, 2011. A world class environmental monitoring, evaluation and reporting system for Alberta: The report of the Alberta Environmental Monitoring Panel. Alberta Environmental Monitoring Panel, Edmonton, Alberta. 84 pp. http://environment.gov.ab.ca/info/library/8381.pdf

[6] See BGC Engineering Inc., 2010. Oil Sands Tailings Technology Review. OSRIN Report No. TR-1. 136 pp. http://hdl.handle.net/10402/era.17555 vs. Sobkowicz, J., 2012. Oil sands tailings technology deployment roadmaps. Project Report Volume 2 - Component 1 results. Alberta Innovates - Energy and Environment Solutions, Edmonton, Alberta. 102 pp. plus appendices. http://www.ai-ees.ca/media/7361/1906-component_1_report.pdf

[7] See Godwalt, C., P. Kotecha and C. Aumann, 2010. Oil Sands Tailings Management Project. OSRIN Report No. TR-7. 64 pp. http://hdl.handle.net/10402/era.22536

2 CREATING KNOWLEDGE

OSRIN's efforts in creating knowledge focused on funding research in four core program areas which are described in the next sections[8]. Within each program area OSRIN funded projects to scope out the state of knowledge, identify knowledge gaps, and provide insights regarding research priorities. OSRIN also directed funds to commission or support new work that expanded the knowledge base and filled in knowledge gaps.

In addition to the projects being situated within the umbrella program area there were often project linkages between program areas. Figure 2 shows how OSRIN's efforts formed an integrated, coherent research program.

Figure 3 shows the allocation of funding amongst the four core research program areas. In total OSRIN funded 80 research projects and workshops, and produced 71 technical reports. While the majority of OSRIN-funded research led to traditional technical reports, OSRIN also experimented with alternative formats, including:

- a brochure-style visual guide to use of woody materials for reclamation[9],
- a suite of Species Profile Sheets describing important characteristics of plants potentially relevant to oil sands reclamation[10], and
- a video on sampling reclaimed marshes[11].

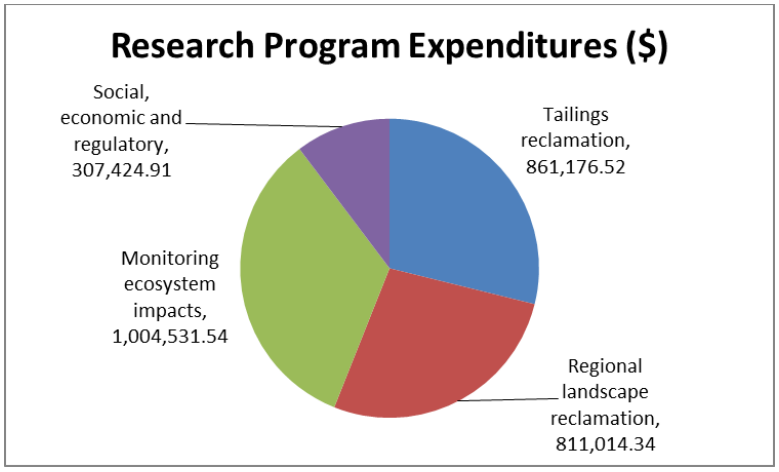

Figure 3. Research funding allocation amongst four core programs areas.

[8] OSRIN Annual Reports identified two additional funding areas (Increasing Awareness – reported here under Sharing Knowledge) and Strategic Design (reported as a separate line item in Table 1).

[9] See Pyper, M. and T. Vinge, 2013. A Visual Guide to Handling Woody Materials for Forested Land Reclamation. OSRIN Report No. TR-31. 10 pp. http://hdl.handle.net/10402/era.30381

[10] Available online in the OSRIN archives on the ACRRE website – http://acrre.ualberta.ca/

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

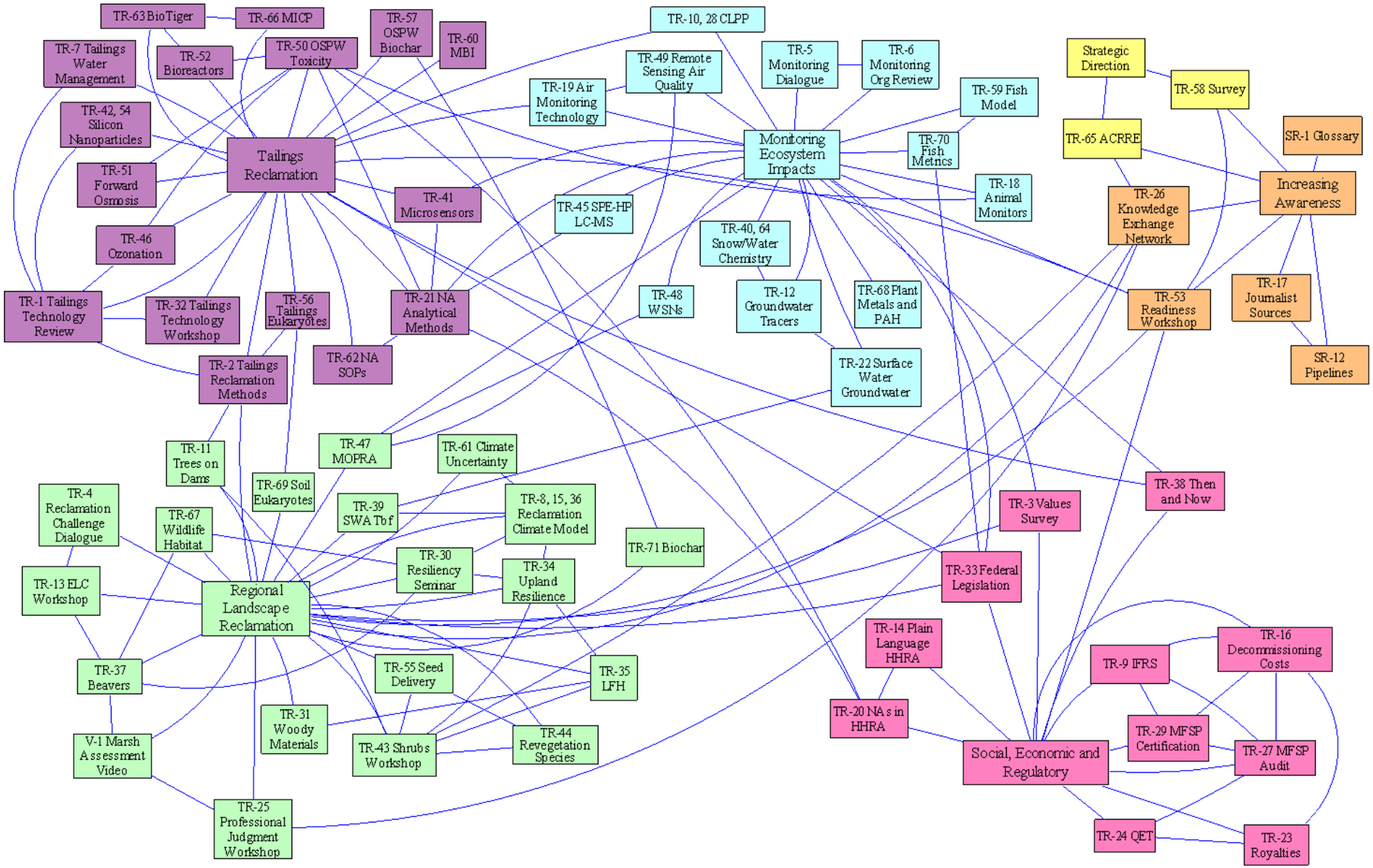

Figure 2. Linkages between OSRIN-funded project reports.

The following sections describe the goals of each core program area and provide examples of the range of projects conducted in each program. A full list of research reports is provided in Appendix 2; a compilation of the research report summaries is provided in OSRIN, 2011. Summary of OSRIN Projects – December 2014 Update. OSRIN Report No. SR-5. 130 pp. http://hdl.handle.net/10402/era.20529

2.1 Tailings Reclamation

This program sought to identify challenges that must be addressed in accelerating the reclamation of tailings ponds and tailings disposal areas and to catalyze necessary research, demonstration and development efforts to resolve them.

There were 20 projects funded (see Appendix 3 for the full list); some of the key projects include:

> BGC Engineering Inc., 2010. Oil Sands Tailings Technology Review. OSRIN Report No. TR-1. 136 pp. http://hdl.handle.net/10402/era.17555
> This report presents an in-depth review of the state-of-knowledge related to oil sands fine tailings treatment technologies. Thirty-four oil sands tailings treatment technologies are discussed and analyzed from a fundamental and practical point of view. The technologies were divided into five groups: (i) Physical/Mechanical Processes, (ii) Natural Processes, (iii) Chemical/ Biological Amendments, (iv) Mixtures/Co-disposal, and (v) Permanent Storage.
>
> Zhao, B., R. Currie and H. Mian, 2012. Catalogue of Analytical Methods for Naphthenic Acids Related to Oil Sands Operations. OSRIN Report No. TR-21. 65 pp. http://hdl.handle.net/10402/era.26792
> This report provides an overview of methods currently used for the analysis of the naphthenic acid (NA) class of compounds including sampling, sample preservation, sample transport, extraction and clean-up, analytical techniques, and future needs, with a major focus on NAs from oil sands process-affected water (OSPW). Issues affecting both qualitative and quantitative data from a variety of analytical methods are reviewed to generate an awareness of the challenges faced by laboratories conducting NA determinations. The report also highlights the issues of naming these compounds "naphthenic acids" since many of the compounds being extracted from OSPW do not conform to the classical NA formula.
>
> Li, C., A. Singh, N. Klamerth, K. McPhedran, P. Chelme-Ayala, M. Belosevic and M. Gamal El-Din, 2014. Synthesis of Toxicological Behavior of Oil Sands Process-Affected Water Constituents. OSRIN Report No. TR-50. 101 pp. http://hdl.handle.net/10402/era.39659
> Naphthenic acids (NAs) are widely considered as the major toxic components of Oil Sands Process-Affected Water (OSPW), exhibiting their toxic effects through multiple modes of action such as narcosis, endocrine disruption, and carcinogenicity. However, other pollutants present in OSPW, including polycyclic aromatic hydrocarbons (PAHs),

benzene, toluene, ethylbenzene, and xylenes (BTEX), phenols, dissolved ions, heavy metals, and other unknown constituents may also contribute to or modify the overall OSPW toxicity. Although specific information on the toxicity of the compounds present in OSPW is limited, they have been associated with a wide range of biological dysfunctions in exposed organisms, such as mutagenicity, carcinogenicity, immunotoxicity, and endocrine disruptive effects, caused by the organics (e.g., PAHs, phenols), and ionic imbalances induced by the high levels of total dissolved solids and salts. This report reviews the adverse effects of individual compounds, or mixtures of compounds, that are present in OSPW and/or other oil-related sources.

2.2 Regional Landscape Reclamation

This program focused on providing the knowledge necessary to support development of regional reclamation targets as well as site- and mine-level objectives.

There were 25 projects funded (see Appendix 4 for the full list); some of the key projects include:

BGC Engineering Inc., 2010. Review of Reclamation Options for Oil Sands Tailings Substrates. OSRIN Report No. TR-2. 59 pp. http://hdl.handle.net/10402/era.17547
This report is a scoping study of the state of knowledge related to technologies for reclaiming oil sands tailings substrates to upland boreal forests and wetlands. The objective is to help establish an understanding of the status of fine tailings reclamation technology in the Athabasca Oil Sands Region. Reclamation of fine tailings using a dry landscape scenario first requires stabilization of the deposit to allow access for heavy machinery (trafficability). Soil cover designs and revegetation prescriptions are used to reclaim the tailings substrate to an equivalent land capability or ecosystem function. Wetland design and upland forest reclamation are active areas of research in fine tailings reclamation, including the potential impacts of increased salinity on plant species selection, germination and growth.

Naeth, M.A., S.R. Wilkinson, D.D. Mackenzie, H.A. Archibald and C.B. Powter, 2013. Potential of LFH Mineral Soil Mixes for Land Reclamation in Alberta. OSRIN Report No. TR-35. 64 pp. http://hdl.handle.net/10402/era.31855
Recent research shows LFH mineral soil mix is a good source of propagules for native and woody species that are not readily available commercially or by wild collection. Most plants in LFH mineral soil mix establish from seed and resultant communities have greater plant cover, more upland species and fewer non-native species than with traditional peat mineral soil mix used in oil sands mines. Stockpiling before placement reduces seed viability and species diversity, thus direct placement is recommended although stockpiling still results in more diverse and abundant plant communities than peat mineral soil mix. Placement depth has greater effect on plant community development than salvage depth. Thresholds for salvage and placement have not been determined and are dependent on donor soil texture, ecosite, topography, forest type and substrate placed on. Short term research results (< 10 years) clearly show benefits of

LFH mineral soil mix for reclamation. However, whether short term effects will persist with time and lead to a more natural, diverse and sustainable plant community than conventional reclamation techniques is unknown. Enhanced soil properties and native regeneration strongly suggest reclaimed communities are on a trajectory towards the structure and function of self-sustaining natural forest.

Eaton, B., T. Muhly, J. Fisher and S-L. Chai, 2013. Potential Impacts of Beaver on Oil Sands Reclamation Success – an Analysis of Available Literature. OSRIN Report No. TR-37. 65 pp. http://hdl.handle.net/10402/era.32764

Mine sites will have to be reclaimed, and those reclaimed sites will consist of engineered landforms (including water bodies and waterways); the long-term hydrological and ecological function of those sites may be vulnerable to beaver activity. Beavers alter stream form and function, create wetlands, and change vegetation patterns. The most important predictor of beaver occurrence is stream gradient, with low gradients being associated with higher beaver activity. Stream depth and width, soil drainage, and stream substrate are also important. Reclamation of functional ecosystems in the region must therefore integrate beavers and their engineered structures. Ecological function requires the presence of beaver on the post-reclamation landscape, and the species is important to First Nations peoples and other trappers in the area. The most ecologically- and cost-effective approach is to design reclaimed areas with the objective of including beaver, but directing beaver activity to areas away from vulnerable reclamation structures. Although beaver abundance can be expected to increase in the area after reclamation, their activities will result in the replacement of existing vegetation with species of lower nutritional quality to beaver (conifer trees). This is expected to result in a beaver population decline and then stabilization over time. With beavers an integral component of the functional landscape, it is important to create "beaver exclusion zones" to ensure that the impact of the species is diverted to areas where beaver activity does not damage reclamation structures.

2.3 Monitoring Ecosystem Impacts

This program focused on components of a comprehensive, robust system in Alberta to monitor the effects of oil sands mining operations on ecosystem health – a system that is scientifically sound and has the confidence of the general public.

There were 19 projects funded (see Appendix 5 for the full list); some of the key projects include:

Gibson, J.J., S.J. Birks, M. Moncur, Y. Yi, K. Tattrie, S. Jasechko, K. Richardson, and P. Eby, 2011. Isotopic and Geochemical Tracers for Fingerprinting Process-Affected Waters in the Oil Sands Industry: A Pilot Study. OSRIN Report No. TR-12. 109 pp. http://hdl.handle.net/10402/era.23000

A pilot study was conducted during 2009 and 2010 to assess potential for labelling process-affected water from oil sands operations using a suite of isotopic and geochemical tracers, including inorganic and organic compounds in water. Overall,

while selected isotopic and geochemical tracers were found to be definitive for labelling water sources in some locations, it is unreliable to attempt any universal labelling of water sources based solely on individual tracers or simple combinations of tracers. Understanding of the regional hydrogeological system, and interpretation of tracer variations in the context of a biogeochemical systems approach on a case by case basis offers the greatest potential for comprehensive understanding and labelling of water source and pathways. While limited in number of samples, the survey demonstrates the complimentary use of various fingerprinting techniques. We find no evidence of robust connections between tailings ponds and the river seeps that were sampled over the 125-km reach traversing the oil sands development area, although many seeps were not sampled. Although the seeps we did sample appear to be directly related to occurrence of natural groundwater seepage, we do not have enough evidence at this point to rule out the possibility that minor or trace amounts of process-affected water may be present in some of these seeps.

Hashisho, Z., C.C. Small and G. Morshed, 2012. Review of Technologies for the Characterization and Monitoring of VOCs, Reduced Sulphur Compounds and CH_4. OSRIN Report No. TR-19. 93 pp. http://hdl.handle.net/10402/era.25522
A review was conducted to determine the available technologies for characterizing and measuring the flux of each of the three groups of pollutants (VOCs, reduced sulphur compounds, and methane). The review of the technologies included the following: a short description of the technology and its operating principle; instrument sensitivity (detection limit); advantages and limitations of the technique (performance, versatility, reliability); and cost, whenever possible. Costs do not include the labour to collect samples or the costs involved in running the analyses at other laboratories, as these are variable. However, such costs should be weighed when considering the application of the different technologies. Sample collecting procedures are important as they may affect the accuracy and precision of the technologies; these techniques are generally standard and have not been focused on for this report. The report concludes with recommendations for technologies to use for monitoring air emissions from oil sands tailings ponds based on the following factors: spatial coverage, quantification of the pollutants, determination of emission factor, characterization of VOC speciation, and frequency of monitoring. For a variety of reasons there may not be one technology that is best suited for emission measurements across the oil sands region, and it is important to understand the different advantages and limitations of the technologies when selecting an option and interpreting the resulting data.

Taheriazad, L., C. Portillo-Quintero and G.A. Sanchez-Azofeifa, 2014. Application of Wireless Sensor Networks (WSNs) to Oil Sands Environmental Monitoring. OSRIN Report No. TR-48. 51 pp. http://hdl.handle.net/10402/era.38858
This report presents a comprehensive review of industrial applications of an emerging environmental monitoring technology called Wireless Sensor Networks (WSN). This technology consists of a series of individual wireless nodes that have the capacity to

measure different micro-climatic as well as other chemical variables at costs that are significantly cheaper that current wired systems. This review describes monitoring in four main sectors: agricultural, environmental, forest, and industrial. The report reviews publications over the last 13-years; none of the case studies are from Alberta. Given current environmental monitoring needs, plus the large areal extent of the oil sands region, wireless sensor networks have the potential to support traditional monitoring networks. The federal/provincial oil sands environmental monitoring implementation plan specifically mentions the use of remote sensing tools to enhance the monitoring system.

2.4 Social, Economic and Regulatory

This program sought to identify social, economic and regulatory issues that may affect environmental management of oil sands and to evaluate the effectiveness of environmental management in addressing social, economic and regulatory issues.

There were 11 projects funded (see Appendix 6 for the full list); some of the key projects include:

Kindzierski, W., J. Jin and M. Gamal El-Din, 2011. Plain Language Explanation of Human Health Risk Assessment. OSRIN Report TR-14. 37 pp. http://hdl.handle.net/10402/era.23487

This report explains what a human health risk assessment is and how it is used to investigate the relationship between activities such as oil sands developments and human health risk. It focuses on oil sands developments; however the principles and procedures described here apply to any type of industrial development. A general overview of the human health risk assessment process is presented to help understand how it is done. Human health risk assessments are prepared by professional consultants (scientists and engineers) for government, industry and other organizations. This is done to help decision makers, especially policy makers and regulators, understand potential health impacts from the release of chemical pollutants into the environment by industrial operations. This type of information can help to inform policy and regulatory decisions that help protect people from chemical exposures as a result of pollution. Human health risk assessment procedures described here are normally accepted by regulatory agencies because they are, purposely, conservative. This conservatism makes it less likely to under estimate potential exposures and human risk and more likely that resulting regulatory decisions made will protect people from chemical pollution by industrial operations in real situations.

Dixon, R., M. Maier, A. Sandilya and T. Schneider, 2012. Qualifying Environmental Trusts as Financial Security for Oil Sands Reclamation Liabilities. OSRIN Report No. TR-24. 32 pp. http://hdl.handle.net/10402/era.28305

Funds set aside in a trust arrangement to ensure that a specific environmental liability will be paid for in the future are known as an environmental trust. Various versions of environmental trusts exist in tax jurisdictions throughout the world. Funds put into them

are usually deductible for income tax purposes, which is the case in Canada for Qualifying Environmental Trusts (QETs). A QET is an environmental trust as defined by the federal *Income Tax Act*. At the time of the introduction of the provincial government's new Mine Financial Security Program, qualifying environmental trusts (QETs) were added to the list of acceptable forms of financial security. At present, virtually all of the financial security is in the form of an irrevocable letter of credit (LOC). Funding of a QET for future suspension, abandonment, remediation and surface reclamation costs is immediately deductible for royalty and income tax purposes, thus we expect that as oil sands mines approach their end-of-life, the operators will establish QETs to avoid forfeiting the deduction of their suspension, abandonment, remediation and surface reclamation costs. The suspension, abandonment, remediation and surface reclamation liabilities that have accrued to the oil sands operators are now in the billions of dollars. If even a portion of these are funded by QETs, the effect on the amount of royalties and taxes flowing to the Government of Alberta will be in the hundreds of millions of dollars. Thus, understanding if and when oil sands operators will choose to use QETs is important for the forecasting of government revenues, particularly as oil sands royalties are now the single biggest contributor to Alberta's total royalty revenue.

Howlett, M. and J. Craft, 2013. Application of Federal Legislation to Alberta's Mineable Oil Sands. OSRIN Report No. TR-33. 94 pp. http://hdl.handle.net/10402/era.31627
This report examines the Government of Canada's legislation that may impact oil sands environmental management in Alberta. It focuses on the evolution, and current state of, pertinent federal legislative Acts in the environmental, natural resource, and energy policy sectors. Five Acts form the core of the review: the *Fisheries Act*, the *Canadian Environmental Protection Act*, the *Canadian Environmental Assessment Act*, the *Species at Risk Act*, and the *Migratory Birds Convention Act*. In particular, the report focuses on descriptively setting out the implications and potential impacts stemming from recent legislative changes spurred by the passage of the 2011 and 2012 federal 'omnibus' budget implementation bills (Bills C-38 and C-45, respectively). These bills not only amended a large existing suite of legislation in the environmental, energy, and natural resources sectors, they also created *new* legislation with direct implications for oil sands environmental management. The report concludes that recent legislative changes have increased uncertainty related to the application of federal legislation to oil sands development. This is due to the lack of precedent by which to understand its application, and because not all regulations have been brought into force. The report concludes this uncertainty is particularly acute for the reclamation and post-certification phase because of the limited reclamation and certification that has occurred to date.

3 SHARING KNOWLEDGE

OSRIN undertook a number of direct and supportive actions to share oil sands environmental management knowledge with researchers, government, industry, academia, Aboriginal communities, stakeholders and the general public. Through all of these activities OSRIN maintained a neutral, balanced stance with the goal of providing people a diversity of

information sources and content to allow them to develop informed opinions about oil sands environmental management. This balanced approach is one of the key differentiators separating OSRIN from other organizations.

3.1 Direct Actions

3.1.1 *Website*

OSRIN's website was established in late summer of 2010 as the key vehicle for making oil sands environmental management information accessible to the public. The website provided information about OSRIN and its activities, and it provided access to current events (What's New) and educational materials (links, videos).

To ensure that the value of the extensive collection of resource materials developed over the years was not lost, OSRIN arranged to have the content archived in the website of the newly established Alberta Centre for Reclamation and Restoration Ecology (ACRRE) at the University of Alberta.

3.1.2 *Did You Know Series*

In July 2010 OSRIN initiated the Did You Know series as a means of highlighting interesting current and historical facts about development, economics and environmental management in the oil sands region. The series expanded to cover items of broader interest in the oil sands region. Each Did You Know piece was released on the website and often included links to other related resources. A total of 66 Did You Know pieces were released, and were compiled into a report[12].

3.1.3 *Newsletter*

In July 2011 OSRIN started a bi-weekly Newsletter subscription service that allowed interested parties to have information about updates to the website content (e.g., What's New, new conferences[13], new videos, digitized content), interesting reports and OSRIN activities (e.g., project starts, report releases) *pushed* to them. As of December 2014, there were 274 Newsletter subscribers.

3.1.4 *Staff Reports*

OSRIN's Staff Reports series included: the strategic design report discussed above; the program Annual Reports from 2009/10 to 2013/14; guidance to researchers on funding and report preparation; a summary of the active and completed research projects; a glossary of terms; the Did You Know compilation and a catalogue of media headlines related to oil sands pipelines and rail transport. Appendix 7 provides a list of the Staff Reports.

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[12] See OSRIN, 2014. OSRIN's Did You Know Series: The Collected Works. OSRIN Report No. SR-11. 163 pp. http://hdl.handle.net/10402/era.40220

[13] To ensure compliance with new federal spam legislation, OSRIN stopped including this information in the Newsletter in June 2014.

3.1.5 *Oil Sands Environmental Management Bibliography*

Given the rapidly expanding universe of oil sands environmental management literature (Figure 4) OSRIN recognized the need for an easily accessible, current, online-searchable bibliography. A survey of four existing online systems found that three had been developed but were not being kept up to date, while a fourth was not easy to use and focused on internal information, much of which was not public.

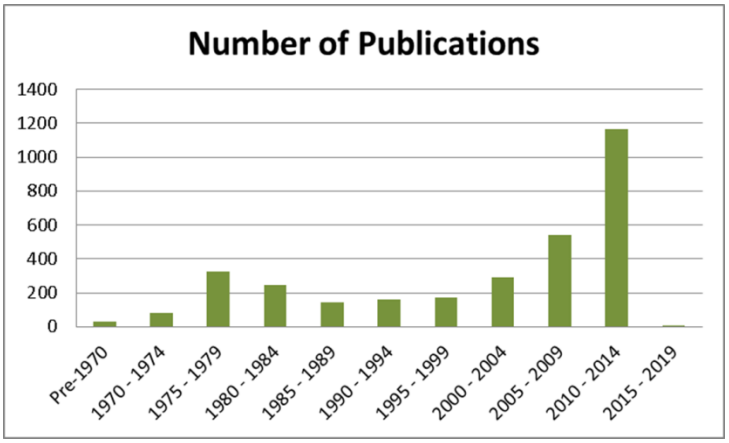

Figure 4. Number of oil sands environmental management citations in various time periods. Data taken from the Oil Sands Environmental Management Bibliography as of November 27, 2014.

Rather than create a completely new system, OSRIN partnered with CEMA to upgrade and expand the Reclamation Research Database. The result was the Oil Sands Environmental Management Bibliography. The Bibliography upgrades included an easier search and retrieval system for users (Figure 5), with the ability to generate reports from searches.

The original database had under 400 entries current to 2007; as of December 2014 the Bibliography had 3,176 entries from 1914 to 2015.

To preserve this storehouse of information CEMA transferred the bibliography content to Athabasca University's Bibliography of the Athabasca River Basin (BARB) in December 2014.

Figure 5. Search page of the Oil Sands Environmental Management Bibliography.

3.1.6 *Digitizing Historical Reports*

In recognition of the dominant use of web searches to find information and the unfortunate tendency to move on if a search doesn't produce desired results or finds a document or resource that isn't available online OSRIN decided to seek out and digitize government policy and research documents, and early Environmental Impact Assessment reports, and make them broadly available to researchers and the public with the assistance of provincial government departments (Alberta Agriculture, Alberta Environment and Sustainable Resource Development, and Alberta Health) and the Alberta Government Libraries[14]. In November of 2014 OSRIN received permission from Syncrude Canada Ltd. to digitize their Environmental Research Monograph series and their Professional Paper series from mid-70s to the mid-80s[15]. In total, OSRIN digitized a total of 439 documents.

3.1.7 *Presentations*

OSRIN's Executive Director made 31 presentations at conferences and to classes and visiting delegations to promote awareness of oil sands environmental management issues and policy and

[14] See Alberta Oil Sands Environmental Research Program (AOSRP) reports at http://hdl.handle.net/10402/era.17505; Environmental Impact Assessment reports at http://hdl.handle.net/10402/era.38903; Government of Alberta reports at http://hdl.handle.net/10402/era.22665; and, Reclamation Research Technical Advisory Committee (RRTAC) reports at http://hdl.handle.net/10402/era.17506

[15] See Syncrude Canada Ltd. Reports at http://hdl.handle.net/10402/era.40201

research efforts to address them. The complete list of presentations is available in the OSRIN Archives website at the Alberta Centre for Reclamation and Restoration Ecology.

3.2 Supporting Actions

3.2.1 *Conference Sponsorship*

OSRIN supported 17 oil sands-related conferences to help ensure subject matter experts had access to the latest advances in oil sands environmental management work. The sponsorships covered a wide variety of topics of interest to researchers and practitioners:

March 2010 – Restoration and Reclamation of Boreal Ecosystems: Attaining Sustainable Development (funded publication of follow-up book)

December 2010 – Second International Oil Sands Tailings Conference (IOSTC 2010)

June 2011 – 3rd International Symposium on Applied Microbiology and Molecular Biology in Oil Systems (ISMOS-3)

July 2011 – IASTED International Conference on Unconventional Oils and the Environment

November 2011 – CPANS Fall 2011 Technical Conference

February 2013 – CONRAD 3rd Biannual Oil Sands Clay Conference and Workshop

March 2012 – 2012 CONRAD Water Conference

April 2012 – 2012 ASPB Conference – Exploring the Boreal Forest: Oil Sands in Alberta

April 2012 – David C. Sego Symposium – Celebrating 33 Years of Teaching and Research 1977 - 2010

October 2012 – RemTech 2012

December 2012 – Third International Oil Sands Tailings Conference (IOSTC 2012)

April 2013 – WaterTech 2013

March 2014 – COSIA Oil Sands Water Conference and Workshops 2014

December 2014 – Fourth International Oil Sands Tailings Conference (IOSTC 2014)

April 2015 – COSIA Oil Sands Clay Conference and Workshop

April 2015 – WaterTech 2015

October 2015 – RemTech 2015

3.2.2 *Student Support*

In addition to funding research projects that M.Sc. and Ph.D. students, and post-doctoral fellows worked on, OSRIN provided funding to student groups and activities as a means of promoting

awareness of oil sands issues and enhancing student technical skills. OSRIN provided funding for the following student activities:

2009 – iGEM Oil Sands Awareness Project (in association with ConocoPhillips)

2010, 2011 and 2012 – iGEM Award Sponsorship (in association with the Oil Sands Leadership Initiative)

2010 – Support to University of Alberta iGEM team

September 2012 – 3rd annual Alberta Energy Challenge at the University of Alberta

October 2012, 2013, 2014 – University of Alberta Oil Sands Student Delegation oil sands tour

3.2.3 *OSRIN-Hosted External Research Reports*

External researchers recognized OSRIN's capacity to make documents accessible to the public and began asking if their works could be housed under OSRIN's umbrella and promoted through the Newsletter and Oil Sands Environmental Management Bibliography. As a result OSRIN hosted five documents from a variety of academic and government sources[16].

4 NETWORKING

The focus of the networking mandate was to:

1. Create awareness of OSRIN research funding opportunities and seek funding partners
2. Create awareness of OSRIN projects and reports
3. Increase awareness of research and policy initiatives and needs
4. Link researchers with other researchers and with funders
5. Link government and industry with academia

To meet these goals, the OSRIN Executive Director: participated on a number of CEMA Working Groups, spent time talking with researchers to better understand their capabilities and interests, and spent time with industry and government to better understand their needs and current initiatives.

The OSRIN Executive Director also fielded requests from media looking for interviews with knowledgeable University of Alberta researchers, and requests for students looking for potential projects and funding opportunities.

The website originally included a Who's Who section intended to help direct people to subject matter experts (an electronic means of addressing points 4 and 5 above). However, there

[16] Available at http://hdl.handle.net/10402/era.30197

appeared to be limited use of this feature, and in July 2014, following a request to the Newsletter subscribers about their interest in this feature, it was deleted.

5 OSRIN WORKSHOPS – FULFILLING ALL THREE MANDATES

OSRIN held 11 workshops with a total of 627 participants as a means of bringing subject matter experts together to discuss topics relevant to oil sands environmental management. These workshops fulfilled all three of OSRIN's mandates by synthesizing existing information, sharing the workshop results and creating an environment where people from a variety of sectors and disciplines could come together to share knowledge. Appendix 8 shows the list of reports arising from these workshops.

In addition, OSRIN sponsored an innovative electronic exchange between government, industry and academia in Edmonton with a collection of large investment firm managers in Sweden to describe oil sands issues and how they were being addressed. An overview of this session can be found on the website.

6 ACRONYMS

ACRRE	Alberta Centre for Reclamation and Restoration Ecology
AI – EES	Alberta Innovates – Energy and Environment Solutions
BARB	Bibliography of the Athabasca River Basin
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CEMA	Cumulative Environmental Management Association
CONRAD	Canadian Oil Sands Network for Research and Development
FY	Fiscal Year (April to March)
LFH	Litter, Fibric, Humic
LOC	Letter of Credit
NA	Naphthenic Acid
OSPW	Oil Sands Process-Affected Water
OSRIN	Oil Sands Research and Information Network
PAH	Polycyclic Aromatic Hydrocarbon
QET	Qualifying Environmental Trust
SEE	School of Energy and the Environment
VOC	Volatile Organic Carbon
WSN	Wireless Sensor Network

APPENDIX 1: OSRIN Board of Directors

The following people participated at various times as members of the OSRIN Board of Directors:

Name	Representing
Lorne Babiuk	University of Alberta – Vice-President (Research)
Andy Greenshaw	University of Alberta – Vice-President (Research)
Richard Fedorak	University of Alberta – Vice-President (Research)
Jillian Buriak	University of Alberta – Department of Chemistry
Julia Foght	University of Alberta – Department of Biological Sciences
David Layzelle	University of Calgary – Institute for Sustainable Energy Environment and Economy (ISEEE)
Haneef Mian	NovaNAIT
Preston McEachern	Oil Sands Environmental Management Division, Alberta Environment
Roger Ramcharita	Oil Sands Environmental Management Division, Alberta Environment Alberta Energy – Oil Sands Sustainable Development Secretariat
Kem Singh	Alberta Environment and Sustainable Resource Development
Neil Barker	Alberta Sustainable Resource Development
Murray Anderson	Alberta Sustainable Resource Development
Eddy Issacs	Alberta Advanced Education and Technology
John Zhou	Alberta Innovates – Energy and Environment Solutions
Ted Cyr	Alberta Department of Energy
Chris Holly	Alberta Department of Energy
Bert Aram	Alberta Treasury Board
Jennifer McGill	Alberta Treasury Board – Oil Sands Secretariat
Robert Fernandez	Alberta Treasury Board – Oil Sands Secretariat
Sandra Klashinsky	Alberta Treasury Board – Oil Sands Secretariat
Mel Miller	Alberta Energy – Oil Sands Sustainable Development Secretariat
Gary Haynes	Alberta Energy – Oil Sands Sustainable Development Secretariat
Bruce Carson	Canada School of Energy and Environment Ltd

Name	Representing
Rick Hyndman	Canada School of Energy and Environment Ltd
Robert Skinner	Canada School of Energy and Environment Ltd
Stephen Smith	Energy Resources Conservation Board
Terry Abel	Energy Resources Conservation Board

APPENDIX 2: Research Reports

This list does not include reports related to workshops which are found in Appendix 8.

NOTE: One additional research report on metals in mammals will be released in early 2015.

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

BGC Engineering Inc., 2010. Oil Sands Tailings Technology Review. OSRIN Report No. TR-1. 136 pp. http://hdl.handle.net/10402/era.17555

BGC Engineering Inc., 2010. Review of Reclamation Options for Oil Sands Tailings Substrates. OSRIN Report No. TR-2. 59 pp. http://hdl.handle.net/10402/era.17547

Chapman, K.J. and S.B. Das, 2010. Survey of Albertans' Value Drivers Regarding Oil Sands Development and Reclamation. OSRIN Report TR-3. 13 pp. http://hdl.handle.net/10402/era.17584

Lott, E.O. and R.K. Jones, 2010. Review of Four Major Environmental Effects Monitoring Programs in the Oil Sands Region. OSRIN Report No. TR-6. 114 pp. http://hdl.handle.net/10402/65.20287

Godwalt, C., P. Kotecha and C. Aumann, 2010. Oil Sands Tailings Management Project. OSRIN Report No. TR-7. 64 pp. http://hdl.handle.net/10402/era.22536

Welham, C., 2010. Oil Sands Terrestrial Habitat and Risk Modeling for Disturbance and Reclamation – Phase I Report. OSRIN Report No. TR-8. 109 pp. http://hdl.handle.net/10402/era.22567

Schneider, T., 2011. Accounting for Environmental Liabilities under International Financial Reporting Standards. OSRIN Report TR-9. 16 pp. http://hdl.handle.net/10402/era.22741

Davies, J. and B. Eaton, 2011. Community Level Physiological Profiling for Monitoring Oil Sands Impacts. OSRIN Report No. TR-10. 44 pp. http://hdl.handle.net/10402/era.22781

Hurndall, B.J., N.R. Morgenstern, A. Kupper and J. Sobkowicz, 2011. Report and Recommendations of the Task Force on Tree and Shrub Planting on Active Oil Sands Tailings Dams. OSRIN Report No. TR-11. 15 pp. http://hdl.handle.net/10402/era.22782

Gibson, J.J., S.J. Birks, M. Moncur, Y. Yi, K. Tattrie, S. Jasechko, K. Richardson, and P. Eby, 2011. Isotopic and Geochemical Tracers for Fingerprinting Process-Affected Waters in the Oil Sands Industry: A Pilot Study. OSRIN Report No. TR-12. 109 pp. http://hdl.handle.net/10402/era.23000

Kindzierski, W., J. Jin and M. Gamal El-Din, 2011. Plain Language Explanation of Human Health Risk Assessment. OSRIN Report TR-14. 37 pp. http://hdl.handle.net/10402/era.23487

Welham, C. and B. Seely, 2011. Oil Sands Terrestrial Habitat and Risk Modelling for Disturbance and Reclamation – Phase II Report. OSRIN Report No. TR-15. 93 pp. http://hdl.handle.net/10402/era.24547

Paskey, J. and G. Steward, 2012. The Alberta Oil Sands, Journalists, and Their Sources. OSRIN Report No. TR-17. 33 pp. http://hdl.handle.net/10402/era.25266

Cruz-Martinez, L. and J.E.G. Smits, 2012. Potential to Use Animals as Monitors of Ecosystem Health in the Oil Sands Region – July 2013 Update. OSRIN Report No. TR-18. 59 pp. http://hdl.handle.net/10402/era.25417

Hashisho, Z., C.C. Small and G. Morshed, 2012. Review of Technologies for the Characterization and Monitoring of VOCs, Reduced Sulphur Compounds and CH_4. OSRIN Report No. TR-19. 93 pp. http://hdl.handle.net/10402/era.25522

Kindzierski, W., J. Jin and M. Gamal El-Din, 2012. Review of Health Effects of Naphthenic Acids: Data Gaps and Implications for Understanding Human Health Risk. OSRIN Report No. TR-20. 43 pp. http://hdl.handle.net/10402/era.26060

Zhao, B., R. Currie and H. Mian, 2012. Catalogue of Analytical Methods for Naphthenic Acids Related to Oil Sands Operations. OSRIN Report No. TR-21. 65 pp. http://hdl.handle.net/10402/era.26792

Valera, E. and C.B. Powter, 2012. Implications of Changing Environmental Requirements on Oil Sands Royalties. OSRIN Report No. TR-23. 21 pp. http://hdl.handle.net/10402/era.27344

Dixon, R., M. Maier, A. Sandilya and T. Schneider, 2012. Qualifying Environmental Trusts as Financial Security for Oil Sands Reclamation Liabilities. OSRIN Report No. TR-24. 32 pp. http://hdl.handle.net/10402/era.28305

Dixon, R.J., J. Kenney and A.C. Sandilya, 2012. Audit Protocol for the Mine Financial Security Program. OSRIN Report No. TR-27. 27 pp. http://hdl.handle.net/10402/era.28514

Davies, J., B. Eaton and D. Humphries, 2012. Microcosm Evaluation of Community Level Physiological Profiling in Oil Sands Process Affected Water. OSRIN Report No. TR-28. 33 pp. http://hdl.handle.net/10402/era.29322

Thibault, B., 2012. Assessing Corporate Certification as Impetus for Accurate Reporting in Self-Reported Financial Estimates Underlying Alberta's Mine Financial Security Program. OSRIN Report No. TR-29. 37 pp. http://hdl.handle.net/10402/era.29361

Pyper, M. and T. Vinge, 2013. A Visual Guide to Handling Woody Materials for Forested Land Reclamation. OSRIN Report No. TR-31. 10 pp. http://hdl.handle.net/10402/era.30381

Howlett, M. and J. Craft, 2013. Application of Federal Legislation to Alberta's Mineable Oil Sands. OSRIN Report No. TR-33. 94 pp. http://hdl.handle.net/10402/era.31627

Welham, C., 2013. Factors Affecting Ecological Resilience of Reclaimed Oil Sands Uplands. OSRIN Report No. TR-34. 44 pp. http://hdl.handle.net/10402/era.31714

Naeth, M.A., S.R. Wilkinson, D.D. Mackenzie, H.A. Archibald and C.B. Powter, 2013. Potential of LFH Mineral Soil Mixes for Land Reclamation in Alberta. OSRIN Report No. TR-35. 64 pp. http://hdl.handle.net/10402/era.31855

Welham, C. and B. Seely, 2013. Oil Sands Terrestrial Habitat and Risk Modelling for Disturbance and Reclamation: The Impact of Climate Change on Tree Regeneration and Productivity – Phase III Report. OSRIN Report No. TR-36. 65 pp. http://hdl.handle.net/10402/era.31900

Eaton, B., T. Muhly, J. Fisher and S-L. Chai, 2013. Potential Impacts of Beaver on Oil Sands Reclamation Success – an Analysis of Available Literature. OSRIN Report No. TR-37. 65 pp. http://hdl.handle.net/10402/era.32764

Paskey, J., G. Steward and A. Williams, 2013. The Alberta Oil Sands Then and Now: An Investigation of the Economic, Environmental and Social Discourses Across Four Decades. OSRIN Report No. TR-38. 108 pp. http://hdl.handle.net/10402/era.32845

Watson, B.M. and G. Putz, 2013. Preliminary Watershed Hydrology Model for Reclaimed Oil Sands Sites. OSRIN Report No. TR-39. 193 pp. http://hdl.handle.net/10402/era.34250

Birks, S.J., Y. Yi, S. Cho, J.J. Gibson and R. Hazewinkel, 2013. Characterizing the Organic Composition of Snow and Surface Water in the Athabasca Region. OSRIN Report No. TR-40. 62 pp. http://hdl.handle.net/10402/era.36643

De Corby, R.G., 2013. Development of Silicon-Based Optofluidic Sensors for Oil Sands Environmental Monitoring. OSRIN Report No. TR-41. 19 pp. http://hdl.handle.net/10402/era.36936

Iqbal, M., T.K. Purkait, J.G.C. Veinot and G.G. Goss, 2013. Benign-by-Design: Synthesis of Engineered Silicon Nanoparticles and their Application to Oil Sands Water Contaminant Remediation. OSRIN Report No. TR-42. 30 pp. http://hdl.handle.net/10402/era.37308

Smreciu, A., K. Gould and S. Wood, 2013. Boreal Plant Species for Reclamation of Athabasca Oil Sands Disturbances. OSRIN Report No. TR-44. 23 pp. plus appendices. http://hdl.handle.net/10402/era.37533

Pereira, A.S. and J.W. Martin, 2014. On-Line Solid Phase Extraction – HPLC – Orbitrap Mass Spectrometry for Screening and Quantifying Targeted and Non-Targeted Analytes in Oil Sands Process-Affected Water and Natural Waters in the Athabasca Oil Sands Region. OSRIN Report No. TR-45. 33 pp. http://hdl.handle.net/10402/era.37793

Liang, J., F. Tumpa, L.P. Estrada, M. Gamal El-Din and Y. Liu, 2014. Ozone-Assisted Settling of Diluted Oil Sands Mature Fine Tailings: A Mechanistic Study. OSRIN Report No. TR-46. 43 pp. http://hdl.handle.net/10402/era.38226

Rochdi, N., J. Zhang, K. Staenz, X. Yang, D. Rolfson, J. Banting, C. King and R. Doherty, 2014. Monitoring Procedures for Wellsite, In-Situ Oil Sands and Coal Mine Reclamation in Alberta – December 2014 Update. OSRIN Report No. TR-47. 167 pp. http://hdl.handle.net/10402/era.38742

Taheriazad, L., C. Portillo-Quintero and G.A. Sanchez-Azofeifa, 2014. Application of Wireless Sensor Networks (WSNs) to Oil Sands Environmental Monitoring. OSRIN Report No. TR-48. 51 pp. http://hdl.handle.net/10402/era.38858

Marey, H.S., Z. Hashisho and L. Fu, 2014. Satellite Remote Sensing of Air Quality in the Oil Sands Region. OSRIN Report No. TR-49. 104 pp. http://hdl.handle.net/10402/era.38882

Li, C., A. Singh, N. Klamerth, K. McPhedran, P. Chelme-Ayala, M. Belosevic and M. Gamal El-Din, 2014. Synthesis of Toxicological Behavior of Oil Sands Process-Affected Water Constituents. OSRIN Report No. TR-50. 101 pp. http://hdl.handle.net/10402/era.39659

Jiang, Y. and Y. Liu, 2014. Application of Forward Osmosis Membrane Technology for Oil Sands Process-Affected Water Desalination. OSRIN Report No. TR-51. 27 pp. http://hdl.handle.net/10402/era.39855

Zhu, L., M. Yu, L. Delgado Chávez, A. Ulrich and T. Yu, 2014. Review of Bioreactor Designs Applicable to Oil Sands Process-Affected Water Treatment. OSRIN Report No. TR-52. 39 pp. http://hdl.handle.net/10402/era.39903

Oil Sands Research and Information Network, 2014. Oil Sands Rules, Tools and Capacity: Are we Ready for Upcoming Challenges? OSRIN Report No. TR-53. 120 pp. http://hdl.handle.net/10402/era.39985

Iqbal, M., T.K. Purkait, M. Aghajamali, L. Hadidi, J.G.C. Veinot, G.G. Goss and M. Gamal El-Din, 2014. Hybrid Aerogel SiNP Membranes for Photocatalytic Remediation of Oil Sands Process Water. OSRIN Report No. TR-54. 29 pp. http://hdl.handle.net/10402/era.40004

Schoonmaker, A., J-M. Sobze, E. Fraser, E. Marenholtz, A. Smreciu, C.B. Powter and M. Mckenzie, 2014. Alternative Native Boreal Seed and Plant Delivery Systems for Oil Sands Reclamation. OSRIN Report No. TR-55. 61 pp. http://hdl.handle.net/10402/era.40099

Aguilar, M., E. Glücksman, D. Bass and J.B. Dacks, 2014. Next Generation Sequencing of Protists as a Measure of Microbial Community in Oil Sands Tailings Ponds: Amplicon Versus Metagenomic Approaches. OSRIN Report No. TR-56. 24 pp. http://hdl.handle.net/10402/era.40100

Alessi, D.S., M.S. Alam and M.C. Kohler, 2014. Designer Biochar-Coke Mixtures to Remove Naphthenic Acids from Oil Sands Process-Affected Water (OSPW). OSRIN Report No. TR-57. 38 pp. http://hdl.handle.net/10402/era.40122

Oil Sands Research and Information Network, 2014. Survey of Oil Sands Environmental Management Research and Information Needs. OSRIN Report No. TR-58. 67 pp. http://hdl.handle.net/10402/era.40128

Huang, Q., H. Wang and M.A. Lewis, 2014. Development of a Toxin-Mediated Predator-Prey Model Applicable to Aquatic Environments in the Athabasca Oil Sands Region. OSRIN Report No. TR-59. 59 pp. http://hdl.handle.net/10402/era.40140

Currie, R., S. Bansal, I. Khan and H. Mian, 2014. An Investigation of the Methylene Blue Titration Method for Clay Activity of Oil Sands Samples. OSRIN Report No. TR-60. 50 pp. http://hdl.handle.net/10402/era.40164

Welham, C., 2014. Risk and Uncertainty in Oil Sands Upland Reclamation: Best Management Practices within the Context of Climate Change. OSRIN Report No. TR-61. 26 pp. http://hdl.handle.net/10402/era.40171

Mahdavi, H., H. Mian, S. Hepperle and Z. Burkus, 2014. Standard Operating Procedures for Analysis of Naphthenic Acids from Oil Sands Process-Affected Water. OSRIN Report No. TR-62. 67 pp. http://hdl.handle.net/10402/era.40181

McPhedran, K., M.S. Islam and M. Gamal El-Din, 2014. Development of a Novel Engineered Bioprocess for Oil Sands Process-Affected Water and Tailings Fines/Bitumen/Water Separation. OSRIN Report No. TR-63. 28 pp. http://hdl.handle.net/10402/era.40190

Birks, J., Y. Yi, S. Cho, E. Taylor and J. Gibson, 2014. Characterizing the Organic Composition of Snow and Surface Water Across the Athabasca Region: Phase 2. OSRIN Report No. TR-64. 47 pp. http://hdl.handle.net/10402/era.40243

Alberta Centre for Reclamation and Restoration Ecology and Oil Sands Research and Information Network, 2014. Creating a Knowledge Platform for the Reclamation and Restoration Ecology Community: Expanding the OSRIN Model Beyond the Oil Sands. OSRIN Report No. TR-65. 19 pp. http://hdl.handle.net/10402/era.40323

Liang, J., Z. Guo, L. Deng and Y. Liu, 2014. MFT Consolidation Through Microbial Induced Calcium Carbonate Precipitation. OSRIN Report No. TR-66. 31 pp. http://hdl.handle.net/10402/era.40330

Eaton, B.R., J.T. Fisher, G.T. McKenna, and J. Pollard. 2014. An Ecological Framework for Wildlife Habitat Design for Oil Sands Mine Reclamation. OSRIN Report No. TR-67. 83 pp. http://hdl.handle.net/10402/era.40338

Hopkins, D, K. Wall and C. Wilson, 2014. Measured Concentrations of Metals and Polycyclic Aromatic Hydrocarbons in Plants, Berries and Soil Located North of Fort McMurray, Alberta. OSRIN Report No. TR-68. 134 pp. http://hdl.handle.net/10402/era.40339

Richardson, E., G. Walker, G. MacIntyre, S. Quideau, J.B. Dacks and S. Adl, 2014. Next-Generation Sequencing of Protists as a Measure of the Microbial Community in Oil Sand-Associated Soils. OSRIN Report No. TR-69. 26 pp. http://hdl.handle.net/10402/era.40343

Christensen-Dalsgaard, K.K., R.N. Sinnatamby and M. Poesch, 2014. Metrics for Assessing Fisheries Productivity and Offsetting Strategies under Canada's New *Fisheries Act*. OSRIN Report No. TR-70. 58 pp. http://hdl.handle.net/10402/era.40345

Mackenzie, M.D., S. Hofstetter, I. Hatam and B. Lanoil, 2014. Carbon and Nitrogen Mineralization and Microbial Succession in Oil Sands Reclamation Soils Amended with Pyrogenic Carbon. OSRIN Report No. TR-71. 29 pp. http://hdl.handle.net/10402/era.40354

APPENDIX 3: Tailings Reclamation Projects

Project	Researcher
2013 Tailings Technology Development and Commercialization Workshop	Dr. Haneef Mian, NAIT
A Design-of-Experiment Approach to Optimize the Methylene Blue Titration Method for Oil Sands Tailings Clay Activity	Dr. Haneef Mian, NAIT Applied Research Center for Oil Sands Sustainability
Application of Forward Osmosis Membrane Technology for Oil Sands Process-Affected Water Desalination	Dr. Yang Liu, University of Alberta
Benign By Design: Engineered Si Nanoparticles for Oil Sands Process Water Contaminant Remediation	Dr. Jonathan Veinot, University of Alberta
Catalogue of Analytical Methods for Naphthenic Acids	Dr. Haneef Mian, NAIT
Community Structure and Bio-Prospecting in Oil Sands Tailings Ponds	Dr. Joel Dacks, University of Alberta
Designer Biochar-Coke Mixtures to Remove Naphthenic Acids from Oil Sands Process-affected Water (OSPW)	Dr. Daniel Alessi, University of Alberta
Development of a Novel Engineered Bioprocess for Oil Sands Tailings Fines/Bitumen/Water Separation	Dr. Mohamed Gamal El-Din, University of Alberta
Development of Silicon-based Optofluidic Sensors for Environmental Monitoring	Dr. Ray DeCorby, University of Alberta
Engineered Biological Processes to Accelerate Oil Sands Tailings Consolidation and Improve Reuse Water Quality	Dr. Tong Yu, University of Alberta
Expedited Oil Sands Tailings Consolidation Through Microbial Induced Calcite Precipitation	Dr. Yang Liu, University of Alberta
In-Situ Tailings Ozonation: A Combined Tailings Consolidation and Remediation Process	Dr. Yang Liu, University of Alberta
Mining Clean Bitumen Technology Action Plan (CBTAB)	Petroleum Technology Alliance Canada (PTAC)
Quantitative Characterization of Air Pollutant Emissions from Oil Sands Tailings Ponds: Phase 1 Review and Assessment of Air Pollutant Measurement Technologies	Dr. Zaher Hashisho, University of Alberta
Reclamation of Dewatered Fine Tailings	Kevin Biggar, BGC Engineering

Project	Researcher
Silicon Nanoparticle Membranes for Photocatalytic Oil Sands Process Water Treatment	Dr. Johnathan Veinot, University of Alberta
Standard Operating Procedures and Physical Properties of Oil Sands Naphthenic Acids	Dr. Haneef Mian, NAIT Applied Research Center for Oil Sands Sustainability
Synthesis of Toxicological Behavior of Oil Sands Process-Affected Water Constituents	Dr. Mohamed Gamal El-Din, University of Alberta
Tailings Dewatering Technology Review	Kevin Biggar, BGC Engineering
Tailings Water Management Project	Chris Godwalt, Alberta WaterSMART

APPENDIX 4: Regional Landscape Reclamation Projects

Project	Researcher
A Framework for Wildlife Habitat Design for Oil Sands Mine Reclamation: Building Wildlife Communities from the Bottom Up	Dr. Brian Eaton, Alberta Innovates – Technology Futures
Assessment of Safety Concerns Related to Tree Planting on Active Tailings Dams	Barry Hurndall, BJH Engineering
A Tool for Adaptation Decision-Making in Oil Sands Reclamation Under Risk of Climate Change	Dr. Clive Welham, University of British Columbia
Boreal Plant Species for Reclamation of Athabasca Oil Sands Disturbances	Ann Smreciu, Wildrose Consulting, Inc.
Conducting a Dialogue 'Challenges and Timelines in Reclamation and the Feasibility of Alternative End Land Uses'	Keith Jones, Innovation Expedition Consulting Inc.
Development of a Geomatics Monitoring Tool for Oil Sands Reclamation Monitoring	Dr. Karl Staenz, University of Lethbridge
Equivalent Land Capability Workshop	Mark Polet, Klohn Crippen Berger
Evaluating Use of Biochar for Oil Sands Reclamation	Dr. Derek MacKenzie, University of Alberta
Factors Affecting Ecological Resilience of Reclaimed Oil Sands Uplands	Dr. Clive Welham, FORRx Consulting Inc.
Future of Shrubs in Oil Sands Reclamation Workshop	Oil Sands Research and Information Network, University of Alberta
Oil Sands Terrestrial Habitat and Risk Modeling for Disturbance and Reclamation (Phase I)	Dr. Clive Welham, FORRx Consulting Inc.
Oil Sands Terrestrial Habitat and Risk Modeling for Disturbance and Reclamation (Phase II)	Dr. Clive Welham, FORRx Consulting Inc.
Oil Sands Terrestrial Habitat and Risk Modeling for Disturbance and Reclamation (Phase III)	Dr. Clive Welham, University of British Columbia
Oil Sands Wetlands Assessment Training Video	Brenda Rooney, Rooney Productions
Potential Impacts of Beavers on Oil Sands Reclamation Success	Dr. Brian Eaton, Alberta Innovates – Technology Futures
Preliminary Watershed Hydrology and Chemical Export Model for Reclaimed Oil Sands Sites	Dr. Gordon Putz, University of Saskatchewan
Reclamation Alternatives Dialogue Assessment and Design	Keith Jones, Innovation Expedition Consulting Inc.

Project	Researcher
Resiliency of Reclaimed Boreal Forest Landscapes	Matthew Pyper, University of Alberta
Review of Alternative Seed Packaging and Delivery Systems for Oil Sands Reclamation	Dr. Amanda Schoonmaker, Northern Alberta Institute of Technology
Role of Professional Expertise in Reclamation Certification	Roger Creasey, Terrain FX Inc.
Soil Microbiology as an Index of Oil Sands Reclamation Success	Dr. Sylvie Mercier Quideau, University of Alberta
Soil Nitrogen Indicators for Land Reclamation	Dr. Scott Chang, University of Alberta
Support Wetland Reclamation Conference	Dr. Dale Vitt, PeatNet
What Constitutes Success for LFH Salvage and Replacement	Dr. Anne Naeth, University of Alberta
Woody Debris Field Guide	Dr. Vic Lieffers, University of Alberta

APPENDIX 5: Monitoring Ecosystem Impacts Projects

Project	Researcher
An Evaluation of Wireless Sensor Networks and their Potential Implementation to Monitor Environmental Variables at Oil Sands Sites	Dr. Arturo Sanchez-Azofeifa, University of Alberta
A Rapid Solution for Screening and Quantifying Targeted and Non-Targeted Analytes in Oil Sands Process Water and Natural Waters in the Athabasca Region	Dr. Jonathan Martin, University of Alberta
Assessment and Design of a Challenge Dialogue titled "What Constitutes Monitoring Adequacy in the Oil Sands Region?"	Doug James, Congruent Strategies
Assessment of Air Quality Remote Sensing Technology for Alberta's Oil Sands Region	Dr. Zaher Hashisho, University of Alberta
Characterizing the Organic Composition of Snow and Surface Water Across the Athabasca Region – Phase 2	Dr. Jean Birks, Alberta Innovates – Technology Futures
Dialogue on Monitoring and Information Reporting Adequacy	Doug James, Congruent Strategies
Evaluation of Community Level Physiological Profiling as a Means of Assessing Aquatic Ecosystem Health in the Oil Sands Region	Jim Davies, Alberta Innovates – Technology Futures
Instruments for Research on Air Quality Control and Characterization	Dr. Zaher Hashisho, University of Alberta
Inventory and Characterize the Monitoring and Reporting of Oil Sands Environmental Health	Eric Lott, EO Consulting
Isotope and Geochemical Tracers for Fingerprinting Process-Affected Waters in the Oil Sands Industry	Dr. John Gibson, Alberta Innovates – Technology Futures
Metrics for Assessing Fisheries Productivity of Oil Sands Compensation Lakes	Dr. Mark Poesch, University of Alberta
Microcosm Evaluation of CLPP in Oil Sands Process Affected Water	Dr. Jim Davies, Alberta Innovates - Technology Futures
Modeling and Assessing the Impact of Oil Sands Contaminants on Aquatic Food Webs	Dr. Mark Lewis, University of Alberta
Oil Sands Groundwater – Surface Water Interactions Workshop	OSRIN and Canadian Environmental Assessment Agency
Organic Footprint of Atmospheric Deposits: Snow and Surface Water Fingerprinting Across the Athabasca Region	Dr. Jean Birks, Alberta Innovates - Technology Futures
PAH and Heavy Metal Content in Mammal Organs in the Mineable Oil Sands Region	Graham Knox, Alberta Innovates - Technology Futures
Potential to Use Wildlife as Monitors of Ecosystem Health and Sustainability in the Oil Sands Region	Dr. Judit Smits, University of Calgary

Project	Researcher
Surface Water – Groundwater Interactions in the Lower Athabasca Region	Melanie Dubois, Cumulative Environmental Management Association
Wild Plant and Soil Sampling in Support of Oil Sands Contaminant Load Assessment	Dr. Cindy Jardine, University of Alberta

APPENDIX 6: Social, Economic and Regulatory Projects

Project	Researcher
Accounting Reporting Standards	Dr. Thomas Schneider, University of Alberta
Audit Protocol to Support Implementation of the Mine Financial Security Program	Richard Dixon, University of Alberta
DCM Survey of Albertan's Value Drivers	Satya Das, Cambridge Strategies Inc.
Factors to Consider in Estimating Oil Sands Plant Decommissioning Costs	Mark Morton Sr., WorleyParsons
How Qualifying Environmental Trusts Work as Reclamation Security	Richard Dixon, University of Alberta
Impacts of Changing Environmental Requirements on Oil Sands Royalties	Elis Valera, University of Alberta
Implications of Corporate Certification on Reclamation Security Estimates	Benjamin Thibault, Pembina Institute for Appropriate Development
Oil Sands Then and Now: How the Dialogue has Changed	Janice Paskey, Mount Royal University
Plain Language Explanation of Human Health Risk Assessment	Dr. Mohamed Gamal El-Din, University of Alberta
Review of Environmental Responsibility for Oil Sands Developments under Federal Legislation	Dr. Michael Howlett, Simon Fraser University
Review of Health Effects of Naphthenic Acids	Dr. Warren Kindzierski, University of Alberta

APPENDIX 7: Staff Reports

OSRIN Staff Reports – http://hdl.handle.net/10402/era.19095

OSRIN, 2010. Glossary of Terms and Acronyms used in Oil Sands Mining, Processing and Environmental Management – December 2014 Update. OSRIN Report No. SR-1. 125 pp. http://hdl.handle.net/10402/era.17544

OSRIN, 2010. OSRIN Writer's Style Guide – November 2013 Update. OSRIN Report No. SR-2. 29 pp. http://hdl.handle.net/10402/era.17545

OSRIN, 2010. OSRIN Annual Report: 2009/2010. OSRIN Report No. SR-3. 27 pp. http://hdl.handle.net/10402/era.17546

OSRIN, 2010. Guide to OSRIN Research Grants and Services Agreements - June 2011 Update. OSRIN Report No. SR-4. 21 pp. http://hdl.handle.net/10402/era.17558

OSRIN, 2011. Summary of OSRIN Projects – December 2014 Update. OSRIN Report No. SR-5. 130 pp. http://hdl.handle.net/10402/era.20529

OSRIN, 2011. OSRIN Annual Report: 2010/11. OSRIN Report No. SR-6. 34 pp. http://hdl.handle.net/10402/era.23032

OSRIN, 2011. OSRIN's Design and Implementation Strategy. OSRIN Report No. SR-7. 10 pp. http://hdl.handle.net/10402/era.23574

OSRIN, 2012. OSRIN Annual Report: 2011/12. OSRIN Report No. SR-8. 25 pp. http://hdl.handle.net/10402/era.26715

OSRIN, 2013. OSRIN Annual Report: 2012/13. OSRIN Report No. SR-9. 56 pp. http://hdl.handle.net/10402/era.31211

OSRIN, 2014. OSRIN Annual Report: 2013/14. OSRIN Report No. SR-10. 66 pp. http://hdl.handle.net/10402/era.38508

OSRIN, 2014. OSRIN's Did You Know Series: The Collected Works. OSRIN Report No. SR-11. 163 pp. http://hdl.handle.net/10402/era.40220

OSRIN, 2014. Media Coverage of Oil Sands Pipelines: A Chronological Record of Headlines from 2010 to 2014. OSRIN Report No. SR-12. 140 pp. http://hdl.handle.net/10402/era.40331

APPENDIX 8: List of OSRIN Workshops

OSRIN held workshops alone, or as part of a larger project to scope and frame issues documents.

Stand-alone workshop reports

Oil Sands Research and Information Network, 2011. Equivalent Land Capability Workshop Summary Notes. OSRIN Report TR-13. 83 pp. http://hdl.handle.net/10402/era.23385

Oil Sands Research and Information Network and Canadian Environmental Assessment Agency, 2012. Summary of the Oil Sands Groundwater – Surface Water Interactions Workshop. OSRIN Report No. TR-22. 125 pp. http://hdl.handle.net/10402/era.26831

Creasey, R., 2012. Professional Judgment in Mineable Oil Sands Reclamation Certification: Workshop Summary. OSRIN Report No. TR-25. 52 pp. http://hdl.handle.net/10402/era.28331

Alberta Innovates – Technology Futures, 2012. Investigating a Knowledge Exchange Network for the Reclamation Community. OSRIN Report No. TR-26. 42 pp. http://hdl.handle.net/10402/era.28407

Pyper, M.P., C.B. Powter and T. Vinge, 2013. Summary of Resiliency of Reclaimed Boreal Forest Landscapes Seminar. OSRIN Report No. TR-30. 131 pp. http://hdl.handle.net/10402/era.30360

Mian, H., N. Fassina, A. Mukherjee, A. Fair and C.B. Powter, 2013. Summary of 2013 Tailings Technology Development and Commercialization Workshop. OSRIN Report No. TR-32. 69 pp. http://hdl.handle.net/10402/era.31012

Oil Sands Research and Information Network, 2013. Future of Shrubs in Oil Sands Reclamation Workshop. OSRIN Report No. TR-43. 71 pp. http://hdl.handle.net/10402/era.37440

Oil Sands Research and Information Network, 2014. Oil Sands Rules, Tools and Capacity: Are we Ready for Upcoming Challenges? OSRIN Report No. TR-53. 120 pp. http://hdl.handle.net/10402/era.39985

Workshops that were part of a larger project

Jones, R.K. and D. Forrest, 2010. Oil Sands Mining Reclamation Challenge Dialogue – Report and Appendices. OSRIN Report No. TR-4. 258 pp. http://hdl.handle.net/10402/era.19092

Jones, R.K. and D. Forrest, 2010. Oil Sands Mining Reclamation Challenge Dialogue – Report. OSRIN Report No. TR-4A. 18 pp. http://hdl.handle.net/10402/era.19091

James, D.R. and T. Vold, 2010. Establishing a World Class Public Information and Reporting System for Ecosystems in the Oil Sands Region – Report and Appendices. OSRIN Report No. TR-5. 189 pp. http://hdl.handle.net/10402/era.19093

James, D.R. and T. Vold, 2010. Establishing a World Class Public Information and Reporting System for Ecosystems in the Oil Sands Region – Report. OSRIN Report No. TR-5A. 31 pp. http://hdl.handle.net/10402/era.19094

Morton Sr., M., A. Mullick, J. Nelson and W. Thornton, 2011. Factors to Consider in Estimating Oil Sands Plant Decommissioning Costs. OSRIN Report No. TR-16. 62 pp. http://hdl.handle.net/10402/era.24630