

# Under-Mining the **ENVIRONMENT**

THE OIL SANDS REPORT CARD

## APPENDICES 1-5



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*January 2008*

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# Introduction

The appendices are divided into to the following five sections:

- Appendix 1 – General Environmental Management
- Appendix 2 – Land
- Appendix 3 – Air Emissions
- Appendix 4 – Water
- Appendix 5 – Climate Change

Within each of these sections you will find summarized responses to each of the questions in the same order as they are found in the report. Specific answers are provided for each of the projects that are considered in the report as listed in Table 1. Projects highlighted in grey, Albian Existing, Suncor and Syncrude, are operating and in a many instances cannot be compared directly with other projects on the list because of data limitations and reporting differences.

**Table 1 Companies included in survey**

Company	Project	Startup Date	Status	Production (bitumen bbl/d)	Participated in survey (y/n)
Shell Canada Ltd.	Jackpine Phase 1A	2010	Construction	100,000	yes
	Jackpine Phase 1B	2012	Approved	100,000	
Albian Sands Energy Inc.	Muskeg River Existing	2002	Operating	150,000	yes
	Muskeg Expansion	2010	Approved	120,000	
Canadian Natural	Horizon - Phase 1	2008	Construction	135,000	no
	Phase 2 & 3	2011	Approved	135,000	
Petro-Canada Oil Sands Inc.	Fort Hills Phase 1 & 2	2011	Approved	100,000	yes
	Fort Hills Phase 3 & 4	2014	Approved	90,000	
Imperial Oil Resources Ventures Ltd.	Kearl Lake Phase 1	2010	Approved	100,000	yes
	Phase 2	2012	Approved	100,000	
	Phase 3	2018	Approved	100,000	

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Company	Project	Startup Date	Status	Production (bitumen bbl/d)	Participated in survey (y/n)
Suncor Energy Inc.	Current	1967	Operating	260,000	yes
Syncrude Canada Ltd.	Current	1978	Operating	214,000	no
Synenco Energy Inc.	Northern Lights Phase 1	2010	Application	57,250	yes
	Phase 2	2012	Application	57,250	
Total E&P Canada	Joslyn Mine Phase 1	2013	Application	50,000	no
	Phase 2	2016	Application	50,000	
<b>Total Production</b>				<b>1,918,500</b>	

# Appendix 1 – General Environmental Management

## Question 1 - Environmental Policy Commitments

Table 2 summarizes the responses to the question, “Does your company have an environmental policy that commits to continuous improvement of environmental performance”?

Table 2 Summary table of environmental policy commitments for each project and its source

Environmental policy with commitment to continuous improvement			
Projects	Policy	Source	Comments
Albian - Muskeg Existing	Yes	Albian Sands Energy Inc, <i>Commitment to Sustainable Development</i> , <a href="http://www.albiansands.com/environment.htm">http://www.albiansands.com/environment.htm</a> (accessed Dec. 1st, 2007)	Athabasca Oil Sands Project has a systematic approach to health, safety and environmental management designed to ensure compliance with the law and to achieve continuous performance improvement.
Albian - Muskeg Expansion	Yes	Albian Sands Energy Inc, <i>Commitment to Sustainable Development</i> , <a href="http://www.albiansands.com/environment.htm">http://www.albiansands.com/environment.htm</a> (accessed Dec. 1st, 2007)	Athabasca Oil Sands Project has a systematic approach to health, safety and environmental management designed to ensure compliance with the law and to achieve continuous performance improvement.
Canadian Natural - Horizon	No	Canadian Natural, <i>Environment: Valuing environmental protection</i> , <a href="http://www.cnrl.com/operations/environment.html">http://www.cnrl.com/operations/environment.html</a> (accessed Dec. 1st, 2007)	There is no commitment to continuous improvement in environmental performance in the Corporate Statement on Environmental Protection.

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Environmental policy with commitment to continuous improvement			
Projects	Policy	Source	Comments
Imperial Resources Ventures Limited - Kearl Phases 1, 2 & 3	Yes	Imperial Oil Ltd., <i>Kearl Oil Sands Project - Mine Development: Regulatory Application</i> , (2005), Volume 2, Appendix A	"We are committed to environmental protection and the broader integration of environmental and economic priorities, in all aspects of our business. We will: adopt company standards and practices that meet or exceed legal requirements and apply continuous efforts to improve environmental performance where benefits justify the costs."
Petro-Canada Oil Sands Inc. - Fort Hills	Yes	Petro-Canada Oil Sands Inc., <i>Total Loss Management</i> , <a href="http://www.petro-canada.ca/pdfs/total_loss_management_policy-e-f.pdf">http://www.petro-canada.ca/pdfs/total_loss_management_policy-e-f.pdf</a> (Accessed on Dec. 1st, 2007)	The Petro-Canada Total Loss Management Policy includes the following environmental commitments: avoiding, minimizing or safely managing the impacts of our operations on the natural environment and on the communities in which we operate; dealing openly with stakeholders who may have an interest in our operations or development projects; supporting research on the health and environmental effects of our products, processes and wastes; avoiding waste and conserving energy and natural resources; setting and reviewing prudent environmental, health and safety targets; and establishing appropriate programs aimed at compliance with applicable regulatory standards.
Shell - Jackpine Phases 1&2	Yes	Shell Canada Ltd., <i>Commitment to Sustainable Development</i> , <a href="http://www.shell.com/static/ca-en/downloads/about_shell/how_we_work/hssd_policy.pdf">http://www.shell.com/static/ca-en/downloads/about_shell/how_we_work/hssd_policy.pdf</a> (Accessed on Dec. 1st, 2007)	Shell Canada Limited has a systematic approach to health, safety and environmental management designed to ensure compliance with the law and to achieve continuous performance improvement. sets targets for improvement and measures, appraises and reports performance.
Suncor - Current Operations	Yes	Suncor Energy Inc., <i>Environment: Policy</i> , <a href="http://www.suncor.com/default.aspx?ID=43">http://www.suncor.com/default.aspx?ID=43</a> (Accessed on Dec. 1 <sup>st</sup> , 2007)	"We strive to achieve levels of performance governed not just by legislation but also by the evolving environmental, social and economic expectations of our stakeholders."



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Environmental policy with commitment to continuous improvement			
Projects	Policy	Source	Comments
Syncrude Current	Yes	Syncrude Canada Ltd., <i>Environment, Health and Safety</i> , <a href="http://www.syncrude.ca/users/folder.asp?FolderID=5717">http://www.syncrude.ca/users/folder.asp?FolderID=5717</a> (Accessed on Dec. 1 <sup>st</sup> , 2007)	“At Syncrude, we are committed to protecting and promoting the safety and well being of our employees, our contractors, our communities, and our environment.” “We believe excellence and continuous improvement in environment, health and safety performance are in the best interest of all of our stakeholders. Our Corporate success depends upon it.”
Synenco - Northern Lights Phases 1 & 2	No	Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006), Volume 3 - Management Plans, Section 3.0: Health, Safety and Environment Management	Synenco’s HSE Policy is referred to in the application. However, the policy is not presented. The HSE policy did not appear to be available on the Northern Lights project website. Synenco is in the process of developing a comprehensive Corporate Responsibility Policy (that will include aspects related to health, safety and environment). If Pembina would like, we can provide a copy of the Policy upon completion. (Synenco communication – June 15, 2007)
Total - Joslyn North Mine Phases 1 & 2	Yes	Deer Creek Energy Ltd., <i>Loss Management</i> , <a href="http://www.deercreekenergy.com/operations/loss_manage.html">http://www.deercreekenergy.com/operations/loss_manage.html</a> (accessed Dec. 1st, 2007)	“Deer Creek has committed to participating in the Canadian Association of Petroleum Producer’s Environmental Health and Safety Stewardship program. For CAPP and its members, stewardship is the continuous improvement and transparent reporting of environment, health and socio-economic performance. As a member of the Stewardship program, Deer Creek commits to be recognized as ethical and credible leaders in the responsible exploration for, development and production of Canada’s resources. Deer Creek recognizes the important environmental and socio-economic issues surrounding oil sands development. Environmental protection is a vital and integral component of Deer Creek’s operations.”

## Question 2 - Environmental Management System

Table 3 summarizes the responses to the question, “Does your oil sands operation have an environmental management system that has been accredited by an independent third-party, such as ISO 14001 or equivalent”?

**Table 3 Summary of projects with third party verified environmental management systems**

Independently accredited environmental management system			
Projects	EMS	Source	Comments
Albian - Muskeg Existing	Yes	Albian Sands Energy Inc, <i>Commitment to Sustainable Development</i> , <a href="http://www.albiansands.com/environment.htm">http://www.albiansands.com/environment.htm</a> (accessed Dec. 1st, 2007)	Albian Sands Environmental Management System (EMS) is certified in accordance with the ISO 14001 standard
Albian - Muskeg Expansion	Yes	Albian Sands Energy Inc, <i>Commitment to Sustainable Development</i> , <a href="http://www.albiansands.com/environment.htm">http://www.albiansands.com/environment.htm</a> (accessed Dec. 1st, 2007)	Albian Sands Environmental Management System (EMS) is certified in accordance with the ISO 14001 standard
Canadian Natural - Horizon	No		No evidence of accreditation of oil sands environmental management system by an independent third party.
Imperial Resources Ventures Limited - Kearl Phases 1, 2 & 3	Yes	Imperial Oil Ltd., <i>Kearl Oil Sands Project - Mine Development: Regulatory Application</i> , (2005), Volume 2, Appendix A	“The Operations Integrity Management System (OIMS) is the primary tool Imperial uses to conduct operations and assess and improve its safety, health and environmental performance. OIMS enables the company to measure progress, plan future improvements and ensure management accountability for results. Lloyd’s Register Quality Assurance, a respected international authority, has attested that the environmental management components of Imperial’s Operations Integrity Management System (OIMS) meets the ISO 14001 Environmental Management Systems Standard.”

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Independently accredited environmental management system			
Projects	EMS	Source	Comments
Petro-Canada Oil Sands Inc. - Fort Hills	No	Personal Correspondence, Petro-Canada Oil Sands Inc., November, 2007	No evidence of a third-party accredited environmental management system. Petro-Canada Oil Sands Inc. is planning on certifying their mine to the ISO standard in 2011.
Shell - Jackpine Phases 1&2	No	<a href="http://www.shell.ca">http://www.shell.ca</a> "Protect the Environment"	Shell Canada has corporate registration of its environmental management system. The EMS for Shell Jackpine Mine has not been accredited.
Suncor - Current Operations	No		No evidence found of an independently accredited environmental management system.
Syncrude Current	No		No evidence of a third-party validated environmental management system such as ISO 14001 used at Mildred Lake or Aurora mines.
Synenco - Northern Lights Phases 1 & 2	No	Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006), Volume 3 - Management Plans, Section 3.0: Health, Safety and Environment Management	No evidence to suggest it has been independently accredited. Synenco's Health, Safety and Environment Management System is currently under development. Therefore, it isn't yet ready to be accredited by a third party.
Total - Joslyn North Mine Phases 1 & 2	No	Deer Creek Energy Limited, <i>Joslyn North Mine Project: Alberta Environment &amp; Alberta Energy and Utilities Board Integrated Application</i> , (2006) Volume 1, Section B.10.1, p. 167	No evidence to suggest the EMS has been independently accredited.

## Question 3 - Environmental Reporting

Table 4 summarizes the responses to the question “Do you publicly report annual Project-specific environmental indicators? [i.e. greenhouse gases (GHG), nitrous oxides (NO<sub>x</sub>), sulfur dioxide (SO<sub>2</sub>), volatile organic compounds (VOC), water use, etc...]

**Table 4 Summary table of environmental reporting**

Projects	Reporting	Environmental reporting	
		Source	Comments
Albian - Muskeg Existing	Yes	Personal communication, Albian Sands	Project-specific environmental indicators are reported as part of Albian Sands' annual reporting. Please see the Albian Sands 2005 Annual Environmental Report.
Albian - Muskeg Expansion	N/A		Albian – Muskeg Expansion has not commenced oil sands mining operations
Canadian Natural - Horizon	N/A		Canadian Natural has not commenced oil sands mining production.
Imperial Resources Ventures Limited - Kearl Phases 1, 2 & 3	N/A		Imperial Kearl has not commenced mining operations.
Petro-Canada Oil Sands Inc. - Fort Hills	N/A		Fort Hills has not commenced mining operations. Once Fort Hills is operational, reporting will be included in the annual Petro-Canada Report to the Community and the Petro-Canada Annual Report. Past reports can be accessed at <a href="http://www.petro-canada.ca">http://www.petro-canada.ca</a>
Shell - Jackpine Phases 1&2	N/A		Shell Jackpine is not currently in operation.
Suncor - Current Operations	Yes	Suncor Energy Ltd., <i>Suncor Energy Report on Sustainability 2006: A closer look at our journey toward sustainable development</i> , (2007),	Suncor will be publishing its next Sustainability Report in June 2007.
Syncrude Current	Yes	Syncrude Canada Limited, <i>Sustainability Report 2005: A New Generation of Opportunity</i> , (2006)	Project-specific environmental indicators are presented in the Syncrude 2005 Sustainability Report

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Environmental reporting			
Projects	Reporting	Source	Comments
Synenco - Northern Lights Phases 1 & 2	N/A		Synenco Northern Lights has not received regulatory approval. While this question doesn't apply to Synenco at the present time, it is important to note that the company does intend to publicly report project-specific environmental indicators once Northern Lights is in operation.
Total - Joslyn North Mine Phases 1 & 2	N/A		Joslyn Mine has not received regulatory approval.

### Question 4 - Legal Compliance

Table 5 summarizes the responses to the question, "Please summarize all ambient air exceedances, and all environmental enforcement actions (including warning letters, prosecutions, fines etc...) in 2006 for this oil sands operation."

**Table 5 Summary of legal compliance record of active operations**

Legal compliance record			
Projects	Clear Record?	Source	Comments
Albian - Muskeg Existing	Yes	Clean Air Strategic Alliance, <i>The CASA Data Warehouse</i> , <a href="http://www.casadata.org">http://www.casadata.org</a> (Accessed April 30, 2007)	The Albian Mine ambient monitoring station (AMS10) monitors ambient concentrations of SO <sub>2</sub> , and there were no exceedances of the 1-hour or 24-hour Alberta Ambient Air Quality Objectives during 2005 or 2006. However, the Albian mine station does not monitor ambient concentrations of H <sub>2</sub> S. The Barge Landing station (AMS9) does not monitor ambient concentrations of SO <sub>2</sub> or H <sub>2</sub> S.  There were no odour complaints, environmental fines or environmental administrative penalties in 2005 or 2006.
Albian – Muskeg Expansion	N/A		Muskeg Expansion is not currently in operation.
Canadian Natural - Horizon	N/A		Horizon Mine is not currently in operation.
Imperial Resources Ventures Limited - Kearl Phases 1, 2 & 3	N/A		Imperial Kearl has not commenced mining operations.

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Legal compliance record			
Projects	Clear Record?	Source	Comments
Petro-Canada Oil Sands Inc. - Fort Hills	N/A		Fort Hills has not commenced mining operations.
Shell - Jackpine Phases 1&2	N/A		Shell Jackpine is not currently in operation.
Suncor - Current Operations	No	Alberta Environment, <a href="http://www3.gov.ab.ca/env/protenf/compliance/pubs/QuarterlyReport_Jan-Mar2005.pdf">http://www3.gov.ab.ca/env/protenf/compliance/pubs/QuarterlyReport_Jan-Mar2005.pdf</a> , (accessed October 11, 2007) and <i>Suncor Energy Report on Sustainability 2006: A closer look at our journey toward sustainable development. (p66)</i>	Suncor received one warning in 2005. Suncor received this warning letter in response to a low free-chlorine residual found in treated water in the clearwell. This contravened its approval. In 2005 Suncor reported 30 air quality exceedences and showed an increasing trend of 240 air quality exceedences in 2006.
Syncrude Current	No	Syncrude Canada Limited, <i>Sustainability Report 2005: A New Generation of Opportunity</i> , (2006), p. 57	Syncrude had two regulatory enforcement actions in 2005/2006, including an Environmental Protection Order to halt operations from a Flue Gas Desulphurization Unit due to an uncontrolled release of ammonia. The company also received a warning letter for late reporting of NH <sub>3</sub> and SO <sub>2</sub> releases. In 2005, the last year for which data was available during our data collection period, the company also reported 46 ambient air exceedences for H <sub>2</sub> S and 1 ambient air exceedence for SO <sub>2</sub> .
Synenco - Northern Lights Phases 1 & 2	N/A		Synenco Northern Lights has not received regulatory approval.
Total - Joslyn North Mine Phases 1 & 2	N/A		Joslyn Mine has not received regulatory approval.

# Appendix 2 – Land

## Question 5 - Certified Land

Table 6 summarizes the responses to the survey question “What is the current ratio of total mine disturbance to certified reclamation?”

**Table 6 Certified reclaimed land by project**

Projects	Reclaimed land per year		
	Certified reclaimed land (Yes/No)	Source	Comments
Albian Sands Energy Inc. - Muskeg Existing	N/A		The Muskeg River Mine produced first bitumen in December of 2002. It has therefore not been in operation long enough to produce certified reclaimed land.
Albian Sands Energy Inc. - Muskeg Expansion	N/A		
Canadian Natural - Horizon	N/A		
Imperial Oil Resources Ventures Limited - Kearl Phases 1,2 & 3	N/A		
Petro-Canada Oil Sands Inc. - Fort Hills	N/A		
Shell Canada Ltd. - Jackpine Phase 1	N/A		
Suncor Energy Inc. - Current Operations	No	Response to Survey	No indication of certified reclaimed land
Synchrude - Current Operations	No		No indication of certified reclaimed land

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Reclaimed land per year			
Projects	Certified reclaimed land (Yes/No)	Source	Comments
Synenco Energy Inc. - Northern Lights Phases 1 & 2	N/A		
Total E&P Canada - Joslyn North Mine Phases 1 & 2	N/A		

### Question 6 - Reclamation Rate

Table 7 includes the land reclamation rate, source and comments on each particular project. These values were calculated by first determining the total land disturbed and the total land reclaimed after 20 years of operation. This percentage value was then divided by the 20 years to determine the reclamation rate of each project. Not all projects presented data at exactly 20 years after start-up; in those instances, the dates presented closest to 20 years were selected. We calculated these values based on responses to the question “What is the current ratio of total mine disturbance to reclamation according to your operation’s definition of reclamation?”

**Table 7 Reclamation data, sources and assumptions**

Reclaimed land per year			
Projects	Reclamation Rate (% per year after 20 years)	Source	Comments
Albian Sands Energy Inc. - Muskeg Existing	1.66%	Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), Appendix 4, pg. 97, Table 23	The application states that by 2027, 17 years after start of operations, 12,474 ha will be cleared with 4,135 ha under some form of reclamation. This result in a reclamation average of 1.66%/year.
Albian Sands Energy Inc. - Muskeg Expansion	1.66%	Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), Appendix 4, pg. 97, Table 23	The application states that by 2027, 17 years after start of operations, 12,474 ha will be cleared with 4,135 ha under some form of reclamation. This result in a reclamation average of 1.66%/year.



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Reclaimed land per year			
Projects	Reclamation Rate (% per year after 20 years)	Source	Comments
Canadian Natural - Horizon	0.81%	Canadian Natural Resources Ltd., <i>Horizon Oil Sands Project: Application for Approval Submitted to Alberta Energy and Utilities Board and Alberta Environment</i> , (2002), Figure 3.5-4, pg. 3-43	The application states that by 2030, 19 years after start of operations, 14,250 ha will be cleared with 2,321 ha under some form of reclamation. This results in a reclamation average of 0.81%/year.
Imperial Oil Resources Ventures Limited - Kearl Phases 1,2 & 3	1.10%	Imperial Oil Ltd., <i>Kearl Oil Sands Project - Mine Development: Regulatory Application</i> , (2005), Volume 2, page 9-29	The application states that by 2026, 19 years after start of operations, 7972 ha will be cleared with 1664 ha under some form of reclamation. This results in a reclamation average of 1.10%/year.
Petro-Canada Oil Sands Inc. - Fort Hills	1.56%	Paragon Soil and Environmental Consulting Inc, Jacques Whitford AXYS Ltd, Gartner Lee Limited, <i>Closure, Conservation and Reclamation Plan for the Fort Hills Oil Sands Project</i> , (2007), Table 8, pg. 20	The reclamation plan states that by 2036 (25 years after the start of the mine life) 3,358.6 hectares will be reclaimed out of a total disturbance of 8,602.1 hectares. This results in an annual reclamation average of 1.56%
Shell Canada Ltd. - Jackpine Phase 1	2.05%	Shell Canada Ltd., <i>Application for Approval of the Jackpine Mine - Phase 1</i> , (2002), pg. 2-25 and SIRs, Table 3.17, Section 3.5	The application states that total 8380 ha of land will be cleared (annual amounts could not be found) will be cleared for the mine with 2583 ha under some form of reclamation by 2025, 15 years after startup. This result in a reclamation average of 2.05%/year.

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Reclaimed land per year			
Projects	Reclamation Rate (% per year after 20 years)	Source	Comments
Suncor Energy Inc. - Current Operations	0.18%	Suncor Energy Ltd., <i>Suncor Energy Report on Sustainability 2006: A closer look at our journey toward sustainable development</i> , (2007), p. 65	As of 2006, 40 years after start of operations, Suncor had 13,093 ha of land disturbed and reclaimed 949 ha. This results in a reclamation average of 0.18% per year. Suncor's reclamation rate is based on actual performance as apposed to plans or projections.
Syncrude - Current Operations	0.78%	Syncrude Canada Ltd. <i>Sustainability Report 2005: a new generation of opportunity</i> .(2006) pg. 60	As of 2005, 29 years after start of operations, Syncrude had 19,160 ha of land disturbed and reclaimed 4,357 ha. This results in a reclamation average of 0.78% per year. Syncrude's reclamation rate is based on actual performance as apposed to plans or projections.
Synenco Energy Inc. - Northern Lights Phases 1 & 2	1.45%	Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006), Volume 2, Tables 6.9.7 and 6.9.7	The application states that by 2030, 22 years after start of operations, 10,445 ha of land will be cleared with 3,344 ha under some form of reclamation. This results in a reclamation average of 1.45%/year.
Total E&P Canada - Joslyn North Mine Phases 1 & 2	2.37%	Deer Creek Energy Limited, <i>Joslyn North Mine Project: Alberta Environment &amp; Alberta Energy and Utilities Board Integrated Application</i> ,(2006) Table 3.5.1.	The application states that by 2029, 16 years after start of operations, 4,267 ha will be cleared with 2,036 ha under some form of reclamation.

## Question 7 - Public Support of Protection

Table 8 summarizes the responses to the survey question, “Does your company publicly support the protection of some areas of unallocated forest in northeastern Alberta, to keep as reference sites for comparison to landscapes disturbed by oil sands projects”?

**Table 8 Summary of public support for the protection of some areas of unallocated forest in northeastern Alberta on a project per project basis**

Public Support of Protection			
Projects	Offsets (yes/no)	Source	Comments
Albian Sands Energy Inc. - Muskeg Existing	No		Does intend to support this initiative through SEWG, a working group within CEMA.
Albian Sands Energy Inc. - Muskeg Expansion	No		Does intend to support this initiative through SEWG, a working group within CEMA.
CNRL Ltd. - Horizon	No		No evidence
Imperial Ltd. - Kearl Phases 1,2 & 3	Yes	Imperial Ltd., Personal Correspondence, September 2007	AI-Pac has identified and voluntarily deferred harvest in two large areas that will act as ecological benchmarks representative of the habitat diversity of the FMA area. These two sites contain forest types representative of those found in the resource use LSA. Imperial Oil supports the establishment of these benchmark areas, as a reference to compare with reclaimed portions of the LSA.
Petro-Canada Oil Sands Inc. - Fort Hills	No	Petro-Canada Oil Sands Inc., Personal Correspondence, June 2007	PCOSI is currently engaged in discussions with the Alberta Conservation Association regarding habitat/terrestrial offsets for the Fort Hills Oil Sands Project.
Shell Canada Ltd. - Jackpine Phases 1&2	No		Does intend to support this initiative through SEWG, a working group within CEMA.

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Public Support of Protection			
Projects	Offsets (yes/no)	Source	Comments
Suncor Energy Inc. - Current Operations	Yes	Suncor Personal Correspondence, June 5th, 2007	1. Letter to Sustainable Development Minister David Coumts, Suncor supported proposal to establish two ecological benchmark areas in NE Alberta. 2. Through the Boreal Conservation Initiative.
Syncrude - Current Operations	No		No evidence
Synenco Energy Inc. - Northern Lights Phases 1 & 2	No		No evidence
Total E&P Canada - Joslyn North Mine Phases 1 & 2	No		No evidence

### Question 8 - Support for the Alberta Monitoring Program

Table 9 summarizes responses to “Does your company provide support (financial or other) to the Alberta Biodiversity Monitoring Program in order to provide meaningful, long term information about changes in biodiversity in the oil sands region?”

**Table 9 Summary of support for the Alberta Biodiversity Monitoring Program (ABMP) on a per project basis**

Public Support of Protection			
Projects	Offsets (yes/no)	Source	Comments
Albian Sands Energy Inc. - Muskeg Existing	Yes	<i>Issue Resolution Document for the Proposed Muskeg River mine Expansion Project, Albian Energy Inc. and the Oil Sands Environmental Coalition, (2006)</i>	Shell financially supports implementation of the Alberta Biodiversity Monitoring Program pilot.
Albian Sands Energy Inc. - Muskeg Expansion	Yes	<i>Issue Resolution Document for the Proposed Muskeg River mine Expansion Project, Albian Energy Inc. and the Oil Sands Environmental Coalition, (2006)</i>	Shell financially supports implementation of the Alberta Biodiversity Monitoring Program pilot.
CNRL Ltd. - Horizon	No		No evidence

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Public Support of Protection			
Projects	Offsets (yes/no)	Source	Comments
Imperial Ltd. - Kearl Phases 1,2 & 3	No		No evidence
Petro-Canada Oil Sands Inc. - Fort Hills	Yes	Petro-Canada Oil Sands Inc., Personal Correspondence, June 2007	PCOSI is participating in, and providing funding to AMBI.
Shell Canada Ltd. - Jackpine Phases 1&2	Yes	<i>Issue Resolution Document for the Proposed Muskeg River mine Expansion Project, Albian Energy Inc. and the Oil Sands Environmental Coalition, (2006)</i>	Shell financially supports implementation of the Alberta Biodiversity Monitoring Program pilot.
Suncor Energy Inc. - Current Operations	Yes	Alberta Biodiversity Monitoring Program, <i>2005 Annual Report, (2006)</i>	Suncor is a funder and participant in the Alberta biodiversity Monitoring Program. Gord Lambert of Suncor is co-chair of the ABMP Board of Directors.
Syncrude - Current Operations	No		No evidence
Synenco Energy Inc. - Northern Lights Phases 1 & 2	No		Still in the early stages of joining the relevant regional partnerships.
Total E&P Canada - Joslyn North Mine Phases 1 & 2	No		No evidence

## Appendix 3 – Air Emissions

Each project is designed differently and this makes it challenging to compare operations fairly with each other. For the purposes of this study we determined the total air emissions produced by each operation per barrel of bitumen produced. We intentionally did not include upgrading and instead focused solely on mining emission sources. Table 10 lists and briefly describes each of the emission sources included in our assessment.

**Table 10 Summary of air emissions sources included in air emission calculations**

Activities		
<b>Mining</b> – Truck and shovel operations release NO <sub>x</sub> , SO <sub>2</sub> , VOC and GHG to the atmosphere	<b>Mine Face</b> – The mine face is primarily a source of VOC emissions.	<b>Fugitive Emissions</b> – Includes all those emissions not included here and was reported differently depending on the company.
<b>Processing Units</b> – Bitumen is partially processed onsite using crushers and heated water. Emissions from these sources are included.	<b>Electricity Production</b> (on or offsite) – Onsite electricity production is usually natural gas fired cogeneration. However, emissions from offsite electricity generation are included in this analysis as well, so as not to penalize projects that produce electricity onsite.	<b>Offsite Natural Gas Production</b> - Oil sands operations use vast amounts of natural gas. Its production results in significant air emissions which are included in this analysis.
<b>Tailings Ponds</b> – Tailings ponds release primarily VOCs and Methane.	<b>Heating</b> – Many onsite buildings require heating, this is sometimes broken out separately from processing and is included in this analysis.	

The majority of these activities take place onsite for all operations, the exceptions being offsite natural gas production and in some cases offsite electricity production. The method for calculating these emissions sources is provided below.

Emissions from **Suncor** and **Syncrude's** operations **are not** compared with the other operations because they do not report air emissions data for only mining operations.

## Upstream natural gas production

Upstream natural gas production includes exploratory drilling, development drilling, gas processing in the field, gathering, flaring, and processing out of the field and transmission. Data Supplied by TransAlta Utilities based on a study performed by Monenco Agra Inc. in 1996. Emissions per metre cubed of natural gas are provided in the table below.

**Table 11 Air emissions factors for upstream natural gas production**

Air Emission	Emission Factor (kg/m <sup>3</sup> )
NO <sub>x</sub>	0.0016
SO <sub>2</sub>	0.0026
VOC	0.0009

Pembina applied these emission factors to every mining operation based on the average natural gas requirements for steady state operations.

## Upstream Electricity Production

Some operations plan to source electricity from the Alberta Grid. Pembina developed an average emission factors for the Alberta grid using NPRI data for electricity generation in Alberta and total electricity production values as reported in the Report on Energy Supply - Demand in Canada Catalogue No. 57-003 for 2005. The results of this analysis are presented in Table 12.

**Table 12 Air emission factors for Alberta Grid electricity generation**

Emission	Emissions (2005) (t)	Electricity Generation (GWh)	Intensity (kg/MWh)
NO <sub>x</sub>	84913	57290	1.482
SO <sub>2</sub>	130476	57290	2.277
VOC	575	57290	0.010

We applied these factors to all operations that sourced electricity from the grid based on expected electricity requirements.

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### Question 9 - Nitrogen Oxide

Table 13 summarizes the responses to the question “what are your overall project-specific nitrous oxide (NOx) emissions in tonnes (t) per calendar day (CD)”? Pembina converted these values in combination with offsite emission values, as discussed above, into NOx intensity values for every project.

**Table 13 Nitrogen oxide emissions intensity with sources and assumptions/comments**

NOx emissions summary			
Project	NOx (g/bbl)	Source	Comment
Albian Sands Energy Inc. - Muskeg Existing	128	Onsite emissions sourced from: Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), Volume 2, Section 3.3.2, Table 3.3-2	This value includes onsite emissions of 17.3 t/d and 1.87 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 150,000 bbl/day yields the intensity value presented here.
Albian Sands Energy Inc. - Muskeg Expansion	155	Onsite emissions sourced from: Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), Volume 2, Section 3.4.2.1, Table 3.4-2. Offsite emissions are based on the lifecycle assumptions discussed at the beginning of the appendix.	This value includes onsite emissions of 14.4 t/d, offsite electricity production emissions of 2.49 t/d and 1.83 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 120,000 bbl/day yields the intensity value presented here.
Canadian Natural - Horizon	158	Onsite emissions sourced from: Canadian Natural Resources Ltd., <i>Horizon Oil Sands Project: Application for Approval Submitted to Alberta Energy and Utilities Board and Alberta Environment - Supplemental Information</i> , Volume 4, Appendix C, Section C2.1.1.7, pg. c2-2 to c2-8	This value includes onsite emissions of 31.62 t/d and 7.71 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 225,000 bbl/day yields the intensity value presented here. Onsite emissions associated with onsite electricity production have been reduced by 30% in order to discount electricity use associated with CNRL onsite upgrader.



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NOx emissions summary			
Project	NOx (g/bbl)	Source	Comment
Imperial Oil Resources Ventures Limited - Kearl Phases 1, 2 & 3	160	Onsite emissions sourced from: Imperial Oil Ltd., <i>Kearl Oil Sands Project - Mine Development: Regulatory Application</i> , (2005), Volume 5, Section 2, Table 2-15, pg. 2-42	This value includes onsite emissions of 42.67 t/d and 5.33 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 300,000 bbl/day yields the intensity value presented here.
Petro-Canada Oil Sands Inc. - Fort Hills	139	Onsite emissions sourced from: Petro-Canada Oil Sands Inc. <i>Application for Approval of the Fort Hills Oil Sands Project</i> .(2002) pg. 6-22	This value includes onsite emissions of 24.31 t/d and 2.13 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 190,000 bbl/day yields the intensity value presented here.
Shell Canada Ltd. - Jackpine Phase 1	113	Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), , Volume 2, Appendix 2-9, Table 30	This value includes onsite emissions of 18.28 t/d and 4.41 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 200,000 bbl/day yields the intensity value presented here.
Suncor Energy Inc. - Current Operations	165	Suncor Energy Ltd., <i>Suncor Energy Report on Sustainability 2006: A closer look at our journey toward sustainable development</i> , (2007), Pg. 64	This value includes emissions associated with mining and upgrading and insitu operations and is therefore not directly comparable with the other data presented in this table.
Syncrude - Current Operations	257	Syncrude Canada Ltd. <i>Sustainability Report 2005: a new generation of opportunity</i> .(2006), pg. 54	Based on the emission of 55 tonnes per day of NOx and a production of 214,000 bbl/day of SCO. This value includes emissions associated with mining and upgrading and is therefore not directly comparable with the other data presented in this table. It is also on a per barrel of SCO basis.

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NO <sub>x</sub> emissions summary			
Project	NO <sub>x</sub> (g/bbl)	Source	Comment
Synenco Energy Inc. - Northern Lights Phases 1 & 2	154	Onsite emissions confirmed by Synenco and sourced from Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006), Volume 5, Table 2.3-13 pg. 2-42	This value includes onsite emissions of 15.71 t/d and 1.94 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 114,500 bbl/day yields the intensity value presented here.
Total E&P Canada - Joslyn North Mine Phases 1 & 2	137	Deer Creek Energy Limited, <i>Joslyn North Mine Project: Alberta Environment &amp; Alberta Energy and Utilities Board Integrated Application</i> , (2006), CR#1, Section 4.1.4, Table 4.4, pg. 41	This value includes onsite emissions of 12.22 t/d and 1.43 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 100,000 bbl/day yields the intensity value presented here.

### Question 10 - Sulphur Dioxide

Table 14 summarizes the responses to the question “what are your overall project-specific Sulphur dioxide (SO<sub>2</sub>) emissions in tonnes (t) per calendar day (CD)”? Pembina converted these values in combination with offsite emission values, as discussed above, into NO<sub>x</sub> intensity values for every project.

**Table 14 Sulphur dioxide emissions intensity with sources and comments/assumptions**

SO <sub>2</sub> emissions summary			
Project	SO <sub>2</sub> (g/bbl)	Source	Comment
Albian Sands Energy Inc. - Muskeg Existing	22	Onsite emissions sourced from: <i>Shell Canada Ltd., Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), , Volume 2, Section 3.3.2, Table 3.3-2	This value includes onsite emissions of 0.20 t/d and 3.05 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 150,000 bbl/day yields the intensity value presented here.

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SO <sub>2</sub> emissions summary			
Project	SO <sub>2</sub> (g/bbl)	Source	Comment
Albian Sands Energy Inc. - Muskeg Expansion	60	Onsite emissions sourced from: Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), Volume 2, Section 3.4.2.1, Table 3.4-2. Offsite emissions are based on the lifecycle assumptions discussed at the beginning of this appendix.	This value includes onsite emissions of 0.4 t/d, offsite electricity production emissions of 3.83 t/d and 2.97 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 120,000 bbl/day yields the intensity value presented here.
Canadian Natural - Horizon	14	Onsite emissions sourced from: Canadian Natural Resources Ltd., <i>Horizon Oil Sands Project: Application for Approval Submitted to Alberta Energy and Utilities Board and Alberta Environment - Supplemental Information</i> , Volume 4, Appendix C, Section C2.1.1.7, pg. c2-2 to c2-8	This value includes onsite emissions of 0.46 t/d and 3.32 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 225,000 bbl/day yields the intensity value presented here. Onsite emissions associated with onsite electricity production have been reduced by 30% in order to discount electricity use associated with CNRL onsite upgrader.
Imperial Oil Resources Ventures Limited - Kearl Phases 1, 2 & 3	31	Onsite emissions sourced from: Imperial Oil Ltd., <i>Imperial Oil Ltd., Kearl Oil Sands Project - Mine Development: Regulatory Application</i> , (2005), Volume 5, Section 2, Table 2-15, pg. 2-42	This value includes onsite emissions of 0.66 t/d and 8.66 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 300,000 bbl/day yields the intensity value presented here.
Petro-Canada Oil Sands Inc. - Fort Hills	27	Onsite emissions sourced from: Petro-Canada Oil Sands Inc. <i>Application for Approval of the Fort Hills Oil Sands Project</i> .(2002) pg. 6-22	This value includes onsite emissions of 1.73 t/d and 3.46 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 190,000 bbl/day yields the intensity value presented here.

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SO <sub>2</sub> emissions summary			
Project	SO <sub>2</sub> (g/bbl)	Source	Comment
Shell Canada Ltd. - Jackpine Phase 1	37	Onsite emissions sourced from: Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), , Volume 2, Appendix 2-9, Table 29 and 30	This value includes onsite emissions of 0.33 t/d and 7.16 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 200,000 bbl/day yields the intensity value presented here.
Suncor Energy Inc. - Current Operations	263	Suncor Energy Ltd., <i>Suncor Energy Report on Sustainability 2006: A closer look at our journey toward sustainable development</i> , (2007),. Pg. 64	This value includes emissions associated with mining and upgrading and in situ operations and is therefore not directly comparable with the other data presented in this table.
Syncrude - Current Operations	1061	Syncrude Canada Ltd. <i>Sustainability Report 2005: a new generation of opportunity</i> .(2006), pg. 54	Based on the emission of 227 tonnes per day of SO <sub>2</sub> and a production of 214,000 bbl/day of SCO. This value includes emissions associated with mining and upgrading and is therefore not directly comparable with the other data presented in this table. It is also on a per barrel of SCO basis.
Synenco Energy Inc. - Northern Lights Phases 1 & 2	31	Onsite emissions confirmed by Synenco and sourced from Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006), Volume 5, Table 2.3-13 pg. 2-42	This value includes onsite emissions of 0.39 t/d and 3.16 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 114,500 bbl/day yields the intensity value presented here.
Total E&P Canada - Joslyn North Mine Phases 1 & 2	24	Onsite emissions sourced from: Deer Creek Energy Limited, <i>Joslyn North Mine Project: Alberta Environment &amp; Alberta Energy and Utilities Board Integrated Application</i> , (2006), CR#1, Section 4.1.4, Table 4.4, pg. 41	This value includes onsite emissions of 0.10 t/d and 2.33 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 100,000 bbl/day yields the intensity value presented here.

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### Question 11 – Volatile Organic Compounds

Tailings ponds are the primary source of emissions from oil sands mines. However, Volatile Organic Compound (VOC) emissions are presented in two ways in the EIA reports. The first method averages the total emissions over a given year and presents them on a daily basis. The other method presents only the maximum daily VOC emissions. In order to harmonize these methods and compare emissions from different companies effectively, VOC data presented as a daily maximum value have been converted into daily average values outlined below.

As presented in the following chart, maximum daily emissions of VOCs occur in the summer months. To determine the average yearly emissions, this maximum value is multiplied by the average percentage of emissions emitted over the year. This value is 40.1% as seen below.

**Table 15 The percentage of maximum VOC emission value on a monthly basis.<sup>1</sup>**

Month	% Emissions
January	2.70%
February	3.40%
March	6.90%
April	29.60%
May	65.30%
June	88.30%
July	100.00%
August	95.00%
September	57.50%
October	25.80%
November	3.80%
December	2.60%
<b>Average</b>	<b>40.08%</b>

The result of multiplying the 40% average by the maximum daily emission value reported by some companies is an emissions value that is comparable with the average daily emissions value presented by other companies.

<sup>1</sup> Muskeg River Mine Expansion Project, Volume 2, Appendix 2-9, Table 25, 78–79.

Table 16 summarizes the responses to the question, “what are your overall project-specific volatile organic compounds (VOC) emissions in tonnes (t) per calendar day (CD)”? Pembina converted these values in combination with offsite emission values, as discussed above, into NO<sub>x</sub> intensity values for every project.

**Table 16 VOC emissions intensity with sources and assumptions/comments**

VOC emissions summary			
Project	VOC (g/bbl)	Source	Comment
Albian Sands Energy Inc. - Muskeg Existing	99	Onsite emissions sourced from: Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), , Volume 2, Section 3.3.2, Table 3.3-2	This value includes onsite emissions of 13.82 t/d and 1.06 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 150,000 bbl/day yields the intensity value presented here.
Albian Sands Energy Inc. - Muskeg Expansion	116	Onsite emissions sourced from: Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), Volume 2, Section 3.4.2.1, Table 3.4-2.	This value includes onsite emissions of 13.0 t/d, offsite electricity production emissions of 0.02 t/d and 1.95 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 120,000 bbl/day yields the intensity value presented here.
Canadian Natural - Horizon	276	Onsite emissions sourced from: Canadian Natural Resources Ltd., <i>Horizon Oil Sands Project: Application for Approval Submitted to Alberta Energy and Utilities Board and Alberta Environment - Supplemental Information</i> , Volume 4, Appendix C, Section C2.1.1.7, pg. c2-2 to c2-8	In order to compare CNRLs tailing pond emissions equivalently with other operators the reported value of 139.36 t/d has been reduced by 60% as per the method described above this table. This value includes onsite emissions of 72.28 t/d and 1.15 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 270,000 bbl/day yields the intensity value presented here. Emissions associated with onsite electricity production have been reduced by 30% in order to discount electricity use associated with CNRL onsite upgrader.

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VOC emissions summary			
Project	VOC (g/bbl)	Source	Comment
Imperial Oil Resources Ventures Limited - Kearl Phases 1, 2 & 3	233	Onsite emissions sourced from: Imperial Oil Ltd., <i>Kearl Oil Sands Project - Mine Development: Regulatory Application</i> , (2005), Volume 5, Section 2, Table 2-15, pg. 2-42	This value includes onsite emissions of 67.0 t/d and 3.00 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 300,000 bbl/day yields the intensity value presented here. Tailings area VOCs are based on the annual average emission as described at the beginning of this section.
Petro-Canada Oil Sands Inc. - Fort Hills	86	Onsite emissions sourced from: Petro-Canada Oil Sands Inc. <i>Application for Approval of the Fort Hills Oil Sands Project</i> .(2002) pg. 6-22	This value includes onsite emissions of 15.11 t/d and 1.20 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 190,000 bbl/day yields the intensity value presented here.
Shell Canada Ltd. - Jackpine Phase 1	102	Onsite emissions sourced from: Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), , Volume 2, Appendix 2-9, Table 29 and 30	This value includes onsite emissions of 17.97 t/d and 2.48 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 200,000 bbl/day yields the intensity value presented here.
Suncor Energy Inc. - Current Operations	276	Suncor Energy Ltd., <i>Suncor Energy Report on Sustainability 2006: A closer look at our journey toward sustainable development</i> , (2007),. Pg. 64	This value includes emissions associated with mining and insitu operations and upgrading and is therefore not directly comparable with the other data presented in this table.

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VOC emissions summary			
Project	VOC (g/bbl)	Source	Comment
Syncrude - Current Operations	137	2005 NPRI Data	NPRI reports Syncrude's operations emit 29.29 t/d VOC. In 2005 Syncrude produced 214,000 bbl/d. This value includes emissions associated with mining and upgrading and is therefore not directly comparable with the other data presented in this table. This value is also on a per barrel of SCO basis.
Synenco Energy Inc. - Northern Lights Phases 1 & 2	270	Onsite emissions sourced from: Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006), Volume 5, Table 2.3-13 pg. 2-42	In order to compare Synenco's tailing pond emissions equivalently with other operators the reported value of 58.6 t/d has been reduced to 40.1% of the original value as per the method described above this table. After this change total onsite and offsite emissions (associated with upstream natural gas production) amount to 29.81 t/d and 1.1 t/d respectively. The sum of these values divided by a daily production value of 114,500 bbl/d yields the value presented here.
Total E&P Canada - Joslyn North Mine Phases 1 & 2	218	Onsite emissions sourced from: Deer Creek Energy Limited, <i>Joslyn North Mine Project: Alberta Environment &amp; Alberta Energy and Utilities Board Integrated Application</i> , (2006), CR#1, Section 4.1.4, Table 4.4, pg. 41	This value includes onsite emissions of 21.00 t/d and 0.81 t/d of offsite emissions associated with upstream natural gas production. The sum of these values divided by a daily production value of 100,000 bbl/day yields the intensity value presented here.

### Question 12 - Air Emissions Targets

In response to the question "Do you have project specific air emission targets?" all companies, with the exception of Syncrude, do not have air emission reduction targets. Syncrude does provide reduction targets for their sulphur emissions on page 54 of their 2006 sustainability report (2005 data).



# Appendix 4 – Water

## Question 13 - Water Intensity

Water intensity values are calculated based on annual water use during normal operations divided by average bitumen production over the same time period. Table 17 contains the results of this analysis as well as the sources and comments when required. These values are in response to question “What is your average freshwater consumption per barrel of bitumen produced (m<sup>3</sup>/bbl)?”

**Table 17 Water intensity values with sources and comments/assumptions**

Water intensity summary table			
Project	Water Intensity (m3/bbl)	Source	Comment
Albian Sands Energy Inc. - Muskeg Existing	0.54	Shell Canada Ltd. <i>Sustainable Choice, Stakeholder Voices</i> .(2006) pg. 69	Confirmed by Shell
Albian Sands Energy Inc. - Muskeg Expansion	0.65	Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project</i> , (2005), Volume 1, Section 10.5, pg. 10-22	Confirmed by Shell based on water use of 28,300,000 m3/year and daily bitumen production of 120,000 bbl/d.
Canadian Natural - Horizon	0.31	Personal Correspondence with Canadian Natural, Sept. 11th, 2007	

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Water intensity summary table			
Project	Water Intensity (m3/bbl)	Source	Comment
Imperial Oil Resources Ventures Limited - Kearl Phases 1,2 & 3	0.22	Imperial Oil Ltd., <i>Kearl Oil Sands Project - Mine Development: Regulatory Application</i> , (2005), Volume 2, Section 5. Table 5.4	Based on water use of 23,880,000 m3/year and daily bitumen production of 300,000 bbl/d. Actual water use varies significantly over life of project with licence allocation ranging from 104Mm3/yr to 550 Mm3/yr. The value presented here is based on the average athabasca river withdrawals from 2010 to 2060 and does not include end pit lake filling. This is taken to be the water use for normal operations.
Petro-Canada Oil Sands Inc. - Fort Hills	0.20	Petro-Canada Oil Sands Inc., Fort Hills Mine Application, (2002), p. 53	Based on annual water use of 14,016,000 m3/yr and average daily production of 190,000 bbl/d.
Shell Canada Ltd. - Jackpine Phase 1	0.46	Shell Canada Ltd., <i>Application for Approval of the Jackpine Mine - Phase 1</i> , (2002), Section 6.5 Table 6-4 pg. 6-28, changed to match that provided in response to survey.	Based on water use of 33,875,000 m3/year and daily bitumen production of 200,000 bbl/d. This is the rate after 2015, peak water withdrawal from athabasca occurs in 2015 at 63.5Mm3.
Suncor Energy Inc. - Current Operations	0.53	Suncor Energy Ltd., <i>Suncor Energy Report on Sustainability 2006: A closer look at our journey toward sustainable development</i> , (2007), p. 65	Based on water use of 50,900,000 m3/year and daily crude oil average production of 264,383 bbl/d. Water use is based on mining, upgrading and in-situ operations and is therefore not comparable with other operations listed here.
Syncrude - Current Operations	0.36	Syncrude Canada Ltd. <i>Sustainability Report 2005: a new generation of opportunity</i> .(2006), pg. 58	Based on total withdrawals of 28.24 Mm3 and production of 214,000 bbl of bitumen converted from Sweet Crude value quoted in sustainability report. Based on mining and upgrading and therefore not comparable with other operations.
Synenco Energy Inc. - Northern Lights Phases 1 & 2	0.31	Synenco Response to Survey	Provided by Synenco in response to survey questions.

Water intensity summary table			
Project	Water Intensity (m3/bbl)	Source	Comment
Total E&P Canada - Joslyn North Mine Phases 1 & 2	0.27	Deer Creek Energy Limited, <i>Joslyn North Mine Project: Alberta Environment &amp; Alberta Energy and Utilities Board Integrated Application</i> , (2006), Section G, Table G.1.0.1, pg. G-2	Based on water use of 9,900,000 m3/yr and daily bitumen production 100,000 bbl/d.

## Question 14 - Water Intensity Reduction Targets

No company surveyed answered yes to the question, “Do you have targets to reduce water intensity and consumption in your operations?” Syncrude does have water intensity targets but they are increasing.

## Question 15 - Mature Fine Tailings

Mature Fine Tailings (MFT) values are calculated by dividing the total MFT remaining at project close and then dividing that by the total bitumen produced over the mine life. Table 18 includes the results of this analysis with references and comments when necessary in response to the question “What is the average volume (m<sup>3</sup>) of mature fine tailings (MFT) produced per barrel of bitumen?”

**Table 18 Mature fine tailings intensity values with sources and comments**

Mature fine tailings summary			
Project	Mature Fine Tailings (m3/bbl)	Source	Comment
Albian Sands Energy Inc. - Muskeg Existing	0.1700	Albian Sands Energy Inc. Personal Correspondence, August 21, 2007.	Provided by Albian Sands
Albian Sands Energy Inc. - Muskeg Expansion	0.1700	Albian Sands Energy Inc. Personal Correspondence, August 21, 2007.	Provided by Albian Sands

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Mature fine tailings summary			
Project	Mature Fine Tailings (m3/bbl)	Source	Comment
Canadian Natural - Horizon	0.0034	CNRL. (2003). Horizon Oil Sands Project: Application for Approval Supplemental Information. Volume 1, Section 3, pg. 3-54	Based on the sum of Thickened Tailings and Mature Fine Tailings at the end of mine operations
Imperial Oil Resources Ventures Limited - Kearl Phases 1, 2 & 3	0.0048	Imperial Oil Ltd. <i>Imperial Oil Resource Ventures Limited: Kearl Oil Sands Project - Mine Development Application and Supplemental Information</i> , (2006), Volume 1, Section 7, pg. 7-28	Based on the average of production of 20 - 30 Mm3 of MFT at mine closure with a cumulative production of 5.14 Billion barrels of bitumen.
Petro-Canada Oil Sands Inc. - Fort Hills	Unavailable	Petro-Canada Oil Sands Inc., Personal Correspondence, June 20th, 2007	"The avg volume of MFT produced per barrel of bitumen was not provided in the original EIA. Volumes will be confirmed during operation of Fort Hills"
Shell Canada Ltd. - Jackpine Phase 1	0.0569	Shell. (2002). Application for Approval of the Jackpine Mine - Phase 1 (Application for Approval). Tailings Management	Confirmed by Shell Canada
Suncor Energy Inc. - Current Operations	0.0785	Response to Survey	Based on current MFT inventory of 166 Mm3 and total bitumen production of 2 Billion barrels of bitumen
Synchrude - Current Operations	Unavailable	-	Did not respond to survey

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Mature fine tailings summary			
Project	Mature Fine Tailings (m3/bbl)	Source	Comment
Synenco Energy Inc. - Northern Lights Phases 1 & 2	0.0000	Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006), Volume 2, Section 8, pg. 8-7	Confirmed by Synenco
Total E&P Canada - Joslyn North Mine Phases 1 & 2	0.0000	Deer Creek Energy Limited, <i>Joslyn North Mine Project: Alberta Environment &amp; Alberta Energy and Utilities Board Integrated Application</i> , (2006), Tailings Management Plan	There is no indication that there will be any MFTs left at the end of mining

### Question 16 - Halt Water Withdrawals

No company surveyed answered yes to the question, “Do you commit to voluntarily halting water withdrawals during low flow periods on the Athabasca River?”

## Question 17 - Water Storage Values

Table 19 summarizes the water storage values we found or were provided with in response to the question “How many days of water storage do you have (on-site or off-site) associated with your oil sands project?”

**Table 19 Water storage values with sources and comments**

Water storage summary			
Project	Water Storage (days)	Source	Comment
Albian Sands Energy Inc. - Muskeg Existing	1.5	Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project, Supplemental Information.</i> , (2005), MRM Upstream SIRs, Question 94b, pg. 9-3	
Albian Sands Energy Inc. - Muskeg Expansion	1.5	Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project, Supplemental Information.</i> , (2005), MRM Upstream SIRs, Question 94b, pg. 9-3	"If no water withdrawal from the Athabasca River is possible, a 35-hour inventory of clean water is available from the raw water pond, after which time the processing plant would be shut down"
Canadian Natural - Horizon	25.0	Personal Correspondence with Canadian Natural, Sept. 11th, 2007	
Imperial Oil Resources Ventures Limited - Kearl Phases 1, 2 & 3	0.0	Imperial Oil Ltd., <i>Kearl Oil Sands Project - Mine Development: Regulatory Application and Supplemental Information</i> , (2006), Volume 2, Section 5, pg. 5-35	"Despite the plan for actual contingency water storage, a minimum continuous water withdrawal rate is required to support raw water requirements for freeze protection on the pipeline and to ensure that firewater is available to support emergency services"
Petro-Canada Oil Sands Inc. - Fort Hills	45.0	Petro-Canada Oil Sands Inc., Personal Correspondence, June 20th, 2007	-

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Water storage summary			
Project	Water Storage (days)	Source	Comment
Shell Canada Ltd. - Jackpine Phase 1	1.0	Shell Canada Ltd., <i>Application for Approval of the Jackpine Mine - Phase 1</i> , (2002), Volume 1, Section 7.2, pg. 7-4	Water storage is 240,000 m <sup>3</sup> , assumes no water from the Athabasca
Suncor Energy Inc. - Current Operations	0.0	Response to Survey	"Suncor does not have water storage facilities on its site capable of providing raw water to feed all its operations."
Syncrude - Current Operations	0.0	-	Did not respond to survey
Synenco Energy Inc. - Northern Lights Phases 1 & 2	0.0	Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006). Volume 3, Sect. 6.5, pg. 6-9	The Fresh Water Reservoir will provide 30 days of storage. "However, at all times the, the Project will require an absolute minimum of 25% of pipe capacity to maintain system integrity"
Total E&P Canada - Joslyn North Mine Phases 1 & 2	30.0	Deer Creek Energy Limited, <i>Joslyn North Mine Project: Alberta Environment &amp; Alberta Energy and Utilities Board Integrated Application</i> , (2006), Section B, pg. B8-32	Designed so the plant can operate for 30 days with no withdrawals from the Athabasca river.

# Appendix 5 – Climate Change

All greenhouse gas emissions are calculated as CO<sub>2eq</sub> made up of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O. Each of these gases has a different global warming potential (GWP). The GWP of the gases used in this report are listed in Table 20.

**Table 20 GWP used to determine CO<sub>2eq</sub><sup>2</sup>**

Gas	GWP
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310

Similar to the air emission calculations, the greenhouse gas emissions include onsite and offsite emissions. Table 21 displays these activities.

**Table 21 Activities included in determination of greenhouse gas emissions.**

Activities		
<b>Mining</b> – Truck and shovel operations release NO <sub>x</sub> , SO <sub>2</sub> , VOC and GHG to the atmosphere	<b>Mine Face</b> – The mine face is primarily a source of VOC emissions.	<b>Fugitive Emissions</b> – Includes all those emissions not included here and was reported differently depending on the company.
<b>Processing Units</b> – Bitumen is partially processed onsite using crushers and heated water. Emissions from these sources are included.	<b>Electricity Production</b> (on or offsite) – Onsite electricity production is usually natural gas fired cogeneration. However, emissions from offsite electricity generation are included in this analysis as well, so as not to penalize projects that produce electricity onsite.	<b>Offsite Natural Gas Production</b> - Oil sands operations use vast amounts of natural gas. Its production results in significant air emissions which are included in this analysis.
<b>Tailings Ponds</b> – Tailings ponds release primarily VOCs and Methane.	<b>Heating</b> – Many onsite buildings require heating, this is sometimes broken out separately from processing and is included in this analysis.	

<sup>2</sup> US EPA



The majority of these activities take place onsite for all operations, the exceptions being offsite natural gas production and offsite electricity production. Onsite emission values are sourced, for the most part, from public documents or provided from the respective companies. Offsite emission values are based on emission factors sourced or calculated from publicly available information. The details of the offsite upstream natural gas and upstream electricity production calculations are discussed below.

## Upstream natural gas production

Upstream natural gas production includes exploratory drilling, development drilling, gas processing in the field, gathering, flaring, and processing out of the field and transmission. Data Supplied by TransAlta Utilities based on a study performed by Monenco Agra Inc. in 1996. Emissions of natural gas are provided in Table 22.

**Table 22 Air emissions factors for upstream natural gas production**

Air Emission	Emission Factor (kg/m <sup>3</sup> )
CO <sub>2</sub>	0.248
CH <sub>4</sub>	0.0042
N <sub>2</sub> O	N/A

Pembina applied these emission factors to every mining operations based on the average natural gas requirements for steady state operations.

## Upstream Electricity Production

Some operations plan to source electricity from the Alberta Grid. Pembina developed an average emission factor for the Alberta grid using the grid intensity factor found in the 2005 version of Canada’s Greenhouse Gas Inventory.

**Table 23 Air emission factors for Alberta Grid electricity generation**

Emission	Intensity (kg/MWh)
CO <sub>2</sub> eq	861

These factors were applied to all operations that sourced electricity from the grid based on steady state operations.

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### Question 18 - Greenhouse Gas Intensity

Table 24 summarizes the responses to questions 21 and 23 from the survey, “What are your absolute project specific greenhouse gas (GHG) emissions in kilotonnes (kt)” and “What is your operational greenhouse gas emission intensity in kilograms (kg) per barrel (bbl) bitumen”?

**Table 24 Greenhouse gas intensity values with sources and comments.**

Greenhouse gas intensity summary			
Project Name	GHG Intensity (kgCO <sub>2</sub> eq/bbl bit) *	Source	Comment
Albian Sands Energy Inc. - Muskeg Existing	24.44	Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project: Supplemental Information</i> , (2005) Q - 178, pg. 12-52	This is the combined emissions from Albian's onsite operations, 22.5 kgCO <sub>2</sub> eq/bbl and offsite emissions, 1.94 kgCO <sub>2</sub> eq/bbl associated with upstream natural gas production.
Albian Sands Energy Inc. - Muskeg Expansion	44.44	Shell Canada Ltd., <i>Application for the Approval of the Muskeg River Mine Expansion Project: Supplemental Information</i> , (2005), Volume 2, Section 3.4, Table 3.4-35, pg. 3-124 and Section 12.2, pg. 12-18, 12-20	This is the combined emissions from Albian's onsite operations, 41.24 kgCO <sub>2</sub> eq/bbl and offsite emissions, 3.2 kgCO <sub>2</sub> eq/bbl associated with offsite electricity production and upstream natural gas production.
Canadian Natural - Horizon	23.34	Canadian Natural Resources Ltd., <i>Horizon Oil Sands Project: Application for Approval Submitted to Alberta Energy and Utilities Board and Alberta Environment - Supplemental Information</i> , Volume 4, Section 5, Table 5-118, pg. 5-118	This is the combined emissions from CNRL's onsite operations, 21.72 kgCO <sub>2</sub> eq/bbl and 1.62kg/bbl offsite emissions associated with upstream natural gas production
Imperial Oil Resources Ventures Limited - Kearl Phases 1, 2 & 3	40.39	Imperial Oil Ltd., <i>Kearl Oil Sands Project - Mine Development: Regulatory Application</i> , (2005), Volume 5, Section 2.9, Table 2-71, pg. 2-177	This is the combined emissions from Imperials onsite operations, 36 kgCO <sub>2</sub> eq/bbl and offsite emissions, 4 kgCO <sub>2</sub> eq/bbl associated with upstream natural gas production.

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Greenhouse gas intensity summary			
Project Name	GHG Intensity (kgCO <sub>2</sub> eq/bbl bit) *	Source	Comment
Petro-Canada Oil Sands Inc. - Fort Hills	40.50	Petro-Canada Oil Sands Inc., <i>Application for Approval of the Fort Hills Oil Sands Project</i> , (2002) pg. 6-23	This is the combined emissions from Petro-Canada Oil Sands Inc.'s onsite operations, 38.15 kgCO <sub>2</sub> eq/bbl and offsite emissions, 2.35 kgCO <sub>2</sub> eq/bbl associated with upstream natural gas production.
Shell Canada Ltd. - Jackpine Phase 1	36.14	Shell Canada Ltd., <i>Application for Approval of the Jackpine Mine - Phase 1</i> , (2002), Volume 5, Table 5.9-1, pg. 5-72	This is the combined emissions from Shell's onsite operations, 31.51 kgCO <sub>2</sub> eq/bbl and 4.63kg/bbl offsite emissions associated with upstream natural gas production
Suncor Energy Inc. - Current Operations	95.10	Suncor Energy Ltd., <i>Suncor Energy Report on Sustainability 2006: A closer look at our journey toward sustainable development</i> , (2007),.pg. 64	Based on the production of 264,384 bbl SCO/day and 9177 ktCO <sub>2</sub> eq/year. This value is not directly comparable to others as it includes emissions from mining, in-situ and upgrading activities.
Synchrude - Current Operations	126.62	Synchrude Canada Ltd. <i>Sustainability Report 2005: a new generation of opportunity</i> .(2006), pg. 54	Based on the production of 214,000 bbl SCO/day and 9890 ktCO <sub>2</sub> eq/year. This value is not directly comparable to others as it includes emissions from mining and upgrading activities.
Synenco Energy Inc. - Northern Lights Phases 1 & 2	41.56	Synenco Energy Inc., <i>Northern Lights, A Synenco SinoCanada Partnership Mining and Extraction Project Application</i> , (2006), Volume 5, p. 2-159	This is the combined emissions from Synenco's onsite operations, 38 kgCO <sub>2</sub> eq/bbl and offsite emissions, 3.56 kgCO <sub>2</sub> eq/bbl, associated with upstream natural gas production.

## Question 20 - Greenhouse Gas Reduction Targets

Table 25 summarizes the response to the question, “Do you have absolute greenhouse gas (GHG) emission reduction targets? If so what are they?”

**Table 25 Greenhouse gas reduction targets for each project**

Greenhouse Gas Reduction Targets Summary			
Project	Targets (Yes/No)	Source	Comments
Albian Sands Energy Inc. - Muskeg Existing	Yes	Shell Canada Ltd., <i>2005 Sustainable Development Report</i> , (2006), pg. 35	“For our Oil Sands business, our target is to cut emissions by 50% below those estimated at project start-up by 2010.” This equals 1,750 (kt CO <sub>2</sub> ).
Albian Sands Energy Inc. - Muskeg Expansion	No		
CNRL Ltd. - Horizon	No		
Imperial Ltd. - Kearl Phases 1,2 & 3	No		
Petro-Canada Oil Sands Inc. - Fort Hills	No		
Shell Canada Ltd. - Jackpine Phase 1	No		
Suncor Energy Inc. - Current Operations	No		
Syncrude - Current Operations	No		
Synenco Energy Inc. - Northern Lights Phases 1 & 2	No		
Total E&P Canada - Joslyn North Mine Phases 1 & 2	No		