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SHELL CANADA ENERGY

Appendix 2: JRP SIR 8 – Cumulative Effects

Submitted to:
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REPORT

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Golder Associates

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Shell Canada Energy (Shell) submitted the Applications and supporting Environmental Impact Assessment (EIA) for the Jackpine Mine Expansion (JME) and Pierre River Mine (PRM) Projects in December 2007. As part of the regulatory process for the PRM Application, the Joint Review Panel (JRP) determined that additional information was needed and accordingly provided Shell with 77 Supplemental Information Requests (SIRs) on October 25, 2012.

In JRP SIR 8, the JRP requested a Pre-Industrial Case (PIC), plus an updated Planned Development Case (PDC) to account for foreseeable projects and activities publicly disclosed since the EIA for PRM was completed. The PRM JRP Terms of Reference issued on June 8, 2012 required the updated assessment cases be current to June 2012.

The JRP also requested an assessment of the Application Case to the PIC, and PDC to PIC with an assessment of the significance of cumulative effects for all appropriate Key Indicator Resources (KIRs) after reclamation for these cases. In addition, the JRP requested that Shell include updated forest harvesting information and an assessment of the effects of past and future forest fires within the regional study area (RSA).

Section 2.0 of this appendix presents the PIC information and Section 3.0 presents the updated PDC assessment. Section 4.0 presents the Application Case to PIC comparison and Section 5 presents the PDC to PIC comparison. A detailed list of the projects included in the updated PDC is provided in Appendix 3.1, Section 2.4.

The response to JRP SIR 8 was developed with consideration of the other JRP SIRs, items raised by regulators and stakeholders during the regulatory process (including the JME regulatory process), and commitments made previously by Shell for supporting assessment work. The updated assessment accounts for these items and maintains consistency between this response and the other information presented in the submission. Key updates that were made to the assessment approach in this submission include:

- Updated Base Case: The EIA Base Case information was updated similar to the 2013 PDC with a project inclusion list current to June 2012. This was done to allow a reasonable comparison between assessment case information within this submission. For example, Total Joslyn North Mine has been added to the updated Base Case, given that regulatory approval has been granted for this project. A detailed list of the projects included in the updated Base Case is provided in Appendix 3.1 (Section 2.4). This updated assessment case is referred to as the 2013 Base Case in this submission.
- Updated Application Case: JRP SIR 8 requested that Shell present the effects of PRM alone, in isolation from JME, for specific sections of the EIA. This updated assessment case for PRM is referred to as the 2013 PRM Application Case throughout the SIR submission and is presented in Appendix 1. The 2013 PRM Application Case results are also discussed in the 2013 PDC assessment presented in Section 3.0 of this appendix, and in the 2013 PRM Application Case to PIC assessment presented in Section 4.0 of this appendix.
- Updated approach to assessing forest fire and forest harvest: A key change in approach involves use of A Landscape Cumulative Effects Simulator (ALCES®) model to simulate forest fire and forest harvest information. Landscape simulations were conducted using the ALCES® and ALCES Mapper® computer programs. The ALCES® program was used to simulate the effects of forest fire and forest harvest in the

Regional Study Area (RSA) over a 60-year period. The ALCES Mapper® program was used to simulate the potential spatial configuration of forest fire and forest harvest. The revised model of burns and cutblocks was applied to the Terrestrial Resources assessment for the PIC, 2013 Base Case, 2013 PRM Application Case and 2013 PDC in this submission.

- Following the Jackpine Mine Expansion Project hearing in November 2012, the JRP submitted Decision Report CEAA Reference No. 59540 in July 2013. While the report considered a number of issues, it noted that the JRP reassessed the effects of JME using a resource management criteria approach as advocated by the Cumulative Environmental Management Agency's (CEMA) Terrestrial Ecosystem Monitoring Framework. In consideration of this, Shell undertook additional work to consider potential differences between the approaches in this assessment. This information is summarized in Sections 4.0 and 5.0 of this Appendix, and fully described in Appendix 3.1.

Other approach updates specific to individual technical components are discussed in their respective introductory sections within Sections 2.0 and 3.0 of this appendix.

1.1 Assessment Case Naming

In the following presentation of assessment cases and their comparisons, Shell has maintained the following naming conventions:

- All references to the "EIA" refer to the 2007 EIA, as amended.
- All references to the "EIA Base", "EIA Application" and "EIA Planned Development" cases refer to the 2007 EIA cases, as amended.
- The updated assessment cases contained in this submission are referred to as:
  - 2013 Base Case;
  - 2013 PRM Application Case; and
  - 2013 Planned Development Case (2013 PDC).

1.2 Structure of Response

The response to JRP SIR 8 is presented in this appendix. Section 2.0 presents the PIC. Section 3.0 presents the 2013 PDC. Section 4.0 presents a comparison of the 2013 PRM Application Case, presented in Appendix 1, to the PIC for appropriate KIRs, as requested in JRP SIR 8, Part a(i). Section 5.0 presents a comparison of the PIC to the 2013 PDC for appropriate Key Indicator Resources (KIRs), as requested in JRP SIR 8, Part a(ii). The significance assessments requested in JRP SIR 8a are presented within the components presented in Sections 4.0 and 5.0.

1.3 Assessment Caveats and Considerations

The following caveats and considerations apply to this assessment:

- The comparison between the PIC and the 2013 PRM Application Case and 2013 PDC provides information on predicted cumulative effects due to resource development, population growth and natural occurrences (e.g., forest harvest, municipal development, industrial development, forest fire) from a time prior to the majority of development in the RSA, to future scenarios that may or may not occur. This comparison does not provide project effects information against a baseline of existing and approved developments as presented in the EIA, as amended. This comparison is also not required by Alberta government guidance, the provincial Terms of Reference for PRM, or the approaches considered and adopted for projects that have been reviewed by multiple Joint Review Panels under the former *Canadian Environmental Assessment Act* and the current *Canadian Environmental Assessment Act, 2012* prior to 2012.

- While the comparison of the PIC to the 2013 PRM Application Case and 2013 PDC is useful for the purposes of identifying long-term regional trends, the comparison should not be relied upon for the purposes of assessing project-specific effects.
- The influence of current or future regional management initiatives that may affect the assessment results, such as the Lower Athabasca Regional Plan or species-specific recovery strategies (e.g., Alberta/Federal Woodland Caribou Recovery Plan), have not been fully included in this assessment. These initiatives have the potential to reduce predicted environmental effects presented in the assessment.
- The assessment of cumulative effects on wildlife species between the PIC, the 2013 PRM Application Case and the 2013 PDC is based on best available data and focused on the effects at an RSA level as required by the Provincial EIA Terms of Reference. Wildlife population trends within the RSA are not known for most species and as a result the certainty of predicted significance determinations varies from low to moderate for the KIRs and Species at Risk (SAR) considered in this assessment
- The assessment of effects before reclamation conservatively assumes that all industrial developments in the 2013 PRM Application Case and 2013 PDC are operating simultaneously at their maximum capacities and with fully cleared and disturbed footprints with no reclamation activities. The assessment of effects after reclamation uses the same conservative assumptions but includes reclamation activities. However, in reality, developments will actually be cleared and progressively reclaimed over different time periods in the region. This approach represents conservatism in the assessment.

1.4 Assessment Methods

The assessment methods used for this appendix are outlined in Appendix 3.1.

2.0 PRE-INDUSTRIAL CASE

2.1 Introduction and Approach

In JRP SIR 8, the JRP requested a Pre-Industrial Case (PIC) to take into account the effects that may have already been experienced prior to PRM. This section addresses the JRP request for a PIC.

The following sections are included in the PIC section of this document:

- Section 2.2 provides the PIC for Air Quality and Environmental Health, including Human Health Risks and Air Emissions Effects on Ecological Receptors.
- Section 2.3 provides the PIC for Aquatic Resources, including hydrogeology, hydrology, water quality, and fish and fish habitat.
- Section 2.4 provides the PIC for Terrestrial Resources, including soils and terrain; terrestrial vegetation, wetlands and forest resources; wildlife; and biodiversity.
- Section 2.5 provides the PIC for the Human Environment, including traditional knowledge and land use, and socio-economics.
- Section 2.6 provides a summary of the PIC comparison with the 2013 Base Case to enable the JRP to identify the effects that have occurred or will occur prior to the PRM.

2.2 Air Quality and Environmental Health

2.2.1 Air Quality

The PIC corresponds to a time before the start of oil sands developments in the region, when the emission sources of sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matter ($PM_{2.5}$) would have been a mix of natural and anthropogenic sources. Natural sources would have included forest fires and windblown dust, while anthropogenic sources could have included vehicle fuel combustion and home heating fuel combustion (e.g., wood or oil). These compounds were selected for assessment because they are typically of interest in air quality assessments in the region. In general, before the start of industrial development in the region, the ambient concentrations of most air quality compounds associated with anthropogenic sources would be quite low.

For the purpose of the PIC, natural and anthropogenic background concentrations were estimated separately for SO_2, NO_2 and $PM_{2.5}$. Values were obtained from a report prepared for the Trace Metal and Air Contaminant Working Group of the Cumulative Environmental Management Association (CEMA), titled *Estimating Contributions to Ambient Concentrations in Fort McKay* (Golder 2005). The primary tool used in the study was a wind sector analysis of SO_2, NO_2 and $PM_{2.5}$ monitoring data collected in Fort McKay.

Natural background concentrations were assumed when winds were blowing from a region with no industrial emission sources. The natural background concentrations presented in the CEMA report are summarized in Table 2.2-1. The concentrations are divided into short-term values and long-term values. Short-term concentrations are represented by 1-hour and 24-hour averaging periods. Long-term concentrations are represented by the annual averaging period. Short-term concentrations are provided as a range, where the minimum is the 75^{th} percentile value and the maximum is the 95^{th} percentile value. Long-term concentrations are also provided as a range, where the minimum is the average value and the maximum is the 50th percentile value.

Table 2.2-1 Natural Background SO_2, NO_2 and $PM_{2.5}$ Concentrations in the Athabasca Oil Sands Region

Parameter	Short-Term Concentration [µg/m³]	Long-Term Concentration [µg/m³]
SO_2	0.8 to 2.9	0.0 to 0.9
NO_2	7.5 to 22.6	1.9 to 5.5
$PM_{2.5}$	5.8 to 12.7	3.6 to 4.8

Source: Golder 2005.

Anthropogenic background concentrations were based on the assumption that there were no major industrial activities in the surrounding areas. The primary anthropogenic emissions in the vicinity of PRM before industrial activity were assumed to be from the community of Fort McKay. The community of Fort McMurray would have had higher ambient concentrations than Fort McKay during this period but is distant enough to negligibly influence ambient air quality in the vicinity of PRM. Therefore, only activities within Fort McKay were considered to contribute to the overall background air quality.

Information on the activities within the community of Fort McKay was gathered anecdotally from community Elders. In 1965, Fort McKay had a population of about 150, and included 20 to 30 log cabins. Although there were no motorized land vehicles, motorized boats with 2-cycle engines were being used. Without any fossil heating fuels available, the main source of emissions in the community was home heating using wood. The basis for estimating the home heating emissions by wood stoves and fireplaces was as follows:

- according to community Elders, Fort McKay had about 30 log cabins in 1965;
- the home heating requirement per dwelling was assumed to be 128 mmBtu/yr;
- the efficiency of wood stoves was assumed to be 54%, based on the United States Environmental Protection Agency (U.S. EPA) AP-42, Table 1.10-5 (U.S. EPA 1995);
- the heating value of pine wood was assumed to be 0.00914 mmBtu/lb; and
- the SO_2, oxides of nitrogen (NO_X) and $PM_{2.5}$ emission factors were obtained from U.S. EPA AP-42, Tables 1.9-1 and 1.10-1 (U.S. EPA 1995).

Representative estimates of SO_2, NO_X (expressed as NO_2) and $PM_{2.5}$ emissions were calculated and are presented in Table 2.2-2. The emissions data were then entered into the CALPUFF model to obtain ground-level predictions of each of the three compounds.

Table 2.2-2 Estimated SO_2, NO_X and $PM_{2.5}$ Emissions From Activities Within Fort McKay in the Pre-Industrial Case

Parameter	Emission Rate [t/d]
SO_2	1.93×10^{-4}
NO_X (expressed as NO_2)	1.25×10^{-3}
$PM_{2.5}$	1.57×10^{-2}

The overall background values for SO_2, NO_2 and $PM_{2.5}$ at Fort McKay were estimated by adding the predicted anthropogenic concentration from Fort McKay to the naturally occurring concentration. A summary of these values is presented in Table 2.2-3. The 2013 Base Case predictions are also shown for comparison. The 2013 Base Case concentrations of SO_2, NO_2 and $PM_{2.5}$ at Fort McKay were predicted using the EIA modelling assessment methods (EIA Volume 3, Appendix 3-8). The 2013 Base Case regional emissions are provided in Appendix 3.2. The peak 24-hour $PM_{2.5}$ 2013 Base Case prediction is above the current Alberta Ambient Air Quality Objectives (AAAQO) of 30 µg/m³ (ESRD 2013); however, the 98th percentile 24-hour $PM_{2.5}$ prediction is below the Canada-wide standard of 30 µg/m³ (CCME 2000).

Table 2.2-3 Pre-Industrial Case and 2013 Base Case SO_2, NO_2 and $PM_{2.5}$ Predictions at Fort McKay

Parameter	Maximum 1-hour Concentration[(a)] [µg/m³]		Peak 24-hour Concentration[(a)] [µg/m³]		98th Percentile 24-hour Concentration [µg/m³]		Peak Annual Concentration[(a)] [µg/m³]	
	Pre-Industrial Case	2013 Base Case[(b)]	Pre-Industrial Case	2013 Base Case[(b)]	Pre-Industrial Case	2013 Base Case[(b)]	Pre-Industrial Case	2013 Base Case[(b)]
SO_2	3.2	86.3	3.1	27.7	–	–	0.9	5.1
NO_2	23.3	117.4	23.1	96.3	–	–	5.5	30.0
$PM_{2.5}$	–	–	25.9	34.7	18.4	27.7	7.8	9.6

(a) The peak concentrations represent the highest predictions from the CALPUFF model. The maximum 1-hour concentration excluded the eight highest 1-hour predictions when determining compliance with the AAAQOs, as per the Alberta model guidelines (AENV 2009).

(b) The 2013 Base Case predictions include a contribution from community emission sources.

– = not available.

2.2.2 Human Health Risk

The level of anthropogenic emissions in the region would generally be lower in the PIC than in the 2013 Base Case assessment discussed in Appendix 3.2. Accordingly, while human health risks could not be adequately characterized for the PIC owing to the overall quality of the database of measured air, soil and vegetation data prior to 1965 for the compounds relevant to the Human Health Risk Assessment (HHRA), there would be lower human health risks via exposure pathways that were dependant on these datasets.

2.2.3 Air Emissions Effects on Ecological Receptors

Air emissions effects on ecological receptors could not be assessed for the PIC because environmental data required for the air emissions effect analyses are not available from the PIC period. However, the level of anthropogenic emissions in the region would generally be lower in the PIC than in the 2013 Base Case predictions discussed in Appendix 1.

2.3 Aquatic Resources

This section presents PIC groundwater levels and flow directions, PIC surface water hydrology statistics, and PIC surface water quality information. The surface water quality information includes water quality data that were compiled for Local Study Area (LSA) watercourses and the Athabasca River, as well as a summary of studies from literature that have evaluated the contribution of natural erosion to Polycyclic Aromatic Hydrocarbon (PAH) concentrations in the Athabasca River.

2.3.1 Hydrogeology

Available groundwater data representative of pre-mining conditions were compiled for the PIC, including data as old as 1972 and as recent as 2007. The data set included data from Hackbarth and Nastasa (1979), the Oil Sands Groundwater Database (OSGD Version 1.6), where pertinent, and groundwater data from the following baseline assessments:

- Aurora North Mine (Syncrude 1996);
- Muskeg River Mine (Shell 1997);
- Horizon Mine (Canadian Natural 2001);
- Jackpine Mine – Phase 1 (Shell 2002);
- Kearl Project (Imperial Oil 2005);
- Muskeg River Mine Expansion (Shell 2005); and
- Jackpine Mine Expansion (WorleyParsons Komex 2007).

2.3.1.1 Hydrogeology Assessment Methods

The PIC data used for the steady-state calibration of the Regional Groundwater Model are summarized in the Hydrogeology Modelling Information report in the EIA, Volume 4B, Appendix 4-1, Table 2. The regional model was calibrated to 101 static groundwater levels in the surficial aquifers, five static groundwater levels in the McMurray Formation oil sands, 154 static groundwater levels in the Basal Aquifer, and five static water levels in the Methy Formation. The Basal Aquifer data set included only the data unaffected by depressurization at Aurora North Mine and Muskeg River Mine, and is considered representative of pre-mining conditions.

The PIC data used for the steady-state calibration of the PRM Local Groundwater Model are summarized in the Hydrogeology Modelling Information report in the EIA, Volume 4B, Appendix 4-1, Table 10. The PRM Local Groundwater Model was calibrated to 18 static groundwater levels in the surficial aquifers, one static groundwater level in the McMurray Formation oil sands, and 16 static groundwater levels in the Basal Aquifer.

2.3.1.2 Hydrogeology Results

The PIC groundwater levels and flow direction in the Basal Aquifer are shown in the EIA, Volume 4A, Section 6.3, Figure 6.3-53. In general, within the LSA, PIC groundwater flow is in an easterly to southeasterly direction towards the Athabasca River, which is the major regional groundwater discharge feature in the RSA.

The PIC groundwater levels and flow directions in the surficial deposits were shown in the EIA, Volume 4A, Section 6.3, Figure 6.3-62. Within the LSA, groundwater flow is generally from the topographic high of the Birch Mountains to the east and southeast toward the Athabasca River valley.

The PIC and EIA Base Case results for hydrogeology are presented in the EIA, Volume 4A, Section 6.3; the water balance within the LSA is presented in Table 6.3-12, and the groundwater discharges to major rivers and streams within the LSA are presented in Table 6.3-13.

2.3.2 Hydrology

Data for PIC surface water hydrology, which is the same as pre-development surface water hydrology, were reported in the EIA, Volume 4A, Section 6.4 and Appendix 4-7. The data set was built by calibrating the hydrologic model to watershed characteristics with no industrial development. Therefore, the data represents PIC hydrologic conditions.

2.3.2.1 Hydrology Assessment Methods

For the hydrologic simulation to characterize the PIC conditions, watershed characteristics in the LSA were assumed to be undisturbed. The 2013 PRM hydrologic assessment update for the PIC hydrologic conditions is similar to the EIA assessment except for additional watersheds that need to be included as part of the current update due to the planned modifications of the PRM.

For the 2013 PRM hydrologic assessment, the LSA for PRM is extended north to include the Redclay Creek and Unnamed Creek 19 watersheds, since these two creeks will be affect by the North and South Redclay Lake as part of the Shell 2012 Draft No Net Loss Plan (NNLP).

The assessment methods used to characterize the PIC hydrologic flow conditions for Redclay Creek and Unnamed Creek 19 watersheds are the same as those outlined in the EIA Volume 4A, Section 6.4.2.7. The Hydrologic Simulation Program – Fortran (HSPF) model was used to generate simulated daily flows in the receiving watercourses to characterize hydrologic conditions for the PIC. Simulated daily flows were then analyzed to estimate the hydrology parameters.

Flows have been recorded on the Athabasca River at Fort McMurray since 1957. Industrial water withdrawals from oil sands operations are downstream of Fort McMurray and do not influence the flow statistics of the Athabasca River at Fort McMurray. Anthropogenic changes in flow are due to non-oil sands industrial and municipal withdrawals upstream of Fort McMurray. These upstream influences have increased over time including a pulp mill in Hinton in 1957 and four additional pulp mills built and operated in the 1980s and 1990s. Agricultural and municipal growth also increased during that period. However, much of the water withdrawn for these purposes is returned to the river system. The current average annualized net withdrawal rate for these upstream demands is less than 2.6 m^3/s. Therefore, the change in flows due to these demands would be insignificant in the Athabasca River downstream of Fort McMurray.

The PIC flows for the Athabasca River at Fort McMurray were derived by adding the upstream withdrawals to data recorded downstream of Fort McMurray at Environment Canada Station 07DA001.

Potential changes to Athabasca River flows due to existing and approved projects in the 2013 Base Case were quantified using Athabasca River PIC flow data generated for Environment Canada Station 07DA001, in combination with Steepbank River flow data from Environment Canada Station 07DA006, as recommended by the Water Management Framework: Instream Flow Needs and Water Management Systems for the Lower Athabasca River (AENV and DFO 2007).

2.3.2.2 Hydrology Results

The PIC flow conditions for Big Creek, Eymundson Creek, Pierre River, Unnamed Creek 19 and Redclay Creek in the LSA are presented in Table 2.3-1 and are taken from the EIA, Volume 4A, Section 6.4.3 and Appendix 4-7.

The Unnamed Creek 19 watershed is located within the updated LSA of PRM and discharges to the Athabasca River. It is situated in a lowland area that lies north of Redclay Creek watershed, and has a drainage area of about 52 km^2 at its mouth. The watershed elevation ranges from about 295 metres above mean sea level (m amsl) to about 250 m amsl with an average slope of about 0.4%.

Redclay Creek watershed, located north of Big Creek, has a drainage area of about 206 km^2 at the mouth, which includes an upland area of about 73 km^2 and a lowland area of about 133 km^2. The watershed elevation ranges from about 833 m amsl to about 225 m amsl at the creek's confluence with the Athabasca River with an average slope of about 1.8%. Redclay Creek transitions to diffused flows through poorly drained muskeg in the middle section of the creek.

Table 2.3-1 Key Hydrologic Statistics for the Pre-Industrial Case

Hydrologic Parameter	Pierre River at Mouth[(b)]	Eymundson Creek at Mouth[(b)]	Big Creek at Mouth[(b)]	Unnamed Creek 19 at Mouth[(b)]	Redclay Creek at Mouth[(b)]	Combined Flows of Big Creek, Unnamed Creek 19 and Redclay Creek[(b)]
drainage area [km^2]	134	311	316	52	206	574
mean annual flow [m^3/s]	0.289	0.665	0.465	0.034	0.346	0.845
mean open-water flow [m^3/s][(a)]	0.469	1.09	0.744	0.048	0.561	1.35
mean ice-cover flow [m^3/s][(a)]	0.035	0.063	0.070	0.014	0.043	0.127
10-year flood peak discharge [m^3/s]	7.50	18.9	12.1	1.11	8.54	21.2
7Q10 low flow discharge [m^3/s]	0.00	0.007	0.00	0.00	0.00	0.00

(a) The "open-water" season is from mid-April to mid-November; "ice-cover" season is from mid-November to mid-April.

(b) Based on simulated discharges from 1954 to 2006.

The key hydrologic statistics of Unnamed Creek 19 at mouth, Redclay Creek at mouth, and the combined flows for Big Creek, Unnamed Creek 19 and Redclay Creek at their mouths based on the simulated flows are summarized in Table 2.3-1.

No existing and approved oil sands projects are present in the tributary streams to the Athabasca River in the LSA. Hence, the 2013 Base Case hydrologic conditions are the same as the PIC flow conditions.

Pre-Industrial Case flow statistics and 2013 Base Case for Athabasca River at Reach 4, below Fort McMurray, are compared in Table 2.3-2 for winter, spring, summer and fall seasons for average, 10-year-dry and 10-year wet hydrologic conditions. The PIC and 2013 Base Case water level statistics for Athabasca River at Node S24 are provided in Table 2.3-3.

Table 2.3-2 Athabasca River Flows in Reach 4 for the Pre-Industrial Case and 2013 Base Case

Hydrologic Condition	Season	Pre-Industrial Case	2013 Base Case	Change from Pre-Industrial Case	
		Stream Flow Discharge [m³/s]	Stream Flow Discharge [m³/s]	[m³/s]	[%]
Average year	winter	179	155	-23.6	-13.2
	spring	530	506	-24.0	-4.5
	summer	1,228	1,204	-24.0	-2.0
	fall	564	540	-24.0	-4.3
10-year dry	winter	118	105	-13.2	-11.2
	spring	250	231	-18.5	-7.4
	summer	1,009	984	-25.2	-2.5
	fall	426	402	-23.8	-5.6
10-year wet	winter	194	172	-22.1	-11.4
	spring	581	558	-22.7	-3.9
	summer	1,746	1,721	-25.1	-1.4
	fall	800	775	-25.1	-3.1

Note: Pre-Industrial Case flows were derived by adding the upstream withdrawal to data recorded downstream of Fort McMurray at Environment Canada Station 07DA001 with Pre-development information re-titled "Pre-Industrial Case".

Table 2.3-3 Athabasca River Flow Depths at Node S24 (Located Within Reach 4) for the Pre-Industrial Case and 2013 Base Case

Hydrologic Condition	Season	Pre-Industrial Case	2013 Base Case	Change from Pre-Industrial Case
		Water Level [m amsl]	Water Level [m amsl]	[m]
Average year	winter	225.94	225.90	-0.04
	spring	226.56	226.52	-0.04
	summer	227.64	227.61	-0.03
	fall	226.62	226.58	-0.04
10-year dry	winter	225.83	225.81	-0.02
	spring	226.07	226.04	-0.03
	summer	227.32	227.29	-0.03
	fall	226.38	226.34	-0.04
10-year wet	winter	225.97	225.93	-0.04
	spring	226.65	226.61	-0.04
	summer	228.32	228.29	-0.03
	fall	227.00	226.96	-0.04

For the Athabasca River, the net annual water allocation to all existing and approved oil sands developments represents a reduction in the mean annual Athabasca River flow of about 2.1% based on the recorded river flows at Fort McMurray from PIC to 2013 Base Case. The combined reductions in seasonal flows in Reach 4 are less than 13.2% for an average year. The predicted combined changes in flow depths at Node S24 are less than 4 cm.

2.3.3 Surface Water Quality

Data for PIC surface water quality were reported in the Surface Water Quality Environmental Setting Report for the EIA (Golder 2007, Section 3) and in the EIA, Volume 4A, Section 6.5 and Volume 4B, Appendix 4-7. These data, along with updates where available, are presented in the following subsections.

2.3.3.1 Surface Water Quality Assessment Methods

Within the LSA, PIC surface water quality data were reported in the Surface Water Quality Environmental Setting Report (Golder 2007) and in the EIA (Volume 4A, Section 6.5 and Volume 4B, Appendix 4-7). The data presented herein are the same as those presented in the aforementioned documents, with the addition of supplemental data that were collected for and presented in the Teck Resources Limited (Teck) Frontier Oil Sands Mine Project Application that was filed with regulators in November 2011 (Teck 2011). All data collected in the LSA represent PIC conditions, because there are no approved or existing developments within these watersheds.

To represent PIC conditions in the Athabasca River, modelling relied on data from present-day and historical monitoring at points upstream of oil sands developments. It is acknowledged that PIC conditions are different from existing conditions because of industrial and municipal withdrawals and discharges upstream of Fort McMurray. However, PIC conditions in the Athabasca River were represented by modelling long-term concentrations in the Lower Athabasca River, and accounting for background concentrations in the Clearwater and Athabasca rivers upstream of Fort McMurray and input from tributaries with undisturbed watersheds. The model was calibrated to existing conditions, including estimated seepages and licensed discharges. The PIC was then simulated without these inputs, which essentially back-calculated PIC concentrations. In this way, the modelled PIC conditions account for post-1965 contributions from developments upstream of Fort McMurray, including non-point source releases, pulp mills and sewage treatment plants. Substances of potential concern contributed by pulp mill and sewage releases are different from those of oil sands operations; therefore, for constituents relevant to this assessment, present-day upstream concentrations are representative of PIC concentrations.

A literature review was conducted to summarize the current state of the knowledge on contributions of natural sources to changes in Athabasca River water quality. The literature review mainly focused on findings in undisturbed reaches and tributaries of the Athabasca River, which are reflective of PIC conditions, as well as historical trends in the Athabasca River (Glozier et al. 2009; Hebben 2009; RAMP 2012).

The contribution of natural erosion of the McMurray formation to changes in water quality in the Lower Athabasca and its tributaries is a topic of ongoing scientific research and debate (RSC 2010). To date, only one study (Hall et al. 2012) has provided a quantitative estimate of the relative or absolute contribution from erosion, despite considerable research effort directed at this topic. The contribution from this source has not been included in the water quality model, because this study has not been verified by any other study. Inclusion of this source term in a water quality model would be premature at this stage. Moreover, setting PIC concentrations in the model to be equal to those measured upstream of oil sands developments provides a more conservative benchmark against which to measure change, because the upstream concentrations are more sensitive to changes (i.e., loading inputs from oil sands developments cause a higher relative change in concentration if natural sources are not added).

Similarly, the contribution of natural saline groundwater inflows to the Athabasca River had not been quantified until recently (Jasechko et al. 2012). Building upon this work, the Athabasca River Model was calibrated to observed longitudinal (i.e., upstream to downstream) increases in major ion concentrations to arrive at estimates of saline groundwater inputs to the river. The calibration process and results are described in Appendix 1, Section 3.4.1. The work by Jasechko et al. (2012) indicated that these rates have not changed over the past few decades, which suggests that the calibrated rates of natural saline groundwater inflow are representative of PIC conditions.

2.3.3.2 Surface Water Quality Results

Pre-Industrial Case data for the LSA watershed are presented in Tables 2.3-4 to 2.3-6. These data are reproduced from the EIA, Volume 4B, Appendix 4-7, Tables 2.1.1.1, 2.2.1.1 and 2.3.1.1, respectively, with the addition of data that have been collected since 2007. Pre-Industrial Case data for the Athabasca River (Tables 2.3-7 and 2.3-8) are reproduced from the EIA, Volume 4B, Appendix 4-7, with updates to reflect the calibrated inputs of natural saline groundwater (Appendix 1, Section 3.3.1).

Table 2.3-4 Pre-Industrial Case Water Quality for Pierre River

Parameter	Unit	Water Quality Guideline Aquatic Life [(a)(b)]		Updated Observed Natural Variation [(c)]	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Aluminum	mg/L	0.75	0.1	0.27 (<0.02 - 1.4) n = 11	**0.19**	**12**
Ammonia	mg/L	14.6	1.1	<0.05 (<0.05 - 0.82) n = 11	0.031	0.91
Antimony	mg/L	-	-	0.0009 (0.00016 - 0.0017) n = 11	0.00072	0.0014
Arsenic	mg/L	0.34	0.005	0.0015 (<0.0004 - 0.0067) n = 11	0.0015	**0.012**
Barium	mg/L	-	-	0.044 (0.025 - 0.094) n = 11	0.058	0.45
Beryllium	mg/L	-	-	<0.001 (<0.0001 - <0.001) n = 11	0.00017	0.00042
Boron	mg/L	29	1.5	0.12 (0.03 - 0.43) n = 11	0.078	0.43
Cadmium	mg/L	0.0033	0.00037	<0.0002 (<0.0001 - <0.0002) n = 11	0.000055	**0.00041**
Calcium	mg/L	-	-	39 (22 - 80) n = 26	44	83
Chloride	mg/L	640	120	4.4 (1.9 - 9.4) n = 25	2.1	4.7
Chromium	mg/L	0.016	0.001	0.0016 (0.0005 - 0.0057) n = 11	**0.0012**	**0.034**
Cobalt	mg/L	-	-	0.0011 (<0.0002 - 0.0085) n = 11	0.0012	0.0071
Copper	mg/L	0.021	0.0034	0.0017 (<0.001 - 0.006) n = 11	0.0016	**0.015**
Iron	mg/L	-	0.3	1.9 (0.96 - 10) n = 11	**1.9**	**18**
Lead	mg/L	0.14	0.0055	0.0003 (<0.0001 - 0.001) n = 11	0.00033	**0.0071**
Lithium	mg/L	-	-	0.046 (0.008 - 0.099) n = 11	0.033	0.078
Manganese	mg/L	-	-	0.15 (0.057 - 4.9) n = 11	0.28	1.8
Mercury	mg/L	0.000013	0.000005	0.0000007 (<0.0000006 - 0.0000049) n = 11	0.00000045	**0.000013**
Molybdenum	mg/L	-	0.073	0.00081 (0.0001 - 0.0038) n = 11	0.00055	0.0024
Naphthenic Acids - Inert	mg/L	-	-	-	0.25	0.82
Naphthenic Acids - Labile	mg/L	-	-	-	0	0
Naphthenic Acids - Refractory	mg/L	-	-	-	0.51	1.4
Naphthenic Acids - Total (Lower)	mg/L	-	-	<1 (<1 - 1) n = 31	0.25	0.82
Naphthenic Acids - Total (Upper)	mg/L	-	-	<1 (<1 - 1) n = 31	0.51	1.4

Table 2.3-4 Pre-Industrial Case Water Quality for Pierre River (continued)

Parameter	Unit	Water Quality Guideline Aquatic Life [(a)(b)]		Updated Observed Natural Variation [(c)]	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Nickel	mg/L	0.67	0.075	0.01 (<0.0002 - 0.016) n = 11	0.0037	0.018
Nitrate	mg/L	124	2.9	<0.045 (<0.003 - 0.11) n = 26	0.033	0.27
PAH group 1	µg/L	-	0.015	<0.025 (<0.00092 - <0.04) n = 6	0	0
PAH group 2	µg/L	-	0.018	0.025 (0.0023 - <0.04) n = 6	0	0
PAH group 3	µg/L	-	-	0.0063 (0.00068 - <0.02) n = 6	0	0
PAH group 4	µg/L	-	5.8	<0.021 (<0.00043 - <0.04) n = 6	0	0
PAH group 5	µg/L	-	0.012	0.04 (0.031 - 0.055) n = 6	0	0
PAH group 6	µg/L	-	-	<0.04 (0.0016 - <0.049) n = 6	0	0
PAH group 7	µg/L	-	0.04	0.04 (0.031 - 0.06) n = 6	0	0
PAH group 8	µg/L	-	1.1	0.035 (0.016 - 0.15) n = 6	0	0
PAH group 9	µg/L	-	0.025	0.04 (0.015 - 0.044) n = 6	0	0
Selenium	mg/L	-	0.001	0.0005 (<0.0003 - 0.0015) n = 11	0.00039	**0.0027**
Silver	mg/L	0.008	0.0001	0.00001 (0.0000035 - 0.000026) n = 11	0.000016	0.000089
Sodium	mg/L	-	-	25 (3 - 33) n = 25	13	24
Strontium	mg/L	-	-	0.22 (0.13 - 0.49) n = 11	0.17	0.38
Sulphate	mg/L	-	-	74 (2.2 - 124) n = 26	45	106
Sulphide	mg/L	-	0.009	0.016 (<0.002 - 0.041) n = 11	0.0088	**0.14**
Tainting potential	TPU	-	1.0	-	0	0
Thallium	mg/L	-	0.0008	<0.0001 (<0.0001 - 0.0002) n = 11	0.000036	0.00028
Total dissolved solids	mg/L	-	-	256 (144 - 720) n = 26	243	510
Total nitrogen	mg/L	-	1.0	1 (0.065 - 1.9) n = 23	0.6	**3.3**
Total phenolics	mg/L	-	0.004	0.0074 (<0.001 - 0.029) n = 24	**0.0047**	**0.031**
Total phosphorus	mg/L	-	0.05	0.09 (0.018 - 0.23) n = 26	**0.089**	**1.2**
Toxicity- acute	TUa	0.3	0.3	-	0	0
Toxicity- chronic	TUc	-	1.0	-	0	0
Uranium	mg/L	0.033	0.015	0.00029 (<0.0001 - 0.0018) n = 11	0.00028	0.0021
Vanadium	mg/L	-	-	0.0016 (<0.0002 - 0.0049) n = 11	0.0022	0.048
Zinc	mg/L	0.17	0.03	0.006 (0.0031 - 0.054) n = 11	0.014	**0.1**

(a) - = No guideline/No data.

(b) From U.S. EPA (2002, 2003, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 7.8, temperature of 6.7°C and hardness of 153 mg/L (reflective of on-site conditions).

(c) Observed natural variation from 1976 to 2010, based on information from the EIA (Golder 2007, Water Quality Section, Appendix F) and ESRD (2012).

Note: **Bold** numbers indicate concentration exceeds Chronic Guideline.

Table 2.3-5 Pre-Industrial Case Water Quality for Eymundson Creek

Parameter	Unit	Water Quality Guideline Aquatic Life [(a, b)]		Updated Observed Natural Variation [(c)]	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Aluminum	mg/L	0.75	0.1	0.46 (0.03 - 18) n = 24	0.08	**3.7**
Ammonia	mg/L	26.8	1.59	<0.05 (<0.05 - 0.89) n = 24	0.03	0.78
Antimony	mg/L	-	-	0.0004 (0.00006 - 0.0013) n = 24	0.00075	0.0014
Arsenic	mg/L	0.34	0.005	0.003 (0.001 - 0.0077) n = 24	0.0014	**0.0084**
Barium	mg/L	-	-	0.053 (0.023 - 0.3) n = 24	0.063	0.36
Beryllium	mg/L	-	-	<0.001 (<0.00001 - <0.001) n = 24	0.00021	0.00068
Boron	mg/L	29	1.5	0.11 (0.069 - 0.15) n = 24	0.079	0.46
Cadmium	mg/L	0.0031	0.00035	0.0002 (0.000009 - 0.00065) n = 24	0.000061	**0.00035**
Calcium	mg/L	-	-	39 (12 - 90) n = 25	45	81
Chloride	mg/L	640	120	3 (0.87 - 4) n = 25	2.3	5.1
Chromium	mg/L	0.016	0.001	0.0013 (0.0001 - 0.034) n = 24	**0.0012**	**0.025**
Cobalt	mg/L	-	-	0.002 (0.00051 - 0.0085) n = 24	0.00095	0.0064
Copper	mg/L	0.02	0.0032	0.0034 (0.00039 - 0.022) n = 24	0.0013	**0.019**
Iron	mg/L	-	0.3	5 (1.2 - 19) n = 24	**1.8**	**13**
Lead	mg/L	0.13	0.0051	0.00088 (<0.0001 - 0.015) n = 24	0.00035	**0.0077**
Lithium	mg/L	-	-	0.043 (0.017 - 0.062) n = 22	0.031	0.077
Manganese	mg/L	-	-	0.28 (0.1 - 1.6) n = 24	0.28	2.5
Mercury	mg/L	0.000013	0.000005	0.0000034 (<0.0000006 - 0.00002) n = 14	0.00000042	**0.000016**
Molybdenum	mg/L	-	0.073	0.001 (0.0004 - 0.0039) n = 20	0.00061	0.003
Naphthenic Acids - Inert	mg/L	-	-	-	0.26	0.89
Naphthenic Acids - Labile	mg/L	-	-	-	0	0
Naphthenic Acids - Refractory	mg/L	-	-	-	0.51	1.5
Naphthenic Acids - Total (Lower)	mg/L	-	-	<1 (<1 - 3) n = 31	0.26	0.89
Naphthenic Acids - Total (Upper)	mg/L	-	-	<1 (<1 - 3) n = 31	0.51	1.5
Nickel	mg/L	0.639	0.071	0.012 (0.00094 - 0.031) n = 24	0.0042	0.02
Nitrate	mg/L	124	2.93	<0.1 (<0.003 - 0.2) n = 25	0.031	0.24
PAH group 1	µg/L	-	0.015	<0.04 (0.0014 - 0.066) n = 16	0	0
PAH group 2	µg/L	-	0.018	<0.04 (0.0034 - 0.067) n = 16	0	0
PAH group 3	µg/L	-	-	<0.01 (0.00056 - 0.058) n = 16	0	0
PAH group 4	µg/L	-	5.8	<0.04 (0.00044 - <0.04) n = 16	0	0
PAH group 5	µg/L	-	0.012	<0.04 (0.014 - 0.22) n = 16	0	0
PAH group 6	µg/L	-	-	<0.04 (0.0041 - 0.48) n = 16	0	0
PAH group 7	µg/L	-	0.04	0.04 (0.01 - 0.21) n = 16	0	0
PAH group 8	µg/L	-	1.1	0.04 (0.01 - 0.78) n = 16	0	0
PAH group 9	µg/L	-	0.025	<0.04 (0.01 - 0.24) n = 16	0	0
Selenium	mg/L	-	0.001	0.0007 (0.00018 - 0.0021) n = 24	0.00038	**0.0019**
Silver	mg/L	0.0076	0.0001	0.000035 (0.0000018 - 0.00097) n = 16	0.000015	0.00009
Sodium	mg/L	-	-	18 (7.9 - 25) n = 25	12	24
Strontium	mg/L	-	-	0.21 (0.072 - 0.32) n = 20	0.17	0.37

Table 2.3-5 Pre-Industrial Case Water Quality for Eymundson Creek (continued)

Parameter	Unit	Water Quality Guideline Aquatic Life [a, b]		Updated Observed Natural Variation [c]	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Sulphate	mg/L	-	-	80 (9.4 - 122) n = 25	48	114
Sulphide	mg/L	-	0.005	0.015 (<0.002 - 0.053) n = 20	**0.0062**	**0.05**
Tainting potential	TPU	-	1	-	0	0
Thallium	mg/L	-	0.0008	0.0001 (0.000002 - 0.00054) n = 24	0.000031	0.00029
Total dissolved solids	mg/L	-	-	273 (146 - 436) n = 21	259	462
Total nitrogen	mg/L	-	1	0.97 (0.21 - 3.4) n = 25	0.68	**3.1**
Total phenolics	mg/L	-	0.004	0.007 (0.003 - 0.026) n = 21	0.0039	**0.023**
Total phosphorus	mg/L	-	0.05	0.25 (0.037 - 0.61) n = 25	**0.07**	**0.9**
Toxicity- acute	TUa	0.3	0.3	-	0	0
Toxicity- chronic	TUc	-	1	-	0	0
Uranium	mg/L	0.033	0.015	0.0008 (0.00017 - 0.0026) n = 24	0.00033	0.0022
Vanadium	mg/L	-	-	0.0024 (<0.0002 - 0.074) n = 24	0.0018	0.04
Zinc	mg/L	0.163	0.03	0.013 (0.002 - 0.1) n = 24	0.013	**0.094**

(a) – = No guideline/No data.

(b) From U.S. EPA (2002, 2003, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 7.4, temperature of 5.1°C and hardness of 144 mg/L (reflective of on-site conditions).

(c) Observed natural variation from 1976 to 2010, based on information from the EIA (Golder 2007, Water Quality Section, Appendix F), Teck (2011) and ESRD (2012).

Notes: **Bold** number indicate concentration exceeds Chronic Guideline.

Table 2.3-6 Pre-Industrial Case Water Quality for Big Creek

Parameter	Unit	Water Quality Guideline Aquatic Life [a, b]		Updated Observed Natural Variation [c]	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Aluminum	mg/L	0.75	0.1	0.13 (0.018 - 9) n = 41	**0.12**	**3.9**
Ammonia	mg/L	18.32	1.27	<0.05 (<0.05 - 1.4) n = 41	0.031	0.73
Antimony	mg/L	-	-	0.0007 (0.000057 - 0.0017) n = 41	0.00076	0.0013
Arsenic	mg/L	0.34	0.005	0.00078 (<0.0004 - 0.041) n = 41	0.0014	**0.0095**
Barium	mg/L	-	-	0.07 (0.026 - 0.54) n = 41	0.062	0.36
Beryllium	mg/L	-	-	<0.001 (<0.0001 - <0.001) n = 41	0.00021	0.00065
Boron	mg/L	29	1.5	0.07 (0.03 - 0.14) n = 41	0.08	0.41
Cadmium	mg/L	0.0037	0.0004	<0.0002 (<0.000005 - 0.0004) n = 41	0.000065	**0.00032**
Calcium	mg/L	-	-	52 (25 - 92) n = 60	45	80
Chloride	mg/L	640	120	1.3 (<0.1 - 3) n = 60	2.3	4.9
Chromium	mg/L	0.016	0.001	0.001 (0.00045 - 0.017) n = 41	**0.0013**	**0.024**
Cobalt	mg/L	-	-	0.0004 (<0.0002 - 0.012) n = 41	0.001	0.0061
Copper	mg/L	0.023	0.0037	0.001 (0.0004 - 0.019) n = 41	0.0014	**0.018**
Iron	mg/L	-	0.3	1 (0.073 - 25) n = 40	**1.8**	**14**
Lead	mg/L	0.16	0.0063	0.0002 (<0.0001 - 0.0095) n = 41	0.00036	**0.0069**
Lithium	mg/L	-	-	0.03 (0.011 - 0.063) n = 41	0.032	0.073
Manganese	mg/L	-	-	0.24 (0.032 - 4.2) n = 40	0.29	2.4
Mercury	mg/L	0.000013	0.000005	<0.0000006 (<0.0000006 - 0.0000076) n = 41	0.00000042	**0.000015**
Molybdenum	mg/L	-	0.073	0.0004 (<0.0001 - 0.002) n = 41	0.00061	0.0026

Table 2.3-6 Pre-Industrial Case Water Quality for Big Creek (continued)

Parameter	Unit	Water Quality Guideline Aquatic Life [a, b]		Updated Observed Natural Variation [c]	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Naphthenic Acids - Inert	mg/L	-	-	-	0.26	0.79
Naphthenic Acids - Labile	mg/L	-	-	-	0	0
Naphthenic Acids - Refractory	mg/L	-	-	-	0.51	1.4
Naphthenic Acids - Total (Lower)	mg/L	-	-	<1 (<1 - 3) n = 60	0.26	0.79
Naphthenic Acids - Total (Upper)	mg/L	-	-	<1 (<1 - 3) n = 60	0.51	1.4
Nickel	mg/L	0.735	0.082	0.0036 (<0.0002 - 0.029) n = 41	0.0042	0.018
Nitrate	mg/L	124	2.93	0.1 (<0.003 - 0.3) n = 60	0.033	0.23
PAH group 1	µg/L	-	0.015	<0.04 (<0.00022 - <0.04) n = 19	0	0
PAH group 2	µg/L	-	0.018	<0.04 (0.00075 - <0.04) n = 19	0	0
PAH group 3	µg/L	-	-	<0.01 (0.00022 - <0.01) n = 19	0	0
PAH group 4	µg/L	-	5.8	<0.04 (<0.00032 - <0.04) n = 19	0	0
PAH group 5	µg/L	-	0.012	0.04 (0.0013 - 0.051) n = 19	0	0
PAH group 6	µg/L	-	-	<0.04 (0.0012 - 0.1) n = 19	0	0
PAH group 7	µg/L	-	0.04	<0.04 (0.00045 - 0.051) n = 19	0	0
PAH group 8	µg/L	-	1.1	<0.04 (0.0044 - 0.15) n = 19	0	0
PAH group 9	µg/L	-	0.025	<0.04 (0.0033 - <0.04) n = 19	0	0
Selenium	mg/L	-	0.001	<0.0004 (<0.0002 - 0.003) n = 41	0.00039	**0.0022**
Silver	mg/L	0.01	0.0001	0.00001 (0.0000009 - 0.00011) n = 41	0.000015	0.000081
Sodium	mg/L	-	-	12 (2 - 25) n = 60	13	23
Strontium	mg/L	-	-	0.17 (0.1 - 0.44) n = 41	0.17	0.38
Sulphate	mg/L	-	-	47 (1.4 - 170) n = 58	49	109
Sulphide	mg/L	-	0.007	0.0075 (<0.002 - 0.8) n = 46	**0.0072**	**0.062**
Tainting potential	TPU	-	1	-	0	0
Thallium	mg/L	-	0.0008	<0.0001 (<0.0001 - 0.0002) n = 41	0.000034	0.00026
Total dissolved solids	mg/L	-	-	255 (140 - 452) n = 59	256	448
Total nitrogen	mg/L	-	1	0.76 (<0.2 - 3.2) n = 56	0.68	**2.6**
Total phenolics	mg/L	-	0.004	0.003 (<0.001 - 0.022) n = 57	**0.004**	**0.024**
Total phosphorus	mg/L	-	0.05	0.079 (0.027 - 1.5) n = 57	**0.074**	**0.94**
Toxicity- acute	TUa	0.3	0.3	-	0	0
Toxicity- chronic	TUc	-	1	-	0	0
Uranium	mg/L	0.033	0.015	0.0002 (<0.0001 - 0.0014) n = 41	0.00032	0.002
Vanadium	mg/L	-	-	0.001 (<0.0002 - 0.042) n = 41	0.0019	0.035
Zinc	mg/L	0.188	0.03	0.006 (0.0022 - 0.17) n = 41	0.013	**0.089**

(a) – = No guideline/No data.

(b) From U.S. EPA (2002, 2003, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 7.7, temperature of 6.8°C and hardness of 174 mg/L (reflective of on-site conditions).

(c) Observed natural variation from 1976 to 2010, based on information from the EIA (Golder 2007, Water Quality Section, Appendix F), Teck (2011) and ESRD (2012).

Note: **Bold** number indicates concentration exceeds Chronic Guideline.

Table 2.3-7 Pre-Industrial Case Water Quality for Athabasca River Downstream of Redclay Creek

Parameter	Unit	Water Quality Guideline Aquatic Life(a)(b)		Natural Variation Observed (c)	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Aluminum	mg/L	0.75	0.1	0.88 (0.02 - 21) n = 136	**0.91**	**17**
Ammonia	mg/L	9.81	0.67	<0.05 (0.02 - 0.47) n = 146	0.042	0.18
Antimony	mg/L	-	-	0.000063 (0.000032 - 0.001) n = 124	0.00008	0.00027
Arsenic	mg/L	0.34	0.005	0.00082 (0.0003 - 0.0085) n = 165	0.0007	0.0031
Barium	mg/L	-	-	0.063 (0.042 - 0.53) n = 162	0.073	0.1
Beryllium	mg/L	-	-	0.000065 (<0.000003 - 0.01) n = 136	0.0001	0.0009
Boron	mg/L	29	1.5	0.029 (0.015 - 0.052) n = 135	0.039	0.078
Cadmium	mg/L	0.0026	0.00031	0.000032 (<0.000002 - 0.0005) n = 122	0.00009	**0.00039**
Calcium	mg/L	-	-	31 (21 - 60) n = 212	31	54
Chloride	mg/L	640	120	10 (1.3 - 54) n = 210	13	54
Chromium	mg/L	0.016	0.001	0.0019 (<0.00003 - 0.027) n = 167	**0.0025**	**0.011**
Cobalt	mg/L	-	-	0.00056 (0.000044 - 0.01) n = 166	0.00081	0.007
Copper	mg/L	0.017	0.0028	0.0015 (0.00046 - 0.017) n = 167	0.0019	**0.012**
Iron	mg/L	-	0.3	0.77 (0.066 - 17) n = 144	**0.85**	**9.5**
Lead	mg/L	0.103	0.004	0.00048 (0.000052 - 0.018) n = 136	0.0012	**0.023**
Lithium	mg/L	-	-	0.0078 (0.002 - 0.023) n = 134	0.0092	0.016
Manganese	mg/L	-	-	0.044 (0.0045 - 0.5) n = 168	0.033	0.29
Mercury	mg/L	0.000013	0.000005	<0.000012 (<0.000000035 - 0.0001) n = 124	0.0000041	**0.000012**
Molybdenum	mg/L	-	0.073	0.00069 (0.00014 - 0.015) n = 164	0.0011	0.0032
Naphthenic acids - labile	mg/L	-	-	-	0.000	0.00
Naphthenic acids - refractory	mg/L	-	-	<1 (<0.004 - 3) n = 113	0.11	0.49
Naphthenic acids - total	mg/L	-	-	<1 (<0.004 - 3) n = 113	0.11	0.49
Nickel	mg/L	0.547	0.061	0.0018 (0.00003 - 0.044) n = 168	0.0037	0.016
Nitrate	mg/L	124	2.93	0.1 (<0.001 - 0.6) n = 218	0.08	0.75
PAH group 1	µg/L	-	0.015	<0.01 (0.0013 - 0.088) n = 28	0	0.000
PAH group 2	µg/L	-	0.018	<0.01 (0.0029 - 0.1) n = 28	0.000	0.005
PAH group 3	µg/L	-	-	<0.01 (0.00075 - 0.026) n = 28	0	0.011
PAH group 4	µg/L	-	5.8	<0.01 (0.00052 - <0.04) n = 28	0	0.001
PAH group 5	µg/L	-	0.012	<0.01 (0.005 - 0.65) n = 28	0.003	**0.017**
PAH group 6	µg/L	-	-	<0.04 (0.0011 - <0.049) n = 11	0	0.001
PAH group 7	µg/L	-	0.04	<0.01 (<0.01 - 0.43) n = 28	0.002	0.006
PAH group 8	µg/L	-	1.1	<0.01 (0.0084 - 0.21) n = 28	0.003	0.13
PAH group 9	µg/L	-	0.025	<0.01 (0.009 - 0.42) n = 28	0.001	0.004
Selenium	mg/L	-	0.001	0.0003 (0.000079 - 0.0014) n = 163	0.00022	0.00078
Silver	mg/L	0.0056	0.0001	0.00001 (<0.0000005 - 0.00014) n = 124	0.000006	**0.00013**
Sodium	mg/L	-	-	13 (6.4 - 53) n = 209	17	45
Strontium	mg/L	-	-	0.21 (0.12 - 0.39) n = 135	0.26	0.45
Sulphate	mg/L	-	-	24 (4 - 67) n = 208	26	59
Sulphide	mg/L	-	0.014	0.004 (<0.001 - 0.22) n = 118	0.003	**0.083**
Tainting potential	TPU	-	1	-	0.00	0.0

Table 2.3-7 Pre-Industrial Case Water Quality for Athabasca River Downstream of Redclay Creek (continued)

Parameter	Unit	Water Quality Guideline Aquatic Life(a)(b)		Natural Variation Observed (c)	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Thallium	mg/L	-	0.0008	0.000034 (0.0000023 - 0.00037) n = 127	0.00004	0.00024
Total dissolved solids	mg/L	-	-	178 (86 - 560) n = 180	185	320
Total nitrogen	mg/L	-	1	0.49 (<0.2 - 2.9) n = 192	0.7	**1.7**
Total phenolics	mg/L	-	0.004	0.003 (<0.001 - 0.05) n = 181	0.0027	**0.008**
Total phosphorus	mg/L	-	0.05	0.041 (0.015 - 1.8) n = 209	**0.053**	**0.6**
Toxicity- acute	TUa	0.3	0.3	-	0.017	0.12
Toxicity- chronic	TUc	-	1	-	0.007	0.053
Uranium	mg/L	0.033	0.015	0.0004 (0.0002 - 0.0022) n = 131	0.00052	0.00086
Vanadium	mg/L	-	-	0.002 (0.00014 - 0.028) n = 190	0.002	0.021
Zinc	mg/L	0.14	0.03	0.0054 (0.00088 - 0.13) n = 164	0.01	**0.038**

(a) - = No guideline / no data.

(b) From U.S. EPA (2002, 2003a, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 8, temperature of 10°C and hardness of 120 mg/L (which are reflective of average conditions in the Athabasca River).

(c) Based on information from RAMP (2012) and from Alberta Environment WDS stations: AB07DA0820\0850\0860\0870\0970\0980\1550 (ESRD 2012).

Note: **Bold** number indicates that the predicted concentration exceeds the Chronic Guideline for the protection of aquatic life.

Table 2.3-8 Pre-Industrial Case Water Quality for Athabasca River Downstream at Embarras

Parameter	Unit	Water Quality Guideline Aquatic Life(a)(b)		Natural Variation Observed (c)	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Aluminum	mg/L	0.75	0.1	0.84 (<0.01 - 8.2) n = 75	**0.86**	**16**
Ammonia	mg/L	9.81	0.67	0.03 (<0.01 - 1) n = 197	0.042	0.2
Antimony	mg/L	-	-	0.00012 (0.00005 - <0.0008) n = 42	0.00013	0.0021
Arsenic	mg/L	0.34	0.005	0.0009 (<0.0001 - 0.018) n = 79	0.0011	0.0031
Barium	mg/L	-	-	0.066 (<0.001 - 0.27) n = 73	0.069	0.099
Beryllium	mg/L	-	-	0.0002 (0.000017 - 0.0012) n = 55	0.0001	0.0008
Boron	mg/L	29	1.5	0.027 (<0.01 - 0.14) n = 49	0.038	0.08
Cadmium	mg/L	0.0026	0.00031	0.00014 (0.000019 - 0.0026) n = 39	0.0002	**0.00064**
Calcium	mg/L	-	-	31 (<1 - 60) n = 263	30	53
Chloride	mg/L	640	120	12 (<0.5 - 65) n = 263	13	53
Chromium	mg/L	0.016	0.001	0.003 (0.00061 - 0.016) n = 101	**0.0044**	**0.013**
Cobalt	mg/L	-	-	0.001 (0.00016 - 0.006) n = 76	0.00079	0.0068
Copper	mg/L	0.017	0.0028	0.0024 (<0.0002 - 0.012) n = 104	**0.0043**	**0.012**
Iron	mg/L	-	0.3	1 (<0.001 - 12) n = 93	**1.6**	**9.3**
Lead	mg/L	0.103	0.004	0.0012 (<0.0001 - 0.026) n = 73	0.0023	**0.023**
Lithium	mg/L	-	-	0.007 (0.0039 - 0.054) n = 44	0.0088	0.015
Manganese	mg/L	-	-	0.048 (<0.001 - 0.3) n = 102	0.062	0.29
Mercury	mg/L	0.000013	0.000005	0.0000055 (<0.0000006 - 0.00005) n = 34	0.0000043	**0.000012**
Molybdenum	mg/L	-	0.073	0.0008 (0.00034 - 0.007) n = 73	0.001	0.0031
Naphthenic acids - labile	mg/L	-	-	-	0.000	0.00

Table 2.3-8 Pre-Industrial Case Water Quality for Athabasca River Downstream at Embarras (continued)

Parameter	Unit	Water Quality Guideline Aquatic Life[(a)(b)]		Natural Variation Observed [(c)]	Pre-Industrial Case	
		Acute	Chronic		Median Concentration	Peak Concentration
Naphthenic acids - refractory	mg/L	-	-	0.15 (0.053 - <1) n = 10	0.15	0.58
Naphthenic acids - total	mg/L	-	-	0.15 (0.053 - <1) n = 10	0.15	0.58
Nickel	mg/L	0.547	0.061	0.0037 (<0.0002 - 0.038) n = 77	0.0036	0.016
Nitrate	mg/L	124	2.93	0.034 (<0.001 - 0.49) n = 263	0.082	0.7
PAH group 1	µg/L	-	0.015	<0.01 (<0.01 - <0.1) n = 16	0	0.000
PAH group 2	µg/L	-	0.018	<0.01 (<0.01 - <0.1) n = 16	0	0.005
PAH group 3	µg/L	-	-	<0.01 (0.003 - <0.2) n = 16	0	0.011
PAH group 4	µg/L	-	5.8	<0.01 (<0.01 - <0.1) n = 16	0	0.001
PAH group 5	µg/L	-	0.012	<0.01 (0.007 - <0.1) n = 16	0.003	**0.016**
PAH group 6	µg/L	-	-	<0.04 n = 1	0	0.001
PAH group 7	µg/L	-	0.04	<0.01 (<0.01 - <0.1) n = 16	0.002	0.005
PAH group 8	µg/L	-	1.1	<0.01 (0.009 - 0.18) n = 16	0.003	0.12
PAH group 9	µg/L	-	0.025	<0.01 (<0.01 - <0.1) n = 16	0.001	0.006
Selenium	mg/L	-	0.001	<0.0002 (<0.0001 - 0.0009) n = 78	0.00022	0.00076
Silver	mg/L	0.0056	0.0001	0.000029 (0.0000016 - 0.0007) n = 35	0.00001	**0.00012**
Sodium	mg/L	-	-	15 (<1 - 55) n = 263	16	43
Strontium	mg/L	-	-	0.19 (0.11 - 0.3) n = 44	0.24	0.44
Sulphate	mg/L	-	-	23 (<0.5 - 62) n = 263	24	57
Sulphide	mg/L	-	0.014	<0.005 (<0.001 - 0.02) n = 85	0.004	**0.083**
Tainting potential	TPU	-	1	-	0.000	0.0
Thallium	mg/L	-	0.0008	0.000098 (0.0000065 - 0.00027) n = 43	0.00005	0.00023
Total dissolved solids	mg/L	-	-	170 (16 - 450) n = 251	180	314
Total nitrogen	mg/L	-	1	0.57 (<0.01 - 3) n = 244	0.7	**1.6**
Total phenolics	mg/L	-	0.004	<0.001 (<0.001 - 0.042) n = 175	0.0027	**0.0078**
Total phosphorus	mg/L	-	0.05	0.049 (0.004 - 0.75) n = 262	**0.053**	**0.57**
Toxicity- acute	TUa	0.3	0.3	-	0.017	0.12
Toxicity- chronic	TUc	-	1	-	0.007	0.053
Uranium	mg/L	0.033	0.015	0.0004 (<0.0001 - 0.003) n = 101	0.00049	0.00081
Vanadium	mg/L	-	-	0.0018 (0.00026 - 0.02) n = 266	0.0019	0.02
Zinc	mg/L	0.14	0.03	0.0063 (0.00053 - 0.054) n = 252	0.011	**0.037**

(a) - = No guideline / no data.

(b) From U.S. EPA (2002, 2003a, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 8, temperature of 10°C and hardness of 120 mg/L (which are reflective of average conditions in the Athabasca River).

(c) Based on information from RAMP (2012) and from Alberta Environment WDS stations: AB07DA0010\0040\0060\0080\0250 (ESRD 2012).

Note: **Bold** number indicates that the predicted concentration exceeds the Chronic Guideline for the protection of aquatic life.

Pre-Industrial Case data were used as the basis of the water quality assessment in the EIA. These data were used to calibrate water quality models. As described in the Surface Water Quality Environmental Setting Report (Golder 2007) and in the EIA (Volume 4A, Section 6.5.6.1), total metals and nutrients frequently exceeded guidelines under PIC conditions in the small streams and the Athabasca River. The high background levels are generally associated with high total suspended solids from upstream of Fort McMurray and occur mostly during the spring season, consistent with the findings of Glozier et al. (2009).

It is well established that the Athabasca River and its tributaries are subject to natural oil sands inputs that affect water quality, as described below. Several studies have examined longitudinal trends in metals and Polycyclic Aromatic Hydrocarbon (PAH) concentrations in the region. While these studies were done after oil sands development began in 1967, many of the studies were completed in undisturbed tributaries, which represent PIC conditions.

The largest group of studies that examined the contributions from natural sources to changes in water quality in the Athabasca River and its tributaries were those conducted under the Northern Rivers Ecosystem Initiative (NREI). Results of these studies were summarized in Brua et al. (2003), and detailed in the primary literature sources cited below. The NREI was initiated in response to recommendations that arose from the previously conducted Northern River Basins Study that was completed from 1991 to 1996 (Northern River Basins Study Board 1996). One of the specific objectives of the NREI was to "quantify the contribution of hydrocarbon contaminants released to Northern Rivers from natural oil-sand deposits", which was the focus of the sub-component study "Identification and characterization of natural hydrocarbon release from oil sands deposits in the northern river basins area".

In a summary of that study, Brua et al. (2003) reported that the Athabasca River mainstem and nine of its tributaries were exposed to the McMurray Formation in the region extending from 50 km upstream of Fort McMurray to Eymundson Creek. The mainstem banks between Fort McMurray and Embarras were fairly stable, and were expected to contribute a small load of sediment to the river, relative to sources upstream of Fort McMurray and downstream of Embarras. Conly et al. (2002) estimated a net sediment load in the Athabasca River of 5,180 kt/y at Fort McMurray, plus 410 kt/y from the Clearwater River, 210 kt/y from smaller tributaries, and 550 kt/y from mainstem bank erosion (mostly near Embarras) to balance out at 6,350 kt/y at Embarras. They estimated that less than 3% of the total sediment load in the Athabasca River at Embarras was derived from natural contributions within the reach exposed to the McMurray Formation. They concluded that "the expectation of finding naturally derived PAHs in the lower reaches of the Athabasca River System would be limited", except during episodic high-flow events that would cause additional erosion within this reach.

In contrast to these findings in the mainstem, the NREI studies found that exposure to the McMurray Formation had higher potential to cause changes to water quality in tributaries. To focus their studies on these effects, Headley et al. (2001) examined bed sediment samples in undisturbed reaches of the Ells, Steepbank and MacKay rivers upstream of and within the exposed McMurray Formation. Because these reaches were undisturbed, they represent PIC conditions. In undisturbed tributary sediments, concentrations of PAH and alkylated PAH increased longitudinally up to 34.7 µg/g, and were generally much higher than the values measured in the Athabasca River sediments, which were typical of pristine systems. The relative proportion of alkylated versus parent PAH indicated that most or all of the PAH were from a common petrogenic source. A chemical source analysis of the PAH indicated that the source of sediment PAH was eroded riverbank from within the McMurray Formation. The most abundant PAH compounds measured were phenanthrene and anthracene, which indicated that the PAH were from natural, as opposed to anthropogenic, sources. Dibenzothiophenes, which do not fall under the definition of PAH because they contain sulphur atoms, were more abundant than phenanthrene and anthracene (Headley et al. 2001). At several locations, highly weathered bitumen was observed in the river bed, which was described as "bitumen pavement" and "asphalt pavement" (Brua et al. 2001).

Samples collected in the Athabasca River near Embarras were thought to be from a similar source as those collected in the tributaries (Akre et al. 2004). These samples were buried by clean sediments deposited from the Athabasca River, and had been buried there for approximately 9,000 years. The downstream sediments had similar distributions of PAH, indicating a petrogenic source, with some differences reflecting various stages of weathering and different dates of deposition.

In the same study reported by Headley et al. (2001), samples were collected and analyzed for metals by Conly et al. (2007), who then conducted longitudinal trend analyses for metals. No longitudinal trends were detected in the McKay and Steepbank rivers, and a decreasing longitudinal trend was detected in the Ells River. The decreasing longitudinal trend in the Ells River was thought to be related to the relatively low abundance of clay in the lower reach, and not to inputs from erosion of the McMurray Formation. Bed and suspended sediment concentrations of all metals except for arsenic were below Canadian Council of Ministers of the Environment (CCME) interim sediment quality guidelines. Arsenic concentrations naturally exceeded guidelines in approximately half of the samples, and there was no apparent spatial trend. Conly et al. (2007) concluded that natural exposure to the McMurray Formation does not lead to increases in suspended or bed sediment metals concentrations in downstream reaches.

Headley et al. (2005) also collected water samples upstream and downstream of the McMurray Formation in the same tributaries during four surveys between 1998 and 2000. Notably, the tributaries were found to have frequent guideline exceedances of aluminum, iron, manganese, and occasional guideline exceedances of copper, lead, silver and zinc. Guideline exceedances for metals were thought to be related to high Total Suspended Solids (TSS) concentrations. The patterns observed by Headley et al. (2005) are similar to those described for PIC conditions in the Athabasca River (presented in Tables 2.3-7 and 2.3-8), except that guideline exceedances for copper are more common in the Athabasca River. Other differences are related to the shorter list of metals reported by Headley et al. (2005) and their comparison to aesthetic guidelines, which was not done with Athabasca River concentrations in this section. In Headley et al. (2005), longitudinal trends were reported for major ions and lithium and strontium in the Ells and MacKay rivers, but not in the Steepbank River. However, longitudinal trends in water concentrations were likely related to erosion and weathering of bedrock, soils and minerals within these reaches, and may have been unrelated to exposure to the McMurray Formation.

The NREI studies, in summary, indicated that water and sediments in the Athabasca River, and in particular in its tributaries, undergo significant changes in concentrations longitudinally due to natural exposure to and erosion of the McMurray Formation. These studies provided valuable information in terms of trends and patterns, but they did not quantify the inputs to the system in terms of loadings of individual constituents, except for TSS. Additional studies would be necessary to quantify these inputs.

Studies by Kelly et al. (2009; 2010) examined concentrations of PAH and dibenziothiophene (as measured using polyethylene membrane devices) and metals in the same tributaries as those studied in the NREI and in three others. Kelly et al. (2009, 2010) also examined longitudinal trends in disturbed watersheds, and attempted to discern the contributions of anthropogenic and natural sources. They found similar increasing trends as those found by the NREI studies, but focused on developed, rather than PIC conditions. Kelly et al. (2009) reported that "Increasing PAC [Polycyclic Aromatic Compounds] concentrations from upstream to downstream in the tributaries … could reflect increasing contributions from natural erosion of the McMF [McMurray Formation], greater disturbance from development, or both.", but did not quantify the loadings from either natural or anthropogenic sources. The Kelly et al. (2009, 2010) studies also examined concentrations of PAH and metals in snow due to aerial deposition, as described in Appendix 3.5.

In 2011, the Regional Aquatics Monitoring Program (RAMP 2012) initiated a special study to examine PAH concentrations in water at RAMP sampling stations. The RAMP had previously discontinued aqueous PAH measurement because analytical methods were not sensitive enough to detect PAH in most water samples, so they measured PAH in sediment only. Aqueous PAH measurements were restarted in 2011 because improvements in commercially available analytical techniques now reliably reach detection limits of 0.1 ng/L, which is low enough to quantify PAH in most surface water samples, and because restarting this sampling was recommended by the RAMP peer review (AITF 2011). The RAMP study design was similar to the Headley et al. (2001) study design in that several undisturbed tributaries were sampled at locations upstream and downstream of the McMurray Formation, and the results were analyzed for longitudinal trends. In addition to the tributaries sampled by Headley et al. (2001), RAMP sampled Pierre River, Eymundson Creek, Big Creek and Redclay Creek, as well as several other disturbed and undisturbed tributaries. All tributaries, both disturbed and undisturbed, showed increasing trends in PAH concentration from upstream to downstream. Water PAH were also correlated with sediment PAH, which also showed trends consistent with Headley et al. (2001). The RAMP (2012) study stated that "This correlation suggests that partitioning of PAHs from river sediments into overlying water may be the primary mechanism for waterborne PAH exposure in regional tributaries, consistent with assumptions or conclusions of several other studies". This conclusion would apply to natural bed sediments in the PIC and disturbed sediments.

In the Athabasca River mainstem, PAHs were correlated with both total organic carbon and TSS, and did not increase from upstream to downstream of oil sands developments. The RAMP (2012) study stated that "The strong association with organic matter and similarity between upstream (DC) and downstream (DD) concentrations suggest a predominantly upstream source for these organic carbon associated PAHs, consistent with observations that the large majority of the sediment load in the Athabasca River downstream of oil sands development originates upstream of Fort McMurray (Conly et al. 2002). However, downstream (DD) concentrations were somewhat higher than upstream concentrations (DC) in spring 2011, suggesting some influence of tributaries in the Oil Sands Region on PAH concentrations in the Athabasca River, at least seasonally."

The PAH concentrations measured by RAMP (2012) were generally higher than those measured by Kelly et al. (2009), likely because the direct aqueous techniques allowed measurement of both dissolved and particulate forms, as opposed to the polyethylene membrane devices used by Kelly et al. (2009), which relied on equilibrium partitioning and secondary measurement of dissolved forms. Like the previously mentioned studies, RAMP (2012) did not quantify the natural versus anthropogenic loadings of PAH to surface waters.

Long-term trends (i.e., over the past two centuries) in sediment PAH concentrations were examined in a study of Athabasca River Delta sediment cores (Hall et al. 2012). This study built upon earlier studies by Wolfe et al. (2012) that used several independent lines of chemical, biological, physical and geochemical evidence to reconstruct a history of flood events in the Peace-Athabasca Delta. Hall et al. (2012) compared core samples from the river to those from perched basins near the Delta that are periodically flooded and subject to deposition of suspended sediments and associated PAHs. They concluded that the majority of PAHs in Athabasca River Delta sediments were derived from natural weathering processes, and that the accumulation of PAHs in sediments has not increased since the onset of oil sands developments. While Hall et al. (2012) did acknowledge that their study was based on a small sample size, they were the first to quantify PAH loadings to the Lower Athabasca River. They estimated that natural processes contribute somewhere in the range of 5,000 to 9,000 tonnes of bitumen to the river and delta. As future studies confirm and refine these values, they will be incorporated into Athabasca River Model calibration for use in EIAs.

2.3.4 Fish and Fish Habitat

A thorough review of historical information on fish and fish habitat was conducted and summarized in the EIA, Volume 4A, Section 6.7.3 and in the Fish and Fish Habitat Environmental Setting Report (Golder 2007). Historical fish and fish habitat data were limited for the streams located within the LSA and were restricted to information from work conducted post 1970. Suitable PIC data to compare fish populations within the LSA are not available. Differences in fish inventory sampling techniques used in historic studies, including poor description of assessment methods, effort and sample site locations do not allow for direct comparisons of fish populations to current studies. However, the fish species distribution used in the EIA and in the development of the 2012 Draft No Net Loss Plan submitted to the JME JRP on September 19, 2012, considered baseline and historic information, as well as traditional knowledge, and assumed that all species documented in streams within the LSA comprised the 2013 Base Case fish community.

Because industrial development had not occurred within the small streams of the LSA when the baseline field studies were conducted, it can be assumed that the species distribution and fish habitat conditions presented in the EIA Base Case and Draft No Net Loss Plan are also representative of PIC fish habitat conditions. Therefore, a fish and fish habitat assessment for the PIC is not required.

2.4 Terrestrial Resources

This section describes the Pre-Industrial Case (PIC) and 2013 Base Case conditions for Terrestrial Resources, including soils and terrain; terrestrial vegetation, wetlands and forest resources; wildlife and wildlife habitat; and biodiversity.

The PIC for terrestrial resources is based on a snapshot of the year 1955. However, there are no complete records of aerial imagery, vegetation, or soils information for the RSA in 1955. In addition, 1955 pre-dates the development of the Alberta Vegetation Inventory (AVI) mapping and classification system of ecosite phases and wetlands classes for the region, which was initiated in 1986. Soils information can be extrapolated from soil maps of the region completed in 1982 (Turchenek and Lindsay 1982), because it can be assumed that only minor changes in soils occurred in the 27-year interval. To reconstruct the 1955 landscape and to estimate PIC terrestrial resources, 1950s aerial imagery, 1974 and 2005 Landsat imagery, AVI data, and Alberta Environment and Sustainable Resource Development (ESRD) fire history records were combined in ArcGIS. More current imagery was replaced by older imagery (i.e., 1974 and 1950s) in areas where industrial disturbances exist now but did not in the 1950s. The PIC's accuracy is limited by the 30 m by 30 m ground resolution of the satellite imagery. A small portion of the RSA (less than 1% or 719 ha of the 2,277,376 ha RSA) could not be classified, due to inconsistencies in the imagery and cloud cover.

2.4.1 Soils and Terrain

2.4.1.1 Soils and Terrain Assessment Methods

The PIC soil map was prepared by extrapolating regional soil information (i.e., soil map units) available from the Alberta Oil Sands Environmental Research Program (AOSERP) soil map (Turchenek and Lindsay 1982) to areas that were disturbances at the time of the 1982 AOSERP soil map, as well as to areas of the RSA that were not covered by the AOSERP soil map. New map units were included as appropriate. This interpretation was completed using a systematic approach to applying a predictive soil model (i.e., map units) to the polygons derived for the Regional Land Cover Classes (RLCCs) determined for the vegetation mapping. Landscape patterns predicted for the Natural Subregions of Alberta (NRC 2006) were also consulted to guide the classification of the regional land cover class polygons.

Each soil map unit was assessed to determine which soil series it included. A map unit composition matrix was then used to translate the distribution of map units into a distribution of soil series. Each soil series contains a range of attributes that allows for extrapolation of land capability, reclamation suitability and parent materials (with assumed ranges of landform characteristics) to the entire RSA. These attributes are discussed in greater detail in the Terrestrial Environmental Setting Report for the EIA, Volume 3, Section 2 (Golder 2007b).

The estimated distribution of soil series in the RSA for the PIC was compared to that of the 2013 Base Case. A negative change in a soil series means that there is less of a particular soil series in the 2013 Base Case than the PIC. New soils, or additional areas of natural soil types already present in the RSA, will not naturally develop in the time frame considered in the assessment. Therefore, it is expected that all soil series extents would be less than or equal to their areal extents in the PIC.

2.4.1.2 Soils and Terrain Results

A comparison between the PIC and the 2013 Base Case is presented in Table 2.4-1.

The increased development activities from the PIC to the 2013 Base Case in the RSA has resulted in a decrease in mineral and organic soils and a corresponding increase in disturbed landscapes. The changes from the PIC to the 2013 Base Case are as follows:

- a decrease in mineral soils from 1,145,463 ha to 1,035,692 ha (a net change of 10% of the resource, 5% of RSA);
- a decrease in organic soils from 984,149 ha to 913,474 ha (a net change of 7% of the resource, 3% of RSA); and
- an increase in the disturbed landscape from 1,557 ha to 186,349 ha (a net change of 11,868% of Resource, 8% of RSA).

Table 2.4-1 Change in Soil Series Types in the Regional Study Area – Pre-Industrial Case to 2013 Base Case

Soil Series, Reclaimed Soils and Non-Soils	Pre-Industrial Case	2013 Base Case	Loss/Alteration due to 2013 Base Case	
	Area [ha]	Area [ha]	Area [ha]	% of Resource[(a)]
Mineral Soils				
Algar Lake	47,983	42,044	-5,939	-12
Bitumount	50,132	37,996	-12,136	-24
Buckton	31,789	31,739	-50	-<1
Dover	59,194	50,801	-8,393	-14
Firebag	74,053	60,364	-13,689	-18
Fort	2,821	1,821	-1,000	-35
Gipsy	6,292	6,291	-1	-<1
Horse River	24,046	23,544	-502	-2
Joslyn	86,192	66,208	-19,984	-23
Kearl	3,940	3,870	-70	-2
Kinosis	54,204	49,429	-4,775	-9
Legend	127,074	126,228	-846	-1
Livock	37,106	36,431	-675	-2
Marguerite	76,769	69,996	-6,773	-9
McMurray	56,877	53,535	-3,342	-6
Mildred	186,704	171,159	-15,545	-8
Namur	61,299	60,640	-659	-1
Ruth Lake	16,294	12,286	-4,008	-25
Steepbank	130,837	120,129	-10,708	-8
Surmont	11,857	11,180	-677	-6
subtotal (mineral soils)	*1,145,463*	*1,035,692*	*-109,771*	*-10*
Organic Soils				
Bayard	14,662	14,616	-46	-<1
Conklin	61,760	57,922	-3,838	-6
Gregoire	20,863	19,342	-1,521	-7
Hartley	174,524	152,844	-21,680	-12
McLelland	152,559	145,313	-7,246	-5
Mikkwa	126,054	125,183	-871	-1
Mariana	156,011	138,616	-17,395	-11
Muskeg	240,944	227,947	-12,997	-5
Wabasca	36,774	31,692	-5,082	-14
subtotal (organic soils)	*984,149*	*913,474*	*-70,674*	*-7*
Reconstructed landforms	0	0	0	n/a
South Redclay Lake	0	0	0	n/a
Rough broken/rock	86,070	82,415	-3,655	-4
Disturbed	1,557	186,349	184,792	11,868
Water	53,958	53,309	-649	-1
Indian Reserves[(a)]	6,179	6,137	-42	-1
subtotal (other)	*147,764*	*328,211*	*180,447*	*122*
Total	**2,277,376**	**2,277,376**	**0**	**0**

(a) Calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

n/a = Not applicable.

2.4.2 Terrestrial Vegetation, Wetlands and Forest Resources

The Terrestrial Vegetation, Wetlands and Forest Resources Assessment is presented in the EIA, Volume 5, Sections 7.3 through 7.6. Details and assessment methods used in the development of 2013 Base Case data are described in the Terrestrial Environmental Setting Report for the EIA (Golder 2007b). The PIC for Terrestrial Vegetation, Wetlands and Forest Resources is compared with the 2013 Base Case in Section 2.4.2.2 of this submission.

2.4.2.1 Terrestrial Vegetation, Wetlands and Forest Resources Assessment Methods

The only disturbances assumed to be present in the PIC are anthropogenic disturbances primarily associated with settlements, cutblocks from forestry, and modelled natural disturbances (i.e., ALCES® modelled burned areas). To facilitate comparisons between the assessment cases, forest fires simulated in the 2013 PDC (discussed in Appendix 3.1) were also represented in the RSA for the PIC and 2013 Base Case. Forest harvest cutblocks simulated in the 2013 PDC were represented in the RSA for the 2013 Base Case, but not the PIC because industrial-scale logging had not occurred in 1955.

A 1955 regional land cover classification map was developed using satellite imagery processed using ArcGIS and eCognition software to provide information on the relative abundance of land cover classes in the RSA. Image classification is a method of automatically categorizing discrete parts of a satellite image.

The RSA vegetation classification is based on the following specifications for the PIC:

- Landsat 5 satellite imagery with a 30 m × 30 m pixel size for 2005;
- Landsat 1 satellite imagery with a 80 m × 80 m pixel size for 1974; and
- Aerial imagery of industrial and urban areas captured in the 1950s.

For the PIC, a vegetation cover dataset was built that minimizes anthropogenic disturbances (with the exception of the established settlements in the study area) and cloud cover. Landsat 5 classification was supplemented with Landsat 1 classification and aerial imagery where required to remove disturbances, including industrial developments and cutblocks. The resolution of the satellite imagery is appropriate for a regional level vegetation classification and allows the spatial data to be processed in a reasonable time frame. Quality control measures were implemented to georeference the source data in the RSA. The imagery was loaded into remote sensing software (eCognition) for the vegetation classification process.

Land cover classes identified from regional satellite imagery and AVI data (Alberta-Pacific Forest Industries 2000) were used in selecting “training sites” or ground truthing for classification assessments. These training sites were selected to capture the range of variation in the reflectance values or “spectral signature” of the vegetation classes. Based on the spectral signatures, the remote sensing software assigned the best-fit classification to the pixels in the image. Although some uncertainty in identifying land cover classes is inherent during classification using remote sensing, ground truthing conducted during vegetation surveys helps provide an accurate representation of the study area. This assessment method allowed for a more efficient assessment and greater number of vegetation communities identified over a large area within the allotted time frame.

The classification resulted in 13 Regional Land Cover Classes (RLCCs) which are assumed to have existed prior to industrial oil sands developments in the RSA. Each class fell into one of the following four broad groups:

- terrestrial;
- wetlands;
- miscellaneous cover classes; and
- disturbances.

Terrestrial vegetation is generally defined as occurring on land where the soils are not saturated with water for extended periods (i.e., non-hydric soils) of the year. The National Wetlands Working Group (NWWG 1988) defines wetlands as *"…land that is saturated with water long enough to promote wetlands or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment".* Wetlands in the RSA consist of marshes, fens, bogs and swamps. Miscellaneous land cover classes include recently burned areas and water. Disturbances are categorized as cutblocks or "other", such as linear disturbances, urban areas and industrial land, and in the 2013 Base Case, include both existing and approved projects. A list of the RLCCs found within the RSA is provided in Table 2.4-2.

Table 2.4-2 Regional Land Cover Classes

General Land Category	Regional Land Cover Class
Terrestrial	coniferous jack pine
	coniferous jack pine-black spruce
	coniferous white spruce
	deciduous aspen-balsam poplar
	mixedwood aspen-jack pine
	mixedwood aspen-white spruce
Wetlands	non-treed wetlands
	treed bog/poor fen
	treed fen
Miscellaneous cover type	burn
	water
Disturbances[(a)]	cutblock
	urban/industrial/other disturbances

(a) Existing disturbances from 1955 include forestry, other industry and municipal projects.

Detailed descriptions of the RLCCs are found in the Terrestrial Environmental Setting Report (Golder 2007b). For the PIC, there is also an unclassified cover class that refers to areas that could not be classified due to cloud cover and cloud shadows.

The PIC information about the vegetation is not at the same accuracy as information that was available for the EIA Base Case at the time of Project application in 2007. These differences limit some of the parameters used for the vegetation assessment; however, efforts have been made to compensate for these limitations. For example, the PIC contains imagery that was blocked by clouds or cloud shadows; therefore these areas were not classified into RLCCs. To compensate for these areas, the cloud and cloud shadow areas were separated into the category “Unclassified”. The Unclassified area was not included in the vegetation assessment. The EIA Base Case imagery was free of clouds, and some of the apparent changes from PIC to the 2013 Base Case will be due to this difference, rather than actual changes to the landscape.

2.4.2.2 Terrestrial Vegetation, Wetlands and Forest Resources Results

The total area and percent cover of RLCCs within the RSA for the PIC and 2013 Base Case are shown in Table 2.4-3. The terrestrial RSA as originally described in the EIA covers an area of 2,277,376 ha. The regional vegetation classification identifies 13 RLCCs including six terrestrial classes, three wetlands classes, two miscellaneous land cover classes, and two disturbance classes in the RSA. In addition, there is an unclassified cover class for areas that could not be classified due to cloud cover and cloud shadows in the PIC.

Table 2.4-3 Total Area and Percent Cover of Land Cover Classes Within the Regional Study Area for the Pre-Industrial Case and 2013 Base Case

Regional Land Cover Class	Pre-Industrial Case[a]	2013 Base Case[b]	Change from Pre-Industrial Case to 2013 Base Case	
	Area [ha]	Area [ha]	Area [ha][c]	% of Resource[d]
Terrestrial Vegetation				
coniferous jack pine	191,070	166,332	-24,738	-13
coniferous jack pine-black spruce	44,624	40,054	-4,570	-10
coniferous white spruce	69,421	52,386	-17,035	-25
deciduous aspen-balsam poplar	233,520	178,067	-55,454	-24
mixedwood aspen-jack pine	49,528	39,033	-10,496	-21
mixedwood aspen-white spruce	197,394	144,759	-52,635	-27
terrestrial vegetation subtotal	*785,557*	*620,630*	*-164,927*	*-21*
Wetlands (including peatlands and patterned fens)				
non-treed wetlands	275,397	241,110	-34,288	-12
treed bog/poor fen	471,749	423,855	-47,894	-10
treed fen	268,124	230,369	-37,755	-14
wetlands subtotal	*1,015,270*	*895,334*	*-119,936*	*-12*
Miscellaneous				
burn	420,169	396,125	-24,044	-6
water	54,040	52,526	-1,514	-3
miscellaneous subtotal	*474,209*	*448,651*	*-25,558*	-5
Disturbances				
cutblock	65	100,160	100,095	154,890
disturbance (urban/industrial/other)	1,557	212,601	211,044	13,557
disturbances subtotal	*1,621*	*312,761*	*311,139*	*19,191*
Unclassified				
unclassified (cloud/cloud shadow)[e]	719	0	-719	-100
unclassified subtotal	*719*	*0*	*-719*	*-100*
Total	**2,277,376**	**2,277,376**	**n/a**	**n/a**

(a) Includes burns as modelled by ALCES®.
(b) Includes burns and cutblocks as modelled by ALCES®.
(c) Calculated as difference between the Pre-Industrial Case and 2013 Base Case.
(d) % of Resource is calculated as a percentage of Pre-Industrial Case area; the areas of this column are not additive.
(e) Describes those areas where the imagery of the earth’s surface had been blocked by clouds or cloud shadows during the image capture period.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Changes in natural RLCCs from the PIC to 2013 Base Case range from 3% to 27% of the resource. The largest percent change occurs in the terrestrial vegetation category, where mixedwood aspen-white spruce was reduced by 27% of the resource or 52,635 ha. Total disturbances, including 100,095 ha of cutblocks, increased by 311,139 ha (19,191% of Resource) due to the loss or alteration of other RLCCs. Approximately 119,936 ha (12% of Resource) of wetlands were lost or altered. Terrestrial vegetation was also reduced by 164,927 ha (21% of Resource). The amount of burn decreased by 24,044 ha (6% of Resource).

2.4.3 Wildlife and Wildlife Habitat

The Wildlife and Wildlife Habitat Assessment methods are presented in the EIA, Volume 5, Sections 7.3.4, 7.5.3, 7.5.4, 7.5.5 and 7.6.3. Methods used in the development of 2013 Base Case data are described in the *Terrestrial Environmental Setting Report for the JME & PRM Project*, Section 5 (Golder 2007a). The PIC for Wildlife and Wildlife Habitat is discussed and compared with the 2013 Base Case in Section 2.4.3.2. Wildlife abundance and movement metrics are not available in the PIC, and the change between the PIC and the 2013 Base Case is based solely on wildlife habitat suitability.

2.4.3.1 Wildlife Habitat Assessment Methods

Habitat Suitability (HS) models were used to predict the distribution and characteristics of wildlife habitat in the PIC and 2013 Base Case (Appendix 3.7, Section 1.0). The HS models were empirically derived Resource Selection Functions (RSFs) for moose, Canada lynx and fisher/marten, and expert knowledge-based Habitat Suitability Index (HSI) models for the remaining Key Indicator Resources (KIRs) including federally listed Species at Risk (SAR) that may be affected by habitat change. The wildlife KIRs for which HS modelling was conducted are listed in Table 2.4-4.

Table 2.4-4 Wildlife Key Indicator Resources and Species at Risk for Which Habitat Suitability Modelling was Conducted

Key Indicator Resource	Species at Risk Key Indicator Resource
moose	Canada warbler
Canada lynx	common nighthawk
fisher/marten	horned grebe
black-throated green warbler	olive-sided flycatcher
barred owl	rusty blackbird
yellow rail	short-eared owl
Canadian toad	western (boreal) toad
black bear	wolverine
beaver	wood bison
	woodland caribou [a]

[a] Woodland caribou are virtually absent from the Local Study Area (LSA), and are therefore not considered a valid linkage for the PRM. However, the effects to woodland caribou habitat are assessed at the request of the Joint Review Panel (JRP) (i.e., JRP SIRs 35a and 40b, for which responses can be found in Appendix 4) because woodland caribou occurred in the LSA in the past.

The models used to predict habitat suitability for wildlife KIRs are described in the EIA, (Appendix 5-4, Section 1.2). The structures of models used to predict habitat suitability for Federally Listed Species at Risk (SAR) KIRs that may be affected by habitat change in the LSA are outlined in the *November 2011, Submission of Information to the Joint Review Panel*, Appendix 2, as is the model for wood bison. The model used to predict the distribution of habitat suitability for woodland caribou is provided in Appendix 3.7, Section 1.2.1 of this submission. The analysis of the effects of development on wildlife in the RSA from the PIC to the 2013 Base Case for each wildlife KIR focuses on the change in the amount of high and moderate-high suitability habitat.

Little brown myotis and northern myotis were listed as “Endangered” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in February 2012 due to population declines caused by the rapidly spreading White-nose Syndrome (WNS), which is a fungal disease that interferes with hibernation (COSEWIC 2012a,b). This disease has not yet been identified in Alberta (AESRD 2011, internet site). Prior to the arrival of WNS in Alberta, the availability of hibernacula may be limiting regional abundance of these species. However, winter hibernacula in the Alberta Oil Sands Region are only known to occur outside the RSA in Cadomin Cave and Wood Buffalo National Park (AESRD and ACA 2009; Barclay 2012, pers. comm.), and will not be affected by the PRM or development in the RSA. Little brown myotis and northern myotis are considered to be habitat generalists with respect to their summer roosting and foraging habitat, typically using a range of mixedwood and coniferous forests (AESRD and ACA 2009; Crampton and Barclay 1998). Therefore, habitat change for little brown and northern myotis may be generalized from changes to the areal extent of mixedwood and coniferous forests in the RSA.

2.4.3.2 Wildlife and Wildlife Habitat Results

The increase in human disturbances from the PIC to the 2013 Base Case result in an increase in the amount of high suitability habitat in the RSA for short-eared owl, due primarily to the increased prevalence of cutblocks in the RSA at the 2013 Base Case. There is a decrease in the amount of high suitability habitat for all remaining KIRs for which effects on habitat were assessed. The decline in high suitability habitat is of low magnitude (i.e., a less than 10% change) for common nighthawk, of high magnitude (i.e., a greater than 20% change) for barred owl, black-throated green warbler, Canada warbler, western toad, wolverine, wood bison and woodland caribou, and of moderate magnitude (i.e., greater than 10% change, but less than 20%) for all other wildlife KIR for which changes in habitat were quantified using HS models (Table 2.4-5).

For little brown myotis and northern myotis foraging and roosting habitat, mixedwood and coniferous forests show a less than 20% decline from the PIC to the 2013 Base Case prior to reclamation (Table 2.4-3). This decline would result in a moderate magnitude effect of development in the RSA on little brown myotis and northern myotis foraging and roosting habitat.

Landscape changes should be assessed in the broader context of the overall availability of habitat. The amount of human disturbance in the RSA has been estimated to increase from less than 0.1% at the PIC to 14% of the RSA at the 2013 Base Case (Table 2.4-3). Therefore, at the 2013 Base Case, 86% of the RSA remains undisturbed by humans.

The distribution of habitat suitability for wildlife in the PIC and the change in habitat suitability from the PIC to the 2013 Base Case is presented in Table 2.4-5, which focuses on high and, where applicable, moderate high suitability habitat, because the assessment of the effects of development on wildlife habitat is based on changes to those habitat classes. Canada lynx, fisher and moose habitat is represented by empirically based Resource Selection Function (RSF) models, for which output is divided into six classes (i.e., nil, low, moderate low, moderate, moderate high, high). Due to insufficient appropriate observation data, changes to habitat for all other species at the RSA scale for which habitat was modelled are represented by literature and expert-knowledge based Habitat Suitability Index (HSI) models, for which output is divided into four classes (i.e., nil, low, moderate, high).

Table 2.4-5 Wildlife Habitat Change in the Regional Study Area – Pre-Industrial Case to the 2013 Base Case

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	Pre-Industrial Case		Change From Pre-Industrial Case to 2013 Base Case	
		Habitat Area [ha]	% of Total Area	Area [ha]	% Resource
barred owl	high	222,863	10	-80,960	-36
	moderate	186,478	8	-85,056	-46
	low	925,294	41	-150,109	-16
	nil	942,742	41	316,124	34
beaver	high	586,995	26	-74,321	-13
	moderate	0	0	0	0
	low	275,397	12	-24,564	-9
	nil	1,414,984	62	98,885	7
black bear	high	1,156,744	51	-125,616	-11
	moderate	519,334	23	-34,159	-7
	low	544,983	24	-23,095	-4
	nil	56,314	2	182,869	325
black-throated green warbler	high	240,349	11	-87,139	-36
	moderate	231,520	10	-99,401	-43
	low	862,807	38	68,458	8
	nil	942,701	41	118,082	13
Canada lynx	high	473,755	21	-101,806	-21
	moderate high	428,628	19	-56,692	-13
	moderate	435,964	19	-13,508	-3
	moderate low	447,484	20	-6,786	-2
	low	435,230	19	-4,078	>-1
	nil [(a)]	56,314	2	182,869	325
Canadian toad	high	193,370	8	-21,121	-11
	moderate	721,523	32	-63,474	-9
	low	171,913	8	-12,119	-7
	nil	1,190,569	52	96,714	8
fisher / marten	high	547,806	24	-122,565	-22
	moderate high	463,711	20	-30,634	-7
	moderate	449,251	20	-15,020	-3
	moderate low	428,437	19	-10,764	-3
	low	331,857	15	-3,887	-1
	nil [(a)]	56,314	2	182,869	325
moose	high	474,607	21	-69,511	-15
	moderate high	457,165	20	-42,718	-9
	moderate	446,519	20	-35,972	-8
	moderate low	429,125	19	-24,743	-6
	low	413,645	18	-9,925	-2
	nil [(a)]	56,314	2	182,869	325
Canada warbler	high	186,246	8	-96,371	-52
	moderate	177,765	8	-64,755	-36
	low	45,330	2	-4,890	-11
	nil	1,868,036	82	166,016	9

Table 2.4-5 Wildlife Habitat Change in the Regional Study Area From the Pre-Industrial Case to the 2013 Base Case (continued)

Key Indicator Resources and Wildlife Species At Risk	Habitat Suitability Class	Pre-Industrial Case		Change From Pre-Industrial Case to 2013 Base Case	
		Habitat Area [ha]	% of Total Area	Area [ha]	% Resource
common nighthawk	high	353,022	16	-30,435	-9
	moderate	1,366,640	60	-124,155	-9
	low	321,427	14	26,153	8
	nil	236,287	10	128,438	54
horned grebe	high	287,315	13	-54,904	-19
	moderate	170	<1	20,233	11,880
	low	0	0	0	0
	nil	1,989,891	87	34,671	2
olive-sided flycatcher	high	440,399	19	-47,092	-11
	moderate	1,049,211	46	-180,613	-17
	low	248,712	11	153,233	62
	nil	539,055	24	74,472	14
rusty blackbird	high	587,732	26	-117,647	-20
	moderate	608,101	27	-49,074	-8
	low	137	<1	44,199	32,372
	nil	1,081,407	47	122,522	11
short-eared owl	high	392,447	17	8,987	2
	moderate	312,601	14	-23,364	-7
	low	603,490	26	-36,150	-6
	nil	968,838	43	50,527	5
western (boreal) toad	high	287,274	13	-61,140	-21
	moderate	429,709	19	-61,585	-14
	low	686,295	30	-23,709	-3
	nil	874,097	38	146,434	17
wolverine	high	2,273,964	100	-477,594	-21
	moderate	0	0	0	0
	low	1,856	<1	266,550	14,363
	nil	1,557	<1	211,044	13,557
wood bison	high	275,067	12	-93,376	-34
	moderate	647,036	28	-69,082	-11
	low	519,110	23	76,679	15
	nil	836,163	37	85,779	10
woodland caribou	high	423,700	19	-206,725	-49
	moderate	1,794,282	79	-1,635,494	-91
	low	3,181	<1	1,371,166	43,099
	nil	56,213	2	471,052	838
yellow rail	high	275,245	12	-54,754	-20
	moderate	152	<1	24,324	15,994
	low	0	0	0	0
	nil	2,001,979	88	30,430	2

[(a)] Nil includes 717.81 ha of area classified as cloud in Pre-Industrial Case vegetation data due to remote sensing limitations.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

2.4.4 Biodiversity

A Biodiversity assessment was presented in the EIA, Volume 5, Sections 7.3.5, 7.5.6 and 7.6.4. Details and assessment methods used for development of the PIC and 2013 Base Case data are the same as those used for the EIA Base Case data. These assessment methods are described in detail within the *Biodiversity Environmental Setting Report for the JME & PRM Project* (Golder 2007) and a general summary is provided in Section 2.4.4.1. Any notable deviations from the EIA assessment methods are described in Appendix 3.1, Section 2.9. Changes in biodiversity from the PIC to the 2013 Base Case are provided in the following sections.

2.4.4.1 Biodiversity Assessment Methods

Areas of high, moderate and low biodiversity potential were identified at the local scale. Biodiversity potential represents the relative contribution of an ecosite phase, wetlands type or other land cover type to the overall biological diversity of an area. To measure biodiversity potential, land cover types were ranked based on the integration of five biodiversity indicators that quantify different components of biodiversity, including: rarity on the landscape, vegetation and wildlife rare species potential, vegetation and wildlife species richness, species overlap (i.e., proportion of species shared with other land cover types), and structural complexity. The biodiversity potential of each RLCC in the RSA was then derived based on the proportional scores of its contributing land cover types. The total area covered by each biodiversity potential rank was then calculated for the PIC and the 2013 Base Case.

2.4.4.2 Biodiversity Results

The changes in biodiversity potential from the PIC to the 2013 Base Case are presented in Table 2.4-6, and are summarized according to rank as follows:

- High biodiversity potential areas will decrease by 72,042 ha (13% of Resource). This decrease is nearly equally distributed between the high-ranked RLCCs, with non-treed wetlands and treed fen declining by 12% and 14% in the RSA, respectively.
- Moderate biodiversity potential areas will decrease by 129,573 ha (15% of Resource). Reductions to the terrestrial RLCCs characterize the majority (62%) of this change.
- Low biodiversity potential areas will increase by 202,334 ha (23% of Resource). All of the low-ranked RLCCs experience losses, with the exception of cutblocks and other disturbances.

Table 2.4-6 Change in Biodiversity Potential in the Regional Study Area – Pre-Industrial Case to 2013 Base Case

Regional Land Cover Class	Pre-Industrial Case	2013 Base Case	Change from Pre-Industrial Case to 2013 Base Case	
	Area [ha]	Area [ha]	Area [ha]	% of Resource[a]
High Biodiversity Potential				
non-treed wetlands	275,397	241,110	-34,288	-12
treed fen	268,124	230,369	-37,755	-14
subtotal	*543,521*	*471,479*	*-72,042*	*-13*
Moderate Biodiversity Potential				
coniferous white spruce	69,421	52,386	-17,035	-25
mixedwood aspen−jack pine	49,528	39,033	-10,496	-21
mixedwood aspen−white spruce	197,394	144,759	-52,635	-27
treed bog/poor fen	471,749	423,855	-47,894	-10
water	54,040	52,526	-1,514	-3
subtotal	*842,132*	*712,559*	*-129,573*	*-15*
Low Biodiversity Potential				
burn	420,169	396,125	-24,044	-6
coniferous jack pine	191,070	166,332	-24,738	-13
coniferous jack pine−black spruce	44,624	40,054	-4,570	-10
cutblock	65	100,160	100,095	154,890
deciduous aspen−balsam poplar	233,520	178,067	-55,454	-24
disturbance	1,557	212,601	211,044	13,557
subtotal	*891,004*	*1,093,338*	*202,334*	*23*
Not Ranked				
cloud[b]	719	0	-719	-100
Total	**2,277,376**	**2,277,376**	**n/a**	**n/a**

(a) This column is calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

(b) Clouds on the Landsat image prevent interpretation of regional land cover class in some areas for the Pre-Industrial Case; less than 1% of the Regional Study Area could not be ranked according to biodiversity potential.

n/a = Not applicable.

Notes: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

2.5 Human Environment

2.5.1 Traditional Knowledge and Land Use

The PIC is intended to represent conditions around the year 1955, before oil and gas development occurred in the region, and the PIC has been calculated for First Nations' traditional territories, Fort McKay First Nation (FMFN) Culturally Significant Ecosystems (CSEs) and Registered Fur Management Areas (RFMAs). Pre-Industrial Case disturbances are compared to 2013 Base Case disturbances and the change is represented in hectares, area percentage, and, where possible, as a percentage increase from the PIC to 2013 Base Case conditions.

First Nation Traditional Territories

The PIC and 2013 Base Case disturbances for affected First Nation traditional territories are presented in Table 2.5-1. Traditional territory areas have been limited to the portion that overlaps the RSA boundaries. Pre-Industrial Case disturbance was estimated at effectively zero, due to the negligible nature of PIC disturbance (1,556 ha or less than 0.05%); therefore, the 2013 Base Case disturbance is the change in disturbance from the PIC to 2013 Base Case. No spatial data regarding the traditional territories of potentially affected Métis groups was available at the time of report preparation, though the discussion of disturbance within First Nations traditional territories should be illustrative of the degree and type of change experienced by Métis groups as well.

Table 2.5-1 Development Affecting First Nation Traditional Territories Within the Regional Study Area – Pre-Industrial Case to 2013 Base Case

First Nation Traditional Territories	Traditional Territory Area Within RSA[(a)] [ha]	2013 Base Case Disturbance	
		[ha]	[%]
FMFN	2,129,818	291,462	14
MCFN	1,673,308	285,113	17
ACFN	1,401,026	239,084	17
FM #468	1,570,098	284,363	18

(a) Total traditional territory area is considered equal to Pre-Industrial Case resource base as Pre-Industrial Case disturbance effectively equals 0% (0.05%); therefore all 2013 Base Case calculations also reflect total change.

Note: Traditional territory areas are based upon digitised images of First Nation territories found in ACFN (2003), FMFN (1994), FM#468 (2006) and MCFN (2006).

Within the RSA, the Fort McKay First Nation (FMFN) has undergone an increase of 14% (291,462 ha) in disturbance of their traditional lands between the PIC and the 2013 Base Case (Table 2.5-1). Within the traditional territory of the Mikisew Cree First Nation (MCFN), 285,113 ha have been disturbed since PIC conditions, an increase of 17% of the territory area that overlaps the RSA. The Athabasca Chipewyan First Nation (ACFN) has also seen an increase in disturbance of 17% (239,084 ha) of their traditional land that ovelraps the RSA from PIC to 2013 Base Case. Fort McMurray First Nation (FM #468) has experienced disturbance of 284,363 ha (18%) of their traditional lands located within the RSA at 2013 Base Case.

Fort McKay Culturally Significant Ecosystems

The PIC and 2013 Base Case disturbance for FMFN CSEs, the change experienced at 2013 Base Case in hectares, as a percent of total CSE area, and as a percentage increase from PIC conditions is presented in Table 2.5-2. Calculations have been made against the entire area of the CSEs, including those that fall outside the RSA.

Table 2.5-2 Development Affecting the Fort McKay First Nation Culturally Significant Ecosystems – Pre-Industrial Case to 2013 Base Case

CSE	Total Area of CSE [ha][(a)]	Pre-Industrial Case Disturbance Area		2013 Base Case Disturbance Area		Change		Percentage Increase [%]
		[ha]	% of CSE	[ha]	% of CSE	[ha]	% of CSE	
All Traditional Uses								
Low use	2,142,679	78	<1	98,526	5	98,448	5	126,540
Moderate use	861,563	1,339	<1	149,980	17	148,642	17	11,103
Intense use	309,215	140	<1	67,706	22	67,565	22	48,227
Total	**3,313,457**	**1,557**	**<1**	**316,212**	**10**	**314,655**	**10**	**20,214**
Large Game Harvesting								
Low use	1,347,998	0	0	18,707	1	18,707	1	n/a[(b)]
Moderate use	1,723,226	1,074	<1	88,633	5	87,559	5	8,153
Intense use	1,018,146	483	<1	213,671	21	213,188	21	44,184
Total	**4,089,370**	**1,557**	**<1**	**321,011**	**8**	**319,454**	**8**	**20,523**
Furbearer Harvesting								
Low use	1,156,838	1,557	<1	28,133	2	26,577	2	1,707
Moderate use	1,691,405	0	0	146,176	9	146,176	9	n/a
Intense use	1,000,784	0	0	142,726	14	142,726	14	n/a
Total	**3,849,026**	**1,557**	**<1**	**317,036**	**8**	**315,479**	**8**	**20,267**
Bird Harvesting								
Low use	1,187,461	156	<1	108,169	9	108,013	9	69,372
Moderate use	694,010	1,401	<1	124,883	18	123,483	18	8,815
Intense use	354,791	0	0	61,638	17	61,638	17	n/a
Total	**2,236,263**	**1,557**	**<1**	**294,690**	**13**	**293,133**	**13**	**18,832**
Fish Harvesting								
Low use	1,773,585	0	0	157,253	9	157,253	9	n/a
Moderate use	620,004	778	<1	128,221	21	127,442	21	16,374
Intense use	132,437	778	<1	4,163	3	3,384	3	435
Total	**2,526,027**	**1,557**	**<1**	**289,636**	**12**	**288,079**	**11**	**18,507**
Traditional Plant (Berry) Harvesting								
Low use	1,396,491	1,121	<1	137,336	10	136,216	10	12,155
Moderate use	396,759	436	<1	111,507	28	111,072	28	25,487
Intense use	74,917	0	0	34,763	46	34,763	46	n/a
Total	**1,868,167**	**1,557**	**<1**	**283,933**	**15**	**282,376**	**15**	**18,141**

(a) Reflects the total area of the CSE, including portions which fall outside RSA and provincial boundaries.

(b) Percentage increase cannot be calculated for an increase with a starting value of 0.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The All Traditional Uses CSEs will experience an increase in disturbance of 314,655 ha (10%) at 2013 Base Case with the intense use areas experiencing the largest percentage increase to 22% (67,565 ha) (Table 2.5-2). Large Game Harvesting CSEs will undergo an increase in disturbance of 8% (319,454 ha) of total CSE area, with the largest impact within the intense use CSE. Furbearer Harvesting CSEs will increase to 8% (315,479 ha) at 2013 Base Case conditions. Bird Harvesting CSEs predict an increase of 13% (293,133 ha) of total CSE area, with the greatest increase being felt by moderate use areas. Similarly, Fish Harvesting CSEs expect an increase of 11% (288,079 ha), with moderate use areas experiencing the largest percentage of disturbance increase. Total Traditional Plant (Berry) Harvesting CSEs have experienced the largest increase in disturbance from PIC to 2013 Base Case, with an increase of 15% (282,376 ha) of the total CSE being disturbed.

Registered Fur Management Areas

The PIC and 2013 Base Case scenarios for RFMAs affected by the PRM are shown in Table 2.5-3. The PIC is considered equal to the total RFMA area because no PIC disturbances were noted.

Table 2.5-3 Development Affecting Registered Fur Management Areas – Pre-Industrial Case to 2013 Base Case

RFMA [#]	Total Area [ha][a][b]	2013 Base Case Total Disturbance Area	
		[ha]	% of RFMA
1275	55,403	5,677	10
2016	15,712	3,098	20
2331	29,207	3,019	10
2939	9,216	120	1
Total	**109,538**	**11,914**	**11**

(a) Includes both LSA and RSA components of the RFMA.

(b) Total RFMA area is considered equal to Pre-Industrial Case resource base as Pre-Industrial Case disturbance equals 0, therefore all 2013 Base Case calculations also reflect total change.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

At 2013 Base Case, RFMA # 1275 has 10% (5,677 ha) of its total area disturbed (Table 2.5-3). Registered Fur Management Area # 2016 has the highest percentage of disturbance at 2013 Base Case, at 20% (3.098 ha), while RFMA # 2939 has the lowest at 1% (120 ha). Registered Fur Management Area # 2331 has seen an impact of 10% (3,019 ha) of its total area disturbed as of 2013 Base Case.

2.5.2 Socio-Economic

This section discusses socio-economic conditions in the early 1960s before large-scale oil sands development began in the region and tracks changes in several socio-economic areas over time. The analysis relies on information collected from past socio-economic reports, available historical data, and interviews and consultation activities conducted for previous socio-economic impact assessments. This section was prepared by Nichols Applied Management (Nichols) on behalf of Shell. Nichols has been engaged in socio-economic work in the region for over 30 years and drew on that experience in preparing this section.

The challenge in carrying out this analysis is that historical data are sometimes not available, or were often collected only infrequently, and are affected by changing definitions and assessment methods. This challenge is especially true for areas outside Fort McMurray that were rural, isolated, and sparsely populated.

2.5.2.1 Socio-Economic Setting

This section provides the historical context for socio-economic conditions for communities and Aboriginal peoples in the region.

2.5.2.1.1 Historical Context

Aboriginal peoples have lived in northeastern Alberta for 10,000 years or more, and evidence of their presence can be found throughout the region. For example, the Cree Burn Lake site was a hub for trading and cultural activities dating back some 8,000 years. It was designated as a Provincial Historic Resource in 1999. Prior to contact with European settlers, Aboriginal peoples maintained a relatively stable way of life based on hunting, fishing, and the gathering of food and medicinal plants.

European settlers first came to the region as explorers and fur traders in the 18th century. Fur trading posts were established at Fort Chipewyan (1788), Fort McKay (1820) and Fort McMurray (1870). Located at the confluence of the Clearwater and Athabasca rivers, Fort McMurray developed into a major staging point for travellers and freight bound for the North via the Slave River, Great Slave Lake and Mackenzie River.

The relationship between Aboriginal peoples of the region and their traditional lands changed as a result of contact with European settlers. The arrival of the Europeans and the fur trade ensured that trapping now supplemented traditional hunting, fishing and gathering activities.

2.5.2.1.2 Pre-Industrial Case – Early 1960s

This section presents regional data which generally refers to the town of Fort McMurray, the unincorporated communities of Fort Chipewyan, Fort McKay, Anzac, and their surrounding areas.

In the early 1960s, the region was a relatively isolated part of the province with a small, predominantly Aboriginal population. Prior to 1966, there was no all-weather road access from the region to the southern parts of the province. Ground transportation was dependent on the railway, completed in the early 1920s, or on winter access via forestry roads.

In 1961 the population of the region was about 2,600. Approximately one-half resided in Fort McMurray with most of the remainder in the unincorporated communities of Fort Chipewyan, Fort McKay and Anzac. There were just over 600 housing units in the region, split fairly evenly between Fort McMurray and the other smaller communities. Housing was predominantly single family dwellings (AOSERP 1979).

The scattered urban settlements, most significantly Fort McMurray, provided only a basic level of services to the region (AOSERP 1979). As an example, in 1960, Fort McMurray had a hospital with 25 beds and just one constable without a police vehicle (AOSERP 1980).

Before large-scale development of the oil sands began, the region's economy was reliant on its function as a transportation thoroughfare to regions further south, and on traditional resource industries such as hunting, fishing, trapping and forestry. With Fort McMurray as its southern terminus, Athabasca River barge transport was an important route for communities in northeastern Alberta, northwestern Saskatchewan and the Far North. While the expansion of highway systems in the late 1950s and early 1960s began diverting traffic away from the barge transport system, it nonetheless remained an important transportation route for many northern communities without rail or all weather road access, such as Fort Chipewyan.

In 1961 Fort McMurray's employed labour force was 330 (AOSERP 1979). The percentage of the population aged 15 and over that was employed was less than 49%, below the provincial average of 55%. The construction and mining sectors comprised a relatively minor share of the employment base of the community at that time. More than one-third of the labour force was engaged in the transportation and communications industry, reflecting the town's importance as a rail and waterways transportation hub.

The region had previously been marked by successions of booms and recessions associated with natural resources and transportation (AOSERP 1978). The oil sands in particular had attracted interest prior to 1960, including:

- the turn of the 20th century, when speculators trying to drill for oil below the oil sands caused a minor boom;
- the late 1920s, when the newly formed Research Council of Alberta made serious efforts to find a method of extracting oil from oil sands deposits; and
- the 1950s, when the exploration period for the Great Canadian Oil Sands (GCOS) began (AOSERP 1980).

Most of the economic effects for these developments fell on the community of Fort McMurray.

Until the mid-1960s, much of the region's Aboriginal population continued to live in the traditional economy as it adapted to the fur trade. By the 1960s, Aboriginal persons in the region were also engaging in various wage-employment opportunities in renewable resource sectors, such as fishing and forestry. For example, commercial fishing on Lake Athabasca provided a relatively significant amount of seasonal employment to Aboriginal people in the Fort Chipewyan area in the early 1960s (AOSERP 1979). The smaller, predominantly Aboriginal communities in the region also depended on seasonal firefighting, local administration, and social assistance.

The living patterns of Aboriginal peoples in the region also began changing in the early 1960s as they settled more permanently in stable communities as a result of the declining fur trade and under the pressure of government policies. As part of the same process, they were obliged to rely increasingly on government transfer payments and the surrounding wage economy to supplement their livelihood from traditional hunting and gathering activities.

Additional information pertaining to the pre-development context for Aboriginal groups who reside in the region can be found in Appendix 7 (SIR 69a Cultural Effects Review).

2.5.2.1.3 Regional Development From 1960s to Current Day

Large-scale development of the region's oil sands resource began in the mid-1960s and helped lead to several significant changes over the next five decades. Development of the region from the 1960s to today can be divided into four distinct time periods associated with oil sands development:

- Early 1960s to 1986 was the first major growth period. Fort McMurray's population grew from 1,200 to nearly 37,000.
- From 1986 to the late 1990s was a period of little growth. Population was essentially stable as oil sands industry employment declined marginally through productivity improvement measures.
- Late 1990s to 2008 was the second major growth period. Employment growth drove rapid population growth in the region, leading to high demand for regional infrastructure and services. The population of Fort McMurray increased to over 70,000.
- From 2008 to 2013, growth in the region moderated as a result of the global economic downturn.

An overview of regional development by socio-economic area in each of these time periods is provided in Table 2.5-4.

Table 2.5-4 Regional Development, 1960 to 2013

Socio-Economic Area	Period 1: Early 1960s to 1986	Period 2: 1986 to Late 1990s	Period 3: Late 1990s to 2008	Period 4: 2008 to 2013
Oil Sands Economy	• First wave of development: Great Canadian Oil Sands Ltd. (now Suncor [Suncor] Energy Inc.) builds its base plant starting in 1964 and commences operations in 1967. • Second wave of development: Construction of the Syncrude Canada Ltd. (Syncrude) facility starts in the 1970s; first production in 1978. • Third wave of development centred around the Alsands Project falters in early 1980 under pressure of technical challenges, rising costs, and depressed product prices. • The labour force of Fort McMurray was estimated at 7,600 in 1976, of which 55% worked outside the town boundaries, mostly at the Suncor and Syncrude plants. In 1980, the labour force was estimated at 13,230, of which 55% worked in the oil sands plants or in construction (AMA 1975, 1976, 1980).	• Technology change in oil sands industry. Movement from bucket wheel to truck and shovel mining. Emergence of in situ production methods. • Debottlenecking and other improvements to processes and facilities. • Stable or marginally declining oil sands industry employment due to productivity improvement measures. • Generic royalty regime, improved plant reliability, improving product prices, and other drivers stimulate the first expansion of the industry since 1976: Steepbank mine, an expansion mine of Suncor, opens in 1999. • Syncrude moves its senior management and administration to the region from Calgary and Edmonton. Suncor has operations-related administration in the region, but retains its corporate functions in Calgary.	• Period of regional economic expansion. Construction and sustaining capital expenditures in the province's oil sands industry increased from $1.5 billion in 1998 to over $18 billion in 2008. • Expansion from a two-company to a multi-company industry. Major new facilities from Shell, Canadian Natural Resources Limited, ConocoPhillips Canada, Cenovus Energy Inc., Cenovus FCCL Ltd. and others. • Employment growth: As of 2007, over 11,000 operations workers were directly employed by the oil sands industry in the region—more than double the number before 1996. • Labour shortages are occurring across several sectors and the region is experiencing an increasing number of mobile workers from elsewhere in Alberta and Canada. Total number of camp-based mobile workers is over 26,000 in 2008 (Nichols 2007).	• A number of oil sands projects are halted in response to the global financial and debt crisis in autumn 2008. • Between 2008-2009, annual construction and capital expenditures in the province's oil sands industry dropped by nearly 40%. • Ongoing investment in facility maintenance and operations; Imperial Oil sanctions its Kearl Mine in early 2009. • Major merger of Suncor and Petro-Canada, consolidating a suite of oil sands projects. • Most projects that were halted in 2008/09 are back on track by the end of 2011. • Skill shortages have been reduced by the recession of 2008 to 2009, but are again on the upswing.
Other Economic Sectors	• Regional economy includes house and commercial construction, natural gas exploration and production, forestry development, tourism, and the emergence of a service sector. • Strong demand for workers in the oil sands industry creates labour recruitment and retention difficulties for all sectors. • Traditional economy remains important for many people in the region, especially in the outlying areas. • Development of large-scale industrial development drives other subsidiary industries, such as all-weather road access to the region and increased pipeline capacity.	• Retrenchment of the construction industry in Fort McMurray. Home and commercial construction starts to pick up after 1995 as oil sands industry expansion gets under way.	• Period of expansion for many industries in the region, especially the land development, commercial and residential construction, commercial and retail sectors. • Strong demand for workers in the oil sands industry creates labour recruitment and retention issues for all sectors. Limited availability and high cost of housing contributes to worker recruitment and retention issues. • Emergence of mostly oil sands industry-focused industrial, commercial, and professional services and manufacturing sectors. • Aggregate production emerges as a large-scale operation in the 1990s with the opening up of the Susan Lake Quarry.	• Reduced demand for workers in the oil sands industry eases but does not eliminate labour recruitment and retention issues for all sectors. • Regional Municipality of Wood Buffalo (RMWB) economic development function places increased emphasis on economic diversification.
Population	• Rapid population growth. • Regional population growth, from about 2,600 in the early 1960s to over 26,000 in 1978, an annual growth rate of 15%. • Most of this growth occurs in Fort McMurray which accounts for over 90% of the regional population, or 24,500, in 1978. • Fort McMurray continues to grow, reaching 36,810 in 1986. Growth in the outlying areas was more modest (AOSERP 1979; AMA 1975, 1980). • Construction of oil sands plants leads to fluctuating camp populations in the region. The camp population reached peaks of about 2,300 in 1966 during the Great Canadian Oil Sands (GCOS) construction phase, and 6,500 in 1977, during Syncrude base plant construction.	• Stable population in Fort McMurray and the region as employment in the oil sands industry marginally declines. • The population of Fort McMurray is approximately 36,500 in 1999 and virtually unchanged from 1986 (RMWB 1999). • The population of the outlying communities is estimated at 2,850 in 1996. Fort Chipewyan is the largest of the outlying communities with an estimated population of 1,020 (RMWB 1999). • Population of the small communities is relatively stable. • The regional camp population is estimated at approximately 3,500 in 1999 (RMWB 1999).	• Rapid population growth. • Municipal census indicates that the resident population of the region increased from 39,280 in 1999 to 74,160 in 2008, an annual average growth rate of 7%. Most of this growth is concentrated in the region's Urban Service Area. • Growth in the non-resident population. As of 2008, over 26,280 workers, or over 90% of the non-resident population, lived in work camps in the outlying rural areas. The remainder lived in hotels, motels and campgrounds in the Urban Service Area. • Most of the workforce camps are temporary construction camps; longer-term operations camps start to emerge in the later part of the period. In 2008, there are three permanent operation camps in the region. • Anzac emerges as a growth community and starts to function as a residential centre. • Population of the other small communities is relatively stable.	• The resident population in the region reaches nearly 80,000 in 2012 (RMWB 2012). The urban communities accounted for about 95% of the resident population, while the rural communities accounted for the remaining 5%. • The population in Fort McMurray grew by an estimated 3% per year between 2008 and 2010, as compared with over 6% between 2000 and 2008 (RMWB 2010a). Between 2010 and 2012, the urban population remained virtually unchanged (RMWB 2012). • The non-resident population was over 40,000 in 2012. It was comprised of mobile workers living primarily in camps, but also in hotels, motels and campgrounds in the region (RMWB 2012). The camp population dropped slightly between 2008 and 2010, before growing from 23,000 in 2010 to nearly 40,000 in 2012.
Land	• The geography and location of Fort McMurray at the confluence of the Clearwater and Athabasca rivers creates land development challenges and a non-concentric city shape. • Active intervention by Alberta Housing Corporation to develop land for housing, roads, and commercial facilities. • Expansion of housing subdivisions in Fort McMurray (e.g., Beacon Hill and Thickwood Heights in 1973). • Development of Timberlea (Area Structure Plan in 1980, first houses built in 1985/86).	• Limited or no demand for residential, commercial, and industrial land. • Substantial availability of developed land in Timberlea throughout most of the period. Re-emergence of oil sands industry development sees increased land uptake in Timberlea in the mid to late 1990s.	• Absorption of available lands in Timberlea by resurgence of home building in late 1990s. • Predominance of provincially owned Crown lands in the region and especially around Fort McMurray creates challenges for the timely availability of developable land for residential, commercial and industrial uses. • Piecemeal release of land for development, including Parsons Creek and North Parsons. • Emerging demand for developable land in outlying communities (e.g., Anzac) and for commercial and industrial land. • Fort McKay First Nation opens an industrial park on reserve lands near Shell and Syncrude mines, north of the Peter Lougheed Bridge. • High land prices.	• Release of land for the North Parsons and Saline developments. • Development of few industrial subdivisions. • Signing of a Memorandum of Understanding in 2011 between the RMWB and Alberta regarding the establishment of an Urban Development Sub-region (UDSR) that will give the municipality jurisdiction over sufficient land to undertake residential, commercial and industrial development for up to 200,000 residents. As of spring 2013, the UDSR has yet to be finalized and additional time will be needed before additional lands are available for development.

Table 2.5-4 Regional Development, 1960 to 2013 (continued)

Socio-Economic Area	Period 1: Early 1960s to 1986	Period 2: 1986 to Late 1990s	Period 3: Late 1990s to 2008	Period 4: 2008 to 2013
Housing	• The number of dwelling units in Fort McMurray increases from 300 in 1961 to more than 8,500 units in 1978, and then to over 12,000 in 1986 (AOSERP 1979; RMWB 1999). • Emergence of duplexes, row housing, apartments, including high-rise apartment buildings, and mobile dwellings. • Focus of initial development is on the lower town site, Beacon Hill, Waterways, and Gregoire Park. • Residential development in Thickwood Heights across the Athabasca River starts in the mid 1970s. • Housing prices increase from below to well above Edmonton equivalents during Syncrude construction. Prices moderate after its completion and fall with the cancellation of the Alsands project in early 1980s. • Syncrude, Suncor, and the Alberta Housing Corporation, a provincial Crown corporation, have a large and direct involvement in the housing market.	• Period with high rental vacancies, depressed housing prices, limited new residential construction, and the withdrawal of Syncrude, Suncor, and the Alberta Housing Corporation from direct involvement in the housing market. • The housing stock is estimated at 12,755 units in 1999, a very slight increase from 1986 (RMWB 1999). • Limited residential growth in the Thickwood Heights and adjacent Timberlea area.	• Period of housing expansion. • Housing prices in Fort McMurray more than doubled between 2003 and 2008 (FMREB 2009). By 2008, rental rates are the highest in Canada and vacancy rates remain close to zero (CMHC 2008b). • The impact of the high housing costs on residents depends on income level. Higher wages for many residents, particularly those working in the oil sands sector, help to offset high housing prices. There are housing affordability challenges for middle and low income residents, particularly those working in the service sector. • A formal and informal market for room rental provides homeowners with additional income. • The Government of Alberta and the RMWB provide cost-of-living allowance to their employees, including all provincially funded organizations in Fort McMurray. • Escalating housing costs and the availability of sufficient land to accommodate future growth are central to growth pressure concerns voiced by stakeholders in the region (e.g., Wood Buffalo Business Case 2003 and 2005). • Alberta responds with the Radke Commission to investigate growth pressures and recommend solutions. • In 2007, RMWB releases the Fringe Area Development Assessment, Urban Service Area report (Preiksaitis 2007) to guide further development decisions such as land release. • In 2008, the Government of Alberta announces plans to develop two new communities in Fort McMurray: Parsons Creek and Saline Creek Plateau. • Several oil sands projects in the area also begin moving towards an “operations camp” model which serves to limit the near-term impact of these projects on the local housing market.	• The average price for single family dwellings drops in 2009 in response to the economic recession. House prices begin increasing again in 2010, rising to levels comparable with 2008. In 2012 house prices continued climbing in Fort McMurray, with an average selling price of over $751,000 (WB 2013). • Rental rates in Fort McMurray have declined slightly in recent years, but rents remain the highest among all urban centres in Alberta (CMHC 2012). • Housing costs remain the principal contributor to the high cost of living in Fort McMurray. • Many rural communities in the RMWB are also experiencing housing pressures as a result of: community members returning, often from Fort McMurray, to avoid high housing prices there; a young population and early family formation; and housing policies and funding allocations by Aboriginal Affairs and Northern Development Canada that do not tend to respond quickly to changing situations.
Transportation Infrastructure	• Expansion of transportation infrastructure in the region. • Highway 63 linking Fort McMurray to the rest of the province is completed in 1963. • Air traffic to and from the region and also intra-regional traffic (primarily Fort McMurray-Fort Chipewyan) increases significantly (AOSERP 1979). An airport is completed in 1967 and scheduled service begins in 1973 (AOSERP 1979). • Construction of the Peter Lougheed Bridge over the Athabasca River north of Fort McKay to gain access to oil sands leases east of the Athabasca.	• Upgrades on Highway 63 up to the Peter Lougheed Bridge over the Athabasca River just north of Fort McKay. • Completion of Highway 881 as a gravel road. • Cessation of dredging of the Athabasca River and much reduced barging services to Fort Chipewyan and other communities on Lake Athabasca. • Abandonment of the rail line between Lynton, near Saprae Creek and Waterways.	• Oil sands expansion leads to increased traffic throughout the region and beyond. For example, traffic on Highway 63 between Fort McMurray and Suncor increases from an estimated 6,570 vehicle movements per day in 2000 to 16,870 in 2007 (AT 2011). • Traffic concerns among local residents include: the increase in traffic congestion, including long traffic delays during peak hours; and an increase in traffic accidents and traffic fatalities. • There are many road infrastructure improvement projects in the region, including twinning sections of Highway 63 between Fort McMurray and Suncor and Syncrude; upgrade of Highway 881 to all-weather road status. • New aerodromes emerge at Shell and Canadian Natural and other projects. • Rail upgrades, but rail traffic remains constrained by limited load capacity and challenging rail bed conditions.	• Road infrastructure in the area continues to undergo changes and improvements. Road work recently completed or underway includes: o improvements to the intersection of Highway 63 with the Fort McKay access road; o construction of a new five-lane bridge on Highway 63 over the Athabasca River, on the northern edge of Fort McMurray; o Highway 63 interchanges with Thickwood Boulevard and Confederation Way as well as the Morrison and Hardin Street intersections bypass lane; and o rebuilds of Steinhaur and Grant MacEwan bridges (to be completed in 2013 and 2014, respectively). • The key roadway project in the region remains the twinning of Highway 63. Regional residents have serious concerns with respect to traffic safety on the highway. In 2012, the Government of Alberta committed to implementing certain measures to improve safety along and accelerate twinning of Hwy 63 (AT 2012 b,c,d). • Long-term planning is also underway for future infrastructure requirements, including highways required for oil sands growth (e.g., highway improvements recommended in the Athabasca Oil Sands Area Comprehensive Regional Infrastructure Sustainability Plan, creation of the Athabasca Oil Sands Transportation Coordinating Committee).

Table 2.5-4 Regional Development, 1960 to 2013 (continued)

Socio-Economic Area	Period 1: Early 1960s to 1986	Period 2: 1986 to Late 1990s	Period 3: Late 1990s to 2008	Period 4: 2008 to 2013
Local Government	• Fort McMurray is designated as a “New Town” under the *New Towns Act*. • Extensive involvement of the provincial government in administration, planning and community development, coordinated through the Northeast Commission. • Fort McMurray attains city status in 1980, giving more autonomy to the local government authorities. • Alberta Municipal Affairs administers Improvement District 18 (ID 18), which is composed of the rural area and the hamlets in the area. Residents of ID 18 have an advisory role in the conduct of municipal affairs by means of two Advisory Committees. • Each of the five First Nations bands (Athabasca Chipewyan First Nation, Mikisew Cree First Nation, Fort McKay First Nation, Fort McMurray First Nation, and Chipewyan Prairie Dene First Nation) is governed by a Chief and Council.	• Creation of the Regional Municipality of Wood Buffalo in 1995. It comprises both the City of Fort McMurray (now the urban service area of Fort McMurray) and the rural area, including the hamlets of Fort Chipewyan, Fort McKay, Anzac, Janvier and Conklin. • Both the urban and rural areas have formal representation on the Regional Council. • With the creation of the Regional Municipality, the relationship between the provincial government and local government becomes the same as in other areas of the province. • Each of the five First Nations bands is governed by a Chief and Council.	• In 2007 the provincial government establishes the Oil Sands Sustainable Development Secretariat to coordinate and improve planning, communications and service delivery to Alberta's oil sands regions, including the Wood Buffalo region. • The provincial government also provides the municipality with $3.6 million over three years (2007 to 2010) for strategic planning support. • Each of the five First Nations bands is governed by a Chief and Council.	• Extensive planning for growth, by the municipality and Alberta. • *Oil Sands Sustainable Development Secretariat develops Responsible Actions: A Plan for Alberta's Oil Sands* (Government of Alberta 2009), and the *Athabasca Oil Sands Area Comprehensive Regional Infrastructure Sustainability Plan* (Government of Alberta 2011). • In 2012, the municipality highlights a number of priority concerns regarding their ability to plan for and accommodate future growth, including: the availability of developable land and the need for an improved transportation network to access newly developed lands. • To facilitate and coordinate the implementation of various planning initiatives at both the provincial and municipal levels, the municipality spearheads a process to develop a Regional Structure Action Strategy (RSAS). The RSAS is led by a task force comprised of municipal, provincial and industry representatives and is expected to develop its action strategy before the end of 2013. • Each of the five First Nations bands is governed by a Chief and Council.
Municipal Finance	• Extensive direct provincial government investment in municipal infrastructure and services.	• Integration of rural (industrial) and urban (residential/ commercial) tax base through the creation of the Regional Municipality of Wood Buffalo. • Limited or no assessment and tax revenue growth and general era of reduced government support for municipalities. • Focus is on municipal costs containment and fiscal balance.	• Expansion of municipal capital and operating budgets. Concerns about debt financing, but the limited capacity to execute projects keeps debt well within set limits. • Rapid growth in assessment and municipal tax revenue, but the growth lags relative to infrastructure and service demands. • Some provincial support for municipal infrastructure financing.	• Reduced pace of infrastructure and service demands, allowing the RMWB to catch up, in part, on earlier demand. • Continued rapid growth in assessment and municipal tax revenue as new facilities come on stream. Property assessment in the Rural Service Area of the RMWB, which consists mostly of oil sands industry facilities, grew on average by 20% per year from $6.6 billion in 2005 to $29.0 billion in 2013.
Municipal Infrastructure and Services	• Municipal Infrastructure reflects the growth waves of the 1960s and 1970s. Some municipal infrastructure (e.g., servicing of part of Timberlea) are in place when growth declines in early 1980s with the cancellation of the Alsands project. • Most of the residential, commercial and industrial development in the 1960s is concentrated in and around the lower town site. • The second wave of municipal infrastructure development extends to north of the Athabasca River. • Expansion of municipal service delivery capacity in Fort McMurray; limited capabilities to deliver municipal services in ID 18 and later the rural services area.	• Period of low population and municipal infrastructure demands. • Surplus capacity in most municipal infrastructure. Much of the urban service area's municipal infrastructure is sized to accommodate a population in excess of 50,000. • Retrenchment of municipal service delivery, reflecting low growth in assessment and reduction in provincial supports for all municipalities.	• Rapid increase in municipal infrastructure and service demands linked to population growth. • Expansion of basic municipal infrastructure, such as potable water and wastewater/solids treatment facilities that require additional capacity. • Ability to put in place infrastructure is limited by available resources to plan, engineer, and build projects. • Cost inflation for all infrastructure and services. • Challenges to recruit and retain municipal staff. • Most municipal infrastructure and services focus on the urban services area of Fort McMurray, where most population growth occurs.	• The municipality's planning initiatives to accommodate future growth include: updating the Municipal Development Plan; updating several municipal infrastructure master plans; and developing a population forecasting tool. • The redeveloped McDonald Island Park opens in 2009. It is billed as Canada's largest community, recreation, and leisure centre. Expansion plans are under way in early 2012. • The RMWB invests in major infrastructure developments, including RCMP force and detachment buildings; and regional emergency service providers and fire halls.

Table 2.5-4 Regional Development, 1960 to 2013 (continued)

Socio-Economic Area	Period 1: Early 1960s to 1986	Period 2: 1986 to Late 1990s	Period 3: Late 1990s to 2008	Period 4: 2008 to 2013
Services and Amenities	• Pressures on local services and infrastructure as population grows. These pressures are especially pronounced during the construction phases of the Suncor and Syncrude projects. • Expansion in available services and amenities in the region. • Construction of the Northern Lights Hospital (1979/80). • By 1976, Fort McMurray has four primary schools and one high school with an additional two under construction and one in the planning stage. • Keyano College builds and operates a Heavy Industrial Campus and a downtown campus focused on academic and industry training.	• Period of consolidation in services and amenities. • By 1996, Fort McMurray has 18 primary and secondary schools, a college with a campus in downtown Fort McMurray and on the south side of Fort McMurray, an 84-bed acute care hospital, and a broad range of protective, emergency, and social services.	• Increased demands on social infrastructure. Available resources often do not keep pace with this growth leading to increased strains and pressure on regional service providers. • In response, government and industry increase funding for social infrastructure and introduce new planning processes and initiatives to alleviate the pressures of rapid growth and to enhance the quality of life of local residents (e.g., the Syncrude Community Sport and Wellness Centre and Arts Centre at Keyano College).	• Between the end of 2008 and 2011, the region sees an easing of some of the pressures associated with the high-growth period of 2000 to 2008. • Recent positive developments in addressing social infrastructure challenges include: new agencies and structures (e.g., Oil Sands Sustainable Development Secretariat); new planning initiatives (e.g., the Athabasca Oil Sands Area Comprehensive Regional Infrastructure Sustainability Plan, Municipal Development Plan); new forecasting tools and information systems (e.g., the RMWB's Population and Employment Projection Model); and additional funding (e.g., over $2 billion has been committed by the provincial government since 2007 for infrastructure and services. According to RMWB representatives, about half those funds have been spent as of late 2012 (CEAA 2012). As of 2012, service delivery outcomes have improved in several social infrastructure areas, such as health and emergency services (e.g., reduced emergency department wait times, targeted emergency response times being met). • Infrastructure and service providers continue to face challenges, including: the demands of non-permanent residents; social stressors in the region; difficulty in attracting and retaining appropriately skilled workers; the need for additional infrastructure (e.g., schools, health facilities), and the need for stable, predictable funding that also recognizes the particular challenges of service delivery in the region (e.g., rural, remote location).

2.5.2.2 Socio-Economic Results

Without oil sands development, the regional population would be much smaller than it is today and communities in the region would not have experienced many of the socio-economic challenges precipitated by development. At the same time, neither would the region or its residents have realized many of the benefits of development, including jobs, income, and increased service offerings and amenities. Although growth is a pathway by which many socio-economic effects occur, the level of that growth alone is not a sufficient indicator of the nature and magnitude of these effects. Consideration must be given to the availing processes and systems in place to handle and address these effects. In the Wood Buffalo region, these processes and systems have expanded considerably over time, especially in recent years as a response to rapid growth in the late 1990s to 2008 period.

2.5.2.2.1 Regional Socio-Economic Effects

From the early 1960s to today, the region has transitioned from a relatively isolated part of the province with small communities and few amenities, into a region that is home to one of Alberta's larger urban centres. While these changes to some degree reflect the general enhancement of services and facilities which occurred throughout the province during this same timeframe, many of these changes were precipitated by the nature and pace of oil sands development.

Residents of the region have experienced the benefits of growth, driven by expansion of the oil sands industry, in a variety of ways, including:

- increased employment and contracting opportunities for residents, including for those groups that are currently under-represented in the labour force (e.g., labour market indicators for Aboriginal persons in the region lag behind the non-Aboriginal population but compare favourably to Aboriginal persons in other communities);
- increased wages and benefits, which can be used by local workers to purchase goods and services;
- increased industry support for community programs and infrastructure used by residents;
- increased revenues to local government, which can be used to increase investment in public infrastructure and services or lower taxes;
- increased revenues to the provincial government, which can be used for province-wide funding, programs, and initiatives that will also benefit the region; and
- a broader range of local services and amenities, including both commercial (e.g., retail, industrial) and public (e.g., education, health, emergency services).

Along with, and sometimes as a direct result of, these benefits, growth over the years has also led to residents experiencing socio-economic challenges, primarily during the two major growth periods noted in Section 2.5.2.1.3 above. These pressures include:

- a shortage of housing, particularly affordable housing, due to high demand for accommodation;
- a rising cost of living, driven especially by housing costs;
- increased demand for regional services, including health, education, emergency, municipal, and social services;

- difficulties for both public and private sector service providers in meeting increased demand because of:
  - difficulties in attracting and retaining personnel because service providers are unable to offer higher wages to offset the high cost of living;
  - funding that has not kept pace with increasing demand from both the resident and non-resident population and rising service delivery costs; and
  - pre-existing structural issues in certain areas such as health care that are further exacerbated by growth in the region.
- increased pressure on physical public infrastructure in the region, including municipal infrastructure and the regional road network;
- increased numbers of non-permanent residents (e.g., camp-based workers) who draw on regional services and infrastructure;
- reduced community cohesion and a sense of transience among residents; and
- increased social stressors related to growth, such as work demands that take time away from family and community life.

Many of these socio-economic concerns do not exist in isolation but have influenced one another and further exacerbated socio-economic challenges in the region. For example, while the lack of affordable housing has created a demand on social service agencies in the area, it has also made it difficult for these same agencies to attract and retain the needed personnel to meet this increased demand.

The ability of service providers to address these challenges has expanded over the years as a result of increased resources (e.g., funding) and growth in the breadth and nature of social infrastructure services available. For example, police, emergency, education, social and health services have all expanded the size and nature of their service offerings. While responsible authorities in the region have often been stuck in catch-up mode in responding to socio-economic issues during periods of rapid growth, many of these service providers, such as the Regional Municipality of Wood Buffalo (RMWB), the Royal Canadian Mounted Police, Alberta Health Services, and others, have also developed into sophisticated organizations that are aware of, and are directly and vigorously engaged in, addressing these challenges. Current socio-economic issues and the actions taken by government and industry in response to those issues are further discussed in Appendix 2, Attachment B.

2.5.2.2.2 Socio-Economic Effects on Aboriginal Peoples

Over the last 50 years, Aboriginal peoples in the region have experienced many of the same benefits – employment and contracting opportunities, support for community programs and services – and challenges – rising cost of living, increased social stressors – related to regional growth as identified above. They have also experienced a number of cultural changes (Appendix 7). As a result, their way of life has changed, including:

- settlement into permanent communities;
- changes in family and community practices and relations (e.g., child rearing, education, visiting);
- declining Aboriginal language skills;

- declining reliance on traditional harvesting;
- fewer traditional practices being carried out;
- increasing reliance on non-traditional activities for their livelihood (e.g., wage economy opportunities, government assistance);
- increasing social challenges, including alcohol and drug abuse; and
- increasing access to improved amenities and services (e.g., health care, emergency and social services).

Many of these changes are shared with other Aboriginal peoples across Canada and have been brought about by increasing contact with non-Aboriginal peoples, values and norms as a result of external influences largely outside their control, including:

- increased use of traditional lands for non-traditional purposes, whether it be resource development such as oil sands development in the Wood Buffalo region, diamond mining in the Northwest Territories, or increased agricultural development and encroaching urbanization in other parts of the country;
- education initiatives that have limited transmission of traditional knowledge values and practices; and
- increased access to other cultural influences through advancements in technology (e.g., television, computers, satellite, internet, cell phones).

Among these external influences, oil sands development has undoubtedly had a strong effect on the Aboriginal population in the region. Some of these effects are detailed further in Table 2.5-5.

Table 2.5-5 Oil Sands Development Effects on the Local Aboriginal Population

Oil Sands Development Practices	Effects on the Local Aboriginal Population
Taking up portions of land for a period of time	• Reducing opportunities to carry out traditional activities on oil sands industry-affected lands and to transmit traditional culture and oral history while on the land. • Raising concerns regarding the effect of pollutants on traditional land and resources, thereby affecting how and where traditional practices are carried out.
Drawing on regional sources of water	• Raising concerns about the quantity and quality of water in the region that is relied upon for carrying out traditional activities (e.g., fishing, means of accessing traditional lands).
Offering opportunities for increased engagement in the wage economy	• Limiting opportunities to carry out traditional pursuits and transfer traditional knowledge to Aboriginal youth while on the land. • Providing greater household spending power, lower need for government transfer payments, and an improved sense of self-worth for some. • Increasing incomes, which may lead to increased disparity and social stratification within Aboriginal communities. • Increasing incomes, which may contribute to negative behaviours, including increased alcohol and drug abuse and gambling, especially among those lacking financial experience.
Increasing the non-Aboriginal population in the region	• Increasing competition for traditional resources from non-Aboriginal community members. • Increasing the exposure to outside cultural values.

Aboriginal peoples in the region are concerned that environmental effects related to industrial development have affected their way of life. Along with various other changes, the use of land and regional water sources by industry has contributed to a declining reliance on traditional harvesting and fewer traditional practices being carried out. This, in turn, has driven socio-economic change within Aboriginal communities by increasing the reliance of local Aboriginal peoples on non-traditional activities for their livelihood and contributing to ongoing social changes within the community (e.g., changes in family and community practices and relations).

Oil sands development has also had a number of positive socio-economic effects on Aboriginal peoples in the region, such as employment and contracting income.

An assessment of the socio-economic effects on Aboriginal groups in the region is provided in Appendix 2, Attachment B.

2.6 Pre-Industrial Case Summary

The PIC is intended to represent conditions prior to substantial industrial development in the region. Since information for some components is lacking, the PIC is based on the oldest data available, or on the most representative, for each component rather than on a consistent year basis. In the EIA and previous regulatory submissions, pre-industrial conditions have been referred to as "Pre-Development" or the "Pre-Development Case". To avoid confusion with the Planned Development Case (PDC) all references to pre-development have been re-titled "Pre-Industrial Case" for this submission.

Components discussed in the PIC are air quality, health risk, air emissions effects on ecological receptors, aquatic resources (hydrogeology, hydrology, water quality, and fish and fish habitat), terrestrial resources (soils and terrain; terrestrial vegetation, wetlands and forest resources; wildlife; and biodiversity), and human environment (traditional knowledge and land use, and socio-economics).

Where possible, the PIC information is compared with 2013 Base Case information. This comparison will allow the JRP to "take into account the effects that may have already been experienced prior to the Project".

2.6.1 Air Quality and Environmental Health

The level of anthropogenic emissions in the region would generally be lower in the PIC than in the 2013 Base Case, discussed in Appendices 1 and 3.2. Accordingly, while human health risks could not be adequately characterized for the PIC owing to the overall quality of the database of measured air, soil and vegetation data prior to 1965 for the compounds relevant to the Human Health Risk Assessment, there would be lower human health risks via exposure pathways that were dependant on these datasets. The air emissions effects on ecological receptors could also not be assessed for the PIC, as much of the essential environmental data for the air emissions effect analyses are not available from the PIC period. As already stated, the level of anthropogenic emissions in the region would generally be lower in the PIC than in the 2013 Base Case predictions.

2.6.2 Aquatic Resources

2.6.2.1 Hydrogeology

In general, within the LSA, PIC groundwater flow in the Basal Aquifer is in an easterly to southeasterly direction towards the Athabasca River, which is the major regional groundwater discharge feature in the RSA. In the surficial deposits within the LSA, groundwater flow is generally from the topographic high of the Birch Mountains to the east and southeast toward the Athabasca River valley.

2.6.2.2 Hydrology

No existing and approved oil sands projects are present in the tributary streams to the Athabasca River in the LSA. Hence, the 2013 Base Case hydrologic conditions are the same as the PIC flow conditions. For Athabasca

River, the net annual water allocation to all existing and approved oil sands developments represents a reduction in the mean annual Athabasca River flow of about 2.1% based on the recorded river flows at Fort McMurray from PIC to 2013 Base Case. The combined reductions in seasonal flows in Reach 4 are less than 13.2% for an average year. The predicted combined changes in flow depths at Node S24 are less than 4 cm.

2.6.2.3 Surface Water Quality

Pre-Industrial Case data were used as the basis of the water quality assessment in the EIA. These data were used to calibrate water quality models. Under PIC conditions, total metals and nutrients frequently exceeded guidelines in the small streams and the Athabasca River. The high background levels are generally associated with high total suspended solids from upstream of Fort McMurray and occur mostly during the spring season, consistent with the findings of Glozier et al. (2009).

It is well established that the Athabasca River and its tributaries are subject to natural oil sands inputs that affect water quality. Several studies have examined longitudinal trends in metals and Polycyclic Aromatic Hydrocarbon (PAH) concentrations in the region. While these studies were done after oil sands development began in 1967, many of the studies were completed in undisturbed tributaries, which represent PIC conditions.

2.6.2.4 Fish and Fish Habitat

Because industrial development had not occurred within the small streams of the LSA when the baseline field studies were conducted, it can be assumed that the species distribution and fish habitat conditions presented in the EIA Base Case and Draft No Net Loss Plan are also representative of PIC fish habitat conditions. Therefore, a fish and fish habitat assessment for the PIC is not required.

2.6.3 Terrestrial Resources

The increased development activities from the PIC to the 2013 Base Case in the RSA has resulted in a decrease in mineral and organic soils and a corresponding increase in disturbed landscapes.

Changes in natural Regional Land Cover Classes RLCCs from the PIC to 2013 Base Case range from 3% to 27% of the resource. The largest percent change occurs in the terrestrial vegetation category, where mixedwood aspen-white spruce was reduced by 27% of the resource or 52,635 ha. Total disturbances, including 100,095 ha of cutblocks, increased by 311,139 ha due to the loss or alteration of other RLCCs. Approximately 119,936 ha (12% of the resource) of wetlands were lost or altered. Terrestrial vegetation was also reduced by 164,927 ha (21% of the resource). The amount of burn decreased by 24,044 ha (6% of the resource).

The increase in human disturbances from the PIC to the 2013 Base Case result in an increase in the amount of high suitability habitat in the RSA for short-eared owl, due primarily to the increased prevalence of cutblocks in the RSA at the 2013 Base Case. There is a decrease in the amount of high suitability habitat for all remaining KIRs for which effects on habitat were assessed. The decline in high and moderate-high suitability habitat combined is of low magnitude (i.e., a less than 10% change) for common nighthawk, of high magnitude (i.e., a greater than 20% change) for barred owl, black-throated green warbler, Canada warbler, western toad, wolverine, wood bison and woodland caribou, and of moderate magnitude (i.e., greater than 10% change, but less than or equal to 20%) for all other wildlife KIRs for which changes in habitat were quantified using HS models.

For little brown myotis and northern myotis foraging and roosting habitat, mixedwood and coniferous forests show a less than 20% decline from the PIC to the 2013 Base Case prior to reclamation. This decline would result in a moderate magnitude effect of development in the RSA on little brown myotis and northern myotis foraging and roosting habitat.

Landscape changes should be assessed in the broader context of the overall availability of habitat. The amount of human disturbance in the RSA has been estimated to increase from less than 0.1% at the PIC to 14% of the RSA at the 2013 Base Case. Therefore, at the 2013 Base Case, 86% of the RSA remains undisturbed by humans.

From the PIC to the 2013 Base Case, areas ranked high for biodiversity potential will decrease by 72,042 ha (13% of the resource). This decrease is nearly equally distributed between the high-ranked RLCCs, with non-treed wetlands and treed fen declining by 12% and 14% in the RSA, respectively. Moderate biodiversity potential areas will decrease by 129,573 ha (15% of the resource). Reductions to the terrestrial RLCCs characterize the majority (62%) of this change. Low biodiversity potential areas will increase by 202,334 ha (23% of the resource). All of the low-ranked RLCCs experience losses, with the exception of cutblocks and other disturbances, which increase from the PIC to the 2013 Base Case.

2.6.4 Human Environment

The cumulative effects of development between the PIC and the 2013 Base Case have disturbed between 8% and 15% of the Community of Fort McKay's CSEs. The cumulative effects of development between PIC and the 2013 Base Case have disturbed 14% of the area of Fort McKay First Nation's traditional territory within the RSA, 17% of the area of the MCFN and ACFN traditional territories within the RSA and 18% of the area of the FM468 traditional territory within the RSA.

Without oil sands development, the regional population would be much smaller than it is today and communities in the region would not have experienced many of the socio-economic challenges precipitated by development. At the same time, neither would the region or its residents have realized many of the benefits of development, including jobs, income, and increased service offerings and amenities. Although growth is a pathway by which many socio-economic effects occur, the level of that growth alone is not a sufficient indicator of the nature and magnitude of these effects. Consideration must be given to the availing processes and systems in place to handle and address these effects. In the Wood Buffalo region, these processes and systems have expanded considerably over time, especially in recent years as a response to rapid growth in the late 1990s to 2008 period.

3.0 PLANNED DEVELOPMENT CASE

3.1 Introduction and Approach

In JRP SIR 8, the JRP requested, among other items, an updated Planned Development Case (PDC) to account for foreseeable projects and activities publicly disclosed since the EIA for PRM was completed. Also, the JRP requested that Shell include updated forest harvesting information and the effects of past and future forest fires. This section of Appendix 2 presents the updated PDC assessment.

The JRP Terms of Reference required the EIA PDC to be current as of June 2012. A detailed list of the projects included in the updated PDC is provided in Appendix 3.1. For the purposes of this submission, the updated PDC is referred to as the 2013 PDC and supersedes the EIA PDC. The PRM is included as a planned development in the 2013 PDC assessment.

3.2 Air Quality and Environmental Health

This section provides the results of the 2013 PDC assessments for Air Quality and Environmental Health to inform the cumulative effects on air quality, human health risk, wildlife health risk, and air emission effects on ecological receptors. The 2013 PDC includes a review of the cumulative air quality effects that could result from the existing and approved developments, PRM, and the planned (publicly disclosed) developments in the Oil Sands Region, as of June 8, 2012.

These assessments focus on determining changes to the chemical composition of the air and the effects of these changes in air quality and deposition to the receiving environment. Potential short-term (acute) and long-term (chronic) health risks to people and wildlife are assessed, as well as effects on ecological receptors, including aquatic and terrestrial resources.

The approaches used for these assessments are the same as those used in the EIA with the following exceptions:

- Shell has adjusted its assumptions around mine fleet emissions used in the assessment of potential acid input given the introduction of *Regulations Amending the Off-Road Compression-Ignition Engine Emission Regulations* by the Government of Canada (2011). Air emissions and predictions are discussed further in Appendix 3.2.
- The Alberta Ambient Air Quality Objectives (AAAQOs) and Texas Commission on Environmental Quality Effects Screening Levels (TCEQ ESLs) for some compounds such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matter with a mean aerodynamic diameter of 2.5 µm or smaller ($PM_{2.5}$) have been revised since the EIA (ESRD 2013; TCEQ 2013), as presented in Appendix 3.2.
- The Human Health Risk Assessment (HHRA) updated the following aspects of the assessment:
  - description of the existing conditions, including exposure and health studies;
  - problem formulation, including changes to the final list of Chemicals of Potential Concern (COPCs) and revisions to the consumption rates;
  - exposure assessment, including a re-evaluation of how the physical-chemical characteristics were used to identify the non-volatile, potentially bioaccumulative chemicals; and
  - toxicity assessment, including an update of any new health-based exposure limits.

3.2.1 Air Quality Assessment

3.2.1.1 Regional Emissions

The 2013 PDC includes planned projects that have not received approval to operate, some of which have yet to submit an application for development. Although most of these planned developments are only disclosed and have not yet been the subject of formal approval applications, they would result in additional environmental effects in the Oil Sands Region should they proceed. The developments included in the 2013 PDC compared to those included in the EIA PDC are presented in Table 3.2-1. Projects included in the 2013 PDC that were updated since the EIA PDC are also indicated. Additional details on the 2013 PDC project inclusion list are provided in Appendix 3.1.

Table 3.2-1 Oil Sands Activities Included in the EIA Planned Development Case and the 2013 Planned Development Case

Oil Sands Development	EIA PDC	2013 PDC	Location	
			Distance[(a)] [km]	Direction[(a)]
Shell Canada Energy				
Pierre River Mine	Yes	Updated	–	–
Jackpine Mine - Phase 1 & Jackpine Mine Expansion	Yes	Yes	34	SSE
Orion Enhanced Oil Recovery (EOR) Project	Yes	Yes	341	SSE
Muskeg River Mine Expansion	Yes	Updated	30	S
Alberta Oilsands Inc.				
Clearwater West Pilot Project	No	Yes	101	SSE
Athabasca Oil Corporation				
Birch Project	No	Yes	86	WNW
Dover West Clastics Phase 1	No	Yes	100	SW
Dover West Leduc Carbonate Pilot	No	Yes	88	WSW
Hangingstone Experimental In-Situ Project	No	Yes	123	S
Hangingstone Project Phase 1	No	Yes	117	S
MacKay River Commercial Project	No	Yes	88	SSW
Baytex Energy Corporation				
Cold Lake	No	Yes	380	SSE
BlackPearl Resources Inc.				
Blackrod SAGD Pilot and Commercial Project	No	Yes	223	SSW
Canadian Natural Resources Limited				
Birch Mountain East Project (formerly Horizon In-Situ Project)	Yes	Updated	26	SSW
Burnt Lake Pilot Project	Yes	Yes	313	SSE
Gregoire Phase 1 In Situ Oil Sands Project	No	Yes	124	SSE
Grouse In-Situ Oil Sands Project	No	Yes	230	S
Horizon Oil Sands Project	Yes	Updated	23	SSW
Kirby In-Situ Oil Sands Project (North and South)	Yes	Updated	231	S
Primrose East In-Situ Project	Yes	Updated	314	SSE
Primrose North In-Situ Project	Yes	Updated	301	SSE
Primrose South In-Situ Project	Yes	Updated	313	SSE
Wolf Lake In-Situ Project	Yes	Updated	320	S
Cavalier Energy				
Hoole Project	No	Yes	211	SW

Table 3.2-1 Oil Sands Activities Included in the EIA Planned Development Case and the 2013 Planned Development Case (continued)

Oil Sands Development	EIA PDC	2013 PDC	Location	
			Distance[(a)] [km]	Direction[(a)]
Cenovus Energy				
Telephone Lake SAGD Project (formerly Borealis In-Situ Project)	Yes	Updated	80	ESE
Grand Rapids SAGD Pilot Project	No	Yes	199	SW
Pelican Lake SAGD Project	No	Yes	191	SW
Cenovus FCCL Ltd.				
Christina Lake Thermal Project	Yes	Updated	221	S
Foster Creek Thermal Project	Yes	Updated	281	SSE
Narrows Lake Project	No	Yes	213	S
Connacher Oil and Gas Limited				
Algar Oil Sands Project	No	Yes	158	S
Great Divide Oil Sands Project	Yes	Updated	158	S
Great Divide Oil Sands Expansion Project	No	Yes	158	S
ConocoPhillips Canada				
Surmont Pilot and Commercial SAGD Project	Yes	Updated	151	SSE
Devon NEC Corporation				
Jackfish SAGD Project	Yes	Updated	227	S
Jackfish SAGD Project 2	Yes	Updated	226	S
Jackfish SAGD Project 3	No	Yes	227	S
Devon Energy and BP Canada				
Pike Project	No	Yes	236	S
Walleye Project	No	Yes	335	S
Brion Energy Corp.				
Dover Pilot Project	No	Yes	83	WSW
Dover Commercial Project	No	Yes	71	WSW
E-T Energy				
Poplar Creek In-Situ Pilot	No	Yes	80	S
Grizzly Oil Sands				
Algar Lake SAGD Project	No	Yes	131	S
Harvest Operations Corp.				
BlackGold Oil Sands Project and Expansion	No	Yes	220	S
Husky Energy Inc.				
Caribou Lake Thermal Demonstration Project	No	Yes	293	SSE
McMullen Thermal Pilot Project	No	Yes	243	SW
Sunrise Thermal Project	Yes	Yes	44	SE
Tucker Thermal Project	Yes	Yes	336	S
Imperial Oil Resources Ltd.				
Cold Lake In-Situ Project	Yes	Yes	334	SSE
Imperial Oil Resources Ventures Ltd.				
Kearl Oil Sands Project	Yes	Yes	33	ESE
Ivanhoe Energy Inc.				
Tamarack Integrated Oil Sands Project	No	Yes	80	SSE
Japan Canada Oil Sands Ltd.				
Hangingstone Pilot In-Situ Project	Yes	Updated	135	S

Table 3.2-1 Oil Sands Activities Included in the EIA Planned Development Case and the 2013 Planned Development Case (continued)

Oil Sands Development	EIA PDC	2013 PDC	Location	
			Distance[(a)] [km]	Direction[(a)]
Hangingstone SAGD Project	Yes	Updated	139	S
Marathon Oil Corporation Canada				
Birchwood Project	No	Yes	83	SSW
MEG Energy Corp.				
Christina Lake Regional Project - Pilot, Phases 2 and 2B	Yes	Updated	214	SSE
Christina Lake Regional Project - Phase 3	No	Yes	222	SSE
Surmont Project	No	Yes	206	SSE
Koch Exploration Canada				
Muskwa Oil Sands Project	No	Yes	182	SW
Laricina Energy Ltd.				
Germain Phase 1 and Expansion	No	Yes	173	SW
Saleski Pilot and Phase 1	No	Yes	150	SSW
OPTI Canada Inc. / Nexen Canada Ltd.				
Long Lake Pilot Project	Yes	Yes	131	SSE
Long Lake Commercial Project	Yes	Yes	130	SSE
Long Lake Project Phases 1 and 2	No	Yes	140	SSE
Oak Point Energy Ltd.				
Lewis Pilot	No	Yes	62	SSE
OSUM Oil Sands Corp.				
Taiga Project	No	Yes	329	SSE
Petrobank Energy and Resources Ltd.				
May River Phase 1 Project and Expansion	No	Yes	209	S
Whitesands Pilot Project	Yes	No	–	–
Teck Resources Limited				
Frontier Oil Sands Mine Project	No	Yes	17	N
Southern Pacific Resource Corporation				
MacKay River Project and Expansion	No	Yes	83	SSW
Statoil Canada Ltd.				
Kai Kos Dehseh SAGD Project	Yes	Updated	191	S
Suncor Energy Inc.				
Chard Project	No	Yes	182	S
Dover SAGD Pilot and VAPEX Pilot	Yes	Yes	57	SSW
Firebag Enhanced Thermal Solvent (ETS) Pilot Project	Yes	Yes	56	SE
Firebag SAGD Project	Yes	Updated	54	SE
Lease 86/17, Steepbank & Millennium Mines	Yes	Updated	60	S
Lewis SAGD Project	Yes	Yes	77	SSE
MacKay River In-Situ and Expansion	Yes	Updated	58	SSW
Meadow Creek In-Situ	Yes	Updated	135	S
Millennium Coker Unit (MCU)	Yes	Updated	58	S
Millennium Vacuum Unit (MVU)	Yes	Updated	58	S
North Steepbank Extension Mine and Millennium Dump 9	Yes	Updated	58	S
South Tailings Pond	Yes	Updated	74	S
Upgrader Complex	Yes	Updated	58	S

Table 3.2-1 Oil Sands Activities Included in the EIA Planned Development Case and the 2013 Planned Development Case (continued)

Oil Sands Development	EIA PDC	2013 PDC	Location	
			Distance[a] [km]	Direction[a]
Voyageur South Project	Yes	Yes	66	S
Voyageur Upgrader	Yes	Updated	62	S
Fort Hills Oil Sands Project	Yes	Updated	17	SSW
Sunshine Oil Sands Ltd.				
Harper Pilot	No	Yes	140	W
Legend Lake SAGD Project Phase 1	No	Yes	81	WSW
Thickwood SAGD Project Phase 1	No	Yes	107	SW
West Ells SAGD Project	No	Yes	79	WSW
Surmont Energy Ltd.				
Wildwood Project	No	Yes	157	S
Syncrude Canada Ltd.				
Aurora North Mine	Yes	Yes	26	S
Aurora South Mine	Yes	Updated	41	SSE
Mildred Lake Upgrader	Yes	Yes	54	S
Total E&P Canada Ltd.				
Joslyn Creek SAGD Project - Phase 1 and Commercial	Yes	No	–	–
Joslyn North Mine Project	Yes	Updated	33	SSW
Joslyn Mine Expansion	No	Updated	38	SSW
Northern Lights Project	Yes	No	–	–
Value Creation Inc.				
Terre de Grace Pilot and SAGD Project	No	Yes	32	WSW
TriStar Pilot Project	No	Yes	108	S
Advanced Tristar Commercial Project	No	Yes	108	S
Other Industries	Yes	Updated	–	–
Communities	Yes	Updated	–	–

(a) Distance and direction are relative to the Pierre River Mine plant site.

– = Not applicable.

The emissions calculated for the 2013 PDC are, in part, speculative given that limited emission information is available for future planned projects. Because these developments are in various stages of planning, the following should be noted:

- There is uncertainty about whether these planned developments will proceed.
- All of the planned developments must submit applications, undergo assessment, and receive approval before proceeding.

The oil sands industrial and non-industrial source emissions used in the 2013 PDC are summarized in Table 3.2-2. Details on the emission source parameters and emission rates for 2013 PDC sources are presented in Appendix 3.2 of this submission.

Table 3.2-2 Summary of 2013 Planned Development Case Emissions

Source	Emissions Rates[a]						
	Stream-day SO_2 [t/sd]	Calendar-day SO_2 [t/cd]	NO_X [t/d]	CO [t/d]	$PM_{2.5}$ [t/d]	VOC[b] [t/d]	TRS[b] [t/d]
Shell Pierre River Mine	0.06	0.06	13.46	13.58	0.69	17.46	0.14
Shell Jackpine Mine - Phase 1 and Expansion	0.07	0.07	21.91	18.69	1.03	26.62	0.22
Shell Muskeg River Mine Expansion	0.61	0.61	30.73	27.03	1.61	26.80	0.13
Shell in-situ projects	0.90	0.90	1.26	0.41	0.10	0.09	0.00
Suncor Energy Inc.	63.52	91.65	167.64	90.35	12.04	345.39	3.52
Syncrude Canada Ltd.	67.17	100.17	101.21	98.73	8.72	183.94	3.12
Canadian Natural Resources Limited	25.27	30.35	86.08	62.80	4.93	161.29	2.43
SilverBirch Energy	1.46	1.46	19.32	45.78	0.84	83.05	0.48
Total E&P Joslyn Ltd.	0.13	0.13	19.71	18.99	0.47	87.70	0.00
other industries[c]	140.52	145.58	304.40	595.14	20.18	357.19	1.23
gas plants	2.18	2.18	18.37	5.31	0.27	0.51	0.00
communities	0.65	0.65	4.18	–[d]	–[d]	14.39	0.00
Total	**302.54**	**373.82**	**788.27**	**976.81**	**50.87**	**1,304.43**	**11.27**

(a) Emissions are expressed as tonnes per stream-day (t/sd), tonnes per calendar-day (t/cd) or tonnes per day (t/d).

(b) Emissions presented for Suncor, Canadian Natural Horizon, Imperial Oil Kearl, Syncrude Aurora South, and Total Joslyn tailings represent the maximum daily emission rates and vary as discussed in Section 3.5.

(c) The "other industries" category includes the emissions from other oil sands developments and industrial sources.

(d) Background data were added to model predictions to represent CO and $PM_{2.5}$ emissions from the communities. Therefore, community emissions of CO and $PM_{2.5}$ were not modelled. A description of the background data used is provided in the EIA, Volume 3, Appendix 3-8, Section 2.3.

Note: Some numbers are rounded for presentation purposes; therefore, it may appear that the totals do not equal the sum of the individual values.

3.2.1.2 Assessment Results

The approach to conducting cumulative effects assessments defined by the *Canadian Environmental Assessment Act, 2012* (Government of Canada 2012) indicates that environmental effects should be considered when they accumulate or interact with those of other developments. Although modelling was conducted to predict concentrations of SO_2, NO_2, carbon monoxide (CO), $PM_{2.5}$, and select Total Reduced Sulphur (TRS), Volatile Organic Compounds (VOCs), Polycyclic Aromatic Hydrocarbons (PAHs) and metals in the region and at selected regional communities, only those compounds that had a low, moderate or high environmental consequence are included in this section. This is consistent with the assessment methods used in the EIA (EIA, Volume 3, Section 2.1.2). The predictions for the 2013 PDC are presented in Appendix 3.2.

Ambient Air Quality

The 2013 PRM Application Case resulted in low, moderate or high environmental consequences for the following compounds: NO_2, $PM_{2.5}$, hydrogen sulphide (H_2S) and select VOCs (i.e., benzene and acrolein). The 2013 PDC predictions for these parameters are presented in this section along with a comparison with the 2013 Base Case and 2013 PRM Application Case predictions. The modelling results were compared to the AAAQOs (ESRD 2013) or other criteria, where applicable. Some parameters (e.g., VOCs) have possible effects on the health of the people and wildlife in the region. The dispersion modelling results for these compounds have been assessed in the Environmental Health section (Sections 3.2.2, 3.2.3 and 3.2.4).

The 2013 Base Case, 2013 PRM Application Case and 2013 PDC emissions are summarized in Table 3.2-3 for the air quality parameters included in the 2013 PDC impact assessment. When the 2013 Base Case and 2013 PDC emissions are compared, there is a projected increase of 34% for NO_X, 33% for $PM_{2.5}$, 83% for VOCs and 44% for TRS due to planned projects in the region.

Table 3.2-3 Summary of 2013 Base Case, 2013 PRM Application Case and 2013 Planned Development Case Emissions

Descriptions	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case
NO_X emissions [t/d]	588.67	602.13	788.27
$PM_{2.5}$ emissions [t/d]	38.28	38.97	50.87
VOC emissions [t/d][a]	712.20	729.65	1,304.43
TRS emissions [t/d][a]	7.82	7.97	11.27

[a] The VOC and TRS emissions for Suncor, Canadian Natural Horizon, Imperial Oil Kearl, Syncrude Aurora South, Suncor Fort Hills and Total Joslyn tailings ponds represent the maximum daily emission rates and vary as discussed in Appendix 3.2. The emissions presented for Teck Frontier tailings represent the maximum annual emission rates and also vary.

The 2013 Base Case, 2013 PRM Application Case and 2013 PDC NO_2 predictions (excluding developed areas) within the LSA and RSA are compared in Table 3.2-4. The comparison shows that the 1-hour NO_2 predictions are below the AAAQO in the LSA and RSA excluding developed areas. There are exceedances of the annual NO_2 AAAQO in the LSA and RSA; however, they are due to the cumulative effects of existing, approved and planned projects. The change in the annual average NO_2 prediction in the RSA due to PRM is less than 1 µg/m³. The NO_2 predictions are considered conservative because, for modelling purposes, it was assumed that all developments were operating at their maximum capacity at the same time; however, the operational life of each development will actually be staggered over time. The model evaluation (EIA Volume 3, Appendix 3-8) also indicates that NO_2 predictions near open pit mine sites are over-predicted.

Table 3.2-4 Comparison of Regional Nitrogen Dioxide Predictions

Parameter	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case
Local Study Area			
maximum 1-hour NO_2 (excluding developed areas)[a][b] [µg/m³]	150.9	150.9	139.4
annual average NO_2 (excluding developed areas)[a] [µg/m³]	26.2	43.3	**45.5**
occurrences above annual AAAQO[c][d]	0	0	1
area above annual AAAQO[c] (excluding developed areas) [ha]	0	0	<1
Regional Study Area			
maximum 1-hour NO_2 (excluding developed areas)[a][b] [µg/m³]	214.2	214.2	212.0
annual average NO_2 (excluding developed areas)[a] [µg/m³]	**51.6**	**52.4**	**57.6**
occurrences above annual AAAQO[c][d]	1	1	1
area above annual AAAQO[c] (excluding developed areas) [ha]	1,414	1,538	3,499

[a] Maximum predictions exclude the eight highest 1-hour predictions as per the Alberta model guidelines (AENV 2009). The eight highest 1-hour predictions were included in the annual values.

[b] Developed areas include the PRM development area and existing, approved and planned open pit mines and upgrading complexes within the RSA and LSA.

[c] The 1-hour and annual AAAQO are 300 and 45 µg/m³, respectively. There is no 24-hour objective.

[d] The number of occurrences is based on the concentrations outside of developed areas.

Note: **Bold** number indicates exceedance of the applicable AAAQO.

Comparisons of the 2013 Base Case, 2013 PRM Application Case and 2013 PDC predictions in the regional communities and trapper cabins for NO_2, $PM_{2.5}$ and H_2S are provided in Tables 3.2-5 to 3.2-7. The 2013 PDC NO_2 and H_2S predictions in the regional communities are below the respective AAAQOs. The 24-hour $PM_{2.5}$ predictions are above the AAAQO of 30 µg/m³ at Fort McKay, Fort McMurray, Cabin J, Cabin K and the Oil Sands Lodge. These exceedances are due to existing, approved and planned projects in the region and there is minimal increase in predicted concentrations due to PRM. For Fort McMurray, the background $PM_{2.5}$ concentration, which accounts for the community emissions, was estimated to be above 30 µg/m³.

Table 3.2-5 Comparison of Nitrogen Dioxide Predictions in the Regional Communities

Community	Maximum 1-Hour NO_2[(a)(b)] [µg/m³]			Peak Annual Average NO_2[(a)(b)] [µg/m³]		
	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case
Anzac	77.0	77.9	80.9	7.8	7.9	9.5
Conklin	86.1	86.1	89.6	5.2	5.2	6.7
Fort Chipewyan	67.3	69.0	73.9	3.1	3.2	3.5
Fort McKay	117.4	118.4	115.1	30.0	30.2	32.4
Fort McMurray	102.6	102.7	105.5	21.5	21.6	22.9
Janvier/Chard (IR 194)	64.5	65.1	73.9	5.4	5.4	6.6
Clearwater (IR 175)	55.9	56.0	57.0	5.4	5.5	6.7
Namur River (IR 174A)	48.1	48.3	52.0	2.6	2.7	3.9
Poplar Point (IR 201G)	56.3	56.5	59.4	6.8	7.1	8.3
Cabin A	81.2	84.0	81.6	13.8	15.0	17.4
Cabin B	73.2	73.7	75.0	11.1	11.3	12.6
Cabin C	81.1	83.9	81.1	13.9	14.7	16.4
Cabin D	89.6	89.7	87.8	15.2	16.1	18.0
Cabin E	83.8	83.8	84.8	15.2	15.6	17.5
Cabin F	84.6	84.7	86.1	16.0	16.4	18.3
Cabin G	101.9	101.9	104.5	15.0	15.2	16.0
Cabin H	105.8	105.8	117.1	18.6	18.7	21.2
Cabin I	124.0	124.0	111.5	25.2	29.6	30.0
Cabin J	165.6	165.6	151.3	34.4	35.7	35.1
Cabin K	152.1	152.2	148.8	32.2	33.0	33.5
Cabin L	110.0	110.1	104.2	20.3	24.0	25.9
Descharme Lake, SK	24.0	24.0	27.4	1.7	1.8	2.2
La Loche, SK	52.2	52.4	58.0	3.7	3.8	4.4
Oil Sands Lodge	152.2	152.3	152.3	34.9	35.1	37.0
PTI Camp	97.9	98.4	97.0	25.8	26.0	28.3

(a) Maximum 1-hour predictions exclude the eight highest 1-hour concentrations, as per the Alberta model guidelines (AENV 2009). The eight highest 1-hour predictions were included in the annual values.

(b) The 1-hour and annual AAAQOs used in the EIA are 300 and 45 µg/m³, respectively. There is no 24-hour objective.

Table 3.2-6 Comparison of $PM_{2.5}$ Predictions in the Regional Communities

Community	Maximum 24-Hour $PM_{2.5}$[(a)] [µg/m³]			98th Percentile 24-Hour $PM_{2.5}$[(b)] [µg/m³]		
	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case
Anzac	17.5	17.7	20.0	12.4	12.5	13.9
Conklin	21.6	21.9	25.7	11.4	11.5	12.9
Fort Chipewyan	13.2	13.3	14.5	9.2	9.2	9.9
Fort McKay	**32.8**	**32.9**	**33.6**	27.7	27.8	28.3
Fort McMurray	**73.0**	**73.1**	**75.9**	18.6	18.6	20.3
Janvier/Chard (IR 194)	24.3	24.6	28.3	11.1	11.1	12.6
Clearwater (IR 175)	10.0	10.3	11.8	5.3	5.3	6.3
Namur River (IR 174A)	11.7	11.8	14.9	4.9	5.1	5.8
Poplar Point (IR 201G)	7.3	7.5	9.3	6.0	6.0	7.1
Cabin A	14.4	15.5	16.0	10.2	10.6	11.3
Cabin B	10.5	10.8	11.4	7.0	7.2	7.8
Cabin C	13.3	14.0	14.6	10.0	10.3	11.2
Cabin D	14.7	16.0	16.0	11.3	11.5	11.9
Cabin E	15.5	16.3	16.7	9.8	10.0	11.3
Cabin F	17.8	18.5	17.9	10.3	10.6	11.8
Cabin G	17.7	17.9	18.7	10.4	10.5	11.4
Cabin H	12.9	12.9	19.6	12.0	12.1	15.5
Cabin I	20.3	20.4	22.2	16.3	16.5	16.8
Cabin J	**37.7**	**38.2**	**39.7**	25.9	26.0	27.0
Cabin K	**35.8**	**36.0**	**38.8**	21.6	21.9	22.3
Cabin L	23.9	24.3	23.0	16.6	18.0	17.4
Descharme Lake, SK	3.7	3.8	4.7	2.6	2.6	3.1
La Loche, SK	13.4	13.4	14.5	10.0	10.0	10.8
Oil Sands Lodge	**33.0**	**33.1**	**32.5**	27.7	27.9	27.9
PTI Camp	22.1	22.2	24.1	15.8	15.9	15.6

(a) The maximum 24-hour predictions exclude the first highest 24-hour concentration, as per the Alberta model guidelines (AENV 2009). The 24-hour AAAQO for $PM_{2.5}$ is 30 µg/m³.

(b) The Canada-Wide Standard for particulate matter ($PM_{2.5}$) is 30 µg/m³ and is based on the 98th percentile 24-hour reading annually, averaged over three years (CCME 2000).

Note: **Bold** number indicates exceedance of the applicable AAAQO.

Table 3.2-7 Comparison of Hydrogen Sulphide Predictions in the Regional Communities

Community	Peak 1-Hour H_2S[(a)(b)] [µg/m³]			Peak 24-Hour H_2S[(a)(b)] [µg/m³]		
	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case
Anzac	1.2	1.2	1.2	0.4	0.4	0.4
Conklin	0.1	0.1	0.1	0.0	0.0	0.0
Fort Chipewyan	0.2	0.2	0.2	0.1	0.1	0.1
Fort McKay	1.3	1.3	1.4	0.5	0.5	0.5
Fort McMurray	0.5	0.5	0.6	0.2	0.2	0.2
Janvier/Chard (IR 194)	0.2	0.2	0.2	0.1	0.1	0.1
Clearwater (IR 175)	0.3	0.3	0.4	0.1	0.1	0.1
Namur River (IR 174A)	0.5	0.5	0.5	0.1	0.1	0.2
Poplar Point (IR 201G)	0.3	0.4	0.9	0.2	0.2	0.3
Cabin A	0.8	0.9	6.5	0.4	0.5	1.2
Cabin B	0.4	0.4	0.8	0.2	0.2	0.3
Cabin C	0.7	0.7	3.5	0.4	0.4	0.8
Cabin D	0.8	0.8	5.3	0.4	0.4	0.8
Cabin E	0.6	0.6	6.1	0.3	0.3	0.6
Cabin F	0.6	0.6	8.3	0.3	0.4	0.6
Cabin G	0.8	0.8	0.9	0.3	0.3	0.3
Cabin H	1.3	1.3	2.5	0.3	0.3	0.4
Cabin I	2.0	2.0	2.0	0.5	0.6	0.6
Cabin J	5.6	5.6	6.0	0.9	0.9	2.2
Cabin K	6.9	6.9	7.1	0.9	0.9	0.9
Cabin L	2.2	3.1	8.7	0.5	1.5	1.6
Descharme Lake, SK	0.1	0.1	0.1	0.0	0.0	0.0
La Loche, SK	0.1	0.1	0.2	0.0	0.0	0.1
Oil Sands Lodge	1.3	1.3	1.3	0.6	0.6	0.6
PTI Camp	3.3	3.3	3.4	0.5	0.5	0.6

(a) The peak concentrations include the eight highest 1-hour predictions from the model.

(b) The 1-hour and 24-hour AAAQOs for hydrogen sulphide (H_2S) are 14 and 4 µg/m³, respectively (ESRD 2013).

Comparisons of the 2013 Base Case, 2013 PRM Application Case and 2013 PDC benzene predictions in the regional communities and trapper cabins are presented in Table 3.2-8. The 2013 PDC predicted benzene concentrations are within applicable AAAQOs at all locations except Fort McMurray. The 2013 PDC 1-hour benzene concentration is above the AAAQO of 30 µg/m³ in Fort McMurray and is predicted to exceed 2% of the time (207 hours per year). The annual benzene prediction is also slightly above the AAAQO of 3 µg/m³. The benzene exceedances are primarily due to the estimated increase in benzene emissions from future population growth in Fort McMurray. The effects of benzene on human and wildlife health are discussed in the HHRA (Appendix 3.3).

Table 3.2-8 Comparison of Benzene Predictions in the Regional Communities

Community	Maximum 1-Hour Benzene[a] [µg/m³]			Annual Average Benzene[a] [µg/m³]		
	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case
Anzac	1.4	1.4	1.4	0.1	0.1	0.1
Conklin	0.4	0.4	0.4	0.0	0.0	0.1
Fort Chipewyan	2.7	2.7	2.7	0.4	0.4	0.4
Fort McKay	4.4	4.4	4.7	0.7	0.7	0.7
Fort McMurray	25.3	25.3	**64.6**	1.5	1.5	**3.8**
Janvier/Chard (IR 194)	0.3	0.3	0.4	0.0	0.0	0.0
Clearwater (IR 175)	0.8	0.8	1.6	0.1	0.1	0.1
Namur River (IR 174A)	0.5	0.5	0.5	0.0	0.0	0.0
Poplar Point (IR 201G)	0.6	0.6	0.9	0.0	0.0	0.1
Cabin A	1.4	2.4	2.8	0.1	0.1	0.2
Cabin B	1.0	1.0	1.2	0.1	0.1	0.1
Cabin C	1.6	1.6	2.0	0.1	0.1	0.1
Cabin D	1.8	1.9	2.3	0.1	0.1	0.2
Cabin E	1.4	1.4	1.6	0.1	0.1	0.1
Cabin F	1.3	1.4	1.6	0.1	0.1	0.1
Cabin G	2.1	2.1	2.5	0.1	0.1	0.1
Cabin H	1.9	1.9	11.7	0.1	0.1	0.3
Cabin I	2.7	2.7	2.8	0.2	0.2	0.2
Cabin J	21.0	21.1	19.5	1.9	1.9	1.2
Cabin K	5.4	5.4	12.1	0.3	0.3	0.4
Cabin L	2.6	2.7	3.0	0.2	0.2	0.2
Descharme Lake, SK	0.1	0.1	0.2	0.0	0.0	0.0
La Loche, SK	1.4	1.4	1.4	0.3	0.3	0.3
Oil Sands Lodge	3.8	3.8	4.0	0.4	0.4	0.4
PTI Camp	7.0	7.0	7.3	0.6	0.6	0.6

(a) The maximum 1-hour predictions exclude the first eight highest 1-hour predictions. The eight highest hours are included in the annual predictions.

(b) The 1-hour and annual AAAQOs for benzene are 30 and 3 µg/m³, respectively (ESRD 2013).

Note: **Bold** number indicates exceedance of the applicable AAAQO.

Comparisons of the 2013 Base Case, 2013 PRM Application Case and 2013 PDC acrolein predictions in the regional communities and trapper cabins are presented in Table 3.2-9. The 2013 PDC predicted acrolein concentrations are within the TCEQ ESLs at all locations except Fort McMurray and the Oil Sands Lodge. The 2013 PDC annual acrolein concentrations are slightly above the long-term TCEQ ESL of 0.15 µg/m³ at both locations. The acrolein exceedances are primarily due to the estimated increase in emissions from future population growth in Fort McMurray. The effects of acrolein on human and wildlife health are discussed in the HHRA (Appendix 3.3).

Table 3.2-9 Comparison of Acrolein Predictions in the Regional Communities

Community	Maximum 1-Hour Acrolein[(a)] [μg/m³]			Annual Average Acrolein[(a)] [μg/m³]		
	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case
Anzac	0.16	0.16	0.17	0.01	0.01	0.01
Conklin	0.19	0.19	0.18	0.01	0.01	0.01
Fort Chipewyan	0.14	0.14	0.14	0.02	0.02	0.02
Fort McKay	1.32	1.34	1.33	0.13	0.13	0.14
Fort McMurray	0.86	0.86	2.13	0.07	0.07	**0.16**
Janvier/Chard (IR 194)	0.07	0.07	0.07	0.01	0.01	0.01
Clearwater (IR 175)	0.25	0.25	0.20	0.01	0.01	0.01
Namur River (IR 174A)	0.17	0.19	0.20	0.01	0.01	0.01
Poplar Point (IR 201G)	0.32	0.32	0.31	0.02	0.02	0.02
Cabin A	0.63	0.68	0.64	0.04	0.04	0.04
Cabin B	0.61	0.62	0.61	0.03	0.03	0.03
Cabin C	0.78	0.79	0.76	0.04	0.04	0.04
Cabin D	0.83	0.85	0.81	0.04	0.05	0.05
Cabin E	0.87	0.87	0.90	0.04	0.05	0.05
Cabin F	0.85	0.85	0.90	0.05	0.05	0.05
Cabin G	1.17	1.18	1.20	0.06	0.06	0.06
Cabin H	0.80	0.80	0.91	0.05	0.06	0.06
Cabin I	1.14	1.15	1.06	0.08	0.09	0.09
Cabin J	2.36	2.42	2.13	0.14	0.15	0.14
Cabin K	1.99	1.99	1.95	0.12	0.13	0.13
Cabin L	1.25	1.25	1.18	0.06	0.08	0.08
Descharme Lake, SK	0.04	0.04	0.04	0.00	0.00	0.00
La Loche, SK	0.17	0.17	0.17	0.03	0.03	0.03
Oil Sands Lodge	1.83	1.83	1.83	**0.16**	**0.16**	**0.16**
PTI Camp	0.95	0.97	0.98	0.07	0.07	0.07

(a) The maximum 1-hour predictions exclude the first eight highest 1-hour predictions. The eight highest hours are included in the annual predictions.

(b) The short-term (1-hour) and long-term (annual) TCEQ ESLs are 3.2 and 0.15 μg/m³, respectively (TCEQ 2013).

Note: **Bold** number indicates exceedance of the TCEQ ESL.

Residual Impact Classification for Ambient Air Quality

The 2013 PDC emissions were predicted to result in changes to regional air quality. The impacts associated with these changes have been evaluated using the assessment methods described in the EIA, Volume 3, Section 3.2. In general, the impacts have been described according to six criteria: direction, magnitude, geographic extent, duration, reversibility and frequency. The assessment method outlined in the EIA Volume 3, Section 3.2.3.9 was used to classify the magnitude of air quality impacts. The assessment method compares the predicted ambient air quality to applicable air quality criteria, when criteria exist. The results of the impact classification for changes to the ambient air quality are presented in Table 3.2-10. The rating assessment methods are described in the EIA, Volume 3, Section 3.2.3.7.

Not all of the parameters have air quality guidelines and standards against which the predicted concentrations could be evaluated. In such cases, the results of the modelling analyses were evaluated in the HHRA (Appendix 3.3).

Table 3.2-10 Residual Impact Classification for 2013 Planned Development Case Changes to the Ambient Air Quality

Parameter	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
local annual NO_2	negative	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)
regional annual NO_2	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
community annual NO_2	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
community 24-hour $PM_{2.5}$	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	high (+16)
community 1-hour H_2S	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)
community 24-hour H_2S	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)
community 1-hour acrolein	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)
community annual acrolein	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)
community 1-hour benzene	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	high (+16)
community annual benzene	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Of the 10 ambient air quality parameters assessed for the 2013 PDC, four are rated as having a low environmental consequence, two are rated as moderate, and four are rated as having a high environmental consequence.

The community 1-hour and annual benzene and annual acrolein are classified as having a high environmental consequence. This classification is primarily due to the estimated increase in emissions from future population growth in Fort McMurray. The PRM did not cause a change in the benzene and acrolein predictions in Fort McMurray. Further discussion of the effects of these predictions is provided in the HHRA (Appendix 3.3).

The community 24-hour $PM_{2.5}$ was also classified as having a high environmental consequence due to the predicted exceedances of the AAAQO at Fort McKay, Fort McMurray, Cabin J, Cabin K and the Oil Sands Lodge. The exceedances are due to other regional projects and the PRM causes a minimal increase in the predicted concentrations at some communities.

The regional and local annual NO_2 predictions were classified as having a moderate environmental consequence because the predictions outside developed areas were above the AAAQO but below the National Ambient Air Quality Objective (Health Canada 2006). The exceedances are due to other regional projects and the PRM causes a minimal increase in the predicted concentrations.

Acid-Forming Compounds

The approach to conducting cumulative effects assessments defined by the *Canadian Environmental Assessment Act, 2012* (Government of Canada 2012) indicates that environmental effects should be considered when they accumulate or interact with those of other developments. Therefore, only residual impacts that were considered to have low, moderate or high environmental consequences have been assessed for the 2013 PDC. Residual impacts resulting in a negligible rating indicate that the cumulative effects of the 2013 PRM Application Case emissions are not distinguishable from 2013 Base Case conditions. Therefore, there is no appreciable incremental change with the addition of PRM to the 2013 Base Case conditions, and no requirement for a further cumulative assessment.

Since the residual impact for the 2013 PRM Application Case Potential Acid Input (PAI) presented in the Air Emission Effects on Ecological Receptors resulted in a negligible environmental consequence (Appendix 1), the effects of PAI were not assessed in this section.

The PAI predictions for the 2013 PDC are provided in Appendix 3.2. The effect of the PAI predictions for the 2013 PDC on ecological receptors is provided in Section 3.2.4.

3.2.1.3 Summary of Results

The air quality assessment of the 2013 PDC was conducted using the same assessment methods used in the EIA. The CALPUFF modelling system with two years of meteorological data (1995 and 2002) was used to predict concentrations of SO_2, NO_2, CO, $PM_{2.5}$, select TRS, VOCs, PAHs and metals in the region and at selected regional communities. Potential acid input was also assessed. Only those compounds that had a low, moderate or high environmental consequence were included in this section; however, predictions for air quality compounds considered are provided in Appendix 3.2. The air predictions for this assessment provided data for the HHRA (Appendix 3.3).

The compounds assessed for the 2013 PDC were NO_2, $PM_{2.5}$, H_2S, benzene and acrolein. The regional annual NO_2 predictions were above the AAAQO outside developed areas; however, the predicted annual NO_2 concentrations in the communities were below the AAAQO. The H_2S predictions at the regional communities remain below the AAAQOs. The 24-hour $PM_{2.5}$ predictions were above the AAAQO at some communities. The 2013 PDC predicted 1-hour and annual benzene exceedances at Fort McMurray, and annual acrolein exceedances at Fort McMurray and the Oil Sands Lodge. The benzene and acrolein predictions at all other communities were within applicable AAAQOs and other applicable criteria. The exceedances at Fort McMurray are primarily due to the estimated increase in emissions from future population growth in Fort McMurray. Further discussion of the effects of these predictions is provided in the HHRA (Appendix 3.3).

3.2.2 Human Health Risk Assessment

The 2013 HHRA addressed the JRP requests for an assessment of the 2013 PDC. The full 2013 HHRA is presented in Appendix 3.3. The assessment methods used for this 2013 HHRA were consistent with those applied to the EIA HHRA, with a number of minor changes in the exposure and toxicity assessments. Over time, such changes are typical for health risk assessments, although the changes specific to this 2013 HHRA did not have a material impact on the EIA findings.

Overall, the changes between the 2013 Base Case and 2013 PDC risks are generally small. Cumulative environmental risks associated with the additional projects and activities planned for the region are not expected to result in adverse health effects. Based on the re-analysis, the 2013 PDC does not alter the assessment results or the conclusions originally presented in the HHRA of the EIA.

3.2.3 Wildlife Health Risk Assessment

The potential risks to terrestrial wildlife were re-assessed based on the 2013 PDC. The full 2013 Screening Level Wildlife Health Risk Assessment (SLWHRA) is presented as an attachment to the 2013 HHRA (Appendix 3.3, Attachment A).

The results of the 2013 WHRA indicate that the overall risks posed to wildlife health will be low. Therefore, no impacts to wildlife populations are expected based on estimated wildlife exposures to predicted maximum acute and chronic air concentrations or predicted soil and surface water concentrations. These conclusions are consistent with those presented in the EIA WHRA.

3.2.4 Air Emissions Effects on Ecological Receptors Assessment

The approach to conducting cumulative effects assessments defined by the *Canadian Environmental Assessment Act, 2012* indicates that environmental effects should be considered when they accumulate or interact with those of other developments. Therefore, only residual impacts that were considered to have low, moderate or high environmental consequences have been assessed for the 2013 PDC. Residual impacts resulting in a negligible rating indicate that the cumulative effects of the 2013 PRM Application Case emissions are not distinguishable from 2013 Base Case conditions. Therefore, there is no appreciable incremental change with the addition of PRM to the 2013 Base Case conditions, and no requirement for a further cumulative assessment.

Since the 2013 PRM Application Case assessment of air emissions effects on ecological receptors resulted in negligible environmental consequences, a classification of 2013 PDC effects was not completed. The 2013 PDC air quality predictions of regional SO_2, NO_X and PAI are presented in Appendix 3.2.

3.3 Aquatic Resources

This section presents the results of the 2013 PDC assessment for Aquatic Resources to inform the cumulative effects assessment on the aquatic environment. The 2013 PDC includes a review of the cumulative effects that could result from existing and approved developments, PRM, and planned (publicly disclosed) projects including the Teck Resources Limited (Teck) Frontier Oil Sands Mine Project (Frontier Mine).

3.3.1 Hydrogeology Assessment

This assessment focuses on Basal Aquifer depressurization and overburden dewatering from the developments with potential to overlap with the groundwater resources and geographic area affected by PRM. It addresses effects on groundwater levels and flows.

The assessment methods used in the EIA, Volume 4A, Appendix 4-8, were also used in this assessment. Because the timing of planned projects is uncertain, Basal Aquifer depressurization and overburden dewatering at planned developments were simulated assuming that all developments were simultaneously at their maximum extent of build out over the 2008 to 2065 time period that corresponds to the original development timeline of Jackpine Mine, including the JME. This time period has been consistently simulated for all Base Case, Application Case and PDC simulations completed for PRM and Jackpine Mine/JME with the regional model. This assumption means that groundwater levels in the Basal Aquifer and surficial deposits would be drawn down at all locations and at all times over this period. The assessment methods therefore, overestimate the potential effects on groundwater levels and flows and are conservative for assessing the effects of planned developments.

3.3.1.1 Assessment Results

The following figures illustrate the effects on groundwater levels in 2031 due to depressurization and dewatering from developments in the 2013 PDC:

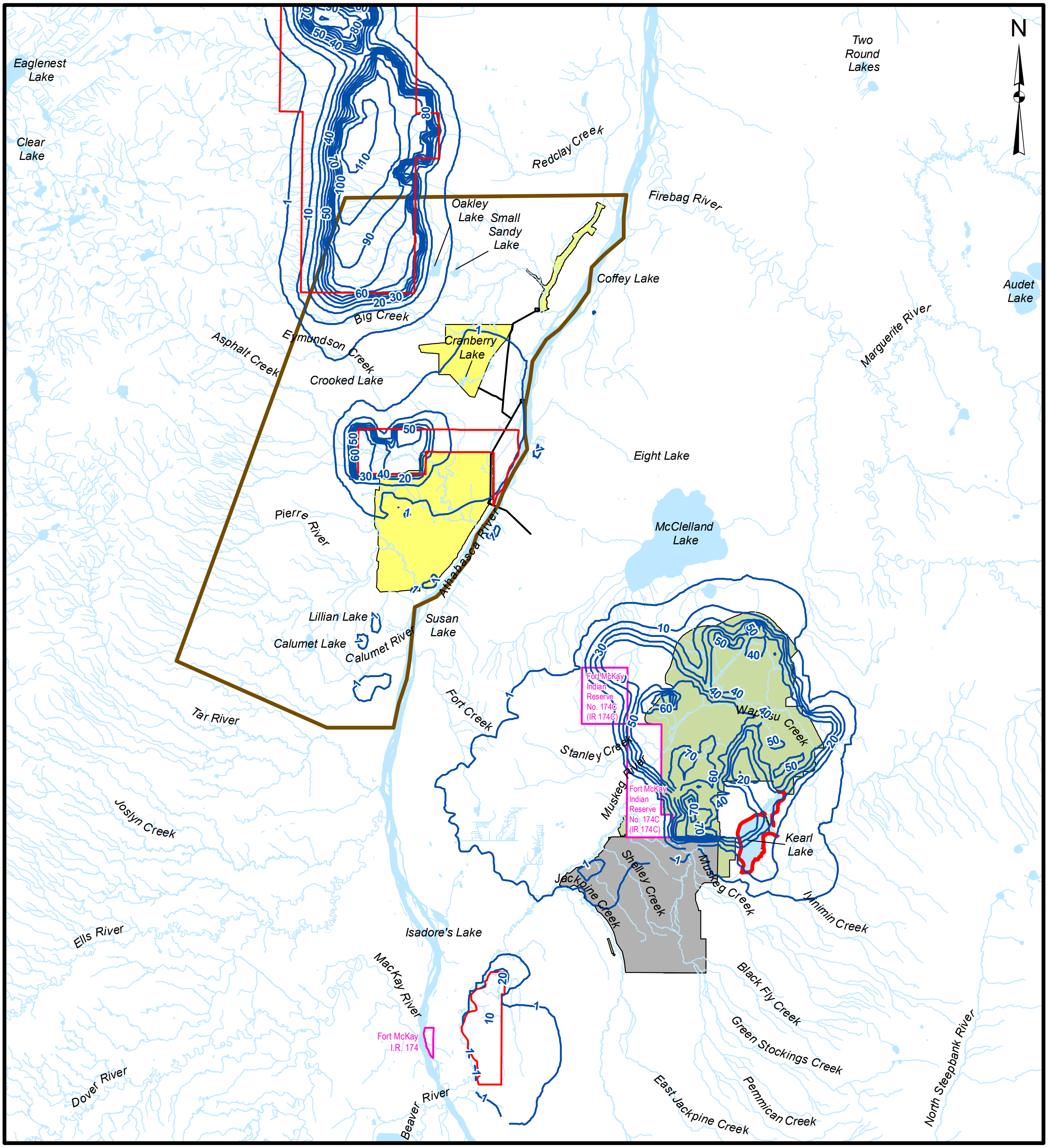
- Figure 3.3-1: incremental drawdown in Basal Aquifer in 2031 due to planned projects; and
- Figure 3.3-2: incremental drawdown in surficial deposits in 2031 due to planned projects.

This date (2031) represents the snapshot with the greatest effect on groundwater flows for the EIA Application Case (EIA, Volume 4A, Section 6.3.6.2). Incremental drawdown is equal to 2013 PDC drawdown minus the 2013 PRM Application Case drawdown, and is, therefore the maximum extent of drawdown due to depressurization and dewatering at planned projects.

The results presented in Figures 3.3-1 and 3.3-2 show the effects of the planned projects and their interaction with PRM. The portion of the Teck Frontier Mine immediately adjacent to PRM is projected to cause effects of surficial dewatering and Basal Aquifer depressurization that overlap with PRM. The northern portion of the Teck Frontier Mine extends into the LSA but associated drawdown effects on groundwater levels are not expected to overlap with PRM.

Simulated major groundwater balance components for the LSA at the 2031 snapshot are listed in Table 3.3-1. The simulated increase in outflows due to mine activities (depressurization and dewatering) of 250 L/s between the EIA PDC and 2013 PDC represents the influence from the Teck Frontier Mine. A reduction in outflows to surface waters within the LSA of 70 L/s is predicted as a result of the Teck Frontier Mine.

An Athabasca River assessment was conducted for the 2031 snapshot, which represents the greatest effect on groundwater discharge to the Athabasca River for the 2013 PRM Application Case. Minimal additional effects from planned developments are expected for the Athabasca River reaches between Nodes A1 and A3 (Table 3.3-2). This result is consistent with the limited additional drawdown predicted in the Basal Aquifer in the immediate vicinity of the river.



LEGEND

- PIERRE RIVER MINE LOCAL STUDY AREA
- PIERRE RIVER MINE
- INDIAN RESERVE
- JACKPINE MINE - PHASE 1
- JACKPINE MINE EXPANSION
- PLANNED OIL SANDS DEVELOPMENTS
- WATERBODIES
- DRAWDOWN CONTOUR (m) CONTOUR INTERVAL = 10 m; 1 m CONTOUR ALSO SHOWN
- KEARL LAKE PERIMETER LEVEE

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS (SEPTEMBER 2004); PLANNED DEVELOPMENTS OBTAINED FROM GOLDER; MINING AREAS OBTAINED FROM SHELL.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

PROJECT

PIERRE RIVER MINE

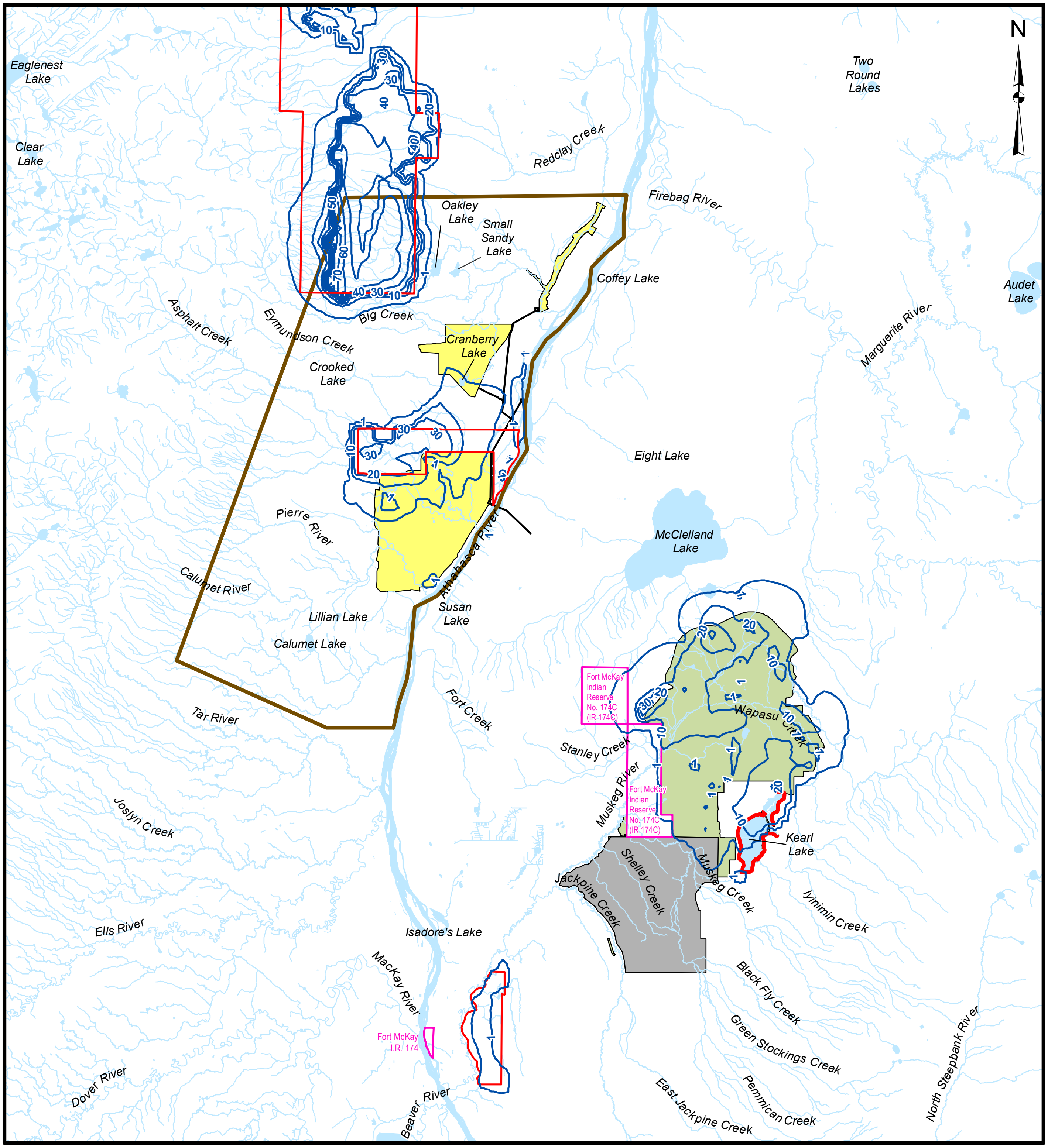
TITLE

INCREMENTAL DRAWDOWN IN BASAL AQUIFER IN 2031 DUE TO PLANNED PROJECTS

Shell Canada Limited

PROJECT No. 13-1346-0001			SCALE AS SHOWN	REV. E
DESIGN	JH	25 Jun. 2007	**FIGURE: 3.3-1**	
GIS	PK	25 Sep. 2013		
CHECK	TB	25 Sep. 2013		
REVIEW	TB	25 Sep. 2013		

FILE: Q:\PROJECTS\Shell\PierreRiverMine\MXDs\307076-04826.300\PRM_DD_basal_RevE.mxd Issued By: Edmonton GIS



SCALE 1:400,000

LEGEND

- PIERRE RIVER MINE LOCAL STUDY AREA
- PIERRE RIVER MINE
- INDIAN RESERVE
- JACKPINE MINE - PHASE 1
- JACKPINE MINE EXPANSION
- PLANNED OIL SANDS DEVELOPMENTS
- WATERBODIES
- DRAWDOWN CONTOUR (m) CONTOUR INTERVAL = 10 m; 1 m CONTOUR ALSO SHOWN
- KEARL LAKE PERIMETER LEVEE

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS (SEPTEMBER 2004); PLANNED DEVELOPMENTS OBTAINED FROM GOLDER; MINING AREAS OBTAINED FROM SHELL.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

PROJECT

PIERRE RIVER MINE

TITLE

INCREMENTAL DRAWDOWN IN SURFICIAL DEPOSITS IN 2031 DUE TO PLANNED PROJECTS

Shell Canada Limited

PROJECT No. 13-1346-0001			SCALE AS SHOWN	REV. E
DESIGN	JH	25 Jun. 2007	**FIGURE: 3.3-2**	
GIS	PK	25 Sep. 2013		
CHECK	TB	25 Sep. 2013		
REVIEW	TB	25 Sep. 2013		

FILE: Q:\PROJECTS\Shell\PierreRiverMine\MXDs\307076-04826.300\PRM_DD_surficial_RevE.mxd Issued By: Edmonton GIS

Table 3.3-1 Pierre River Mine Local Study Area Major Water Balance Components for the 2013 Planned Development Case

Component	EIA PDC Flow [L/s]	2013 PDC Flow [L/s]	Change From EIA PDC	
			[L/s]	[%]
2031				
Net Inflows	640	820	180	28
Outflows due to Mine Activities	220	470	250	113
Outflows to Surface Water Resources	420	350	-70	-17

Notes: Net Inflows include recharge, aquifer storage and lateral inflows/outflows.
Mine activities include overburden dewatering and Basal Aquifer depressurization (open mines).
Outflows to surface water resources (rivers/streams, wetlands and lakes) equal net inflows minus flows allocated by mine activities.
Mass balance calculations are for PRM Local Study Area.
Values rounded to nearest 10 L/s; outflows may not add up to inflows due to rounding.

Table 3.3-2 Comparison of Groundwater Discharge to the Athabasca River – 2013 PRM Application Case and 2013 Planned Development Case

Assessment Nodes	2013 PRM Application Case [L/s]	2013 PDC [L/s]	Change	
			[L/s]	[%]
2031				
A1 to A2	10	10	0	0
A2 to A3	210	200	-10	-5

Note: Values rounded to nearest 10 L/s.
A description of how assessment nodes were chosen and their location is provided in the EIA, Volume 4A, Section 6.2.3.
Aquatic Resources assessment nodes are presented in the EIA, Volume 4A, Section 6.2.3, Figure 6.2-5.

3.3.1.2 Summary of Results

The results of the 2013 PDC show that the effects of dewatering and depressurization from the portion of the proposed Teck Frontier Mine that is immediately adjacent to PRM will overlap with the effects from PRM.

An Athabasca River assessment was conducted for the 2031 snapshot, which represents the greatest effect on groundwater discharge to the Athabasca River for the 2013 PRM Application Case. Minimal additional effects on groundwater discharge rates (5% reduction) are expected for the Athabasca River reaches between Nodes A1 and A3 from planned developments. This result is consistent with the limited additional drawdown predicted in the Basal Aquifer in the immediate vicinity of the Athabasca River.

3.3.2 Hydrology Assessment

The hydrology assessment for PRM was presented in the EIA, Volume 4A, Section 6.4.

The 2013 PDC includes the following in the LSA and RSA:

- An update to the EIA Application Case hydrologic assessment at the outlet of the South Redclay Lake for the PRM. This update is required as a result of an update to the South Redclay Lake that was developed as part of the Draft No Net Loss Plan (NNLP) submitted to the JME JRP on September 19, 2012.
- An update to the EIA PDC hydrologic assessment for the PRM at all the assessment nodes in the LSA and RSA. The EIA PDC assessment update is required as a result of the following changes in the LSA and RSA:
  - planned development of the Teck Frontier Mine in the LSA that will affect the surface water hydrology assessment for the North and South Redclay Lake, Eymundson Creek and Pierre River;
  - an update to the Redclay Lake that was developed as part of the NNLP that includes the north portion of the Redclay Lake proposed as part of future fish habitat compensation requirements; and
  - planned development of the Total E&P Joslyn Ltd. Joslyn South Mine in the RSA of the PRM that will affect the surface water hydrology assessment for the Athabasca River.

The assessment nodes are similar to the nodes presented in the EIA, Volume 4A, Section 6.2.3. The time snapshots are revised as indicated in Appendix 3.1, Section 2.2.

The mine plans for the 2013 PDC along with assessment nodes within the LSA are shown in Figures 3.3-3 to 3.3-7. These plans are used in the Aquatic Resources Assessment.

The assessment methods used to assess the effects of PRM for the 2013 PDC is the same as those outlined in the EIA, Volume 4A, Section 6.4.2.7.

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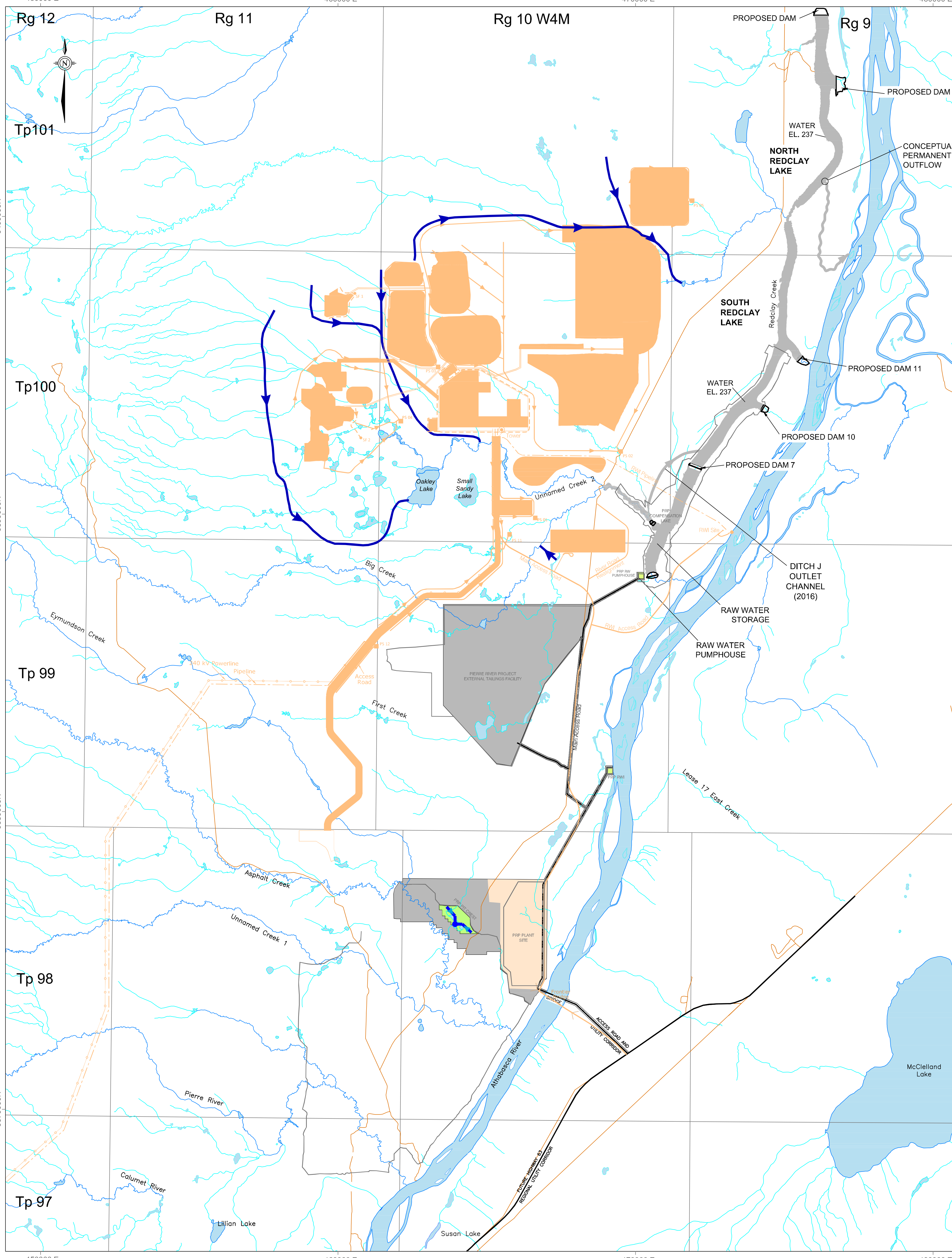

LEGEND

- CLOSE-CIRCUIT MINE DEVELOPMENT AREA
- CLEARED AREA
- OPEN-CIRCUIT DRAINAGE AREA
- LAKE OR WATERBODY
- TECK FRONTIER PROJECT
- DYKE
- DIVERSION DRAINAGE
- CONCEPTUAL INLET / OUTLET CHANNEL
- DRAINAGE - OPEN CIRCUIT
- OPEN-CIRCUIT POLISHING POND
- DRAINAGE
- PUBLIC ROAD

SCALE 2.5 0 2.5 KILOMETRES

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.)
USED UNDER LICENSE. PROJECTION: TRANSVERSE MERCATOR
DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

2013 PLANNED DEVELOPMENT CASE ACTIVITIES IN THE PIERRE RIVER MINE LOCAL STUDY AREA - YEAR 2018

Shell Canada Limited

PROJECT	13.1346.0001.6107		FILE No. 13134600016107A001	
DESIGN	DS	24 May 2013	SCALE AS SHOWN	REV. 0
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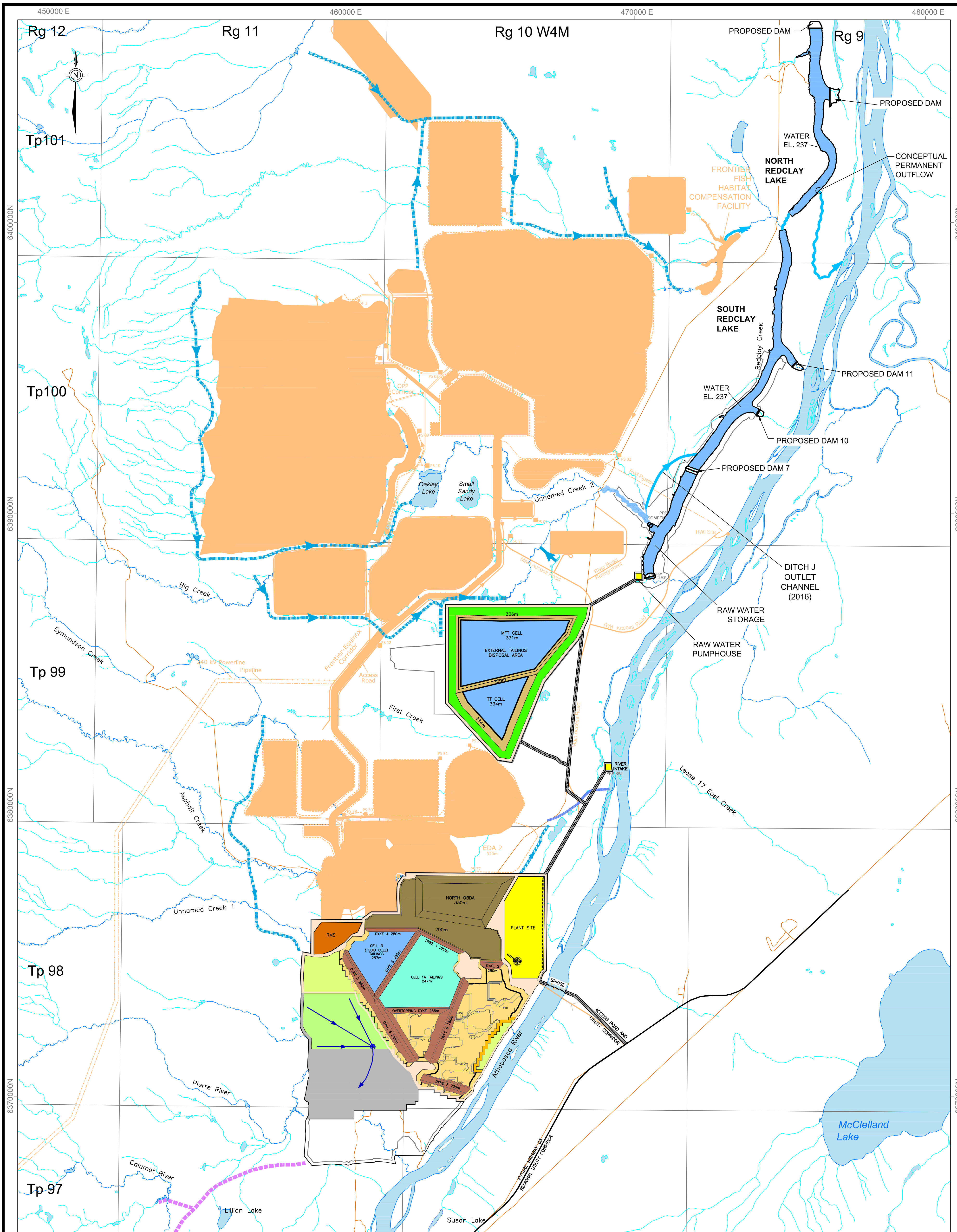
CHECK	CY	23 Jul. 2013		
REVIEW	WES	23 Jul. 2013		



LEGEND

- CLOSE-CIRCUIT MINE DEVELOPMENT AREA
- CLEARED AREA
- EXTERNAL DUMP
- OPEN-CIRCUIT DRAINAGE AREA
- LAKE OR WATERBODY
- REDCLAY COMPENSATION LAKE
- RECLAMATION MATERIAL STOCKPILE (RMS)
- TECK FRONTIER PROJECT
- DYKE
- DIVERSION DRAINAGE
- CONCEPTUAL INLET / OUTLET CHANNEL
- OPERATIONAL DITCH (CANADIAN NATURAL-2021)
- DRAINAGE - OPEN CIRCUIT
- DRAINAGE - CLOSED CIRCUIT
- SUMP
- CLOSE-CIRCUIT POND SYSTEM
- OPEN-CIRCUIT POLISHING POND
- PUBLIC ROAD

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.) USED UNDER LICENSE. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

2.5 0 2.5
SCALE KILOMETRES

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

2013 PLANNED DEVELOPMENT CASE ACTIVITIES IN THE PIERRE RIVER MINE LOCAL STUDY AREA - YEAR 2034

Shell Canada Limited

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CHECK	CY	23 Jul. 2013	**FIGURE: 3.3-4**	
REVIEW	WES	23 Jul. 2013		

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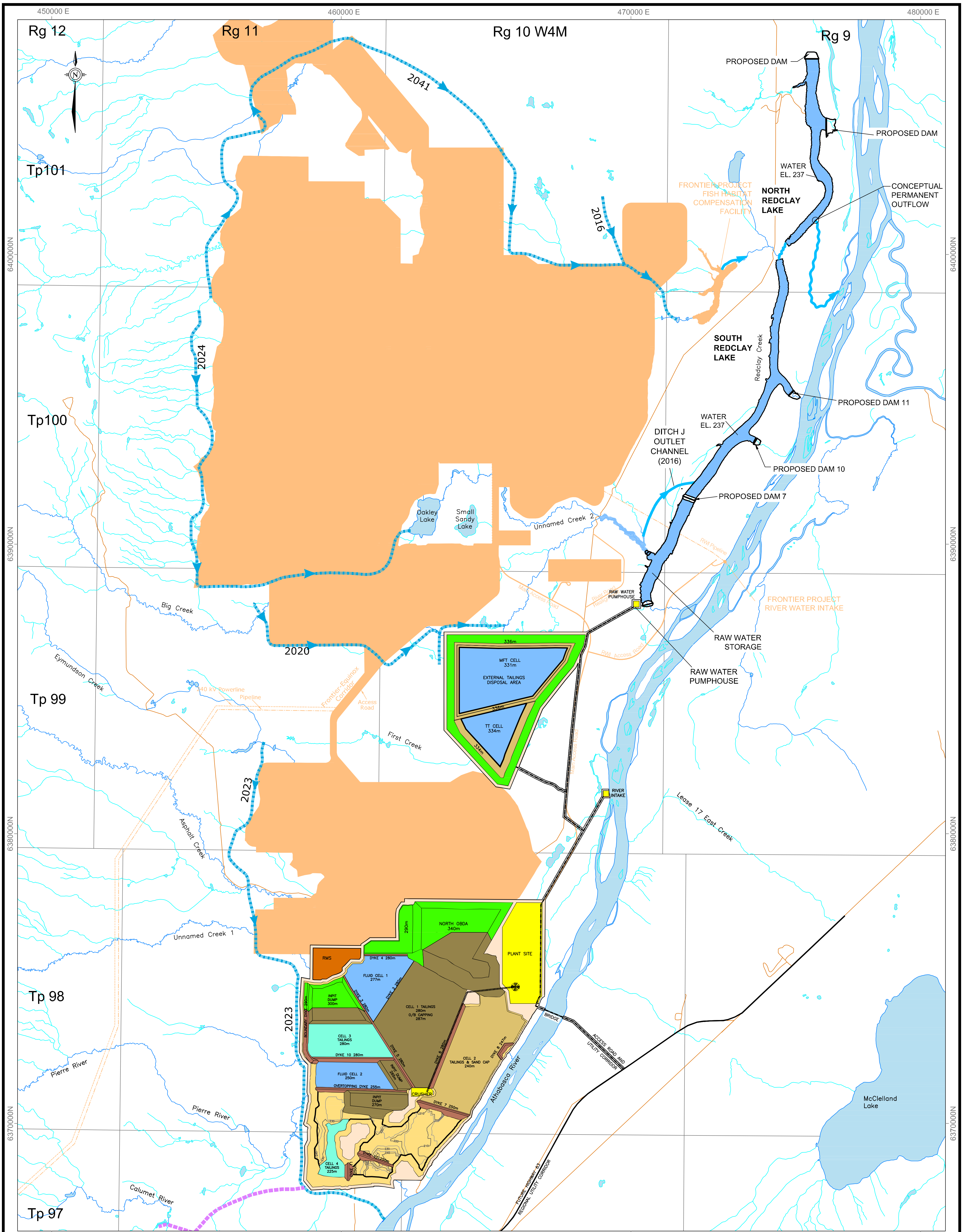

LEGEND

- CLOSE-CIRCUIT MINE DEVELOPMENT AREA
- CLEARED AREA
- EXTERNAL DUMP
- OPEN-CIRCUIT DRAINAGE AREA
- LAKE OR WATERBODY
- REDCLAY COMPENSATION LAKE
- RECLAMATION MATERIAL STOCKPILE (RMS)
- TECK FRONTIER PROJECT
- DYKE
- DIVERSION DRAINAGE
- CONCEPTUAL INLET / OUTLET CHANNEL
- OPERATIONAL DITCH (CANADIAN NATURAL-2021)
- DRAINAGE - OPEN CIRCUIT
- DRAINAGE - CLOSED CIRCUIT
- SUMP
- CLOSED-CIRCUIT POND SYSTEM
- OPEN-CIRCUIT POLISHING POND
- PUBLIC ROAD

2.5 0 2.5
SCALE KILOMETRES

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.) USED UNDER LICENSE. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

2013 PLANNED DEVELOPMENT CASE ACTIVITIES IN THE PIERRE RIVER MINE LOCAL STUDY AREA - YEAR 2042

Shell Canada Limited

PROJECT	13.1346.0001.6107		FILE No.	13134600016107A003
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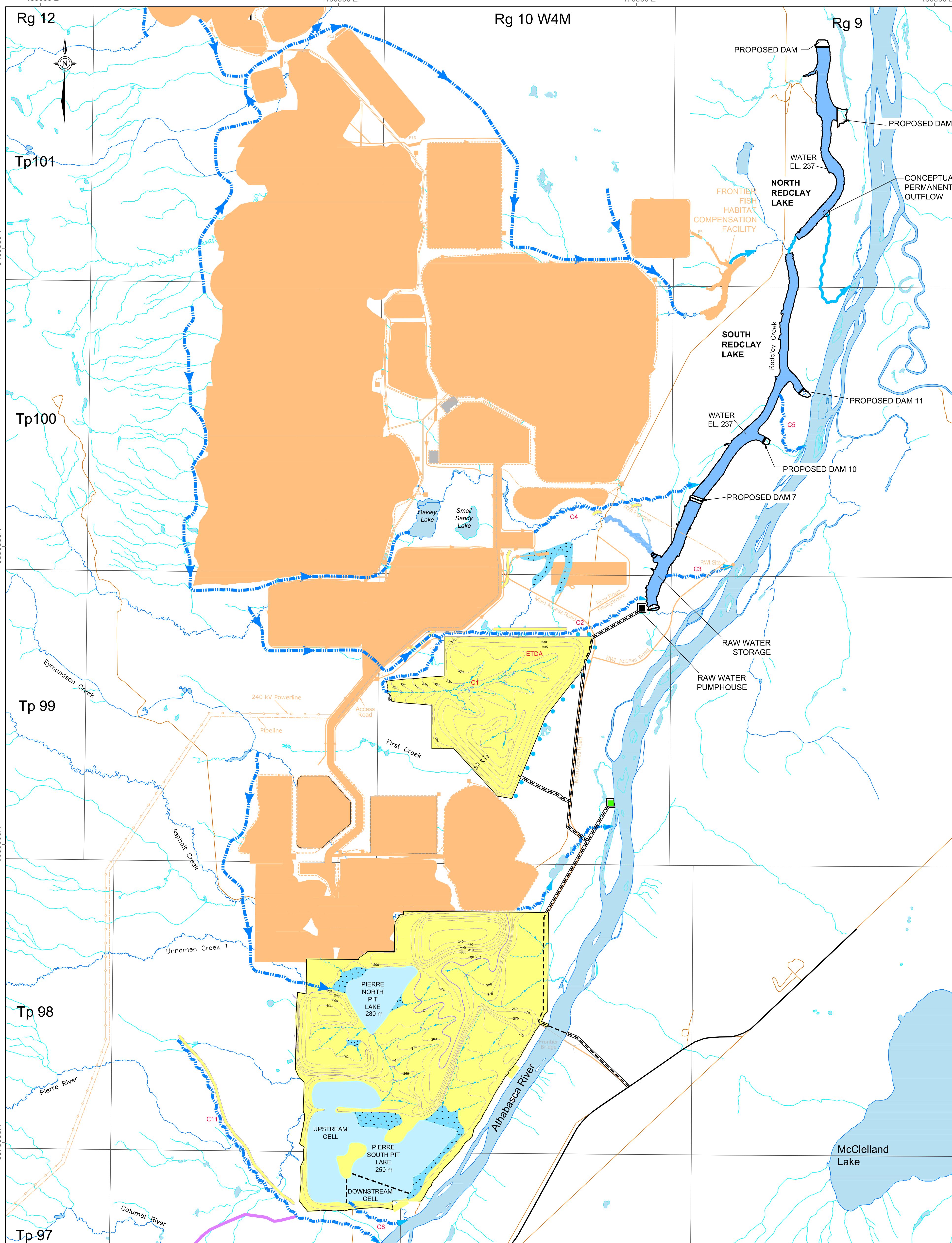

LEGEND

- MAIN CHANNEL
- SECONDARY CHANNEL
- RECLAIMED SURFACE
- CONTOURS
- WETLANDS
- CLOSURE LAKE
- CNRL CLOSURE DITCH
- WELLS
- SUBMERGED DYKE
- DYKE
- DIVERSION DRAINAGE
- CONCEPTUAL INLET / OUTLET CHANNEL
- TECK FRONTIER PROJECT
- PUBLIC ROAD
- PROPOSED ACCESS FOR PIERRE RIVER MINE

2.5 0 2.5

SCALE KILOMETRES

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.) USED UNDER LICENSE. PROJECTION: TRANSVERSE MERCATOR
DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

2013 PLANNED DEVELOPMENT CASE ACTIVITIES IN THE PIERRE RIVER MINE LOCAL STUDY AREA - YEAR 2052

Shell Canada Limited

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CHECK	CY	23 Jul. 2013	
REVIEW	WES	23 Jul. 2013	

FIGURE: 3.3-6

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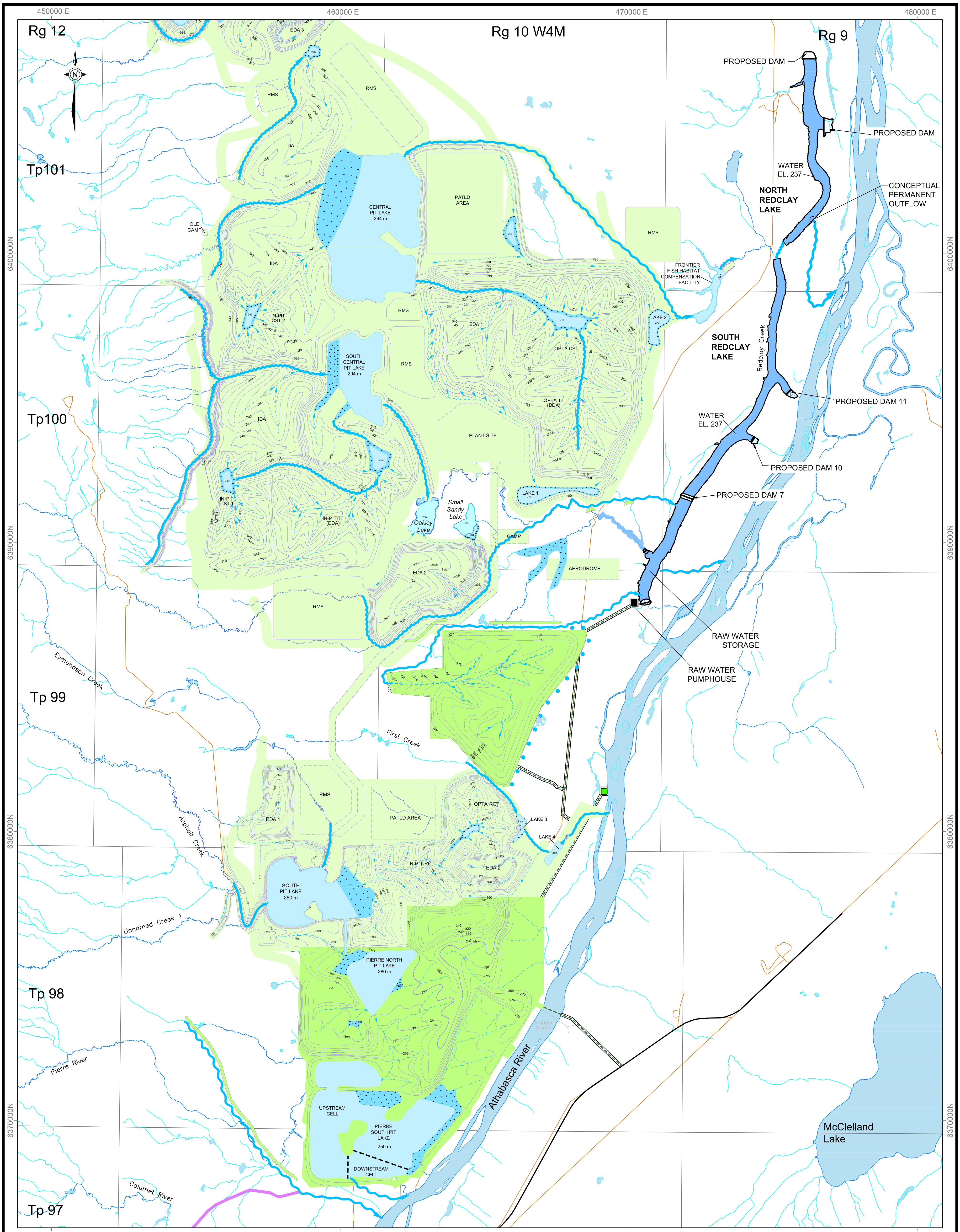

LEGEND

- LAKE OR WATERBODY
- REDCLAY COMPENSATION LAKE
- DYKE
- PROPOSED ACCESS FOR PIERRE RIVER MINE
- CONCEPTUAL INLET / OUTLET CHANNEL
- MAIN CHANNEL
- SECONDARY CHANNEL
- OPERATIONAL FACILITY LIMIT
- FINAL RECLAIMED SURFACE
- TECK FRONTIER PROJECT FINAL RECLAIMED SURFACE
- WETLANDS
- CLOSURE LAKE
- CNRL CLOSURE DITCH
- WELLS
- SUBMERGED DYKE
- PUBLIC ROAD

2.5 0 2.5
SCALE KILOMETRES

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.)
USED UNDER LICENSE. PROJECTION: TRANSVERSE MERCATOR
DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

2013 PLANNED DEVELOPMENT CASE ACTIVITIES IN THE PIERRE RIVER MINE LOCAL STUDY AREA - FAR FUTURE

Shell Canada Limited

PROJECT	13.1346.0001.6107	FILE No. 13134600016107A005	
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CHECK	CY	23 Jul. 2013	FIGURE: 3.3-7
REVIEW	WES	23 Jul. 2013	

3.3.2.1 Assessment Results

The 2013 PDC assessment considers the cumulative effects of existing and approved developments, PRM, and planned developments including the Teck Frontier Mine within the LSA and the JME within the RSA.

The hydrologic assessment presented in the EIA Application Case did not include a PDC assessment in the LSA, since there were no planned developments in this LSA in 2007. Since the EIA, planned projects now include Teck Frontier Mine in the LSA and RSA, and Total Joslyn South Mine in the RSA. It is assumed that the water withdrawal location for Joslyn South Mine will be in Reach 4 of the Athabasca River.

The 2013 PRM hydrology assessment includes an update to the EIA Application Case flow statistics for the assessment node located at the outlet of the South Redclay Lake and the PDC assessment at all assessment nodes in the LSA for the five time snapshots (i.e., 2018, 2034, 2042, 2052 and the Far Future). The update to the EIA Application Case for the outlet of the South Redclay Lake is required as a result of an update to the South Redclay Lake that was developed as part of Shell's 2012 Draft No Net Loss Plan.

The predicted incremental changes in outflows from the North and South Redclay Lake are presented in Table 3.3-3. The predicted incremental changes in Eymundson Creek and the Pierre River flows due to the 2013 PDC projects are presented in Tables 3.3-4 and 3.3-5, respectively.

South Redclay Lake

The head watershed of Unnamed Creek 19, Redclay Creek and Big Creek will be diverted to the South Redclay Lake after 2018. The outlet from the South Redclay Lake will be a new outlet channel. Flow statistics from this new outlet channel are compared to combined PIC flow statistics for Unnamed Creek 19, Redclay Creek, and Big Creek near the mouth to determine changes in flows due to the PRM and planned developments in the LSA.

During the operational phases of the PRM, site clearing, closed-circuit operations and dewatering discharges will change outflows from the Redclay Lake.

For the 2018 time snapshot, changes to the expected values of the mean annual flows and open-water mean flows will increase by less than 2%, and the expected value of the mean ice-cover flow will increase by about 20%. Changes to the expected values of mean annual and mean open-water flows are less than 8% for 2034 and 2042 snapshots, and less than 10% after the closure period (after 2052). The 10-year peak flow will be reduced significantly during operation period (i.e., about 38% reduction in 2034 and 2042) and also after the closure period (i.e., about 39% reduction) due to significant attenuation of flood flow by the North and South Redclay Lake. The mean ice-cover flow is expected to decrease by 10% during operation period and 13% after the closure period. The 7Q10 low flow will not change over the life of the mine.

Table 3.3-3 Changes to the North and South Redclay Lake Flows

Year	Expected Value of Parameter Under Conditions for Given Snapshot	Pre-Industrial Case	2013 PRM Application Case			2013 Planned Development Case		
			2013 PRM Application Case	Change (Δ) from Pre-Industrial Case		2013 Planned Development Case	Change (Δ) from 2013 PRM Application Case	
		[m³/s]	[m³/s]	[m³/s]	[%]	[m³/s]	[m³/s]	[%]
2018[b]	mean annual discharge	0.845	0.861	0.016	2	0.815	-0.046	-5
	mean open-water discharge[a]	1.35	1.36	0.01	1	1.30	-0.060	-4
	mean ice-cover discharge[a]	0.127	0.153	0.026	20	0.136	-0.017	-11
	7Q10 low flow discharge	0.000	0.000	0.000	-	0.000	0.000	-
	10-year flood peak discharge	21.2	19.7	-1.5	-7	19.0	-0.7	-4
2034	mean annual discharge	0.845	0.780	-0.065	-8	0.697	-0.083	-11
	mean open-water discharge[a]	1.35	1.25	-0.1	-7	1.08	-0.17	-14
	mean ice-cover discharge[a]	0.127	0.116	-0.011	-9	0.154	0.038	33
	7Q10 low flow discharge	0.000	0.000	0.000	-	0.000	0.000	-
	10-year flood peak discharge	21.2	13.2	-8	-38	8.10	-5.1	-39
2042	mean annual discharge	0.845	0.780	-0.065	-8	0.668	-0.112	-14
	mean open-water discharge[a]	1.35	1.25	-0.1	-7	1.04	-0.213	-17
	mean ice-cover discharge[a]	0.127	0.116	-0.011	-9	0.148	0.032	28
	7Q10 low flow discharge	0.000	0.000	0.000	-	0.000	0.000	-
	10-year flood peak discharge	21.2	13.2	-8	-38	7.86	-5.34	-40
2052	mean open-water discharge[a]	0.845	0.761	-0.084	-10	0.609	-0.152	-20
	mean ice-cover discharge[a]	1.35	1.22	-0.13	-10	0.952	-0.268	-22
	7Q10 low flow discharge	0.127	0.110	-0.017	-13	0.127	0.017	15
	10-year flood peak discharge	0.000	0.000	0.000	-	0.000	0.000	-
	10-year flood peak discharge	21.2	13.0	-8.2	-39	7.31	-5.69	-44
Far Future	mean annual discharge	0.845	0.761	-0.084	-10	0.700	-0.061	-8
	mean open-water discharge[a]	1.35	1.22	-0.13	-10	0.963	-0.257	-21
	mean ice-cover discharge[a]	0.127	0.110	-0.017	-13	0.330	0.22	200
	7Q10 low flow discharge	0.000	0.000	0.000	-	0.000	0.000	-
	10-year flood peak discharge	21.2	13.0	-8.2	-39	5.46	-7.54	-58

[a] The "open-water" season is from mid-April to mid-November; "ice-cover" season is from mid-November to mid-April.

[b] South Redclay Lake construction starts in 2018. Hence, the 2018 flows are the combined flows from Big Creek at the mouth, Redclay Creek at the mouth and unnamed Creek 19 at the mouth.

- = Flow parameter is zero and hence no percentage calculated.

Table 3.3-4 Incremental Changes to Eymundson Creek Flows for the 2013 Planned Development Case

Year	Expected Value of Parameter Under Conditions for Given Snapshot	2013 PRM Application Case	2013 Planned Development Case		
			2013 Planned Development Case	Change (Δ) from 2013 PRM Application Case	
		[m^3/s]	[m^3/s]	[m^3/s]	[%]
2018	mean annual discharge	0.687	0.687	0.000	0.0
	mean open-water discharge[(a)]	1.12	1.12	0.000	0.0
	mean ice-cover discharge[(a)]	0.076	0.076	0.000	0.0
	7Q10 low flow discharge	0.007	0.007	0.000	0.0
	10-year flood peak discharge	18.9	18.9	0.000	0.0
2034[(b)]	mean annual discharge	0.519	-	-	-
	mean open-water discharge[(a)]	0.848	-	-	-
	mean ice-cover discharge[(a)]	0.052	-	-	-
	7Q10 low flow discharge	0.000	-	-	-
	10-year flood peak discharge	14.9	-	-	-
2042[(b)]	mean annual discharge	0.519	-	-	-
	mean open-water discharge[(a)]	0.848	-	-	-
	mean ice-cover discharge[(a)]	0.052	-	-	-
	7Q10 low flow discharge	0.000	-	-	-
	10-year flood peak discharge	15.0	-	-	-
2052[(c)]	mean annual discharge	0.589	0.565	-0.024	-4.1
	mean open-water discharge[(a)]	0.858	0.821	-0.037	-4.5
	mean ice-cover discharge[(a)]	0.210	0.205	-0.005	-2.4
	7Q10 low flow discharge	0.000	0.000	0.000	-
	10-year flood peak discharge	6.07	5.67	-0.400	-6.6
Far Future[(d)]	mean annual discharge	0.589	0.558	-0.031	-5.3
	mean open-water discharge[(a)]	0.858	0.712	-0.146	-17
	mean ice-cover discharge[(a)]	0.210	0.342	0.132	63
	7Q10 low flow discharge	0.000	0.000	0.000	-
	10-year flood peak discharge	6.07	4.14	-1.93	-32

(a) The "open-water" season is from mid-April to mid-November; "ice-cover" season is from mid-November to mid-April.

(b) Eymundson Creek outlet does not exist in 2034 and 2042. Therefore, all the pre-industrial watershed contributing runoff to Eymundson Creek at mouth during pre-industrial is directed to the PRM operational drainage channel in 2034 and 2042.

(c) In 2052, Unnamed Creek 1, Asphalt Creek and Eymundson Creek will be directed to the PRM pit lakes. Hence, the 2013 PRM Application Case and 2013 PDC flows represent outflows from the PRM south pit lake.

(d) In Far Future, Unnamed Creek 1, Asphalt Creek and Eymundson Creek will be directed to the south pit lake of the Teck Resources Limited Frontier Oil Sands Mine Project, which ultimately flows to the PRM pit lakes. Hence, the Far Future flows represent outflows from the PRM south pit lake.

– = No data available.

Golder Associates

Table 3.3-5 Incremental Changes to the Pierre River Flows for the 2013 Planned Development Case

Year	Expected Value of Parameter Under Conditions for Given Snapshot	2013 PRM Application Case	2013 Planned Development Case		
			2013 Planned Development Case	Change (∆) from 2013 PRM Application Case	
		[m³/s]	[m³/s]	[m³/s]	[%]
2018	mean annual discharge	0.289	0.289	0.000	0.0
	mean open-water discharge[(a)]	0.469	0.469	0.000	0.0
	mean ice-cover discharge[(a)]	0.035	0.035	0.000	0.0
	7Q10 low flow discharge	0.000	0.000	0.000	-
	10-year flood peak discharge	7.50	7.50	0.000	0.0
2034[(b)]	mean annual discharge	0.925	0.907	-0.018	-1.9
	mean open-water discharge[(a)]	1.52	1.49	-0.030	-2.0
	mean ice-cover discharge[(a)]	0.088	0.081	-0.007	-8.0
	7Q10 low flow discharge	0.000	0.000	0.000	-9
	10-year flood peak discharge	25.8	25.8	0.000	0.0
2042[(b)]	mean annual discharge	0.925	0.910	-0.015	-1.6
	mean open-water discharge[(a)]	1.52	1.50	-0.020	-1.3
	mean ice-cover discharge[(a)]	0.088	0.081	-0.007	-8.0
	7Q10 low flow discharge	0.000	0.000	0.000	-
	10-year flood peak discharge	25.8	25.7	-0.100	-0.4
2052	mean annual discharge	0.257	0.257	0.000	0.0
	mean open-water discharge[(a)]	0.420	0.420	0.000	0.0
	mean ice-cover discharge[(a)]	0.027	0.027	0.000	0.0
	7Q10 low flow discharge	0.000	0.000	0.000	-
	10-year flood peak discharge	7.00	7.00	0.000	0.0
Far Future	mean annual discharge	0.257	0.257	0.000	0.0
	mean open-water discharge[(a)]	0.420	0.420	0.000	0.0
	mean ice-cover discharge[(a)]	0.027	0.027	0.000	0.0
	7Q10 low flow discharge	0.000	0.000	0.000	-
	10-year flood peak discharge	7.00	7.00	0.000	0.0

(a) The "open-water" season is from mid-April to mid-November; "ice-cover" season is from mid-November to mid-April.

(b) 2013 PRM Application Case and 2013 PDC flows include diversion of the head watershed of Eymundson Creek and its tributaries.

- = Flow parameter is zero and hence no percentage calculated

During the operational phase of the PRM, all flow parameters except mean ice-cover and 7Q10 low flows will decrease as a result of the Teck Frontier Mine closed-circuit operations in the LSA. The expected values of the mean annual and mean open-water flows will decrease by less than 5%, and the expected value of the mean ice-cover flow will decrease by about 11% in 2018.

Changes to the expected values of mean annual and mean open-water flows will be less than 22% for 2034 and 2042 snapshots. The 10-year peak flow will reduce significantly during operation period. The mean ice-cover flow is expected to increase by 33% in 2034 and 28% in 2042.

After Closure, changes in the mean annual, mean open-water, and 10-year peak flows will decrease because of the attenuation effect of the pit lakes that will be developed for the Teck Frontier Mine upstream of the North and South Redclay Lake. However, change in the mean ice-cover flow will significantly increase due to increased outflow from the pit lakes in the winter period.

Eymundson Creek Near the Mouth

Predicted incremental changes to Eymundson Creek flow parameters at the outflow to Athabasca River are shown in Table 3.3-4. The planned development projects for the 2013 PDC will not cause incremental changes to Eymundson Creek in 2018.

In 2034 and 2042, the head watershed of Eymundson Creek and its tributaries (Asphalt Creek and Unnamed Creek 1) will be diverted south to the PRM operational drainage channel around the Teck Frontier Mine south development area and the PRM. Therefore, the effects for the 2013 PDC assessment for the Eymundson Creek outflow to the Athabasca River in 2034 and 2042 are presented as part of the Pierre River outflow to Athabasca River in Table 3.3-5.

In 2052, runoff from the head watershed of Eymundson Creek and its tributaries will be directed to the PRM pit lakes. Flow statistics from the PRM South Pit Lake outlet channel were compared to the 2013 PRM Application Case flow statistics to determine incremental changes due to the 2013 PDC projects. The expected mean annual flow for the 2013 PDC will decrease by a maximum of about 4.1% from the 2013 PRM Application Case. The mean open-water, mean ice-covered and the 10-year peak discharge will also decrease compared to the 2013 PRM Application Case.

In the Far Future, Eymundson Creek and its tributaries will be directed to the Frontier Mine South Pit Lake and then to the PRM pit lakes. The storage effect of the pit lakes will affect the flow parameters at the PRM South Pit Lake outlet channel. The predicted mean annual flow will decrease by about 5.3% compared to the 2013 PRM Application Case. The predicted mean open-water flow and the 10-year peak discharge will also decrease, and the mean ice-cover flow will increase significantly compared to the 2013 PRM Application Case due to the attenuation effect of the pit lakes.

Pierre River Near the Mouth

No changes will occur in flow parameters at the mouth of Pierre River due to the planned projects in 2018, 2052 and the Far Future compared to the 2013 PRM Application Case (Table 3.3-5).

The Pierre River and the head watershed of Eymundson Creek and its tributaries will be diverted south to the PRM drainage channel in 2034 and 2042. Flow statistics at the outlet of the PRM drainage channel were compared to the 2013 PRM Application Case flow statistics to determine the predicted changes due to the planned development projects for the 2013 PDC. The predicted changes in mean annual, mean open-water and 10-year flood flows will be less than 1.9% compared to the 2013 PRM Application Case flows. The expected mean ice-cover flow will decrease by about 8% compared to the 2013 PRM Application Case.

Changes in Runoff From the Pierre River Mine Local Study Area

In 2018, flow statistics from LSA will decrease for the 2013 PDC compared to the 2013 PRM Application Case as a result of closed-circuit operations from the Frontier Mine (Table 3.3-6).

The mean annual flow and mean open-water flow will decrease due to closed-circuit operations for 2034 and 2042 time snapshots, and due to increased evaporation from pit lakes for the 2052 and Far Future time snapshots. The mean ice-covered flow from the LSA will increase significantly for Far Future time snapshots as a result of increased discharge from pit lakes in winter period.

Table 3.3-6 Effect on Flow from the Local Study Area for the 2013 PRM Application Case and 2013 Planned Development Case

Year	Expected Value of Flow Parameter Under Conditions for Given Snapshot	Pre-Industrial Case Streamflow Discharge [m^3/s]	2013 PRM Application Case		2013 Planned Development Case	
			2013 PRM Application Case [m^3/s]	Change (Δ) from Pre-Industrial Case [m^3/s]	2013 Planned Development Case [m^3/s]	Change from 2013 PRM Application Case [m^3/s]
2018	mean annual discharge	1.80	1.84	0.040	1.79	-0.050
	mean open-water discharge[(a)]	2.91	2.95	0.040	2.88	-0.070
	mean ice-cover discharge[(a)]	0.225	0.264	0.039	0.247	-0.017
2034	mean annual discharge	1.80	1.75	-0.050	1.65	-0.100
	mean open-water discharge[(a)]	2.91	2.84	-0.070	2.64	-0.200
	mean ice-cover discharge[(a)]	0.225	0.218	-0.007	0.245	0.027
2042	mean annual discharge	1.80	1.73	-0.070	1.58	-0.150
	mean open-water discharge[(a)]	2.91	2.81	-0.100	2.54	-0.270
	mean ice-cover discharge[(a)]	0.225	0.214	-0.011	0.231	0.017
2052	mean annual discharge	1.80	1.72	-0.080	1.5	-0.220
	mean open-water discharge[(a)]	2.91	2.64	-0.270	2.27	-0.370
	mean ice-cover discharge[(a)]	0.225	0.421	0.196	0.412	-0.009
Far Future	mean annual discharge	1.80	1.72	-0.080	1.62	-0.100
	mean open-water discharge[(a)]	2.91	2.64	-0.270	2.22	-0.420
	mean ice-cover discharge[(a)]	0.225	0.421	0.196	0.777	0.356

(a) The "open-water" season is from mid-April to mid-November; "ice-cover" season is from mid-November to mid-April.

Athabasca River

An updated summary of current Alberta water licence allocations, return flows and projected annual allocations of all existing, approved and planned oil sands developments for surface water withdrawals from the Athabasca River and its tributary watercourses is provided in Table 3.3-7. It is assumed that the water withdrawal locations for the planned projects will be in Reach 4. Hence, the Water Management Framework withdrawal restrictions for Reach 4 will apply to all operators.

The 2013 PDC assessment for the Athabasca River includes quantification of the potential changes in the surface water hydrology in the RSA, using the same assessment methods presented in the EIA, Volume 4B, Appendix 4-8, Section 2.

The total annual net water requirement from the Athabasca River for the regional development excluding the oil sands projects is 188.7 million m^3 (5.98 m^3/s). The total projected net water allocations to existing, approved and planned oil sands mining projects is about 611 million m^3 (19.4 m^3/s). This represents about 76% of the total net water allocation of 799 million m^3 (25.4 m^3/s) in the Athabasca River basin.

Table 3.3-7 Water Allocations From Athabasca River and Tributaries

Purpose	Existing Licences and Licence Applications for Water Allocations [dam³][(a)]						Peak Instantaneous Licence Allocations [m³/s]
	Interim Licenses	WRLIC Licenses[(b)]	WALIC Licenses[(c)]	Total Withdrawals	Return Flows	Net Water Allocations	
agricultural	24	686	56	766	0	766	n/a
commercial[(d)]	4,783	145,784	3,772	154,339	123,562	30,777	n/a
dewatering	280	35,367	0	35,647	1,293	34,354	n/a
habitat enhancement	14	1,413	0	1,427	0	1,427	n/a
industrial	4,517	36,547	53,507	94,571	2,772	91,799	n/a
irrigation	37	2,773	858	3,668	1,381	2,287	n/a
municipal	7,997	32,227	2,416	42,640	34,851	7,789	n/a
water management	0	21,590	1	21,591	2,221	19,370	n/a
other use	2	125	29	156	2	154	n/a
subtotal	*17,654*	*276,512*	*60,639*	*354,805*	*166,082*	*188,723*	*n/a*
Water Licences for Oil Sands:							
2013 Base Case:							
Syncrude Canada Ltd.[(e)]	0	60,441	0	60,441	0	60,441	4.17
Suncor Energy Inc.[(f)]	0	62,825	0	62,825	38,655	24,170	3.79
Shell Muskeg River Mine[(g)]	0	0	55,100	55,100	0	55,100	3.33[(k)]
Suncor Fort Hills[(h)]	0	0	39,270	39,270	0	39,270	1.67
Canadian Natural Resources Limited Horizon[(i)]	0	0	79,320	79,320	0	79,320	3.1
Shell Jackpine Mine – Phase 1[(j)]	0	0	63,500	63,500	0	63,500	0.83[(k)]
Imperial Oil Kearl[(l)]	0	0	80,000	80,000	0	80,000	4.6
Total E&P Canada Ltd.– Joslyn Creek[(m)]	0	0	22,000	22,000	0	22,000	1.4[(n)]
subtotal	*0*	*123,266*	*339,190*	*462,456*	*38,655*	*423,801*	*22.9*
2013 PRM Application Case							
PRM[(o)]	0	0	55,000	55,000	0	55,000	4.17[(o)]
subtotal	*0*	*0*	*55,000*	*55,000*	*0*	*55,000*	*4.17*

Table 3.3-7 Water Allocations From Athabasca River and Tributaries (continued)

Purpose	Existing Licences and Licence Applications for Water Allocations [dam³][(a)]						Peak Instantaneous Licence Allocations [m³/s]
	Interim Licenses	WRLIC Licenses[(b)]	WALIC Licenses[(c)]	Total Withdrawals	Return Flows	Net Water Allocations	
2013 Planned Development Case							
JME[(p)]	0	0	18,000	18,000	0	18,000	0.55[(p)]
Total E&P Canada Ltd. Northern Light[(q)]	0	0	20,900	20,900	0	20,900	1.33[(r)]
Total E&P Canada Ltd.- Joslyn South Mine[(s)]	0	0	22,000	22,000	0	22,000	1.4
Teck Resources Limited Frontier Project[(t)]	0	0	71,500	71,500	0	71,500	4.2
subtotal	*0*	*0*	*132,400*	*132,400*	*0*	*132,400*	*7.48*
Total [dam³] [(u)]	**17,654**	**399,778**	**587,229**	**1,004,661**	**204,737**	**799,924**	**34.55**

(a) 1 dam^3 = 1,000 m^3.
(b) Water Resources Licenses issued before 1999 under *Water Resources Act.*
(c) Water Act Licenses issued since 1999 under *Water Act*.
(d) Except oil sands mines.
(e) Syncrude License letter attached to Cumulative Environmental Management Association (CEMA) Report (Golder 2005).
(f) Suncor License letter from Alberta Environment and Sustainable Resource Development (ESRD 2013, Internet site).
(g) Shell License letter from Alberta Environment and Sustainable Resource Development (ESRD 2013, Internet site). Daily water withdrawal is restricted to 1.8% of Athabasca River Flow at Fort McMurray.
(h) Fort Hills License letter from Alberta Environment and Sustainable Resource Development (ESRD 2013, Internet site).
(i) Canadian Natural Resources Ltd. License letter from Alberta Environment and Sustainable Resource Development (ESRD 2013, Internet site).
(j) Shell License letter from Alberta Environment and Sustainable Resource Development (ESRD 2013, Internet site). For Stage 2, the mean annual water requirement will be 35.3 million m^3.
(k) Jackpine Mine – Phase 1, Muskeg River Mine and Jackpine Mine Expansion would share the same water intake. The combined peak instantaneous rate of 4.72 m^3/s is currently approved as part of Jackpine Mine – Phase 1, *Water Act* Licence No.186157-00-00; and as part of the Muskeg River Mine Expansion, *Water Act* License No. 00071821-01-00.
(l) Based on EIA application documents (Imperial Oil 2005) approved by ERCB.
(m) Based on EIA application documents (Total 2010) approved by ERCB.
(n) Peak instantaneous rates were assumed for this project.
(o) For Stage 2 (2029 to 2039), the mean annual water requirement will be 45 million m^3.
(p) Expansion Mine during Stage 2 operations (2016 to 2052) only.
(q) Based on EIA application documents (Total 2010) approved by ERCB.
(r) Peak instantaneous rates were assumed for these projects.
(s) Assumed to be the same as Joslyn North Mine based on application submitted to ERCB (Deer Creek 2006; Total 2010).
(t) Based on EIA application documents (Teck 2011) submitted to ERCB by Teck/SilverBirch for Frontier Project.
(u) EIA Application Case Sub-total and Total sum does not include additional water withdrawal for JME and PRM during Stage 2 operations since the Stage 1 withdrawal is used to assess effects on Athabasca River flow parameters.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.

Effects of the 2013 PDC on the Athabasca River flows and water levels were quantified for Reach 4 and Node S24, respectively. The total peak water withdrawal for the 2013 PDC is about 34.6 m^3/s compared to 27.1 m^3/s for the 2013 PRM Application Case.

The predicted reduction in mean seasonal Athabasca River flows for the 2013 PDC ranges from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions (Table 3.3-8). The incremental water level reductions due to planned developments in the Athabasca River are less than 2 cm of the mean seasonal flow depths (Table 3.3-9). The incremental changes in flows and water level reductions for Athabasca River due to updated planned developments are very small as shown in Tables 3.3-8 and 3.3-9.

Shell also considered the effects on water level changes in the Peace-Athabasca Delta (PAD) due to the PRM in conjunction with existing, approved and planned developments (Appendix 3.4). Based on the assessment detailed in Appendix 3.4, the effects for the 2013 PDC on water levels and flooding in the PAD are considered negligible.

Table 3.3-8 Changes to the Athabasca River Flows in Reach 4 for the 2013 Planned Development Case

Hydrologic Condition	Season	2013 PRM Application Case	2013 Planned Development Case[(a)]		
			2013 Planned Development Case	Change from 2013 PRM Application Case	
		[m^3/s]	[m^3/s]	[m^3/s]	[%]
average year	winter	152	151	-1.1	-0.7
	spring	503	499	-4.5	-0.9
	summer	1,199	1,192	-7.5	-0.6
	fall	536	528	-7.5	-1.4
10-year dry	winter	105	105	0.0	0.0
	spring	230	230	-0.8	-0.3
	summer	980	973	-7.4	-0.8
	fall	399	394	-4.6	-1.2
10-year wet	winter	170	167	-2.9	-1.7
	spring	556	552	-3.9	-0.7
	summer	1,717	1,709	-7.5	-0.4
	fall	771	763	-7.5	-1.0

(a) Peak water withdrawals were used as an upper limit although the Water Management Framework allows withdrawal up to 15% of average weekly flows for the green zone.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

Table 3.3-9 Changes to the Athabasca River Flow Depths in Reach 4 for the 2013 Planned Development Case

Hydrologic Condition	Season	2013 PRM Application Case [m]	2013 Planned Development Case	
			2013 Planned Development Case [m]	Change from 2013 PRM Application Case [m]
average year	winter	225.90	225.89	-0.01
	spring	226.52	226.51	-0.01
	summer	227.60	227.59	-0.01
	fall	226.57	226.56	-0.01
10-year dry	winter	225.81	225.81	0.00
	spring	226.04	226.04	0.00
	summer	227.28	227.27	-0.01
	fall	226.34	226.33	-0.01
10-year wet	winter	225.93	225.92	-0.01
	spring	226.60	226.60	0.00
	summer	228.28	228.27	-0.01
	fall	226.96	226.94	-0.02

3.3.2.2 Summary of Results

The planned development activities within the LSA will result in decreased flows to Athabasca River from tributary creeks. The decreases in flows are due to closed-circuit operations during mine operation and due to increased evaporation from pit lakes in the Far Future.

The total annual net water requirement from the Athabasca River for the regional developments excluding the oil sands projects is 188.7 million m^3 (5.98 m^3/s). The total projected annual net water allocations to existing, approved and planned oil sands mining projects are about 611 million m^3. This represents about 76% of the total annual net water allocation of 799 million m^3 (25.4 m^3/s) in the Athabasca River basin.

Effects of the 2013 PDC on the Athabasca River flows and water levels were quantified for Reach 4 and Node S24, respectively. The total peak water withdrawal for the 2013 PDC is about 34.6 m^3/s, compared to 27.1 m^3/s for the 2013 PRM Application Case.

The predicted reduction in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions due to planned developments in the Athabasca River are less than 2 cm of the mean seasonal flow depths.

3.3.1 Water Quality Assessment

This section presents the 2013 PDC water quality assessment. The water quality assessment considers potential changes in concentrations of constituents in watercourses and waterbodies due to effects of the existing, approved and planned developments on water quality during construction, operations and closure phases of PRM. The aquatic health assessment for watercourses and waterbodies within the LSA is also updated to reflect the updated water quality results and updated Chronic Effects Benchmarks (CEBs) (Appendix 3.6). Changes to water quality are further assessed for potential effects to aquatic health in Section 3.3.4. Predicted concentrations of individual substances were passed through a screening procedure (using the rationale and decision rules presented in the EIA, Volume 4A, Section 6.6.2.12) to identify Substances of Potential Concern (SOPCs). The SOPCs are substances that were predicted to be present at concentrations in excess of those observed under the 2013 Base Case and that also exceed relevant water quality guidelines and CEBs. The concentrations used for comparing predicted results are collectively referred to as "screening criteria" in the following sections.

Potential changes to water quality resulting from aerial deposition of metals and PAHs are evaluated separately in Appendix 3.5 because this assessment is preliminary. An evaluation of water quality in the Peace-Athabasca Delta is provided in Appendix 3.4. This assessment was completed to verify that the selection of the RSA in the EIA was appropriate.

3.3.1.1 Assessment Results

Pierre River Mine Local Study Area

Within the LSA, acute and chronic toxicity and tainting potential levels are predicted to be lower than guideline values, and labile naphthenic acids are predicted to be less than 1 mg/L under the 2013 PDC at the assessment nodes in the snapshots.

The 2013 Base Case concentrations for the small streams are identical to the PIC. Therefore, in this Appendix, water quality predictions for 2013 PDC are compared directly to the PIC. For the 2013 PDC, constituents that were predicted to exceed screening criteria relative to the PIC and did not screen over in the 2013 PRM Application Case are presented below.

Where additional constituents were predicted to exceed screening criteria relative to the 2013 PRM Application Case, or where there were increases in concentrations of constituents that were already predicted to exceed screening criteria in the 2013 PRM Application Case, those concentrations were assessed for aquatic health in Section 3.3.4.

Pierre River at the Mouth (Node PR)

In Pierre River, during all snapshots, the substances predicted to exceed guidelines are also predicted to exceed guidelines under PIC conditions (Table 3.3-10).

In 2018, concentrations of all substances are predicted to stay below Chronic Effect Benchmarks (CEBs), except where CEBs were exceeded under PIC conditions. In 2034 and 2042, Eymundson Creek is diverted to Pierre River. A combination of watershed diversions and closed-circuiting of land areas are predicted to increase concentrations of some substance relative to PIC during these two snapshots. In particular, median concentrations of barium and sulphate and peak concentrations of sulphate and Total Dissolved Solids (TDS) are predicted to increase relative to PIC, but remain below CEBs. Peak concentrations of manganese, sodium and total phenolics are predicted to exceed the screening criteria (Table 3.3-10). At Closure, Pierre River will remain diverted around the PRM site, but the contributing lands and water sources to that river will be similar to the PIC. No constituents are predicted to exceed screening criteria after Closure in Pierre River.

Table 3.3-10 Predicted Water Quality in Pierre River

Parameter	Unit	Water Quality Guideline Aquatic Life[(a)(b)]		Chronic Effects Benchmark	Observed Natural Variation [(c)]	Pre-Industrial Case		2013 Planned Development Case									
								Median Concentration					Peak Concentration				
		Acute	Chronic			Median Concentration	Peak Concentration	2018	2034	2042	2052	2152	2018	2034	2042	2052	2152
Aluminum	mg/L	0.75	0.1	0.15	0.27 (<0.02 - 1.4) n = 11	**0.19**	**12**	**0.19**	**0.13**	**0.12**	**0.17**	**0.17**	**12**	**6.9**	**6.9**	**9.6**	**9.6**
Ammonia	mg/L	14.6	1.1	2.0	<0.05 (<0.05 - 0.82) n = 11	0.031	0.91	0.03	0.031	0.031	0.031	0.03	0.81	1.0	0.73	0.77	0.76
Antimony	mg/L	-	-	0.16	0.0009 (0.00016 - 0.0017) n = 11	0.00072	0.0014	0.00072	0.00076	0.00075	0.00074	0.00074	0.0014	0.0013	0.0013	0.0014	0.0014
Arsenic	mg/L	0.34	0.005	0.025	0.0015 (<0.0004 - 0.0067) n = 11	0.0015	**0.012**	0.0015	0.0015	0.0015	0.0014	0.0014	**0.012**	**0.0085**	**0.0084**	**0.0085**	**0.0085**
Barium	mg/L	-	-	5.8	0.044 (0.025 - 0.094) n = 11	0.058	0.45	0.059	0.062	0.064	0.058	0.058	0.45	0.37	0.37	0.41	0.41
Beryllium	mg/L	-	-	0.0053	<0.001 (<0.0001 - <0.001) n = 11	0.00017	0.00042	0.00016	0.00021	0.0002	0.00017	0.00017	0.00042	0.00078	0.00061	0.00042	0.00042
Boron	mg/L	29	1.5	1.5	0.12 (0.03 - 0.43) n = 11	0.078	0.43	0.075	0.085	0.078	0.077	0.076	0.43	0.44	0.44	0.43	0.43
Cadmium	mg/L	0.0033	0.00037	0.00025	<0.0002 (<0.0001 - <0.0002) n = 11	0.000055	**0.00041**	0.000056	0.000063	0.000062	0.000058	0.000058	**0.00042**	**0.00031**	0.00034	0.00038	0.00038
Calcium	mg/L	-	-	-	39 (22 - 80) n = 26	44	83	44	45	45	44	44	82	81	79	81	81
Chloride	mg/L	640	120	-	4.4 (1.9 - 9.4) n = 25	2.1	4.7	2.1	2.4	2.3	2.2	2.1	4.7	5.0	4.8	6.8	4.8
Chromium	mg/L	0.016	0.001	0.089	0.0016 (0.0005 - 0.0057) n = 11	**0.0012**	**0.034**	**0.0012**	**0.0013**	**0.0013**	**0.0012**	**0.0012**	**0.034**	**0.024**	**0.024**	**0.029**	**0.029**
Cobalt	mg/L	-	-	0.004	0.0011 (<0.0002 - 0.0085) n = 11	0.0012	0.0071	0.00059	0.0011	0.0011	0.0011	0.0011	0.0068	0.006	0.0059	0.0064	0.0064
Copper	mg/L	0.021	0.0034	0.026	0.0017 (<0.001 - 0.006) n = 11	0.0016	**0.015**	0.0014	0.0016	0.0014	0.0014	0.0014	**0.015**	**0.024**	**0.016**	**0.015**	**0.015**
Iron	mg/L	-	0.3	1.5	1.9 (0.96 - 10) n = 11	**1.9**	**18**	**1.8**	**1.9**	**1.8**	**1.7**	**1.7**	**18**	**13**	**13**	**13**	**13**
Lead	mg/L	0.14	0.0055	0.005	0.0003 (<0.0001 - 0.001) n = 11	0.00033	**0.0071**	0.00029	0.00035	0.00035	0.0003	0.0003	**0.0071**	**0.0074**	**0.0065**	0.0065	0.0065
Lithium	mg/L	-	-	-	0.046 (0.008 - 0.099) n = 11	0.033	0.078	0.032	0.032	0.032	0.032	0.032	0.076	0.078	0.073	0.073	0.073
Manganese	mg/L	-	-	1.5	0.15 (0.057 - 4.9) n = 11	0.28	1.8	0.27	0.29	0.29	0.27	0.27	1.1	4.5	1.9	1.0	1.0
Mercury	mg/L	0.000013	0.000005	0.00005	0.0000007 (<0.0000006 - 0.0000049) n = 11	0.00000045	**0.000013**	0.00000045	0.00000045	0.00000045	0.00000047	0.00000047	**0.000013**	**0.000013**	**0.000014**	**0.000014**	**0.000014**
Molybdenum	mg/L	-	0.073	39	0.00081 (0.0001 - 0.0038) n = 11	0.00055	0.0024	0.00054	0.00064	0.00061	0.00068	0.00059	0.0025	0.0027	0.0026	0.0071	0.0026
Naphthenic Acids - Inert	mg/L	-	-	-	-	0.25	0.82	0.25	0.28	0.26	0.25	0.25	0.82	1.0	0.81	0.78	0.78
Naphthenic Acids - Labile	mg/L	-	-	1.0	-	0	0	0	0	0	0.00032	0	0	0	0	0.041	0.00035
Naphthenic Acids - Refractory	mg/L	-	-	-	-	0.51	1.4	0.5	0.55	0.51	0.5	0.5	1.4	2.1	1.2	1.2	1.2
Naphthenic Acids - Total (Lower)	mg/L	-	-	-	<1 (<1 - 1) n = 31	0.25	0.82	0.25	0.28	0.26	0.25	0.25	0.82	1.0	0.81	0.78	0.78
Naphthenic Acids - Total (Upper)	mg/L	-	-	-	<1 (<1 - 1) n = 31	0.51	1.4	0.5	0.55	0.51	0.5	0.5	1.4	2.1	1.2	1.2	1.2
Nickel	mg/L	0.67	0.075	0.13	0.01 (<0.0002 - 0.016) n = 11	0.0037	0.018	0.0035	0.0045	0.0041	0.0037	0.0037	0.018	0.02	0.018	0.018	0.018
Nitrate	mg/L	124	2.9	-	<0.045 (<0.003 - 0.11) n = 26	0.033	0.27	0.033	0.034	0.033	0.032	0.032	0.27	0.23	0.23	0.25	0.25
PAH group 1	µg/L	-	0.015	0.28	<0.025 (<0.00092 - <0.04) n = 6	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 2	µg/L	-	0.018	0.28	0.025 (0.0023 - <0.04) n = 6	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 3	µg/L	-	-	0.99	0.0063 (0.00068 - <0.02) n = 6	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 4	µg/L	-	5.8	42	<0.021 (<0.00043 - <0.04) n = 6	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 5	µg/L	-	0.012	5.6	0.04 (0.031 - 0.055) n = 6	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 6	µg/L	-	-	64	<0.04 (0.0016 - <0.049) n = 6	0	0	0	0	0	0	0	0	0	0	0	0.0002
PAH group 7	µg/L	-	0.04	5.9	0.04 (0.031 - 0.06) n = 6	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 8	µg/L	-	1.1	32	0.035 (0.016 - 0.15) n = 6	0	0	0	0	0	0	0	0	0	0	0	0.00072
PAH group 9	µg/L	-	0.025	2.3	0.04 (0.015 - 0.044) n = 6	0	0	0	0	0	0	0	0	0	0	0	0
Selenium	mg/L	-	0.001	-	0.0005 (<0.0003 - 0.0015) n = 11	0.00039	**0.0027**	0.00039	0.00041	0.00039	0.00038	0.00037	**0.0027**	**0.0021**	**0.0022**	**0.0022**	**0.0022**
Silver	mg/L	0.008	0.0001	0.00022	0.00001 (0.0000035 - 0.000026) n = 11	0.000016	0.000089	0.000016	0.000016	0.000015	0.000016	0.000016	0.00009	0.000078	0.000081	0.000082	0.000082
Sodium	mg/L	-	-	-	25 (3 - 33) n = 25	13	24	13	13	13	13	13	23	27	22	23	23
Strontium	mg/L	-	-	14	0.22 (0.13 - 0.49) n = 11	0.17	0.38	0.17	0.17	0.17	0.17	0.17	0.38	0.37	0.36	0.35	0.35

Table 3.3-10 Predicted Water Quality in Pierre River (continued)

Parameter	Unit	Water Quality Guideline		Chronic Effects Benchmark	Observed Natural Variation [c]	Pre-Industrial Case		2013 Planned Development Case									
		Aquatic Life[a][b]				Median Concentration	Peak Concentration	Median Concentration					Peak Concentration				
		Acute	Chronic					2018	2034	2042	2052	2152	2018	2034	2042	2052	2152
Sulphate	mg/L	-	-	309	74 (2.2 - 124) n = 26	45	106	39	55	46	42	42	105	181	106	105	105
Sulphide	mg/L	-	0.009	0.002	0.016 (<0.002 - 0.041) n = 11	**0.0088**	**0.14**	0.0088	0.0068	0.0067	0.0083	0.0083	**0.14**	**0.074**	**0.074**	**0.11**	**0.11**
Tainting potential	TPU	-	1.0	-	-	0	0	0	0	0	0.00028	0.000025	0	0	0	0.044	0.0075
Thallium	mg/L	-	0.0008	-	<0.0001 (<0.0001 - 0.0002) n = 11	0.000036	0.00028	0.000034	0.000037	0.000034	0.000034	0.000034	0.0003	0.00024	0.00025	0.00029	0.00029
Total dissolved solids	mg/L	-	-	1000	256 (144 - 720) n = 26	243	510	236	265	254	245	245	485	606	424	427	427
Total nitrogen	mg/L	-	1.0	-	1 (0.065 - 1.9) n = 23	0.6	**3.3**	0.59	0.68	0.66	0.62	0.62	**3.3**	**3.1**	**2.8**	**3.1**	**3.1**
Total phenolics	mg/L	-	0.004	0.01	0.0074 (<0.001 - 0.029) n = 24	**0.0047**	**0.031**	**0.0041**	**0.0047**	**0.004**	**0.0041**	**0.0041**	**0.031**	**0.036**	**0.022**	**0.021**	**0.021**
Total phosphorus	mg/L	-	0.05	-	0.09 (0.018 - 0.23) n = 26	**0.089**	**1.2**	**0.09**	**0.078**	**0.079**	**0.087**	**0.087**	**1.2**	**0.87**	**0.88**	**0.97**	**0.97**
Toxicity- acute	TUa	0.3	0.3	-	-	0	0	0	0	0	0	0	0	0	0	0.0032	0.002
Toxicity- chronic	TUc	-	1.0	-	-	0	0	0	0	0	0.000075	0.00005	0	0	0	0.011	0.0071
Uranium	mg/L	0.033	0.015	-	0.00029 (<0.0001 - 0.0018) n = 11	0.00028	0.0021	0.00029	0.00029	0.00034	0.00031	0.00031	0.0022	0.0021	0.0021	0.0022	0.0022
Vanadium	mg/L	-	-	0.034	0.0016 (<0.0002 - 0.0049) n = 11	0.0022	0.048	0.0021	0.002	0.0019	0.0021	0.0021	0.048	0.036	0.037	0.036	0.036
Zinc	mg/L	0.17	0.03	0.14	0.006 (0.0031 - 0.054) n = 11	0.014	**0.1**	0.014	0.015	0.015	0.014	0.014	**0.1**	**0.089**	**0.092**	**0.097**	**0.097**

[a] – = No guideline/No data.

[b] From U.S. EPA (2002, 2003, and 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 7.8, temperature of 6.7°C and hardness of 153 mg/L (reflective of on-site conditions).

[c] Observed natural variation from 1976 to 2010, based on information from the EIA (Golder 2007, Water Quality Section, Appendix F) and ESRD (2012).

Notes: **Bold** number indicates concentration exceeds chronic guideline for the protection of aquatic life.
The CEB values were updated in this submission.

Eymundson Creek at the Mouth (Node EC)

In 2018, water quality results for this node are the same as the 2013 PRM Application Case (Appendix 1, Section 3.4.2). In 2034 and 2042, Eymundson Creek and Pierre River are diverted into the same channel, and water quality is assessed at the mouth of the Pierre River diversion channel, as discussed above. In 2052 and 2152, water quality of Eymundson Creek is assessed at the South Pit Lake. There is no change at this assessment node compared to the results presented for the 2013 PRM Application Case in Appendix 1, Section 3.4.

Big Creek at the Mouth (Node BC)

During all snapshots, the substances predicted to exceed guidelines in Big Creek are also predicted to exceed guidelines under PIC conditions, except for chloride, molybdenum and PAH Groups 1, 2, 5, 7 and 9 (Table 3.3-11).

In 2018, median concentrations of barium, PAH Groups 3 and 6, and total phenolics and peak concentrations of copper, PAH Groups 1 to 9, strontium and sulphate are predicted to increase relative to the PIC, but remain below CEBs. Median concentrations of calcium and iron and peak concentrations of cobalt, lead, lithium, manganese, and sodium are predicted to exceed all screening criteria (Table 3.3-11). The increases are due to discharge of muskeg drainage and overburden dewatering from the Teck Frontier Mine and also watershed diversions, which incorporate natural lands with slightly different runoff chemistry.

In 2034 and 2042, Big Creek will be directed to the South Redclay Lake. The act of impounding water tends to increase median concentrations and decrease peak concentrations because of the longer residence times in waterbodies compared to watercourses. In 2034, concentrations of some substances are predicted to increase relative to PIC because of water impoundment, watershed diversions, closed-circuiting of land areas, and discharge of muskeg drainage and overburden dewatering from Teck Frontier mine. In particular, median concentrations of PAH Groups 3 and 6 and peak concentrations of PAH Groups 3, 4 and 6 are predicted to increase relative to PIC, but remain below CEBs. In 2042, median concentrations of cobalt and manganese are predicted to increase relative to PIC, but remain below CEBs. The median concentration of iron is predicted to exceed all screening criteria (Table 3.3-11).

In 2052, watershed diversions are predicted to increase median concentrations of total phosphorus relative to the PIC. In 2152, discharge from Teck Frontier's South Central Pit Lake and process-affected seepages are predicted to increase concentrations of some substances. In particular, median concentrations of antimony, barium, beryllium, chromium, manganese, PAH Group 6, strontium, sulphate, TDS and vanadium, and peak concentrations of antimony, molybdenum, PAH Groups 2 and 6 and strontium are predicted to increase relative to the PIC, but remain below CEBs. Median concentrations of aluminum, calcium, cobalt, iron, lithium, sodium, total nitrogen and total phosphorus, and peak concentrations of boron, cadmium, calcium, chloride, cobalt, lithium, sodium and TDS are predicted to exceed the screening criteria (Table 3.3-11).

South Redclay Lake (Node RCL)

In all snapshots, the substances predicted to exceed guidelines in Redclay Creek are also predicted to exceed guidelines under PIC, except for molybdenum and PAH Groups 1, 2, 5, 7 and 9 (Table 3.3-12).

Table 3.3-11 Predicted Water Quality in Big Creek

Parameter	Unit	Water Quality Guideline Aquatic Life [a, b]		Chronic Effects Benchmark	Observed Natural Variation [c]	Pre-Industrial Case		2013 Planned Development Case									
						Median Concentration	Peak Concentration	Median Concentration					Peak Concentration				
		Acute	Chronic					2018	2034	2042	2052	2152	2018	2034	2042	2052	2152
Aluminum	mg/L	0.75	0.1	0.15	0.13 (0.018 - 9) n = 41	**0.12**	**3.9**	**0.18**	**0.23**	**0.3**	0.094	**0.27**	**6.5**	**0.7**	**1.1**	**2.6**	**3.4**
Ammonia	mg/L	18.32	1.27	2	<0.05 (<0.05 - 1.4) n = 41	0.031	0.73	0.077	0.01	0.0082	0.029	0.024	0.89	0.073	0.093	0.63	0.68
Antimony	mg/L	-	-	0.157	0.0007 (0.000057 - 0.0017) n = 41	0.00076	0.0013	0.00074	0.00071	0.00072	0.00074	0.0011	0.0013	0.00091	0.00091	0.0013	0.0024
Arsenic	mg/L	0.34	0.005	0.025	0.00078 (<0.0004 - 0.041) n = 41	0.0014	**0.0095**	0.0015	0.0013	0.0014	0.0013	0.0023	**0.015**	0.0022	0.0026	**0.0076**	**0.0082**
Barium	mg/L	-	-	5.8	0.07 (0.026 - 0.54) n = 41	0.062	0.36	0.071	0.064	0.061	0.058	0.094	0.46	0.1	0.1	0.44	0.37
Beryllium	mg/L	-	-	0.0053	<0.001 (<0.0001 - <0.001) n = 41	0.00021	0.00065	0.00021	0.00018	0.00019	0.00019	0.0004	0.00065	0.00027	0.0004	0.00044	0.001
Boron	mg/L	29	1.5	1.5	0.07 (0.03 - 0.14) n = 41	0.08	0.41	0.081	0.094	0.096	0.073	0.48	0.68	0.28	0.28	0.49	**1.6**
Cadmium	mg/L	0.0037	0.0004	0.00025	<0.0002 (<0.000005 - 0.0004) n = 41	0.000065	**0.00032**	0.000073	0.000065	0.000073	0.00006	**0.00039**	**0.00072**	0.00014	0.0002	**0.0003**	**0.0013**
Calcium	mg/L	-	-	-	52 (25 - 92) n = 60	45	80	50	42	40	44	52	108	50	47	79	95
Chloride	mg/L	640	120	-	1.3 (<0.1 - 3) n = 60	2.3	4.9	2.5	2.2	2.2	2.2	55	7.2	2.9	3.0	4.9	**198**
Chromium	mg/L	0.016	0.001	0.089	0.001 (0.00045 - 0.017) n = 41	**0.0013**	**0.024**	**0.0015**	**0.0015**	**0.0015**	**0.0011**	**0.0022**	**0.028**	**0.005**	**0.0051**	**0.018**	**0.023**
Cobalt	mg/L	-	-	0.004	0.0004 (<0.0002 - 0.012) n = 41	0.001	0.0061	0.00047	0.001	0.0015	0.00082	0.0055	0.018	0.0037	0.0053	0.0059	0.017
Copper	mg/L	0.023	0.0037	0.0256	0.001 (0.0004 - 0.019) n = 41	0.0014	**0.018**	0.0019	0.0023	0.0027	0.0016	0.003	**0.022**	**0.006**	**0.012**	**0.015**	**0.013**
Iron	mg/L	-	0.3	1.5	1 (0.073 - 25) n = 40	**1.8**	**14**	**2.0**	**1.8**	**2.3**	**1.5**	**2.7**	**24**	**3.4**	**5.3**	**8.9**	**9.8**
Lead	mg/L	0.16	0.0063	0.005	0.0002 (<0.0001 - 0.0095) n = 41	0.00036	**0.0069**	0.0004	0.00042	0.00062	0.0003	0.00062	**0.012**	0.0021	0.0035	0.0063	0.0055
Lithium	mg/L	-	-	-	0.03 (0.011 - 0.063) n = 41	0.032	0.073	0.036	0.03	0.029	0.029	0.053	0.11	0.036	0.036	0.067	0.13
Manganese	mg/L	-	-	1.455	0.24 (0.032 - 4.2) n = 40	0.29	2.4	0.3	0.26	0.33	0.26	0.41	6.2	0.63	1.2	1.6	2.2
Mercury	mg/L	0.000013	0.000005	0.00005	<0.0000006 (<0.0000006 - 0.0000076) n = 41	0.00000042	**0.000015**	0.00000082	0.0000015	0.0000011	0.00000055	0.0000009	**0.000016**	0.0000049	0.0000046	**0.000016**	**0.000014**
Molybdenum	mg/L	-	0.073	38.7	0.0004 (<0.0001 - 0.002) n = 41	0.00061	0.0026	0.00063	0.00062	0.00066	0.00053	0.073	0.0025	0.00091	0.0013	0.0029	**0.27**
Naphthenic Acids - Inert	mg/L	-	-	-	-	0.26	0.79	0.29	0.32	0.32	0.25	3.6	1.1	0.56	0.57	0.93	13
Naphthenic Acids - Labile	mg/L	-	-	1	-	0	0	0	0	0	0	0.015	0	0	0	0	0.049
Naphthenic Acids - Refractory	mg/L	-	-	-	-	0.51	1.4	0.58	0.6	0.6	0.5	4.0	1.9	0.83	0.92	1.2	12
Naphthenic Acids - Total (Lower)	mg/L	-	-	-	<1 (<1 - 3) n = 60	0.26	0.79	0.29	0.32	0.32	0.25	3.6	1.1	0.56	0.57	0.93	12
Naphthenic Acids - Total (Upper)	mg/L	-	-	-	<1 (<1 - 3) n = 60	0.51	1.4	0.58	0.6	0.6	0.5	4.0	1.9	0.83	0.92	1.2	13
Nickel	mg/L	0.735	0.082	0.125	0.0036 (<0.0002 - 0.029) n = 41	0.0042	0.018	0.0045	0.0046	0.0057	0.0038	0.0077	0.028	0.007	0.015	0.019	0.019
Nitrate	mg/L	124	2.93	-	0.1 (<0.003 - 0.3) n = 60	0.033	0.23	0.042	0.028	0.026	0.031	0.049	0.23	0.057	0.055	0.23	0.2
PAH group 1	µg/L	-	0.015	0.281	<0.04 (<0.00022 - <0.04) n = 19	0	0	0.00025	0.0007	0	0	0.0014	**0.075**	0.0018	0	0	0.0039
PAH group 2	µg/L	-	0.018	0.278	<0.04 (0.00075 - <0.04) n = 19	0	0	0.00052	0.0017	0	0	0.0066	**0.16**	0.0047	0	0	**0.019**
PAH group 3	µg/L	-	-	0.99	<0.01 (0.00022 - <0.01) n = 19	0	0	0.00015	0.0004	0	0	0	0.041	0.0014	0	0	0
PAH group 4	µg/L	-	5.8	41.5	<0.04 (<0.00032 - <0.04) n = 19	0	0	0.0003	0.0003	0	0	0.00012	0.041	0.0006	0	0	0.0005
PAH group 5	µg/L	-	0.012	5.6	0.04 (0.0013 - 0.051) n = 19	0	0	0.0016	0.0056	0	0	0.00065	**1.2**	**0.014**	0	0	0.0023
PAH group 6	µg/L	-	-	64	<0.04 (0.0012 - 0.1) n = 19	0	0	0.000025	0.0001	0	0	0.0051	0.0058	0.0002	0	0	0.014
PAH group 7	µg/L	-	0.04	5.9	<0.04 (0.00045 - 0.051) n = 19	0	0	0.0014	0.0073	0	0	0.0038	**1.5**	0.037	0	0	0.011
PAH group 8	µg/L	-	1.1	32	<0.04 (0.0044 - 0.15) n = 19	0	0	0.00033	0.001	0	0	0.0068	0.14	0.0035	0	0	0.02
PAH group 9	µg/L	-	0.025	2.3	<0.04 (0.0033 - <0.04) n = 19	0	0	0.00062	0.0025	0	0	0.0013	**0.32**	0.0055	0	0	0.0038
Selenium	mg/L	-	0.001	-	<0.0004 (<0.0002 - 0.003) n = 41	0.00039	**0.0022**	0.0004	0.00034	0.00035	0.00035	0.00067	**0.0029**	0.00062	0.00078	**0.0017**	**0.0023**
Silver	mg/L	0.01	0.0001	0.00022	0.00001 (0.0000009 - 0.00011) n = 41	0.000015	0.000081	0.000016	0.000015	0.000015	0.000013	0.000037	0.000085	0.00003	0.000031	0.000084	**0.0001**
Sodium	mg/L	-	-	-	12 (2 - 25) n = 60	13	23	13	12	12	12	37	34	16	17	22	110
Strontium	mg/L	-	-	14.1	0.17 (0.1 - 0.44) n = 41	0.17	0.38	0.18	0.16	0.16	0.17	0.31	0.44	0.19	0.2	0.34	0.81

Table 3.3-11 Predicted Water Quality in Big Creek (continued)

Parameter	Unit	Water Quality Guideline Aquatic Life (a, b)		Chronic Effects Benchmark	Observed Natural Variation (c)	Pre-Industrial Case		2013 Planned Development Case									
						Median Concentration	Peak Concentration	Median Concentration					Peak Concentration				
		Acute	Chronic					2018	2034	2042	2052	2152	2018	2034	2042	2052	2152
Sulphate	mg/L	-	-	309	47 (1.4 - 170) n = 58	49	109	52	58	60	46	71	160	76	77	106	139
Sulphide	mg/L	-	0.007	0.002	0.0075 (<0.002 - 0.8) n = 46	**0.0072**	**0.062**	**0.0072**	0	0.000075	**0.007**	0.0035	**0.063**	0.0028	0.0027	**0.039**	**0.04**
Tainting potential	TPU	-	1	-	-	0	0	0	0	0	0	0.074	0	0	0	0	0.28
Thallium	mg/L	-	0.0008	-	<0.0001 (<0.0001 - 0.0002) n = 41	0.000034	0.00026	0.000037	0.000033	0.000034	0.000032	0.000048	0.00024	0.000083	0.000082	0.00027	0.00022
Total dissolved solids	mg/L	-	-	1000	255 (140 - 452) n = 59	256	448	258	257	253	246	448	462	282	290	400	1090
Total nitrogen	mg/L	-	1	-	0.76 (<0.2 - 3.2) n = 56	0.68	**2.6**	0.7	0.7	0.7	0.64	**1.3**	**2.5**	**1.0**	**1.0**	**2.4**	**3.0**
Total phenolics	mg/L	-	0.004	0.01	0.003 (<0.001 - 0.022) n = 57	**0.004**	**0.024**	**0.0051**	0.0002	0.0002	**0.0042**	0.002	**0.033**	0.0033	0.0032	**0.024**	**0.02**
Total phosphorus	mg/L	-	0.05	-	0.079 (0.027 - 1.5) n = 57	**0.074**	**0.94**	**0.09**	**0.11**	**0.11**	**0.092**	**0.12**	**1.1**	**0.25**	**0.25**	**0.74**	**0.81**
Toxicity- acute	TUa	0.3	0.3	-	-	0	0	0	0	0	0	0.011	0	0	0	0	0.033
Toxicity- chronic	TUc	-	1	-	-	0	0	0	0	0	0	0.025	0	0	0	0	0.081
Uranium	mg/L	0.033	0.015	-	0.0002 (<0.0001 - 0.0014) n = 41	0.00032	0.002	0.00038	0.00045	0.00035	0.00029	0.00085	0.0061	0.00075	0.00072	0.0021	0.0023
Vanadium	mg/L	-	-	0.0338	0.001 (<0.0002 - 0.042) n = 41	0.0019	0.035	0.0022	0.003	0.0033	0.002	0.0062	0.049	0.011	0.011	0.035	0.031
Zinc	mg/L	0.188	0.03	0.138	0.006 (0.0022 - 0.17) n = 41	0.013	**0.089**	0.013	0.013	0.013	0.013	0.017	**0.086**	**0.044**	**0.047**	**0.088**	**0.078**

(a) – = No guideline/No data.

(b) From U.S. EPA (2002, 2003, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 7.7, temperature of 6.8°C and hardness of 174 mg/L (reflective of on-site conditions).

(c) Observed natural variation from 1976 to 2010, based on information from the EIA (Golder 2007, Water Quality Section, Appendix F) and ESRD (2012).

Notes: **Bold** number indicates concentration exceeds chronic guideline for the protection of aquatic life.
The CEB values were updated in this submission.

Table 3.3-12 Predicted Water Quality in South Redclay Lake

Parameter	Unit	Water Quality Guideline Aquatic Life [(a, b)]		Chronic Effects Benchmark	Observed Natural Variation [(c)]	Pre-Industrial Case [(d)]		2013 Planned Development Case									
						Median Concentration	Peak Concentration	Median Concentration					Peak Concentration				
		Acute	Chronic					2018	2034	2042	2052	2152	2018	2034	2042	2052	2152
Aluminum	mg/L	0.75	0.1	0.15	0.07 (0.006 - 9) n = 91	0.038 - 0.12	**2.1 - 3.9**	0.032	**0.23**	**0.27**	**0.23**	**0.45**	**1.2**	**0.51**	**0.56**	**0.5**	**0.77**
Ammonia	mg/L	25.7	1.55	2	<0.05 (<0.05 - 1.4) n = 91	0.031 - 0.045	0.73 - 0.86	0.064	0.00092	0.00092	0.0015	0.0013	0.92	0.012	0.013	0.014	0.014
Antimony	mg/L	-	-	0.157	0.0007 (<0.0002 - 0.0018) n = 89	0.00058 - 0.00076	0.0012 - 0.0013	0.00052	0.00069	0.0007	0.00069	0.0012	0.0011	0.00082	0.00083	0.00082	0.0015
Arsenic	mg/L	0.34	0.005	0.025	0.0004 (<0.0002 - 0.041) n = 91	0.00024 - 0.0014	0.00098 - 0.0095	0.00022	0.00098	0.001	0.0009	0.002	0.0012	0.0011	0.0012	0.0011	0.0025
Barium	mg/L	-	-	5.8	0.051 (0.013 - 0.54) n = 91	0.039 - 0.062	0.087 - 0.36	0.04	0.054	0.053	0.054	0.09	0.096	0.071	0.068	0.067	0.12
Beryllium	mg/L	-	-	0.0053	<0.001 (<0.001 - <0.001) n = 65	0.00021 - 0.0005	0.00065 - 0.0007	0.00048	0.00033	0.00036	0.00032	0.00053	0.00068	0.00037	0.00041	0.00038	0.00067
Boron	mg/L	29	1.5	1.5	0.1 (0.03 - 0.17) n = 91	0.08 - 0.11	0.16 - 0.41	0.11	0.12	0.12	0.12	0.63	0.73	0.16	0.16	0.16	0.88
Cadmium	mg/L	0.005	0.0005	0.00025	<0.0002 (<0.000005 - 0.0004) n = 71	0.000065 - 0.000089	0.00014 - 0.00032	0.000076	0.00009	0.0001	0.000089	**0.00063**	**0.00053**	0.00011	0.00012	0.00011	**0.00088**
Calcium	mg/L	-	-	-	-	42 - 45	80 - 102	43	43	42	43	62	94	51	51	51	74
Chloride	mg/L	640	120	-	2 (<0.1 - 3.1) n = 111	2.3 - 2.6	4.9 - 9.4	2.3	2.7	2.8	2.7	77	9.0	3.3	3.4	3.3	109
Chromium	mg/L	0.016	0.001	0.089	<0.0008 (<0.0008 - 0.039) n = 91	0.00066 - 0.0013	**0.0025 - 0.024**	0.00063	**0.0015**	**0.0016**	**0.0015**	**0.0027**	**0.0025**	**0.0022**	**0.0022**	**0.0021**	**0.0034**
Cobalt	mg/L	-	-	0.004	-	0.00013 - 0.001	0.0006 - 0.0061	0.00014	**0.00072**	**0.001**	**0.00065**	**0.0062**	0.00087	**0.0011**	**0.0013**	**0.0011**	**0.0068**
Copper	mg/L	0.031	0.0048	0.0256	<0.001 (0.0002 - 0.019) n = 91	0.0006 - 0.0014	0.0017 - 0.018	0.00062	0.0018	0.002	0.0017	0.0032	0.0018	0.0024	0.0029	0.0023	0.0041
Iron	mg/L	-	0.3	1.5	1.4 (0.073 - 26) n = 90	**1.1 - 1.8**	**8.8 - 14**	**1.2**	**1.6**	**2.0**	**1.6**	**2.6**	**11**	**2.3**	**2.8**	**2.2**	**3.5**
Lead	mg/L	0.236	0.0092	0.005	0.0001 (<0.0001 - 0.0095) n = 91	0.00011 - 0.00036	0.00074 - 0.0069	0.0001	0.00042	0.00055	0.00036	0.0012	0.00061	0.00072	0.00097	0.0007	0.0014
Lithium	mg/L	-	-	-	-	0.032 - 0.048	0.073 - 0.076	0.046	**0.035**	**0.036**	**0.033**	**0.069**	0.1	**0.043**	**0.044**	**0.042**	**0.081**
Manganese	mg/L	-	-	1.455	0.26 (0.032 - 2.8) n = 88	0.27 - 0.29	2.4 - 3.1	0.3	0.34	0.41	0.33	0.59	3.1	0.54	0.82	0.53	0.79
Mercury	mg/L	0.000013	0.000005	0.00005	<0.0000006 (<0.0000006 - 0.00001) n = 93	0.0000003 - 0.00000042	0.0000015 - 0.000015	0.00000032	0.000001	0.0000009	0.0000009	0.0000013	0.0000041	0.0000015	0.0000013	0.0000015	**0.0000098**
Molybdenum	mg/L	-	0.073	38.7	0.0002 (<0.0001 - 0.002) n = 91	0.000096 - 0.00061	0.00049 - 0.0026	0.000095	0.00041	0.00042	0.00037	**0.1**	0.001	0.00047	0.00057	0.00043	**0.14**
Naphthenic Acids - Inert	mg/L	-	-	-	-	0.26 - 0.26	0.77 - 0.79	0.51	0.65	0.67	0.65	5.1	1.5	0.74	0.76	0.74	8.1
Naphthenic Acids - Labile	mg/L	-	-	1	-	0	0	0	0	0	0	0.0066	0	0	0	0	0.028
Naphthenic Acids - Refractory	mg/L	-	-	-	-	0.51 - 0.52	1.1 - 1.4	0.51	0.62	0.64	0.61	4.8	1.5	0.7	0.71	0.69	7.1
Naphthenic Acids - Total (Lower)	mg/L	-	-	-	-	0.26 - 0.26	0.77 - 0.79	0.51	0.62	0.64	0.61	4.8	1.5	0.7	0.71	0.69	7.1
Naphthenic Acids - Total (Upper)	mg/L	-	-	-	-	0.51 - 0.52	1.1 - 1.4	0.51	0.65	0.67	0.65	5.1	1.5	0.74	0.76	0.74	8.1
Nickel	mg/L	0.95	0.106	0.125	0.0018 (<0.0002 - 0.029) n = 91	0.00085 - 0.0042	0.0024 - 0.018	0.00085	0.0034	0.004	0.0032	0.0076	0.004	0.004	0.0046	0.0039	0.01
Nitrate	mg/L	124	2.93	-	-	0.014 - 0.033	0.16 - 0.23	0.021	0.03	0.03	0.03	0.06	0.18	0.041	0.041	0.04	0.079
PAH group 1	µg/L	-	0.015	0.281	<0.04 (<0.00022 - <0.04) n = 19	0	0	0.00005	0.0002	0	0	0.0019	**0.021**	0.0003	0	0	0.0025
PAH group 2	µg/L	-	0.018	0.278	<0.04 (<0.00023 - <0.04) n = 19	0	0	0.00015	0.0006	0	0	0.0099	**0.039**	0.0012	0	0	0.014
PAH group 3	µg/L	-	-	0.99	<0.01 (<0.00012 - <0.01) n = 19	0	0	0.000025	0.0001	0	0	0	0.015	0.0003	0	0	0.0001
PAH group 4	µg/L	-	5.8	41.5	<0.04 (<0.00032 - <0.04) n = 19	0	0	0.0001	0	0	0	0.0001	0.01	0.00005	0	0	0.0002
PAH group 5	µg/L	-	0.012	5.6	<0.04 (0.0015 - 0.1) n = 19	0	0	0.00035	0.0004	0	0	0.0004	**0.54**	0.0011	0	0	0.0014
PAH group 6	µg/L	-	-	64	<0.04 (<0.0015 - 0.1) n = 19	0	0	0	0	0	0	0.0077	0.0015	0.0001	0	0	0.011
PAH group 7	µg/L	-	0.04	5.9	<0.04 (0.0099 - 0.051) n = 19	0	0	0.00028	0.0013	0	0	0.0036	**0.63**	0.0029	0	0	0.0075
PAH group 8	µg/L	-	1.1	32	<0.04 (0.01 - 0.15) n = 19	0	0	0.000075	0.0002	0	0	0.0084	0.026	0.0004	0	0	0.012
PAH group 9	µg/L	-	0.025	2.3	<0.04 (0.00071 - <0.04) n = 19	0	0	0.00015	0.0005	0	0	0.0016	**0.15**	0.0008	0	0	0.0026
Selenium	mg/L	-	0.001	-	<0.0004 (<0.0002 - 0.008) n = 91	0.0002 - 0.00039	**0.0015 - 0.0022**	0.0002	0.0003	0.00032	0.00028	0.00073	**0.0021**	0.0004	0.00048	0.00037	0.00099

Table 3.3-12 Predicted Water Quality in South Redclay Lake (continued)

Parameter	Unit	Water Quality Guideline		Chronic Effects Benchmark	Observed Natural Variation [c]	Pre-Industrial Case [d]		2013 Planned Development Case									
		Aquatic Life [a, b]				Median Concentration	Peak Concentration	Median Concentration					Peak Concentration				
		Acute	Chronic					2018	2034	2042	2052	2152	2018	2034	2042	2052	2152
Silver	mg/L	0.017	0.0001	0.00022	0.0000086 (0.0000009 - 0.00011) n = 92	0.0000088 - 0.000015	0.000051 - 0.000081	0.0000085	0.000013	0.000013	0.000013	0.000045	0.000052	0.000015	0.000015	0.000015	0.000059
Sodium	mg/L	-	-	-	-	13 - 13	23 - 26	13	13	13	13	53	26	15	16	15	74
Strontium	mg/L	-	-	14.1	0.19 (0.086 - 0.44) n = 91	0.17 - 0.25	0.38 - 0.52	0.26	0.22	0.23	0.23	0.47	0.54	0.26	0.27	0.27	0.61
Sulphate	mg/L	-	-	309	66 (1.4 - 209) n = 109	49 - 82	109 - 195	72	75	77	73	86	190	90	94	90	104
Sulphide	mg/L	-	0.005	0.002	0.008 (<0.002 - 0.14) n = 92	**0.0061 - 0.0072**	**0.033 - 0.062**	**0.0052**	0	0	0	0	**0.026**	0.00036	0.00037	0.00062	0.00048
Tainting potential	TPU	-	1	-	-	0	0	0	0	0	0	0.013	0	0	0	0	0.052
Thallium	mg/L	-	0.0008	-	-	0.000014 - 0.000034	0.00011 - 0.00026	0.000017	0.000036	0.000036	0.000036	0.000084	0.0001	0.000054	0.000053	0.000054	0.0001
Total dissolved solids	mg/L	-	-	1000	264 (140 - 690) n = 110	256 - 298	448 - 658	279	285	285	282	563	602	339	342	335	693
Total nitrogen	mg/L	-	1	-	0.7 (<0.2 - 3.2) n = 107	0.68 - 0.7	**2.2 - 2.6**	0.71	0.77	0.78	0.75	**1.5**	**2.2**	0.94	0.94	0.93	**1.9**
Total phenolics	mg/L	-	0.004	0.01	0.003 (<0.001 - 0.022) n = 107	0.003 - 0.004	**0.022 - 0.024**	0.0023	0	0	0	0	**0.021**	0.00055	0.0005	0.0008	0.0005
Total phosphorus	mg/L	-	0.05	-	0.088 (0.007 - 2.2) n = 109	**0.07 - 0.074**	**0.39 - 0.94**	**0.071**	**0.1**	**0.11**	**0.1**	**0.13**	**0.35**	**0.13**	**0.13**	**0.14**	**0.18**
Toxicity- acute	TUa	0.3	0.3	-	-	0	0	0	0	0	0	0.012	0	0	0	0	0.02
Toxicity- chronic	TUc	-	1	-	-	0	0	0	0	0	0	0.019	0	0	0	0	0.045
Uranium	mg/L	0.033	0.015	-	-	0.00001 - 0.00032	0.000075 - 0.002	0.000033	0.00025	0.0002	0.0002	0.0013	0.0029	0.00036	0.00028	0.0003	0.0016
Vanadium	mg/L	-	-	0.0338	0.0006 (<0.0002 - 0.042) n = 91	0.00025 - 0.0019	0.0022 - 0.035	0.0003	0.0023	0.0023	0.0022	0.0066	0.0021	0.0037	0.0035	0.0035	0.01
Zinc	mg/L	0.243	0.03	0.138	0.0085 (<0.003 - 0.17) n = 90	0.0078 - 0.013	**0.079 - 0.089**	0.0073	0.015	0.017	0.015	0.016	**0.074**	0.023	0.025	0.022	0.022

(a) – = No guideline/No data.

(b) From U.S. EPA (2002, 2003, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 7.4, temperature of 4.6°C and hardness of 230 mg/L (reflective of on-site conditions).

(c) Observed natural variation at Redclay Creek from 1976 to 2010, based on information from the EIA (Golder 2007, Water Quality Section, Appendix F) and ESRD (2012).

(d) Predicted concentrations at Big Creek and Redclay Creek.

Notes: **Bold** number indicates concentration exceeds chronic guideline for the protection of aquatic life.
The CEB values were updated in this submission.

In 2018, watershed diversions and discharge of muskeg drainage and overburden dewatering by the Teck Frontier Mine are predicted to increase concentrations of some substances. In particular, median concentrations of manganese and PAH Group 3, and peak concentrations of cobalt and PAH Groups 1 to 9 are predicted to increase relative to the PIC, but remain below CEBs. Peak concentrations of cadmium, lithium, iron and selenium are predicted to exceed all screening criteria (Table 3.3-12).

In 2034, median and peak concentrations of PAH Group 3 and peak concentration of PAH Group 6 are predicted to increase relative to the PIC, but remain below CEBs. These increases are due to dewatering to Big Creek that eventually discharges to the South Redclay Lake. In 2042 and 2052, concentrations of all assessed substances are predicted to stay below CEBs.

In 2152, concentrations of some substances are predicted to increase because of discharge from Teck Frontier Mine including process-affected seepage from the external tailings area and discharge from Central Pit Lake A. During this snapshot, median concentrations of molybdenum, PAH Group 6, strontium and TDS, and peak concentrations of antimony, barium, chromium, mercury and PAH Group 3 are predicted to increase relative to PIC, but remain below CEBs. Median concentrations of cadmium, calcium, lithium, sodium and total nitrogen are predicted to exceed all screening criteria (Table 3.3-12).

Athabasca River

In the Athabasca River, levels of acute and chronic toxicity and tainting potential are predicted to remain below guideline values for all snapshots under the 2013 PDC. Substances predicted to exceed guidelines are also predicted to exceed guidelines under PIC conditions (Tables 3.3-13 and 3.3-14).

Concentrations of naphthenic acids are predicted to have negligible changes from the 2013 Base Case concentrations at both assessment nodes. At the Far Future snapshot, median concentrations of antimony and manganese are predicted to increase relative to 2013 Base Case concentrations but remain below CEBs in the Athabasca River downstream of Redclay Creek. Overall, the PRM, along with existing, approved and planned developments, is predicted to cause negligible changes to water quality in the Athabasca River. Because the PRM is predicted to have negligible effects on the water quality of the Athabasca River at Embarras, the PRM is consequently predicted to have negligible effects on the water quality downstream of this point as well.

In this submission, predicted concentrations in Athabasca River upstream of Old Fort were also compared to the water quality limits developed by the *Lower Athabasca Region Surface Water Quality Management Framework for the Lower Athabasca River* (Government of Alberta 2012). The 95^{th} percentile of PIC and 2013 PDC results for the constituents that have water quality limits are shown in Table 3.3-15. Concentrations of the assessed constituents are predicted to remain below the Framework water quality limits.

3.3.1.2 Summary of Results

Water quality was assessed for the LSA and the Athabasca River under the 2013 PDC. Increases in constituent concentrations in LSA watercourses were predicted due to the Teck Frontier Mine, which is the only other planned project in the LSA. Negligible changes were predicted to pit lakes or to the Athabasca River under the 2013 PDC. These changes were further assessed for effects on Aquatic Health in Section 3.3.4, and for Human and Wildlife Health in Section 3.2.3.

Table 3.3-13 Predicted Water Quality in Athabasca River at the Mouth of Redclay Creek

Parameter	Unit	Water Quality Guideline Aquatic Life[(a)(b)] Acute	Water Quality Guideline Aquatic Life[(a)(b)] Chronic	Chronic Effect Benchmarks	Natural Variation Observed [(c)]	Pre-Industrial Case Median Concentration	Pre-Industrial Case Peak [(d)] Concentration	2013 Planned Development Case 2018 Median	2018 Peak [(d)]	2034 Median	2034 Peak [(d)]	2042 Median	2042 Peak [(d)]	2052 Median	2052 Peak [(d)]	2152 Median	2152 Peak [(d)]
Aluminum	mg/L	0.75	0.1	0.15	0.88 (0.02 - 21) n = 136	**0.91**	**17**	**0.9**	**17**	**0.9**	**17**	**0.9**	**17**	**0.9**	**17**	**0.9**	**17**
Ammonia	mg/L	9.81	0.67	2	<0.05 (0.02 - 0.47) n = 146	0.042	0.18	0.049	0.21	0.053	0.27	0.052	0.27	0.053	0.27	0.052	0.26
Antimony	mg/L	-	-	0.157	0.000063 (0.000032 - 0.001) n = 124	0.00008	0.00027	0.0001	0.0003	0.0001	0.0003	0.00011	0.0003	0.00013	0.0003	0.00013	0.0003
Arsenic	mg/L	0.34	0.005	0.025	0.00082 (0.0003 - 0.0085) n = 165	0.0007	0.0031	0.0007	0.0031	0.0007	0.0031	0.0007	0.0031	0.0007	0.0031	0.0007	0.0031
Barium	mg/L	-	-	5.8	0.063 (0.042 - 0.53) n = 162	0.073	0.1	0.074	0.1	0.074	0.104	0.074	0.104	0.074	0.104	0.074	0.104
Beryllium	mg/L	-	-	0.0053	0.000065 (<0.000003 - 0.01) n = 136	0.0001	0.0009	0.0001	0.0009	0.0001	0.0009	0.0001	0.0009	0.0001	0.0009	0.0001	0.0009
Boron	mg/L	29	1.5	1.5	0.029 (0.015 - 0.052) n = 135	0.039	0.078	0.047	0.103	0.048	0.092	0.053	0.114	0.057	0.13	0.061	0.15
Cadmium	mg/L	0.0026	0.00031	0.00025	0.000032 (<0.000002 - 0.0005) n = 122	0.00009	**0.00039**	0.00011	**0.0004**	0.00011	**0.0004**	0.00011	**0.00041**	0.00012	**0.00041**	0.00013	**0.00041**
Calcium	mg/L	-	-	-	31 (21 - 60) n = 212	31	54	32	56	32	55	32	55	32	54	32	54
Chloride	mg/L	640	120	-	10 (1.3 - 54) n = 210	13	54	14	57	14	58	14	57	14	58	15	58
Chromium	mg/L	0.016	0.001	0.089	0.0019 (<0.00003 - 0.027) n = 167	**0.0025**	**0.011**	**0.0026**	**0.011**	**0.0026**	**0.011**	**0.0026**	**0.011**	**0.0026**	**0.011**	**0.0026**	**0.011**
Cobalt	mg/L	-	-	0.004	0.00056 (0.000044 - 0.01) n = 166	0.00081	0.007	0.00088	0.007	0.00088	0.007	0.00088	0.007	0.00089	0.007	0.00094	0.007
Copper	mg/L	0.017	0.0028	0.0256	0.0015 (0.00046 - 0.017) n = 167	0.0019	**0.012**	0.002	**0.012**	0.002	**0.012**	0.002	**0.012**	0.002	**0.012**	0.002	**0.012**
Iron	mg/L	-	0.3	1.5	0.77 (0.066 - 17) n = 144	**0.85**	**9.5**	**0.9**	**9.5**	**0.8**	**9.5**	**0.8**	**9.4**	**0.8**	**9.5**	**0.9**	**9.5**
Lead	mg/L	0.103	0.004	0.005	0.00048 (0.000052 - 0.018) n = 136	0.0012	**0.023**	0.0012	**0.022**	0.0012	**0.022**	0.0012	**0.022**	0.0012	**0.022**	0.0012	**0.022**
Lithium	mg/L	-	-	-	0.0078 (0.002 - 0.023) n = 134	0.0092	0.016	0.0097	0.017	0.0098	0.017	0.0099	0.017	0.010	0.017	0.0105	0.018
Manganese	mg/L	-	-	1.455	0.044 (0.0045 - 0.5) n = 168	0.033	0.29	0.041	0.29	0.04	0.29	0.04	0.29	0.039	0.29	0.041	0.29
Mercury	mg/L	0.000013	0.000005	0.00005	<0.000012 (<0.000000035 - 0.0001) n = 124	0.0000041	**0.000012**	0.0000047	**0.000013**	0.0000047	**0.000013**	0.0000049	**0.000013**	0.0000048	**0.000013**	0.0000045	**0.000012**
Molybdenum	mg/L	-	0.073	38.7	0.00069 (0.00014 - 0.015) n = 164	0.0011	0.0032	0.0018	0.0051	0.002	0.0057	0.0022	0.007	0.0032	0.0107	0.0041	0.0178
Naphthenic acids - labile	mg/L	-	-	1	-	0.000	0.00	0.021	0.123	0.029	0.16	0.036	0.19	0.046	0.24	0.047	0.24
Naphthenic acids - refractory	mg/L	-	-	-	<1 (<0.004 - 3) n = 113	0.11	0.49	0.16	0.58	0.17	0.63	0.2	0.74	0.25	0.9	0.3	1.15
Naphthenic acids - total	mg/L	-	-	-	<1 (<0.004 - 3) n = 113	0.11	0.49	0.19	0.67	0.21	0.76	0.24	0.91	0.3	1.1	0.35	1.3
Nickel	mg/L	0.547	0.061	0.125	0.0018 (0.00003 - 0.044) n = 168	0.0037	0.016	0.0039	0.016	0.0039	0.016	0.0039	0.016	0.0039	0.016	0.0038	0.016
Nitrate	mg/L	124	2.93	-	0.1 (<0.001 - 0.6) n = 218	0.08	0.75	0.1	0.77	0.11	0.77	0.11	0.77	0.11	0.77	0.085	0.75
PAH group 1	µg/L	-	0.015	0.281	<0.01 (0.0013 - 0.088) n = 28	0	0.000	0	0.001	0	0.001	0	0.001	0	0.002	0	0.001
PAH group 2	µg/L	-	0.018	0.278	<0.01 (0.0029 - 0.1) n = 28	0.000	0.005	0.001	0.005	0.001	0.005	0.001	0.005	0.002	0.005	0.001	0.005
PAH group 3	µg/L	-	-	0.99	<0.01 (0.00075 - 0.026) n = 28	0	0.011	0	0.011	0	0.011	0	0.011	0	0.011	0	0.011
PAH group 4	µg/L	-	5.8	41.5	<0.01 (0.00052 - <0.04) n = 28	0	0.001	0	0.002	0	0.002	0	0.001	0	0.001	0	0.001
PAH group 5	µg/L	-	0.012	5.6	<0.01 (0.005 - 0.65) n = 28	0.003	**0.017**	0.005	**0.017**	0.005	**0.017**	0.005	**0.017**	0.005	**0.017**	0.004	**0.016**
PAH group 6	µg/L	-	-	64	<0.04 (0.0011 - <0.049) n = 11	0	0.001	0	0.001	0	0.001	0	0.002	0	0.002	0	0.002
PAH group 7	µg/L	-	0.04	5.9	<0.01 (<0.01 - 0.43) n = 28	0.002	0.006	0.003	0.015	0.003	0.009	0.003	0.009	0.003	0.011	0.003	0.010
PAH group 8	µg/L	-	1.1	32	<0.01 (0.0084 - 0.21) n = 28	0.003	0.13	0.004	0.13	0.004	0.13	0.004	0.13	0.005	0.13	0.004	0.13
PAH group 9	µg/L	-	0.025	2.3	<0.01 (0.009 - 0.42) n = 28	0.001	0.004	0.001	0.004	0.001	0.004	0.001	0.004	0.002	0.004	0.001	0.004
Selenium	mg/L	-	0.001	-	0.0003 (0.000079 - 0.0014) n = 163	0.00022	0.00078	0.00025	0.00079	0.00025	0.00079	0.00026	0.00079	0.00026	0.00079	0.00024	0.00078
Silver	mg/L	0.0056	0.0001	0.00022	0.00001 (<0.0000005 - 0.00014) n = 124	0.000006	**0.00013**	0.000009	**0.00012**	0.000009	**0.00012**	0.00001	**0.00012**	0.00001	**0.00012**	0.000009	**0.00012**
Sodium	mg/L	-	-	-	13 (6.4 - 53) n = 209	17	45	18	49	18	49	18	50	19	53	19	51
Strontium	mg/L	-	-	14.1	0.21 (0.12 - 0.39) n = 135	0.26	0.45	0.26	0.45	0.26	0.45	0.26	0.45	0.26	0.46	0.26	0.45
Sulphate	mg/L	-	-	309	24 (4 - 67) n = 208	26	59	29	74	29	75	30	77	30	78	27	62
Sulphide	mg/L	-	0.014	0.002	0.004 (<0.001 - 0.22) n = 118	0.003	**0.083**	0.003	**0.083**	0.003	**0.083**	0.003	**0.083**	0.003	**0.083**	0.003	**0.083**
Tainting potential	TPU	-	1	-	-	0.00	0.0	0.023	0.33	0.036	0.43	0.044	0.52	0.058	0.6	0.062	0.55

Table 3.3-13 Predicted Water Quality in Athabasca River at the Mouth of Redclay Creek (continued)

Parameter	Unit	Water Quality Guideline Aquatic Life[(a)(b)]		Chronic Effect Benchmarks	Natural Variation Observed [(c)]	Pre-Industrial Case		2013 Planned Development Case									
								2018		2034		2042		2052		2152	
		Acute	Chronic			Median Concentration	Peak [(d)] Concentration	Median	Peak [(d)]	Median	Peak [(d)]	Median	Peak [(d)]	Median	Peak [(d)]	Median	Peak [(d)]
Thallium	mg/L	-	0.0008	-	0.000034 (0.0000023 - 0.00037) n = 127	0.00004	0.00024	0.00004	0.00024	0.00004	0.00024	0.00004	0.00024	0.00004	0.0002	0.00004	0.00024
Total dissolved solids	mg/L	-	-	1000	178 (86 - 560) n = 180	185	320	195	354	195	355	197	362	199	368	198	351
Total nitrogen	mg/L	-	1	-	0.49 (<0.2 - 2.9) n = 192	0.7	**1.7**	0.7	**1.7**	0.8	**1.7**	0.8	**1.7**	0.8	**1.7**	0.8	**1.7**
Total phenolics	mg/L	-	0.004	0.01	0.003 (<0.001 - 0.05) n = 181	0.0027	**0.008**	0.0027	**0.008**	0.0027	**0.008**	0.0027	**0.008**	0.0027	**0.008**	0.0027	**0.008**
Total phosphorus	mg/L	-	0.05	-	0.041 (0.015 - 1.8) n = 209	**0.053**	**0.6**	**0.055**	**0.6**	**0.055**	**0.6**	**0.055**	**0.59**	**0.055**	**0.59**	**0.055**	**0.6**
Toxicity- acute	TUa	0.3	0.3	-	-	0.017	0.12	0.019	0.13	0.019	0.13	0.02	0.13	0.021	0.14	0.021	0.13
Toxicity- chronic	TUc	-	1	-	-	0.007	0.053	0.019	0.114	0.022	0.13	0.023	0.14	0.027	0.16	0.021	0.11
Uranium	mg/L	0.033	0.015	-	0.0004 (0.0002 - 0.0022) n = 131	0.00052	0.00086	0.00054	0.00086	0.00054	0.00086	0.00054	0.00086	0.00054	0.00086	0.00054	0.00088
Vanadium	mg/L	-	-	0.0338	0.002 (0.00014 - 0.028) n = 190	0.002	0.021	0.0026	0.021	0.0027	0.021	0.0027	0.021	0.0028	0.021	0.0022	0.021
Zinc	mg/L	0.14	0.03	0.138	0.0054 (0.00088 - 0.13) n = 164	0.01	**0.038**	0.011	**0.038**	0.011	**0.038**	0.011	**0.038**	0.011	**0.038**	0.011	**0.038**

(a) - = No guideline / no data.

(b) From U.S. EPA (2002, 2003a, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 8, temperature of 10°C and hardness of 120 mg/L (which are reflective of average conditions in the Athabasca River).

(c) Based on information from RAMP (2012) and from Alberta Environment WDS stations: AB07DA0820\0850\0860\0870\0970\0980\1550 (ESRD 2012).

(d) Peak concentrations represent 99.91 percentile values calculated from a model dataset containing more than 16,000 data points; with the exception of acute toxicity, which is a daily peak, concentrations are shown as four-day average concentrations.

Notes: **Bold** number indicates that the predicted concentration exceeds the chronic guideline for the protection of aquatic life.

TPU = Tainting Potential Unit; TUa = Toxic Unit - Acute; TUc = Chronic Toxicity Unit.

Table 3.3-14 Predicted Water Quality in Athabasca River Downstream of Redclay Creek

Parameter	Unit	Water Quality Guideline Aquatic Life(a)(b)		Chronic Effect Benchmarks	Natural Variation Observed(c)	Pre-Industrial Case		2013 Planned Development Case									
								2018		2034		2042		2052		2152	
		Acute	Chronic			Median Concentration	Peak Concentration	Median	Peak (d)	Median	Peak (d)	Median	Peak (d)	Median	Peak (d)	Median	Peak(d)
Aluminum	mg/L	0.75	0.1	0.15	0.84 (<0.01 - 8.2) n = 75	**0.86**	**16**	**0.86**	**16**	**0.86**	**16**	**0.86**	**16**	**0.86**	**16**	**0.86**	**16**
Ammonia	mg/L	9.81	0.67	2	0.03 (<0.01 - 1) n = 197	0.042	0.2	0.047	0.18	0.051	0.23	0.05	0.23	0.051	0.23	0.05	0.23
Antimony	mg/L	-	-	0.157	0.00012 (0.00005 - <0.0008) n = 42	0.00013	0.0021	0.00014	0.0022	0.00014	0.0022	0.00014	0.0022	0.00014	0.0022	0.00014	0.0021
Arsenic	mg/L	0.34	0.005	0.025	0.0009 (<0.0001 - 0.018) n = 79	0.0011	0.0031	0.0011	0.0031	0.0011	0.0031	0.0011	0.0031	0.0011	0.0031	0.0011	0.0031
Barium	mg/L	-	-	5.8	0.066 (<0.001 - 0.27) n = 73	0.069	0.099	0.07	0.1	0.07	0.099	0.07	0.099	0.07	0.099	0.07	0.099
Beryllium	mg/L	-	-	0.0053	0.0002 (0.000017 - 0.0012) n = 55	0.0001	0.0008	0.0001	0.0008	0.0001	0.0008	0.0001	0.0008	0.0001	0.0008	0.0001	0.0008
Boron	mg/L	29	1.5	1.5	0.027 (<0.01 - 0.14) n = 49	0.038	0.08	0.045	0.086	0.046	0.086	0.049	0.098	0.052	0.11	0.052	0.11
Cadmium	mg/L	0.0026	0.00031	0.00025	0.00014 (0.000019 - 0.0026) n = 39	0.0002	**0.00064**	0.00021	**0.00072**	0.00021	**0.00073**	0.00021	**0.00073**	0.00022	**0.00076**	0.00022	**0.0007**
Calcium	mg/L	-	-	-	31 (<1 - 60) n = 263	30	53	31	54	31	53	31	53	31	53	31	53
Chloride	mg/L	640	120	-	12 (<0.5 - 65) n = 263	13	53	14	55	14	56	14	55	14	56	14	56
Chromium	mg/L	0.016	0.001	0.089	0.003 (0.00061 - 0.016) n = 101	**0.0044**	**0.013**	**0.0045**	**0.013**	**0.0045**	**0.013**	**0.0045**	**0.013**	**0.0045**	**0.013**	**0.0044**	**0.013**
Cobalt	mg/L	-	-	0.004	0.001 (0.00016 - 0.006) n = 76	0.00079	0.0068	0.00085	0.0068	0.00085	0.0068	0.00085	0.0068	0.00086	0.0068	0.00086	0.0068
Copper	mg/L	0.017	0.0028	0.0256	0.0024 (<0.0002 - 0.012) n = 104	**0.0043**	**0.012**	**0.0044**	**0.012**	**0.0044**	**0.012**	**0.0044**	**0.012**	**0.0044**	**0.012**	**0.0043**	**0.012**
Iron	mg/L	-	0.3	1.5	1 (<0.001 - 12) n = 93	**1.6**	**9.3**	**1.7**	**9.3**	**1.7**	**9.3**	**1.7**	**9.3**	**1.7**	**9.3**	**1.6**	**9.3**
Lead	mg/L	0.103	0.004	0.005	0.0012 (<0.0001 - 0.026) n = 73	0.0023	**0.023**	0.0023	**0.023**	0.0023	**0.023**	0.0023	**0.023**	0.0023	**0.023**	0.0023	**0.023**
Lithium	mg/L	-	-	-	0.007 (0.0039 - 0.054) n = 44	0.0088	0.015	0.0092	0.016	0.0093	0.016	0.0094	0.016	0.0094	0.016	0.0096	0.016
Manganese	mg/L	-	-	1.455	0.048 (<0.001 - 0.3) n = 102	0.062	0.29	0.07	0.29	0.069	0.29	0.068	0.28	0.067	0.28	0.063	0.28
Mercury	mg/L	0.000013	0.000005	0.00005	0.0000055 (<0.0000006 - 0.00005) n = 34	0.0000043	**0.000012**	0.0000047	**0.000012**	0.0000048	**0.000012**	0.0000048	**0.000012**	0.0000048	**0.000012**	0.0000046	**0.000011**
Molybdenum	mg/L	-	0.073	38.7	0.0008 (0.00034 - 0.007) n = 73	0.001	0.0031	0.0016	0.0044	0.0019	0.0051	0.002	0.0059	0.0029	0.0095	0.0029	0.0092
Naphthenic acids - labile	mg/L	-	-	1	-	0.000	0.00	0.017	0.096	0.028	0.15	0.029	0.16	0.039	0.2	0.041	0.21
Naphthenic acids - refractory	mg/L	-	-	-	0.15 (0.053 - <1) n = 10	0.15	0.58	0.2	0.6	0.23	0.65	0.24	0.73	0.29	0.89	0.29	0.86
Naphthenic acids - total	mg/L	-	-	-	0.15 (0.053 - <1) n = 10	0.15	0.58	0.22	0.65	0.26	0.75	0.28	0.86	0.33	1.1	0.34	1.0
Nickel	mg/L	0.547	0.061	0.125	0.0037 (<0.0002 - 0.038) n = 77	0.0036	0.016	0.0037	0.016	0.0037	0.016	0.0038	0.016	0.0038	0.016	0.0037	0.016
Nitrate	mg/L	124	2.93	-	0.034 (<0.001 - 0.49) n = 263	0.082	0.7	0.1	0.71	0.11	0.71	0.11	0.71	0.11	0.71	0.088	0.7
PAH group 1	µg/L	-	0.015	0.281	<0.01 (<0.01 - <0.1) n = 16	0	0.000	0	0.001	0	0.001	0	0.001	0	0.001	0	0.001
PAH group 2	µg/L	-	0.018	0.278	<0.01 (<0.01 - <0.1) n = 16	0	0.005	0.001	0.005	0.001	0.005	0.001	0.005	0.001	0.005	0.001	0.005
PAH group 3	µg/L	-	-	0.99	<0.01 (0.003 - <0.2) n = 16	0	0.011	0	0.011	0	0.011	0	0.011	0	0.011	0	0.011
PAH group 4	µg/L	-	5.8	41.5	<0.01 (<0.01 - <0.1) n = 16	0	0.001	0	0.002	0	0.002	0	0.001	0	0.001	0	0.001
PAH group 5	µg/L	-	0.012	5.6	<0.01 (0.007 - <0.1) n = 16	0.003	**0.016**	0.005	**0.016**	0.005	**0.016**	0.005	**0.016**	0.005	**0.016**	0.004	**0.016**
PAH group 6	µg/L	-	-	64	<0.04 n = 1	0	0.001	0	0.001	0	0.001	0	0.001	0	0.002	0	0.002
PAH group 7	µg/L	-	0.04	5.9	<0.01 (<0.01 - <0.1) n = 16	0.002	0.005	0.003	0.009	0.002	0.008	0.003	0.008	0.003	0.009	0.003	0.009
PAH group 8	µg/L	-	1.1	32	<0.01 (0.009 - 0.18) n = 16	0.003	0.12	0.004	0.12	0.004	0.12	0.004	0.12	0.004	0.12	0.004	0.12
PAH group 9	µg/L	-	0.025	2.3	<0.01 (<0.01 - <0.1) n = 16	0.001	0.006	0.002	0.007	0.002	0.007	0.002	0.007	0.002	0.007	0.002	0.006
Selenium	mg/L	-	0.001	-	<0.0002 (<0.0001 - 0.0009) n = 78	0.00022	0.00076	0.00024	0.00076	0.00024	0.00076	0.00024	0.00077	0.00025	0.00077	0.00023	0.00076
Silver	mg/L	0.0056	0.0001	0.00022	0.000029 (0.0000016 - 0.0007) n = 35	0.00001	**0.00012**	0.000012	**0.00012**	0.000012	**0.00012**	0.000012	**0.00012**	0.000012	**0.00012**	0.000011	**0.00012**
Sodium	mg/L	-	-	-	15 (<1 - 55) n = 263	16	43	17	47	17	48	18	49	18	51	18	50
Strontium	mg/L	-	-	14.1	0.19 (0.11 - 0.3) n = 44	0.24	0.44	0.24	0.44	0.24	0.44	0.24	0.44	0.25	0.44	0.25	0.44
Sulphate	mg/L	-	-	309	23 (<0.5 - 62) n = 263	24	57	26	65	26	65	26	66	27	67	24	59
Sulphide	mg/L	-	0.014	0.002	<0.005 (<0.001 - 0.02) n = 85	0.004	**0.083**	0.004	**0.083**	0.004	**0.083**	0.004	**0.083**	0.004	**0.083**	0.004	**0.083**
Tainting potential	TPU	-	1	-	-	0.000	0.0	0.021	0.28	0.038	0.42	0.037	0.42	0.051	0.51	0.057	0.5
Thallium	mg/L	-	0.0008	-	0.000098 (0.0000065 - 0.00027) n = 43	0.00005	0.00023	0.00005	0.00023	0.00005	0.00023	0.00005	0.00023	0.00005	0.0002	0.00005	0.00023

Table 3.3-14 Predicted Water Quality in Athabasca River Downstream of Redclay Creek (continued)

Parameter	Unit	Water Quality Guideline Aquatic Life[(a)(b)]		Chronic Effect Benchmarks	Natural Variation Observed[(c)]	Pre-Industrial Case		2013 Planned Development Case									
								2018		2034		2042		2052		2152	
		Acute	Chronic			Median Concentration	Peak Concentration	Median	Peak [(d)]	Median	Peak [(d)]	Median	Peak [(d)]	Median	Peak [(d)]	Median	Peak[(d)]
Total dissolved solids	mg/L	-	-	1,000	170 (16 - 450) n = 251	180	314	187	337	188	338	189	342	191	347	188	333
Total nitrogen	mg/L	-	1	-	0.57 (<0.01 - 3) n = 244	0.7	**1.6**	0.7	**1.6**	0.7	**1.6**	0.8	**1.6**	0.8	**1.6**	0.7	**1.6**
Total phenolics	mg/L	-	0.004	0.01	<0.001 (<0.001 - 0.042) n = 175	0.0027	**0.0078**	0.0027	**0.0077**	0.0027	**0.0077**	0.0027	**0.0077**	0.0027	**0.0077**	0.0027	**0.0077**
Total phosphorus	mg/L	-	0.05	-	0.049 (0.004 - 0.75) n = 262	**0.053**	**0.57**	**0.055**	**0.57**	**0.055**	**0.57**	**0.055**	**0.57**	**0.055**	**0.57**	**0.055**	**0.57**
Toxicity- acute	TUa	0.3	0.3	-	-	0.017	0.12	0.019	0.13	0.019	0.13	0.019	0.13	0.021	0.14	0.02	0.13
Toxicity- chronic	TUc	-	1	-	-	0.007	0.053	0.017	0.097	0.02	0.11	0.02	0.12	0.023	0.13	0.019	0.11
Uranium	mg/L	0.033	0.015	-	0.0004 (<0.0001 - 0.003) n = 101	0.00049	0.00081	0.0005	0.00082	0.0005	0.00082	0.00051	0.00082	0.00051	0.00082	0.0005	0.00082
Vanadium	mg/L	-	-	0.0338	0.0018 (0.00026 - 0.02) n = 266	0.0019	0.02	0.0024	0.02	0.0024	0.02	0.0025	0.02	0.0026	0.02	0.0021	0.02
Zinc	mg/L	0.14	0.03	0.138	0.0063 (0.00053 - 0.054) n = 252	0.011	**0.037**	0.011	**0.037**	0.011	**0.037**	0.011	**0.037**	0.011	**0.037**	0.011	**0.037**

(a) - = No guideline / no data.

(b) From U.S. EPA (2002, 2003a, 2009), CCME (1999, 2012) and AENV (1999), assuming a pH of 8, temperature of 10°C and hardness of 120 mg/L (which are reflective of average conditions in the Athabasca River).

(c) Based on information from RAMP (2012) and from Alberta Environment WDS stations: AB07DA0010\0040\0060\0080\0250 (ESRD 2012).

(d) Peak concentrations represent 99.91 percentile values calculated from a model dataset containing more than 16,000 data points; with the exception of acute toxicity, which is a daily peak, concentrations are shown as four-day average concentrations.

Note: **Bold** number indicates that the predicted concentration exceeds the chronic guideline for the protection of aquatic life.

TPU = Tainting Potential Unit; TUa = Toxic Unit - Acute; TUc = Chronic Toxicity Unit.

Table 3.3-15 Predicted Water Quality in Athabasca River at Embarras

Parameter	Unit	Natural Variation Observed [(a)]	LARP[(b)] Limit	Predicted Concentrations		
				Pre-Industrial Case 95% peak	2013 PRM Application Case - Far Future 95% peak	2013 PDC - Far Future 95% peak
Ammonia	mg/L	0.03 (<0.01 - 1) n = 197	2.8	0.09	0.12	0.13
Antimony	mg/L	0.00012 (0.00005 - <0.0008) n = 42	0.006	0.00042	0.00043	0.00043
Arsenic	mg/L	0.0009 (<0.0001 - 0.018) n = 79	0.005	0.002	0.002	0.002
Barium	mg/L	0.066 (<0.001 - 0.27) n = 73	1	0.085	0.085	0.085
Beryllium	mg/L	0.0002 (0.000017 - 0.0012) n = 55	0.1	0.0003	0.0003	0.0003
Boron	mg/L	0.027 (<0.01 - 0.14) n = 49	0.5	0.048	0.076	0.088
Calcium	mg/L	31 (<1 - 60) n = 263	1,000	47	47	47
Chloride	mg/L	12 (<0.5 - 65) n = 263	100	37	40	40
Chromium	mg/L	0.003 (0.00061 - 0.016) n = 101	0.05	0.0088	0.0087	0.0086
Cobalt	mg/L	0.001 (0.00016 - 0.006) n = 76	0.05	0.0031	0.0031	0.0031
Lithium	mg/L	0.007 (0.0039 - 0.054) n = 44	2.5	0.012	0.013	0.013
Molybdenum	mg/L	0.0008 (0.00034 - 0.007) n = 73	0.01	0.0019	0.0056	0.0065
Nickel	mg/L	0.0037 (<0.0002 - 0.038) n = 77	0.061	0.0089	0.0089	0.0089
Nitrate	mg/L	0.034 (<0.001 - 0.49) n = 263	2.935	0.31	0.31	0.31
Selenium	mg/L	<0.0002 (<0.0001 - 0.0009) n = 78	0.001	0.00043	0.00043	0.00043
Silver	mg/L	0.000029 (0.0000016 - 0.0007) n = 35	0.0001	0.000042	0.000042	0.000042
Sodium	mg/L	15 (<1 - 55) n = 263	200	34	39	39
Sulphate	mg/L	23 (<0.5 - 62) n = 263	500	46	48	49
Thallium	mg/L	0.000098 (0.0000065 - 0.00027) n = 43	0.0008	0.00012	0.00012	0.00012
Uranium	mg/L	0.0004 (<0.0001 - 0.003) n = 101	0.01	0.00064	0.00064	0.00064
Vanadium	mg/L	0.0018 (0.00026 - 0.02) n = 266	0.1	0.0093	0.0093	0.0093

(a) Based on information from RAMP (2012) and from Alberta Environment WDS stations: AB07DA0010\0040\0060\0080\0250 (ESRD 2012).

(b) LARP = Lower Athabasca Regional Plan (Government of Alberta 2012).

3.3.2 Aquatic Health Assessment

This section addresses aquatic health issues relevant to JRP SIR 8. Specifically, it presents an update to the EIA aquatic health assessment to account for combined effects of PRM and cumulative effects from other planned developments in the LSA. The section also compares these combined predicted effects to the PIC.

The assessment methods applied for the 2013 PDC are the same as those applied for the 2013 PRM Application Case (Appendix 1, Section 3.4). The Aquatic Health assessment builds upon the water quality predictions that have been updated in Section 3.3. This section evaluates potential impacts to aquatic health as a result of Substances of Potential Concern (SOPCs) that are expected to increase in concentration for the 2013 PDC relative to the PIC. These Project scenarios are defined below:

- The Pre-Industrial Case represents the predicted state of aquatic health within the study area prior to the establishment of existing developments, and forms the basis for comparison of the predicted effects of the PRM and other existing and planned projects.
- The 2013 PDC represents the predicted changes to aquatic health within the study area as a result of the construction, operation and closure of the PRM as well as other existing and planned projects (for the local study area (LSA), this is limited to the Teck Resources Limited [Teck] Frontier Oil Sands Mine Project).

3.3.2.1 Pre-Industrial Case Results

The PIC assessment considered the predicted state of aquatic health within the study area prior to the establishment of existing developments. The assessment methods and format of results for the PIC assessment closely match the 2013 PDC assessment discussed below. For that reason, and because the interpretation of aquatic health results for the 2013 PDC depends on the relative magnitudes of concentrations between the two scenarios, a side-by-side comparison of exposure data are informative.

3.3.2.2 Assessment Results

3.3.2.2.1 Small Streams

Water Quality Assessment

The assessment methods used to identify SOPCs for the 2013 PDC was the same as that applied for the 2013 PRM Application Case (Appendix 1, Section 3.4), with the exception that it focused only on those SOPCs that were predicted to be higher than the 2013 PRM Application Case, and at levels exceeding CEBs. The SOPCs for the 2013 PDC are presented in Table 3.3-16. Lithium and sodium did not exceed the Lower Athabasca Region Surface Water Quality Management Framework (Government of Alberta 2012; described in Appendix 1, Section 3.4) screening values and were therefore not retained as SOPCs for this case.

For each SOPC the worst-case peak concentration that was identified through the screening in Section 3.3.3 of this assessment was selected from the watercourses in the LSA (Table 3.3-16). As with the 2013 PRM Application Case this concentration was assumed to apply to the entire LSA (Pierre River, Redclay Creek, Big Creek and Eymundson Creek), regardless of the watercourse in which the exceedance was predicted to occur.

A key consideration in the small streams assessment was the frequency of exceedance of the CEBs. The frequency of exceedance for SOPCs in each stream and snapshot are summarized in Attachment A.

Table 3.3-16 Substances Carried Forward to the 2013 Planned Development Case (Small Streams)

Parameter	Unit	Chronic Effects Benchmark (CEB)[(a)]	Pre-Industrial Case Peak Concentration	2013 Planned Development Case Peak Concentration	Snapshot	Watercourse
Boron	mg/L	1.5	0.41	1.6	2152	Big Creek
Cadmium	µg/L	0.25 to 0.62	0.32	1.3	2152	Big Creek
Chloride	mg/L	100[b)]	4.9	198	2152	Big Creek
Cobalt	mg/L	0.004	0.0061	0.018	2018 and 2152	Big Creek
Iron	mg/L	1.5	14	24	2152	Big Creek
Lead	mg/L	0.005	0.0069	0.012	2152	Big Creek
Lithium	mg/L	2.5[(b)]	0.073	0.13	2152	Big Creek
Manganese	mg/L	1.455	2.4	6.2	2152	Big Creek
Naphthenic acids – labile	mg/L	1.0	0	0.049	2152	Big Creek
Naphthenic acids – refractory	mg/L	19	1.4	12	2152	Big Creek
Naphthenic acids – total	mg/L	1.0 to 19[(c)]	1.4	13	2152	Big Creek
Sodium	mg/L	200[(b)]	23	110	2152	Big Creek
Total dissolved solids	mg/L	1,000	448	1,090	2152	Big Creek

(a) Refer to Appendix 3.6.

(b) Denotes that screening applied a Lower Athabasca Region Surface Water Quality Framework (Government of Alberta 2012) screening value rather than a CEB.

(c) Indicates that either CEB may apply, see discussion in text.

Note: An evaluation of each substance is provided in more detail below.

Most results of the water quality screening for the 2013 PDC are similar to the model results from the 2013 PRM Application Case, with some peak concentrations exhibiting small increases and some exhibiting small decreases in the 2013 PDC relative to the 2013 PRM Application Case. Generally the changes were not sufficiently large to impact the overall residual impact classifications; the findings and differences of possible significance are discussed below.

Metals

The 2013 PRM Application Case (Appendix 1, Section 3.4) considered several factors that limit the bioavailability of metals, and the associated conservative nature of total metals predictions in small streams. These considerations remain applicable to the 2013 PDC, and include:

- association of total metals concentrations with particulate loads in streams which would be far less bioavailable than dissolved fractions; and
- lack of modelling of sorption and complexation processes, which would further limit the bioavailability of metals in streams of the LSA.

The predicted peak concentrations therefore provide an overestimate of actual exposure by aquatic organisms. Individual metals are discussed below.

Boron

Boron was not an SOPC for the 2013 PRM Application Case; however, the increase in peak predicted concentrations for the 2013 PDC resulted in exceedance of the CEB.

Predicted peak concentrations of total boron for the 2013 PDC are 3.9 times those of the PIC (i.e., total boron peak concentration for 2013 PDC is 1.6 mg/L versus peak concentration for PIC of 0.41 mg/L). The boron concentrations in the 2013 PDC are 2.4 times that of the 2013 PRM Application Case (i.e., 2013 PRM Application Case peak concentration 0.66 mg/L). However, there are indications of low environmental impact, including:

- the 2013 PDC peak concentration only slightly exceeds the CEB of 1.5 mg/L;
- the frequency of exceedance for the snapshots and watercourses (i.e., Pierre River, Big Creek, Eymundson Creek and Redclay Creek) is less than 1%; and
- predicted median concentrations for total boron in the 2013 PDC range from 0.075 to 0.63 mg/L, which was well below the CEB.

Considering the very low frequency of exceedance, and low magnitude of exceedance of peak concentrations over the CEB, the predicted concentrations of total boron are anticipated to represent a negligible change in the potential for chronic effects on aquatic health.

Cadmium

The aquatic health assessment for total cadmium in the 2013 PRM Application Case is described in Appendix 1, Section 3.4. The peak concentration of total cadmium for the 2013 PDC was 1.3 µg/L, based on predictions for Big Creek in snapshot 2152. This concentration was approximately 1.9 times that of the 2013 PRM Application Case (i.e., 2013 PRM Application Case peak cadmium concentration 0.67 µg/L) and 4.1 times that of the PIC (i.e., PIC peak cadmium concentration 0.32 µg/L). For the 2013 PDC, multiple peak concentrations exceeded the hardness adjusted CEB range of 0.25 to 0.62 µg/L suggesting a potential for chronic effects on aquatic health when peak concentrations occur. For most watercourses and snapshots, frequency of exceedance was low (under 4%) suggesting that the CEB would be exceeded infrequently.

However, for the Far Future snapshot (2152) in Big Creek and Redclay Creek (which will have been converted to the South Redclay Lake during operation), frequency of exceedance for cadmium ranged from 62.8 to 100% indicating ongoing exceedance of the CEB with peak concentrations of up to 1.3 µg/L (2-times the CEB). This higher rate of exceedance for the Far Future is the result of process-affected seepage from the external tailings area and discharge from Central Pit Lake A of the Frontier Mine Project.

The peak concentrations of cadmium exceed the chronic effects thresholds for multiple species listed in Appendix 3.6 indicate a short-term potential for chronic effects to these in small streams which is likely overstated, given that peak concentration would occur rarely (i.e., 1 day every 3 years) whereas the effects thresholds are based on chronic exposure (typically 7 days or longer). Median concentrations for these nodes and snapshots, an indicator of the continuous long-term concentration for the Far Future, ranged from 0.39 to 0.63 µg/L, exceeding the species mean chronic values for *Hyallella azteca*, *Daphnia magna*, and *Oncorhynchus mykiss* by a small amount suggesting an increased potential for aquatic health effects that would be more continuous relative to peak exposure for these nodes in 2152.

However, the cadmium concentrations in excess of the CEB and species-specific toxicity thresholds are expected to co-occur with changes to the particulate matter and other water quality conditions that ameliorate cadmium toxicity. Bioavailability of cadmium is dependent on a range of abiotic conditions, such as hardness, alkalinity, pH and dissolved organic matter. Cadmium tends to partition to particulate matter and dissolved organic matter, upon entering the aquatic system, reducing concentrations of the free ion in the water column and thereby lowering its bioavailability (Jonnalagadda and Rao 1993). High dissolved solids and organic matter concentrations may reduce toxicity both through sorption to surfaces and/or complexation of free ions with suspended matter. Thus, the CEB which is based on laboratory studies with primarily dissolved cadmium may be overly protective when assessing total cadmium concentrations in the natural environment that have lower bioavailability. Baseline measurements indicated that total cadmium is naturally elevated in some watercourses of the LSA with maximum observed concentrations of 3.65 µg/L, suggesting that either total cadmium concentrations have low bioavailability or that aquatic life in small streams of the LSA can tolerate occasional peak cadmium concentrations that are well above the CEB.

Given that the CEB for cadmium is likely to overstate the potential for aquatic health effects, the predicted cadmium concentrations and high frequency of exceedance of the CEB in 2152 for Big Creek and Redclay Creek were considered consistent with a potential low magnitude of effect that would be local in spatial extent, long-term in duration, and of high frequency, but reversible. These ratings are integrated in the Residual Impact Classification (below) resulting in an environmental consequence rating of “low”. For the remaining nodes and snapshots, the lower concentrations and low frequency of exceedance (<4%) were indicative of a negligible change in the potential for chronic effects on aquatic health as a result of the PRM and planned developments.

Cobalt

The aquatic health assessment for total cobalt in the 2013 PRM Application Case is outlined in Appendix 1, Section 3.4. The predicted peak concentration of total cobalt for the 2013 PDC was 0.018 mg/L in Big Creek in the 2018 and 2152 snapshots, approximately 2.7 times that of the 2013 PRM Application Case (i.e., 2013 PRM Application Case peak cobalt concentration 0.0066 mg/L). The 2013 PDC peak was 3 times that of the PIC (i.e., PIC peak cobalt concentration 0.0061 mg/L). This peak prediction for the 2013 PDC was 4.5 times the 0.004 mg/L CEB for total cobalt.

Predicted median cobalt concentrations and the frequency of exceedance in the small streams of the LSA were examined to determine the magnitude, frequency and duration of potential adverse effects on aquatic health. The low frequency of exceedance was similar to the 2013 PRM Application Case for Eymundson Creek and Pierre River, and was below 2% for each snapshot. However, the frequency of exceedance for Big Creek and Redclay Creek was higher, with concentrations exceeding the CEB 59.9% of the time for Big Creek and 98.7% of the time for Redclay Creek. The range of median concentrations predicted for the three planned development watercourses (i.e., Big Creek, Redclay Creek and Pierre River) was 0.00014 to 0.0062 mg/L (exceeding the CEB at the upper range) with the highest median concentration observed for Redclay Creek.

Insufficient toxicological data for cobalt is available to develop a species sensitivity distribution; however, data reviewed for development of water quality guidelines for cobalt by the British Columbia Ministry of the Environment (BC MOE) indicate that invertebrates are the most sensitive species to cobalt (BC MOE 2004). The CEB was based on the recent cobalt guideline derivation by BC MWLAP (2004), which was based on the geometric mean of crustacean (*Daphnia* and *Ceriodaphnia*) toxicity endpoints. The derivation applied an application factor of 0.5 to account for the difference between an effect and no-effect level, resulting in a guideline value of 0.004 mg/L. A summary of the available aquatic invertebrate toxicity data for cobalt by BC MWLAP (2004) indicated a lower bound of No Observed Effect Concentration (NOEC) values of 0.01 mg/L, a lower bound of Lowest Observed Effect Concentration (LOEC) values of 0.02 mg/L and an approximate Median Effective Concentration (EC_{50}) of 0.012 mg/L.

The median predicted concentrations for the three planned development watercourses fall below these values, but are above the guideline value which is intended to be highly protective of aquatic species. The peak concentrations exceed these lower bounds of known toxicity thresholds. Consequently the evaluation for the 2013 PDC indicated potential for environmental effects; the results indicate a potential low magnitude effect (i.e., only sensitive taxa potentially affected) that would be limited geographically but long-term in duration and of moderate frequency (i.e., median concentrations reflecting a typical condition exceed the CEB, and highest peak values are predicted for the Far Future snapshot in 2152). These ratings are integrated in the Residual Impact Classification (below) resulting in an environmental consequence rating of “negligible”.

Iron

The aquatic health assessment for total iron for the 2013 PRM Application Case is described in Appendix 1, Section 3.4. The peak concentration of total iron for the 2013 PDC was 24 mg/L, which was predicted for Big Creek in snapshot 2018. The peak iron concentration for the 2013 PDC was generally similar to the 2013 PRM Application Case (i.e., 2013 PRM Application Case peak iron concentration 21 mg/L) and 1.7 times that of the PIC (i.e., PIC peak iron concentration 14 mg/L). As the 2013 PDC predicted peak concentration was similar to the 2013 PRM Application Case peak concentration, the aquatic health assessment for iron for the 2013 PRM Application Case (Appendix 1, Section 3.4.3.1), also applies to the 2013 PDC. Briefly, the elevated iron concentrations expected to be associated with increased particulate matter rather than dissolved-phase contributions to the water column and iron would be primarily in ferric form, which, as stated in Appendix 3.6, is largely non-toxic. As with the 2013 PRM Application Case, the potential for chronic effects associated increased iron concentrations for the 2013 PDC were rated as being low in magnitude, high in frequency and local in geographical extent. Duration was rated as long-term, because the predicted increases are projected to occur during Closure and after final reclamation is complete. These ratings are integrated in the Residual Impact Classification (below) resulting in an environmental consequence rating of “low”.

Lead

The aquatic health assessment for total lead for the 2013 PRM Application Case is outlined in Appendix 1, Section 3.4.3.1. The peak concentration of total lead for the 2013 PDC was 0.012 mg/L based on predictions for Big Creek in the 2018 snapshot, and exceed the CEB (0.005 µg/L) on occasion. The peak lead concentration for the 2013 PDC was 1.4 times that of the 2013 PRM Application Case (0.085 mg/L) and 1.7 times that of the Pre-Industrial Case (0.0069 mg/L). The frequency of exceedance was similar to the 2013 PRM Application Case in that it was very low (below 1%) for the watercourses and snapshots, and the predicted range of median concentrations (0.0001 to 0.00062 mg/L) was well below the CEB in the watercourses and snapshots.

As with the 2013 PRM Application Case, although the peak concentration exceeds the CEB for Big Creek and Eymundson Creek, lead concentrations are expected to be below the CEB >99% of the time. Although the peak exceedance of the CEB is 1.4-fold higher than in the 2013 PRM Application Case, this increase is not sufficient to change the overall conclusion with respect to risk to aquatic health.

The low frequency of exceedance and low magnitude of CEB exceedance indicates that predicted concentrations of total lead pose negligible incremental risk to aquatic health.

Manganese

The aquatic health assessment for total manganese for the 2013 PRM Application Case is described in Appendix 1, Section 3.4. The predicted peak concentration of total manganese for the 2013 PDC was 6.2 mg/L, based on predictions for Big Creek in snapshot 2018, relative to the CEB of 1.455 mg/L. The peak manganese concentration for the 2013 PDC was twice that of the 2013 PRM Application Case (i.e., 2013 PRM Application Case peak manganese concentration 3.1 mg/L) and 2.6 times that of the PIC (i.e., PIC peak manganese concentration 2.4 mg/L). The predicted range of median concentrations was 0.26 to 0.59 mg/L, which was well below the CEB.

The frequency of exceedance with the CEB was higher relative to the 2013 PRM Application Case and there were three cases indicating a potential for sustained exposure relevant to potential chronic effects including:

- a peak of 6.2 mg/L, and frequency of exceedance of 10.5% for Big Creek in snapshot 2018;
- a peak of 4.5 mg/L, and frequency of exceedance of 19.7% for Pierre River in snapshot 2034; and
- a peak of 3.1 mg/L, and frequency of exceedance of 12.3% for Redclay Creek in snapshot 2018.

Frequency of exceedance was lower than 3% in the remaining watercourses and snapshots indicating only occasional peak exceedances of CEBs, not consistent with chronic exposure.

Using the species sensitivity distribution developed for the CEB-derivation, the range of concentrations observed for these three peak cases above have the potential to cause a chronic effect in 28% to 68% of species. For example, Stubblefield et al. (1997) estimated a hardness-based 25% Inhibition Concentration (IC25) of 5.6 mg/L (150 mg/L hardness) for growth in larval brown trout. Also, Baird et al. (1991) determined a range of 4.7 to 56.1 mg/L for 48-hr median lethal concentration (LC50s) in varying laboratory strains of *Daphnia magna* in American Society for Testing and Materials (ASTM) hard water (160 to 180 mg/L hardness). For the Baird et al. study, the applicability of the LC50 range to small streams of the LSA is uncertain given the large range in sensitivity and general higher sensitivity of non-acclimated laboratory populations relative to natural populations. However, a key mitigating factor with respect to potential aquatic health effects is that these studies were based on measured concentrations of dissolved rather than total manganese. Manganese in surface waters typically binds and is associated with particulate matter with 90% to 95% of the total waterborne manganese being in a non-dissolved form (Reimer 1999). The use of peak total manganese concentrations is therefore likely to result in a large overestimate of actual exposure to aquatic organisms.

Balancing both the potential for aquatic health effects at dissolved manganese concentrations consistent with the peak total concentrations, and the uncertainty in actual exposure, given the tendency of manganese to be in non-dissolved form, the peak manganese concentrations are expected to present a potential low magnitude effect on aquatic health. This impact would be local in scale, of medium duration and frequency but reversible. Residual Impact Classification (below) results in an environmental consequence rating of “negligible”.

Chloride

Predicted chloride concentrations met the Lower Athabasca Region Surface Water Quality Framework screening value for 2013 PRM Application Case predictions and was therefore an SOPC for the 2013 PDC, only.

The predicted peak concentration of chloride in Big Creek (198 mg/L) exceeded the Lower Athabasca Region screening value (100 mg/L; Government of Alberta 2012) and the Canadian Council of Ministers of the Environment (CCME) guideline (120 mg/L; CCME 1999) for the 2152 snapshot only. The CCME long-term guideline was derived with mostly no-effect and some low-effect endpoint data and is intended to protect all forms of aquatic life for an indefinite exposure period (CCME 1999; with updates to 2011). Environment Canada and Health Canada (2001) prepared a Priority Substance List assessment report for road salts, specifically inorganic chloride salts. Although not a Water Quality Guideline (WQG) derivation, the report identified thresholds associated with various proportions of species anticipated to be affected. Specifically, it was estimated that 5% of aquatic species would be adversely affected at a chloride concentration of about 210 mg/L, and 10% of aquatic species would be affected at a chloride concentration of 240 mg/L. These concentrations are similar to the United States Environmental Protection Agency chronic water quality criterion of 230 mg/L for chloride (U.S. EPA 1988). Thus, the maximum peak chloride concentration predicted for Big Creek in 2152 is below the range of conservatively derived chronic effects concentrations. Given that the other peak and median concentrations were well below the screening values and chronic effects concentrations, the potential effects on aquatic health are expected to be negligible.

Naphthenic Acids

The rationale for the CEBs for naphthenic acids are outlined in Appendix 3.6 and resulted in a CEB of 1 mg/L for labile naphthenic acids and 19 mg/L for refractory naphthenic acids. Predicted peak concentrations of labile and refractory naphthenic acids for the 2013 PDC met their respective screening thresholds for the model snapshots in the small streams in the study area. However, predicted peak concentrations of total naphthenic acids exceeded the 1 mg/L lower-end benchmark and were higher than PIC concentrations in multiple snapshots for Big Creek, Pierre River and Redclay Creek, with highest peak concentrations of 13 mg/L. Total naphthenic acid concentrations were 2.5 mg/L or lower for most watercourses and snapshots with two higher peak values of 8.1 and 13 mg/L for Redclay Creek and Big Creek for snapshot 2152.

As with the 2013 PRM Application Case, the total naphthenic acid mixtures of relevance to the PRM would be composed of primarily refractory naphthenic acids. The water quality predictions indicate negligible fractions of labile naphthenic acids in the snapshots for these watercourses. The range of CEBs for total naphthenic acids spanned the range of 1 to 19 mg/L, depending on composition. Given the scarcity of labile naphthenic acids expected in the receiving environment, use of the threshold based on the refractory fraction of 19 mg/L based on studies of aged mixtures is more appropriate. In this regard, the predicted peak total concentrations of naphthenic acids are generally well-below the threshold for refractory naphthenic acids (i.e., less than 2.5 mg/L relative to the CEB of 19 mg/L) and meet the CEB with some level of safety for two higher peak cases (i.e., concentrations for snapshot 2152 in two streams ranging from 0.43% to 68% of the CEB).

Therefore, applying the same considerations as for the 2013 PRM Application Case, the predicted changes in naphthenic acid concentrations are expected to have a negligible effect on aquatic biota in small streams of the LSA.

Total Dissolved Solids

Predicted Total Dissolved Solids (TDS) concentrations met the CEB for 2013 PRM Application Case predictions and was therefore an SOPC only for the 2013 PDC.

Total dissolved solids are a measure of the combined content of the inorganic and organic substances contained in a liquid, including molecular, ionized and colloidal suspended matter. Because of the significant variations in TDS sensitivity in aquatic organisms and the large range of concentrations and mixtures of major ions in natural waterbodies, water quality guidelines have not been established for TDS in Canada. As discussed in the derivation of the CEB for TDS, one of the factors influencing the toxicity of the TDS mixture is the composition of major ions. Based on the composition of source waters, which includes a combination of natural watercourses and process-affected water, the composition of this water during the peak concentration would be about: 10% sodium, 10% calcium, 40% bicarbonate, 30% sulphate and 10% other minor constituents. This mixture of major ions would be low in toxicity in relation to studies conducted using individual ions, and relative to mixtures dominated by more toxic ions such as potassium, carbonate, magnesium, and chloride. The sodium, calcium and bicarbonate ions (comprising 60%) exhibit relatively low toxicity (IDNR 2009; Mount et al. 1997). On this basis, the CEB of 1,000 mg/L developed for TDS (in the absence of sufficient data to develop ion-specific values) is expected to be highly conservative for the PRM.

For the 2013 PDC, a peak concentration of 1,090 mg/L was predicted for Big Creek for the 2152 Snapshot. This was the only model snapshot for which the peak concentration exceeded the CEB; for the other snapshots the CEB is met for all small streams even under the worst-case peak conditions. For Big Creek in 2152, the median predicted concentration (448 mg/L) is well below the CEB and the frequency of exceedance is 0.1% indicating that if TDS concentration peaked above the CEB, it would occur very rarely. Because the CEB for TDS will be met in small streams under most cases during the PRM and into the Far Future, the potential effects on aquatic health are expected to be negligible.

Fish Tissue Assessment

Fish tissue metal concentrations in the small streams of the LSA were predicted to be below toxicological benchmarks for the parameters considered with the exception of chromium (Table 3.3-17).

Table 3.3-17 Predicted Changes in Fish Tissue Concentrations Under the 2013 Planned Development Case (Small Streams)

Parameter	Toxicological Benchmark[(a)] [mg/kg ww]	Bioconcentration Factor	Pre-Industrial Case		2013 Planned Development Case	
			Predicted Maximum Median Concentration in Water [mg/L]	Estimated Fish Tissue Concentration [mg/kg]	Predicted Maximum Median Concentration in Water [mg/L]	Estimated Fish Tissue Concentration [mg/kg]
Aluminum	20	1.7	0.19	0.3	0.5	0.8
Antimony	30	40	0.00076	0.03	0.0012	0.048
Arsenic	6.1	114	0.0015	0.17	0.0023	0.26
Cadmium	0.6	377	0.00009	0.03	0.0006	0.24
Chromium	0.58	385	0.0013	0.5	0.0027	**1.04**
Copper	3.4	243	0.0016	0.39	0.0032	0.8
Lead	4	38	0.00036	0.014	0.0012	0.05
Mercury	0.5	126,654	0.0000005	0.06	0.0000036	0.46
Nickel	0.82	39	0.0042	0.16	0.0077	0.3
Selenium[(b)]	20	lotic model[(c)]	0.00039	8.1[(d)]	0.0007	8.8[(d)]
Vanadium	0.41	62	0.0022	0.14	0.0066	0.41
Zinc	60	536	0.014	8	0.017	9

(a) Toxicological benchmarks are from Jarvinen and Ankley (1999) unless otherwise noted.

(b) Toxicological benchmark and estimated fish tissue concentrations are expressed as mg/kg dw in egg and ovary tissue (DeForest et al. 2011).

(c) Tissue selenium concentration was estimated using the lotic model developed by Orr et al. (2012).

(d) Dry weight estimate.

Note: **Bold** numbers exceed toxicological benchmark.

The predicted fish tissue chromium concentrations were the same for the 2013 PRM Application Case and the 2013 PDC. As described for the 2013 PRM Application Case (Appendix 1), the likelihood of adverse effects from the exceedance of the tissue toxicological benchmark is uncertain given that the predicted value was conservatively derived (i.e., estimated from total chromium concentrations) and because the exceeded benchmark is an NOEC value. The predicted benchmark exceedance therefore represents a negligible to low increase in the potential for chronic effects on aquatic health. Any effect would be local in scale, long-term and of high frequency (i.e., continuous accumulation), but reversible. These considerations are integrated in the Residual Impact Classification (below) resulting in an environmental consequence rating of “low”.

Residual Impact Classification

Activities associated with the 2013 PDC are predicted to cause changes in water quality in the LSA. Potential effects on aquatic health were evaluated in consideration of two potential effects pathways:

- direct effects occurring as a result of predicted changes to water quality; and
- indirect effects related to dietary consumption and possible accumulation of substances in fish tissue.

The 2013 PDC assessment focused only on those SOPCs that were predicted to be higher than the 2013 PRM Application Case, and at levels exceeding CEBs. The residual impact classification for the 2013 PDC, small streams following the assessment methods described in Volume 5, Section 4.12.2.3 of the EIA is shown in Table 3.3-18.

Table 3.3-18 Residual Impact Classification for Aquatic Health – 2013 Planned Development Case, Small Streams

Parameter	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Consequence
Toxic Units	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Boron	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Lead	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Cadmium	negative	low (+5)	Local (0)	long-term (+2)	high (+2)	reversible (-3)	low (+6)
Manganese	negative	low (+5)	Local (0)	medium-term (+1)	medium (+1)	reversible (-3)	negligible (+4)
Cobalt	negative	low (+5)	Local (0)	long-term (+2)	medium (+1)	reversible (-3)	negligible (+5)
Iron	negative	low (+5)	Local (0)	long-term (+2)	high (+2)	reversible (-3)	low (+6)
Chloride	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Total dissolved solids	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Naphthenic acids	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Fish tissue (chromium)	negative	low (+5)	Local (0)	long-term (+2)	high (+2)	reversible (-3)	low (+6)

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

n/a = Not applicable.

Boron and chloride were not SOPCs for the 2013 PRM Application Case, but increases in peak concentrations resulted in their identification as SOPCs for the 2013 PDC. However, predicted median concentrations met the CEBs for all watercourses and snapshots, and the frequency of exceedance of the CEBs was very low. Given that the peak value predictions corresponded to the 99.91 percentile, or a one-day in three-year frequency of occurrence, and given the degree of conservatism in water quality predictions due to overestimates of bioavailability in total concentrations, the magnitude of impact for these substances was considered to be negligible and additional residual impact classification was not warranted.

Peak cadmium and manganese concentrations for the 2013 PDC were predicted to be higher than the 2013 PRM Application Case and this was combined with a higher frequency of exceedance with the CEBs in small streams. These more frequent CEB exceedances were considered consistent with a potential low magnitude of effect. For cadmium the geographic extent was local (limited to 1 or 2 watercourses), short-term (limited to 1 or 2 snapshots), of relatively low frequency, and unlikely to result in permanent harm to aquatic health (i.e., reversible). For manganese, geographic extent was local (limited to 1 or 2 watercourses), medium-term (occurring during operations), of relatively low frequency, and reversible. These factors resulted in an overall environmental consequence classification of negligible for each metal.

Predicted cobalt concentrations were higher in the 2013 PDC, compared to the 2013 PRM Application Case. Comparison to the CEB and toxicity data resulted in a conclusion of potential low magnitude effect on aquatic health, moderate frequency, and long duration since the median concentrations exceed the CEB and highest peak values are predicted for the Far Future snapshot. However, these effects would be local in scale and reversible, and the overall environmental consequence classification was still negligible following the classification assessment methods from the EIA.

Iron was predicted to increase by a small amount relative to the 2013 PRM Application Case, but considering the conservatism in the iron assessment for the 2013 PRM Application Case, the increase in iron concentration was not considered large enough to result in a change to the effects classification. Similarly, lead was an SOPC for both the 2013 PRM Application Case and the 2013 PDC. Although the peak concentration of lead was slightly higher (1.4-fold) than in the 2013 PRM Application Case, this increase was not sufficient to change the overall conclusion of negligible environmental consequence with respect to aquatic health.

Although peak naphthenic acid concentrations were higher for the 2013 PDC than the 2013 PRM Application Case, changes in naphthenic acid concentrations are expected to have a negligible effect on aquatic biota in small streams of the LSA based on (1) labile and refractory naphthenic acids meeting their respective CEBs, and (2) the expectation that total naphthenic acids, being comprised primarily of the refractory fraction will meet the CEB for this fraction.

The concentration of chromium predicted in fish tissues for the 2013 PDC was the same as for the 2013 PRM Application Case, and therefore, the effects classification remains the same.

Based on the effects criteria, concentrations of individual substances received negligible to low ratings for environmental consequence (Table 3.3-18). Of the individual substances considered in the assessment, changes in the concentrations of cadmium, and iron in water, and chromium in fish tissue were deemed to be of low consequence to aquatic health, while the others were deemed to be negligible.

Potential effects resulting from elevated levels of these parameters may be over-estimated, because of the conservative assumptions used to complete the assessment. These substances are strongly influenced by site-specific factors that mediate bioavailability and toxicity. It was not possible to fully account for the factors that mediate speciation and aquatic toxicity of these substances using the screening water quality guidelines or CEBs. In many cases, the baseline concentrations at or above the CEBs, combined with the presence of a baseline healthy aquatic community, indicate that CEBs may overstate the potential for adverse effects. When the lines of evidence are considered together, including predicted acute and chronic toxicity levels, as well as predicted changes to sediment quality, water quality and fish tissue metal concentrations, potential changes to aquatic health resulting from the PRM and other existing and planned developments are expected to be negligible to be low for small streams in the LSA.

3.3.2.2.2 Pit Lakes

The capability of the pit lakes to support aquatic life was evaluated in consideration of predicted water, and fish tissue quality in each pit lake, both when the pit lakes begin discharging to the environment and in the Far Future.

The assessment methods used to identify SOPCs in pit lakes (Table 3.3-19) was the same as that applied for the 2013 PRM Application Case, with the exception that it focused only on those SOPCs that were predicted to be higher than the 2013 PRM Application Case, and at levels exceeding CEBs. Lower Athabasca Region values (Government of Alberta 2012) were applied for substances for which CEBs were not available. Lithium and sodium did not exceed the Lower Athabasca values and were therefore not considered further.

Table 3.3-19 Substances Carried Forward to the 2013 Planned Development Case (Pit Lakes)

Parameter	Unit	Chronic Effects Benchmark (CEB)[a]	Predicted Peak Concentrations in Water			
			2052	Pit Lake	2152	Pit Lake
Iron	mg/L	1.5	-	-	3.9	North pit lake
Lithium	mg/L	2.5[b]	-	-	0.037	North pit lake
Naphthenic acids – labile	mg/L	1.0	0.21	North pit lake	0.0047	North pit lake
Naphthenic acids – refractory	mg/L	19	12	South pit lake (upstream cell)	4.6	South pit lake (downstream cell)
Naphthenic acids – total	mg/L	1 to 19[c]	13	South pit lake (upstream cell)	4.6	South pit lake (downstream cell)
Sodium	mg/L	200[a]	81	South pit lake (upstream cell)	36	South pit lake (downstream cell)

(a) Refer to Appendix 3.6.

(b) Denotes that screening applied a Lower Athabasca Region Surface Water Quality Management Framework (Government of Alberta 2012) screening value rather than a CEB.

(c) Indicates that either CEB may apply, see discussion in text.

- = Lack of data or CEB available for a given parameter.

Water Quality Assessment

For the most part, the results of the water quality screening for the 2013 PDC are similar to the model results from the 2013 PRM Application Case, and the changes were not sufficiently large to affect the overall residual impact classifications. The substances which increased relative to the 2013 PRM Application Case, included:

- Naphthenic Acids: Predicted naphthenic acid concentrations in pit lakes were up to 2.6-fold higher for the 2013 PDC, relative to the 2013 PRM Application Case, but the peak concentration of 12.6 total naphthenic acids remained the same. Predicted concentrations of labile and refractory naphthenic acids met their respective screening thresholds for the model snapshots for pit lakes.

  Predicted concentrations of total naphthenic acids exceeded the 1 mg/L threshold for the 2052 and 2152 snapshots with a peak concentration of 12.6 mg/L upper naphthenic acids. As discussed for the 2013 PRM Application Case (Appendix 1, Section 3.4.4.3), the 1 mg/L threshold for the labile fraction is unlikely to provide an accurate representation of the threshold for chronic effects for total naphthenic acids, because ageing of the naphthenic acid mixtures results in removal of labile fractions and a reduction in toxicity (Holowenko et al. 2002). The range of predicted total naphthenic acid concentrations is well below the threshold for refractory naphthenic acids (19 mg/L) and therefore predicted naphthenic acid concentrations in pit lakes are expected to have a negligible impact on aquatic biota in pit lakes.

- Iron: Iron was not an SOPC identified for pit lakes under the 2013 PRM Application Case. The predicted peak 2013 PRM Application Case iron concentrations in the pit lakes is 3.9 mg/L in the North Pit Lake in 2152 with the predicted pit lake concentrations exceeding the CEB of 1.5 mg/L. Concentrations of iron were predicted to increase because of either direct input of process-affected water and seepage from the reclaimed landscape, or elevated concentrations in the local watercourses used for pit lakes filling. The predicted total iron concentrations are above the CEB but the actual potential for adverse effects on aquatic health is uncertain because the total iron concentrations are likely to be associated with suspended sediments rather than freely dissolved. In this scenario iron would have low bioavailability.

  Measured baseline concentrations of total iron in watercourses located in the LSA were elevated, with the highest concentration of 908 mg/L observed in Big Creek in February 2007. As a result, it is anticipated that much of the iron in pit lakes would be associated with natural sources.

  Considering the low bioavailability expected, and the elevated natural sources of iron, the increased iron concentrations for the 2013 PDC indicate a potential for a low magnitude effect that would be high in frequency and local in geographical extent. Duration was rated as long-term, because the predicted increases were projected to occur during Closure and after final reclamation is complete.

Fish Tissue Assessment

Predicted fish tissue concentrations in the pit lakes were projected to be below the toxicological benchmarks for the assessed parameters, with the exception of chromium, mercury and vanadium (Table 3.3-20).

Table 3.3-20 Predicted Changes in Fish Tissue Concentrations Under the 2013 Planned Development Case (Pit Lakes)

Parameter	Predicted Concentrations in Water [mg/L]		Toxicological Benchmarks[a] [mg/kg ww]	Bioconcentration Factor	Estimated Fish Tissue Concentration [mg/kg ww]	
	2052	2152			2052	2152
Aluminum	1.5	0.63	20	1.7	2.6	1.07
Antimony	0.00092	0.00099	30	40	0.037	0.039
Arsenic	0.002	0.0025	6.1	114	0.22	0.28
Cadmium	0.00047	0.00036	0.6	377	0.18	0.13
Chromium	0.0038	0.0027	0.58	385	**1.5**	**1.0**
Copper	0.0036	0.0028	3.4	243	0.9	0.67
Lead	0.0017	0.00097	4	38	0.06	0.037
Mercury	0.0000088	0.0000023	0.5	126,654	**1.12**	0.3
Nickel	0.0067	0.0071	0.82	39	0.26	0.27
Selenium[b]	0.00073	0.00059	20[c]	lentic model	16.0[d]	15.3[d]
Vanadium	0.0072	0.006	0.41	62	**0.45**	0.37
Zinc	0.016	0.019	60	536	9	10

(a) Toxicological benchmarks are from Jarvinen and Ankley (1999) unless otherwise noted.

(b) Toxicological benchmark and estimated fish tissue concentrations are expressed as mg/kg dw in egg and ovary tissue (DeForest et al. 2011).

(c) Tissue selenium concentration was estimated using the lentic model developed by Orr et al. (2012).

(d) Dry weight estimate.

Note: **Bold** numbers exceed toxicological benchmark.

For chromium, mercury and vanadium, the predicted fish tissue concentrations under the 2013 PDC, are very similar to the 2013 PRM Application Case and therefore the discussion of potential effects from the 2013 PRM Application Case also applies to the 2013 PDC. Briefly the predicted effects on aquatic health for these metals and metalloids included:

- *Chromium* – The maximum predicted concentration in 2052 (1.5 mg/kg ww in South Pit Lake) was the same as the 2013 PRM Application Case, whereas the maximum concentration in 2152 was higher than in the 2013 PRM Application Case (1.0 mg/kg ww compared to 0.8 mg/kg ww). Given the similar maximum concentrations, and the discussion of chromium in Section 3.3.4.3.1, above, for small streams, the predicted benchmark exceedance represents a negligible to low increase in the potential for chronic effects on aquatic health.
- *Mercury* – Predicted mercury concentrations in fish tissue are virtually the same for the 2013 PDC as the 2013 PRM Application Case (maximum prediction of 1.13 mg/kg ww compared to 1.12 mg/kg ww) and therefore the conclusion is the same. It is expected predicted mercury concentrations pose a potentially low magnitude of effect to aquatic health in the pit lakes for the 2013 PDC.
- *Vanadium* – For vanadium the predicted maximum fish tissue concentration that exceeded the benchmark was the same between the 2013 PDC and the 2013 PRM Application Case. A similar rating of low was assigned to both scenarios.

For each of these metals, any effect results from tissue accumulation would be local in scale, long-term and of high frequency (i.e., continuous accumulation), but reversible. These considerations are integrated in the Residual Impact Classification (below) resulting in an environmental consequence rating of “low”.

Residual Impact Classification

Activities associated with the 2013 PDC are predicted to influence water quality in pit lakes, affecting their ability to support aquatic life after Closure. Potential effects on aquatic health after Closure were evaluated in consideration of two potential effects pathways:

- direct effects occurring as a result of predicted changes to water quality; and
- indirect effects related to dietary consumption and possible accumulation of substances in fish tissue.

For naphthenic acids and metals in fish tissue (chromium, mercury and vanadium), the residual impact classification (Table 3.3-21) remained the same because peak predicted concentrations were the same or very similar between the 2013 PDC and the 2013 PRM Application Case.

Table 3.3-21 Residual Impact Classification for Aquatic Health – 2013 PRM Application Case, Pit Lakes

Parameter	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Consequence
Iron	negative	low (+5)	local (0)	long-term (+2)	long-term (+2)	reversible (-3)	low (+6)
Naphthenic acids	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Fish tissue quality (chromium, mercury, vanadium	negative	low (+5)	local (0)	long-term (+2)	long-term (+2)	reversible (-3)	low (+6)

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.
n/a = Not applicable.

Iron was an SOPC for the 2013 PDC only. The potential for aquatic health effects from iron in pit lakes was rated as being low in magnitude, high in frequency and local in geographical extent. Duration was rated as long-term, because the predicted increases were projected to occur during Closure and after final reclamation is complete.

The concentrations of chromium, mercury and vanadium predicted in fish tissues for the 2013 PDC were the same as for the 2013 PRM Application Case, and therefore, the effects classification remains the same.

Based on the residual impact classification criteria, concentrations of individual substances received negligible to low ratings for environmental consequence (Table 3.3-21). When the lines of evidence are considered together, including predicted acute and chronic toxicity levels, as well as predicted changes to sediment quality, water quality and fish tissue metal concentrations, the PRM pit lakes are expected to be able to support viable aquatic ecosystems and discharged waters are not anticipated to impair aquatic health in receiving streams.

3.3.3 Fish and Fish Habitat Assessment

The assessment methods used to assess fish and fish habitat for the 2013 PDC assessment is consistent with the assessment methods described in the EIA, Volume 4, Section 6.7. Mitigation and compensation measures for fish and fish habitat are the same as those described in the EIA, Volume 4, Section 6.7 and in the Shell 2012 Draft No Net Loss Plan submitted to the JME JRP on September 19, 2012.

The 2013 PDC assessments for Surface Water Hydrology (Section 3.3.2), Water Quality (Section 3.3.3) and Aquatic Health (Section 3.3.4) were reviewed. Linkages from those assessments were only evaluated for fish and fish habitat if there were changes from the EIA Application Case or 2013 PRM Application Case that might directly affect the Fish and Fish Habitat assessment. Redclay Creek and Unnamed Creek 19 were added to the assessment due to the updated footprint of South Redclay Lake, which will be constructed within the Redclay Creek watershed to provide fish habitat compensation for the PRM.

3.3.3.1 Assessment Results

The 2013 PDC predictions for Water Quality were updated as described in Section 3.3.3. Changes to water quality within the Athabasca River for the 2013 PDC were negligible and were not assessed further. Changes to water quality within small streams assessed for the 2013 PDC did change due to the Frontier Mine and the results were carried forward to the Aquatic Health assessment. The Aquatic Health residual impact classifications and environmental consequences for the 2013 PDC were either negligible or do not differ from the 2013 PRM Application Case and were therefore not included in the 2013 PDC Fish and Fish Habitat assessment. There are also minor changes in predicted stream flows in the 2013 PDC Surface Water Hydrology assessment for Pierre River, Eymundson Creek, Redclay Creek and the Athabasca River, compared to flows predicted in the 2013 PRM Application Case. Therefore, the linkage to fish habitat associated with changes in stream flow was the only pathway carried through to the 2013 PDC Fish and Fish Habitat assessment.

Within the boundary of the PRM, fish habitat within Eymundson Creek and Pierre River was considered to be lost due to the diversion of these watercourses to diversion channels during operations of the PRM. As a result, the habitat within these streams was included in the assessment of fish habitat losses and fully compensated for in the Draft No Net Loss Plan. Although changes in stream flow are presented for Eymundson Creek and Pierre River in the Hydrology 2013 PDC assessment, these are flows within the constructed operational diversion channels, which will be designed and constructed to accommodate the predicted flows. At Closure, the Pierre River and Eymundson Creek channels will be geomorphically designed channels that will provide fish habitat as part of the compensation plan. Changes to flow in Redclay Creek differ in the 2013 PDC compared to the 2013 PRM Application Case; however, flows will remain sufficient to support South Redclay Lake and the compensation habitat predictions from the Draft No Net Loss Plan remain valid. Changes to the outflow of South Redclay Lake are also predicted to change in the 2013 PDC compared to the EIA; however, a geomorphically designed outlet channel from South Redclay Lake will be constructed to match the predicted flow regime with fish habitat features created that will be appropriate for the channel dimensions and flow conditions, and as a result, the quality of the habitat within the channel would not be affected relative to what was considered in the *Shell 2012 Draft No Net Loss Plan*.

Potential effects on fish habitat and fish abundance under the 2013 PDC may differ from those predicted to occur under the 2013 PRM Application Case for the Athabasca River. In the 2013 PRM Application Case, effects to fish habitat that may result from changes in Athabasca River flow or water level, as a result of PRM, are predicted to be negligible. The assessment of effects considers the Water Management Framework for the Lower Athabasca River (AENV and DFO 2007). The Framework was developed to manage cumulative withdrawals from the Athabasca River and protect the aquatic ecosystem, while allowing industry to operate, which would include the planned projects in the 2013 PDC. Because the Framework is adaptive, it will be informed by ongoing scientific study, and modified as necessary to maintain protection of the river. Accordingly, no cumulative effects to fish habitat, beyond those outlined in the Framework, would be expected from changes to stream flow in the Athabasca River in the 2013 PDC. Once mitigation and compensation are taken into account for valid linkages, all residual effects on fish and fish habitat were negligible and considered to have no environmental consequence.

3.4 Terrestrial Resources

This section provides the results of the 2013 PDC assessments for Terrestrial Resources to inform the cumulative effects on the terrestrial environment. The 2013 PDC includes a review of the cumulative effects that could result from the existing and approved developments, the PRM, and the planned (i.e., publicly disclosed) developments in the Oil Sands Region, as of June 2012.

This section presents assessments of soils and terrain, terrestrial vegetation, wetlands and forest resources, wildlife and wildlife habitat, and biodiversity. These assessment methods used for the evaluation are the same as the assessments used in the EIA with the following exceptions:

- Magnitude of residual impacts is determined using % of Resource (e.g., % of the 2013 Base Case amount) rather than % of study area (i.e., % of RSA).
- Species at Risk are incorporated as additional KIRs into the wildlife assessment as requested in JRP SIR 8, building from the work previously submitted in the *November 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Federally Listed Species at Risk Assessment, Appendix B.
- The ALCES® model was used to simulate forest fire and harvest information. Landscape simulations were conducted using the ALCES® and ALCES *Mapper*® computer programs. The ALCES® program was used to simulate the effects of fire and forest harvest in the RSA over a 60-year period. The ALCES Mapper® program was used to simulate the potential spatial configuration of fire and forest harvest. The revised model of burns and cutblocks was applied to the Terrestrial Resources assessment for the 2013 Base Case, 2013 PRM Application Case and 2013 PDC in this appendix.
- Updated Fisheries and Wildlife Management Information System (FWMIS) data were incorporated into the 2013 assessment of the effects of PRM.
- An updated disturbance layer was applied to all components of the terrestrial assessment, and was incorporated into predictive models. Updated linear feature data were obtained from the Government of Alberta in February 2013. Access features including roads and cutlines were updated as of October 2010 and May 2011 (depending on the location in the RSA). Updates are based on interpretation of linear features from satellite imagery. Pipelines and well site updates were obtained from IHS Energy in February 2013 and are current as of November 2012. Within the LSA, both linear and non-linear disturbances were updated by Golder Associates Ltd. (Golder) based on August 2011 high-resolution satellite imagery.
- Forest stands at Closure (after reclamation of PRM) and at Far Future (after reclamation of PRM and other Planned Developments) are considered to be 80 years old (EIA, Volume 5, Section 7.2.3 and *May 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Federally Listed Species at Risk Assessment, Appendix B). Eighty years represents the estimated time required for the development of mature forest on the reclaimed landscape, and is a more appropriate time frame upon which to compare vegetation, wildlife and biodiversity values in the reclaimed landscape against the EIA Base Case values (EIA, Volume 5, Section 7.2.3). However, this assumption represents a change from the EIA (Volume 5,

Section 7.2.3) for habitat suitability modelling, in which stand ages of original wildlife KIRs were assigned using mine progression diagrams to represent stand ages at the point in time at which Closure occurs (i.e., 2070), and therefore resulted in a Closure landscape much younger than that used for habitat suitability modelling here. The assumptions regarding stand age at Closure were changed from those used in the EIA because mature forest stands at Closure represent a more appropriate time frame for the assessment of long-term PRM effects. Robust ecological communities and processes will take time to develop on the Closure landscape.

- Detailed information on modifications is provided in Appendix 3.1 (Section 2.9) of this assessment.

3.4.1 Soils and Terrain Assessment

The effects of JME and PRM and planned developments on soils and terrain were assessed in the EIA, Volume 5, Section 7.3 through 7.6 and in the 2008 EIA Update, Section 2.7.2.

3.4.1.1 Assessment Results

Changes in soil types due to the 2013 PDC are presented in Table 3.4-1. The 2013 PDC soils assessment indicates that prior to reclamation, 79,212 ha (8% of Resource) of mineral soils and 54,089 ha (6% of Resource) of organic soils will be lost or disturbed (Table 3.4-1). These losses and alterations are summarized in Table 3.4-2. The disturbance conditions before reclamation are described in Tables 3.4-1 and 3.4-2; in this scenario, closure pit lakes and the South Redclay Lake are grouped with reconstructed landforms. The disturbance conditions after reclamation are described in Table 3.4-3; in this scenario, closure pit lakes and the South Redclay Lake are grouped with water.

A net positive increase of 172,805 ha (17% of Resource) in mineral soils will occur after reclamation due to an increase of 142,269 ha in reconstructed landforms (Table 3.4-1), and an increased area of water of 20,680 ha (39% of the resource) (Table 3.4-3).

The net changes in soil types after reclamation are summarized in Table 3.4-3. The total changes due to the 2013 PDC account for 142,269 ha or about 6% of the RSA. There is an increase of 13,427 ha of disturbance from the EIA PDC (EIA, Volume 5, Section 7.6, Table 7.6-1) to the 2013 PDC. There is an accompanying net increase in the loss of organic soils from the EIA PDC to the 2013 PDC after reclamation, because disturbed areas are reclaimed to mineral soils.

Table 3.4-1 Changes to Soil Types – 2013 Planned Development Case: Before Reclamation

Soil Series	2013 Base Case		Loss/Alteration Due to 2013 Planned Development Case[(a)]		Loss/Alteration Due to Pierre River Mine		Closure		Net Change Due to 2013 Planned Development Case[(b)]	
	Area [ha]	% of RSA	Area [ha]	% of Resource	Area [ha]	% of Resource	Area [ha]	% of RSA	Area [ha]	% of Resource
Mineral Soils										
Algar Lake	42,044	2	-5,065	-12	-<1	- <1	36,979	2	-5,065	-12
Bitumount	37,996	2	-3,782	-10	-762	-2	34,214	2	-3,782	-10
Buckton	31,739	1	-16	- <1	0	0	31,723	1	-16	- <1
Dover	50,801	2	-5,649	-11	0	0	45,153	2	-5,649	-11
Firebag	60,364	3	-1,366	-2	0	0	58,998	3	-1,366	-2
Fort	1,821	<1	-35	-2	0	0	1,787	<1	-35	-2
Gipsy	6,291	<1	0	0	0	0	6,291	<1	0	0
Horse River	23,544	1	-2,473	-11	0	0	21,071	1	-2,473	-11
Joslyn	66,208	3	-8,273	-12	-2	0	57,935	3	-8,273	-12
Kearl	3,870	<1	-209	-5	0	0	3,661	<1	-209	-5
Kinosis	49,429	2	-2,472	-5	0	0	46,957	2	-2,472	-5
Legend	126,228	6	-4,917	-4	0	0	121,312	5	-4,917	-4
Livock	36,431	2	-1,928	-5	0	0	34,503	2	-1,928	-5
Marguerite	69,996	3	-1,091	-2	-3	- <1	68,905	3	-1,091	-2
McMurray	53,535	2	-3,063	-6	-776	-1	50,472	2	-3,063	-6
Mildred	171,159	8	-9,681	-6	-4,082	-2	161,478	7	-9,681	-6
Namur	60,640	3	-20,645	-34	-2,625	-4	39,995	2	-20,645	-34
Ruth Lake	12,286	1	-2,932	-24	-470	-4	9,354	<1	-2,932	-24
Steepbank	120,129	5	-4,812	-4	-86	- <1	115,316	5	-4,812	-4
Surmont	11,180	<1	-803	-7	0	0	10,377	<1	-803	-7
subtotal (mineral soils)	*1,035,692*	*45*	*-79,212*	-8	*-8,807*	*-1*	*956,480*	*42*	*-79,212*	-8
Organic Soils										
Bayard	14,616	1	-202	-1	0	0	14,414	1	-202	-1
Conklin	57,922	3	-4,737	-8	-14	- <1	53,185	2	-4,737	-8
Gregoire	19,342	1	-1,038	-5	0	0	18,304	1	-1,038	-5
Hartley	152,844	7	-8,822	-6	-541	- <1	144,022	6	-8,822	-6
McLelland	145,313	6	-9,019	-6	-117	- <1	136,294	6	-9,019	-6
Mikkwa	125,183	5	-3,086	-2	0	0	122,097	5	-3,086	-2
Mariana	138,616	6	-12,628	-9	-1,082	-1	125,988	6	-12,628	-9
Muskeg	227,947	10	-12,310	-5	-463	- <1	215,637	9	-12,310	-5
Wabasca	31,692	1	-2,248	-7	-189	-1	29,444	1	-2,248	-7
subtotal (organic soils)	*913,474*	*40*	*-54,089*	-6	*-2,406*	*- <1*	*859,384*	*38*	*-54,089*	-6
Reconstructed landforms	0	0	0	0	0	0	142,269	6	142,269	n/a
Rough broken/rock	82,415	4	-1,869	-2	-213	- <1	80,547	4	-1,869	-2
Disturbed	186,349	8	-5,979	-3	-237	- <1	180,370	8	-5,979	-3
Water	53,309	2	-1,090	-2	-79	- <1	52,218	2	-1,090	-2
Indian Reserves[(a)]	6,137	<1	-30	- <1	0	0	6,107	<1	-30	- <1
subtotal (other)	*328,211*	*14*	*-8,968*	-3	*-529*	*- <1*	*461,512*	*20*	*133,301*	41
Total	**2,277,376**	**100**	**-142,269**	-6	**-11,742**	**-1**	**2,277,376**	**100**	**0**	**0**

(a) Loss/alternation combines direct effect due to PRM and all existing, approved and planned developments in the RSA.

(b) Net change is calculated as the difference between Closure and the 2013 Base Case.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

Table 3.4-2 Summary of Changes to Soil Types – 2013 Planned Development Case: Before Reclamation

Soil Type	2013 Base Case		Loss/Alteration Due to 2013 Planned Development Case		Closure		Net Change to 2013 Planned Development Case [(a)]	
	Area [ha]	% of RSA	Area [ha]	% of Resource	Area [ha]	% of RSA	Area [ha]	% Resource[(b)]
Mineral soils	1,035,692	45	-79,212	-8	956,480	42	-79,212	-8
Organic soils	913,474	40	-54,089	-6	859,384	38	-54,089	-6
Rough Broken/Rock, Disturbed, Reconstructed Landforms, Indian Reserves	274,902	12	-7,878	-3	409,294	18	134,391	49
Water	53,309	2	-1,090	-2	52,218	2	-1,090	-2
Total	**2,277,376**	**100**	**-142,269**	-6	**2,277,376**	**100**	**0**	**0**

(a) Net change is calculated as the difference between 2013 Base Case and Closure, a value upon which the environmental consequence is assessed.

(b) % Resource is calculated as a percentage of 2013 Base Case area; the areas of this column are not additive.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

Table 3.4-3 Summary of Changes to Soil Types – 2013 Planned Development Case: After Reclamation

Soil Type	2013 Base Case		Loss/Alteration Due to 2013 Planned Development Case [(a)]		Closure		Net Change to 2013 Planned Development Case [(b)]	
	Area [ha]	% of RSA	Area [ha]	% of Resource	Area [ha]	% of RSA	Area [ha]	% Resource[(d)]
Mineral soils	1,035,692	45	-79,212	-8	1,208,497	53	172,805	17
Organic soils	913,474	40	-54,089	-6	885,393	39	-28,080	-3
Rough Broken/Rock, Disturbed, Reconstructed, Indian Reserves	274,902	12	-7,878	-3	109,498	5	-165,404	-90
Water [(c)]	53,309	2	-1,090	-2	73,988	3	20,680	39
Total	**2,277,376**	**100**	**-142,269**	**-6**	**2,277,376**	**100**	**0**	**0**

(a) After reclamation closure assumes all disturbed minerals soils are reclaimed and some organic soils are recreated and closure landscape scenario conceptualized for land cover is used to predict the after reclamation scenario.

(b) Total net change due to 2013 PDC is set to zero for presentation purposes only. The residual environmental consequence rating is based on the loss of organic soils.

(c) Includes pit lakes and South Redclay Lake.

(d) % Resource is calculated as a percentage of 2013 Base Case area; the areas of this column are not additive.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

The 2013 PDC residual impact classification after reclamation for soils in the RSA is shown in Table 3.4-4. The environmental consequences for the permanent loss of soils in the RSA were rated as moderate for each of mineral and organic soils before reclamation. After reclamation however, the direction of the impact to mineral soils is positive (Table 3.4-3; 17% increase of resource), and so this parameter is not included in the residual impact summary. There will be a permanent loss of 3% of organic soils in the RSA due to the 2013 PDC. Therefore after reclamation, the residual impact for the permanent loss of organic soils is moderate (Table 3.4-4).

Table 3.4-4 Residual Impact Classification for Soils in the Regional Study Area – 2013 Planned Development Case: After Reclamation

Parameter	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (RSA)
Loss/Alteration of Soils –After Reclamation							
Permanent Loss of Organic Soil	Negative	low (+5)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	moderate (+13)

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

3.4.1.2 Summary of Results

The 2013 PDC assessment shows an increase in planned development disturbances. The area of soil disturbance in the 2013 PDC was 142,269 ha (6% of Resource), compared to the EIA prediction of 128,842 ha (6% of Resource). After reclamation, there will be a net increase of mineral soils (172,805 ha or 17% of Resource) at Closure, compared to the 2013 Base Case. A net loss of 28,080 ha (3% of Resource) of organic soils is predicted after reclamation based on the conceptualized landscape. The environmental consequence rating for permanent loss of organic soils for the 2013 PDC in the RSA is increased from low to moderate compared to the EIA.

3.4.2 Terrestrial Vegetation, Wetlands and Forest Resources Assessment

The effects of JME and PRM and planned developments on terrestrial vegetation, wetlands and forest resources were assessed in the EIA, Volume 5, Section 7. The 2013 PDC was completed for those components that had a low, moderate or high negative environmental consequence in the LSA in the 2013 PRM Application Case assessment at Closure, and were applicable at the RSA scale (Appendix 1). Greater than negligible negative environmental consequences were predicted in the LSA for the following KIRs:

- wetlands (including peatlands and patterned fens);
- old growth forests; and
- high rare plant potential.

The remaining KIRs were assessed to have a positive, neutral or negative negligible environmental consequence in the LSA, and a negligible or not applicable environmental consequence in the RSA for the 2013 PRM Application Case at Closure (Appendix 1), and therefore were not analyzed in the 2013 PDC. Effects of PRM on these KIRs in terms of magnitude, extent, duration, frequency and reversibility at the 2013 PRM Application Case are summarized in Appendix 1. The results of the 2013 PDC assessment both during construction and operations and at 2013 PDC Far Future (i.e., 80 years following final reclamation of all projects in the RSA) are presented below.

3.4.2.1 Assessment Results

The combined developments in the 2013 PDC will result in the direct and indirect loss or alteration to the 2013 Base Case terrestrial and wetlands resources as summarized in Table 3.4-5. A total of 144,451 ha or 6% of the RSA will be disturbed in the 2013 PDC relative to the 2013 Base Case. Although terrestrial vegetation (i.e., uplands) will be lost during construction and operations, from the 2013 Base Case to Far Future there will be an overall increase in terrestrial vegetation by 188,255 ha (30% of Resource). During construction and operations, there will be a loss of 70,722 ha (8% of Resource) of wetlands within the RSA. Following reclamation, the net decrease is reduced to 9,941 ha of wetlands (1% of Resource). From 2013 Base Case to Far Future, the largest portion of terrestrial vegetation gained will be in the deciduous aspen-balsam poplar RLCC, while wetlands area loss will be in the treed bog/poor fen and treed fen RLCCs.

Change in Wetlands Including Peatlands and Patterned Fens

Peatlands and patterned fens are included in the wetlands class in the 2013 PDC. Peatlands and patterned fens cannot be assessed separately because they are indistinguishable from other wetlands classes in the RSA at the scale of the mapping units used to classify RLCCs. Peatlands and patterned fens are discussed in the responses to JRP SIR 46 and 48.

Wetlands in the RSA are represented by the following RLCCs:

- non-treed wetlands;
- treed bog/poor fen; and
- treed fen.

A total of 70,722 ha (8% of Resource) of wetlands will be lost or altered in the 2013 PDC relative to the 2013 Base Case (Table 3.4-5). Following reclamation and regeneration, the predicted effect of planned developments on 2013 Base Case wetlands is a net decrease of 9,941 ha (1% of Resource). Non-treed wetlands at Far Future are predicted to increase by 37,497 ha (16% of Resource) over the 2013 Base Case. This net gain is the result of the development of non-peatland wetlands in reclamation landscapes, e.g., marsh (MONG), shrubland (Sh) or shrubby swamp (SONS) and natural regeneration of non-treed wetlands on linear disturbances (e.g., seismic lines). From 2013 Base Case to the 2013 PDC at Far Future, the treed bog/poor fen RLCC is predicted to decrease by 24,340 ha (6% of Resource), while the treed fen RLCC is predicted to decrease by 23,099 ha (10% of Resource).

Due to the scale of mapping used at the RSA, the treed bog/poor fen, treed fen and non-treed wetlands RLCCs likely include a proportion of non-peatland wetlands types. Based on a review of nine oil sands projects within the RSA, peatlands are estimated to represent 67% of all the wetlands mapped at the regional scale (EIA, Volume 5, Section 7.6.2). Using this proportion as a guide, approximately 6,661 ha of peatlands will be lost (1% of Resource) from 2013 Base Case to 2013 PDC at Far Future (JRP SIR 46).

Wetlands are predicted to account for 885,393 ha or 39% of resource following reclamation relative to the 2013 Base Case.

Table 3.4-5 Regional Land Cover Classes in the Regional Study Area – 2013 Base Case to the 2013 Planned Development Case

Regional Land Cover Class	2013 Base Case[(a)]		Loss/Alteration to 2013 Base Case Due to 2013 PRM[(a)(b)] Application Case		Loss/Alteration to 2013 Base Case Due to 2013 Planned Development[(a)(c)] Case		Far Future[(a)(d)]		Net Change to 2013 Base Case Due to 2013 Planned Development Case[(e)]	
	Area [ha]	% of RSA[(f)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of RSA[(f)]	Area [ha]	% of Resource[(g)]
Terrestrial Vegetation										
coniferous jack pine	166,332	7	-349	-<1	-5,143	-3	178,719	8	12,387	7
coniferous jack pine-black spruce	40,054	2	0	0	-1,621	-4	63,928	3	23,874	60
coniferous white spruce	52,386	2	-622	-1	-5,154	-10	90,754	4	38,368	73
deciduous aspen-balsam poplar	178,067	8	-506	-<1	-23,307	-13	229,061	10	50,994	29
mixedwood aspen-jack pine	39,033	2	0	0	-2,341	-6	59,217	3	20,185	52
mixedwood aspen-white spruce	144,759	6	-1,643	-1	-16,057	-11	187,176	8	42,417	29
terrestrial vegetation subtotal	*620,630*	*27*	*-3,120*	*-<1*	*-53,622*	*-9*	*808,855*	*36*	*188,225*	*30*
Wetlands (Peatlands)								0		
non-treed wetlands	241,110	11	-2,512	-1	-19,141	-8	278,607	12	37,497	16
treed bog/poor fen	423,855	19	-2,380	-<1	-24,753	-6	399,516	18	-24,340	-6
treed fen	230,369	10	-5,014	-2	-26,828	-12	207,270	9	-23,099	-10
wetlands subtotal	*895,334*	*39*	*-9,906*	*-1*	*-70,722*	*-8*	*885,393*	*39*	*-9,941*	*-1*
Miscellaneous								0		
burn	396,125	17	-426	-<1	-9,235	-2	387,185	17	-8,940	-2
water	52,526	2	-52	-<1	-1,139	-2	73,988	3	21,462	41
miscellaneous subtotal	*448,651*	*20*	*-478*	*-<1*	*-10,374*	*-2*	*461,173*	*20*	*12,522*	*3*
Disturbances								0		
cutblock	100,160	4	0	0	-1,048	-1	99,112	4	-1,048	-1
disturbance	212,601	9	-420	-<1	-8,686	-4	22,843	1	-189,758	-89
disturbances subtotal	*312,761*	*14*	*-420*	*-<1*	*-9,733*	*-3*	*121,956*	*5*	*-190,805*	*-61*
Total	**2,277,376**	**100**	**-13,924**	**-<1**	**-144,451**	**-6**	**2,277,376**	**100**	**n/a**	**n/a**

(a) Includes burns and cutblocks as modelled by ALCES®.

(b) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect effects due to surficial aquifer (groundwater) drawdown from PRM within the RSA, and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed during construction and operations. Excluding indirect effects due to surficial aquifer drawdown from PRM there is a total loss/alteration of -11,742 ha within the RSA.

(c) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect PRM effects due to surficial aquifer drawdown from PRM within the RSA, plus existing, approved and planned developments in the RSA. Excluding indirect effects due to surficial aquifer drawdown from PRM the total loss/alteration is -142,269 ha, within the RSA.

(d) Values presented in this column do not include indirect effects due to surficial aquifer drawdown, as drawdown will occur primarily during the life of PRM. Drawdown effects of PRM on wetlands types surrounding pit lakes may extend to Far Future. At Far Future combined direct and indirect effects are predicted to cause an additional loss of 978 ha (22% of Resource) of wetlands.

(e) Net change is calculated as the difference between the 2013 Base Case and Far Future, a value upon which the environmental consequence after reclamation is assessed.

(f) For the purposes of this assessment, each RLCC is assumed to be 100% of Resource at 2013 Base Case.

(g) % of Resource is calculated as a percentage of 2013 Base Case area; the areas of this column are not additive.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Change to Old Growth Forest

The estimated effect of PRM and planned developments within the RSA on old growth forests is outlined in Table 3.4-6. Due to the combined effects of the 2013 PDC developments, up to 24,460 ha or 8% of potential 2013 Base Case old growth forest area may be cleared in the RSA; PRM will contribute to less than 1% of this loss. Old growth forests are not expected to be re-established within the 80-year period defined for the Far Future scenario. However, the proportion of old growth forests in the RSA is predicted to return to its pre-disturbance proportions over time, where additional anthropogenic and natural disturbances do not occur.

Change to Rare Plant Potential

The predicted changes to high rare plant potential habitat under the 2013 PDC are presented in Table 3.4-7. An estimated 45,969 ha of high rare plant potential or 10% of the resource will be lost from 2013 Base Case to the 2013 PDC (Table 3.4-7) in the RSA. Post reclamation, high rare plant potential habitat is predicted to increase by 14,398 ha (3% of Resource) over the 2013 Base Case. This predicted increase in high rare plant potential in the Far Future is mainly a result of non-treed wetlands reclamation and natural wetlands regeneration on existing and future linear disturbances.

Residual Impact Classification

The effects descriptions and environmental consequences of the 2013 PDC during construction and operations are summarized in Table 3.4-8, and at 2013 PDC Far Future in Table 3.4-9. During construction and operations, a negative and low environmental consequence has been assigned to wetlands (including peatlands and patterned fens) (Table 3.4-8). At Far Future, wetlands (including peatlands and patterned fens) have been assigned a negative and low environmental consequence ranking (Table 3.4-9), which has not changed from negative and low for the PDC in the EIA. Although the peatlands (i.e., fens) in the RSA cannot be reclaimed with current technologies, non-treed wetlands can be reclaimed. For this reason, reversible/irreversible was used. Reclamation programs will be adaptively managed to incorporate the results and recommendations from ongoing research regarding establishment of bogs and fens on the closure landscape (EIA, Volume 5, Appendix 5-2, Section 4).

The overall environmental consequence for old growth forests in the RSA is negative and low both before and after reclamation (Tables 3.4-8 and 3.4-9). However, the proportion of old growth forests in the RSA is predicted to return to its pre-disturbance proportions over time, where additional anthropogenic and natural disturbances do not occur. The old growth forests environmental consequence ranking has not changed from the PDC in the EIA.

During construction and operations, a negative and moderate environmental consequence has been assigned to high rare plant potential (Table 3.4-8). At Far Future, the high rare plant potential environmental consequence ranking is positive and low (Table 3.4-9) within the RSA and is the same as in the PDC for the EIA.

Table 3.4-6 Old Growth Forest in the Regional Study Area – 2013 Base Case to 2013 Planned Development Case

Regional Land Cover Class	Forest Type (Old Growth Range)[(a)]	Mid-Point Estimated Occurrence of Old Growth in the RSA[(b)]	Total Area: 2013 Base Case in RSA[(c)]	Total Area: Loss/Alterations Due to 2013 Planned Development Case[(c)]	Estimated 2013 Base Case Old Growth in the RSA[(c)(d)]		Loss/Alteration of 2013 Base Case Old Growth Due to the 2013 PRM[(e)] Application Case		Estimated Loss/Alteration of 2013 Base Case Old Growth Due to 2013 Planned Development Case[(c)(d)]	
		% of Land Cover Class	Area [ha]	Area [ha]	Area [ha]	% of RSA[(f)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]
Terrestrial Vegetation										
coniferous jack pine	pine dominant (16% to 36%)	26	166,332	-5,143	43,246	2	-<1	-<1	-1,337	-3
coniferous jack pine-black spruce	pine dominant (16% to 36%)	26	40,054	-1,621	10,414	<1	-88	-<1	-421	-4
coniferous white spruce	white spruce dominant (10% to 34%)	22	52,386	-5,154	11,525	<1	-72	-<1	-1,134	-10
deciduous aspen-balsam poplar	hardwood dominant (14% to 42%)	28	178,067	-23,307	49,859	2	-95	-<1	-6,526	-13
mixedwood aspen-jack pine	mixedwood dominant (16% to 38%)	27	39,033	-2,341	10,539	<1	-19	-<1	-632	-6
mixedwood aspen-white spruce	mixedwood dominant (16% to 38%)	27	144,759	-16,057	39,085	2	-173	-<1	-4,336	-11
treed bog/poor fen	black spruce dominant (12% to 28%)	20	423,855	-24,340	84,771	4	0	0	-4,868	-6
treed fen	black spruce dominant (12% to 28%)	20	230,369	-26,032	46,074	2	-<1	-<1	-5,206	-11
Total		**n/a**	**1,274,855**	**-103,994**	**295,513**	**13**	**-448**	**-<1**	**-24,460**	**-8**

(a) Based on percent ranges of overmature dominant tree species derived from computer modelling of historic patterns in seral stage variation over time (Andison 2003).

(b) Based on mid-point of the overmature age class range values in Andison (2003).

(c) Burns and cutblocks as modelled by ALCES® are accounted for within each Regional Land Cover Class (RLCC).

(d) Estimations are calculated by multiplying the total area of each land cover class by the mid-point estimated occurrence of old growth.

(e) Values generated by correlating the amount of loss/alteration of old growth in each LSA vegetation type to the corresponding regional land cover class.

(f) For the purposes of this assessment, each RLCC is assumed to be 100% of Resource at 2013 Base Case.

(g) % of Resource is calculated as a percentage of 2013 Base Case area; the areas of this column are not additive.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 3.4-7 Rare Plant Potential in the Regional Study Area – 2013 Base Case to 2013 Planned Development Case

Rare Plant Potential	2013 Base Case[a]		Loss/Alteration to 2013 Base Case Due to the 2013 PRM[a][b] Application Case		Loss/Alteration to 2013 Base Case Due to 2013 Planned Development[a][c] Case		Far Future[a]		Net Change to 2013 Base Case Due to 2013 Planned Development[d] Case	
	Area [ha]	% of RSA[e]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]
high	471,479	21	-7,526	-2	-45,969	-10	485,877	103	14,398	3
moderate	1,165,558	51	-3,155	-<1	-44,139	-4	1,187,677	102	22,118	2
low	640,339	28	-3,243	-<1	-54,343	-8	603,822	94	-36,517	-6
Total	**2,277,376**	**100**	**-13,924**	**-<1**	**-144,451**	**-6**	**2,277,376**	**100**	**n/a**	**n/a**

[a] Includes burns and cutblocks as modelled by ALCES®.

[b] Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect effects due to surficial aquifer drawdown from PRM within the RSA, and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed during construction and operations. Excluding indirect effects due to surficial aquifer drawdown from PRM there is a total loss/alteration of -11,742 ha within the RSA.

[c] Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect Project effects due to surficial aquifer drawdown from PRM within the RSA, plus existing, approved and planned developments in the RSA. Excluding indirect effects due to surficial aquifer drawdown from PRM the total loss/alteration is -142,269 ha, within the RSA.

[d] Net change is calculated as the difference between the 2013 Base Case and Far Future, a value upon which the environmental consequence is assessed.

[e] For the purposes of this assessment, each category is assumed to be 100% of Resource at 2013 Base Case.

[f] % of Resource is calculated as a percentage of 2013 Base Case area; the areas of this column are not additive.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 3.4-8 Residual Impact Classification for Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area – 2013 Base Case to 2013 Planned Development Case: During Construction and Operations

Component Criteria	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
wetlands (including peatlands and patterned fens)	negative	low (+5)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	low (+10)
old growth forests	negative	low (+5)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	low (+10)
high rare plant potential	negative	moderate (+10)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)

(a) Residual impact magnitude is based on percent of resource.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

n/a = Not applicable.

Table 3.4-9 Residual Impact Classification for Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area – 2013 Base Case to the 2013 Planned Development Case: Far Future

Component Criteria	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
wetlands (including peatlands and patterned fens)	negative	low (+5)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	low (+10)
old growth forests	negative	low (+5)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	low (+10)
high rare plant potential	positive	low (+5)	regional (+1)	long term (+2)	n/a	high (+2)	low (+10)

(a) Residual impact magnitude is based on percent of resource.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

n/a = Not applicable.

3.4.2.2 Summary of Results

As assessed in Appendix 1, negative and greater than negligible environmental consequences were predicted in the LSA for the 2013 PRM Application Case at Closure for the following KIRs: wetlands (including peatlands and patterned fens), old growth forests and high rare plant potential.

The results of the 2013 PDC assessment during construction and operations indicate a negative and low environmental consequence for wetlands (including peatlands and patterned fens) and old growth forests. A negative and moderate environmental consequence is assigned to high rare plant potential due to the loss of non-treed wetlands.

The results of the 2013 PDC assessment indicate that there has been no change to wetlands (including peatlands and patterned fens) and old growth forest environmental consequence rankings from the EIA PDC, within the RSA at Far Future. The wetlands (including peatlands and patterned fens) and old growth forest environmental consequence ranking at Far Future remained negative and low as in the EIA PDC (Volume 5, Section 7.6). Although the peatlands (i.e., fens) in the RSA cannot be reclaimed with current technologies if the soil has been disturbed, the non-treed wetlands can be reclaimed, resulting in the irreversible/reversible rating.

The high rare plant potential environmental consequence ranking at Far Future is positive and low, and is the same as the EIA (Volume 5, Section 7.6).

3.4.3 Wildlife Assessment

The effects of PRM, JME and other planned developments on wildlife were assessed in the EIA (Volume 5, Section 7.3.4 through 7.6). The EIA, as amended, assessed the effects of PRM and other planned developments on the abundance, habitat and movement of wildlife KIRs, which were selected based on robust selection rationale. Estimated effects on those species were extrapolated to assess the effects of PRM and other planned developments on other wildlife species, including SAR KIRs. The effects of PRM and other planned developments on wildlife abundance, habitat and movement for SAR KIRs were assessed in the *November 2011 Submission of Information to the Joint Review Panel*, Appendix 2.

The effects of PRM and other planned developments on the abundance of Canadian toad, barred owl, beaver, Canada lynx, fisher and black-throated green warbler were not previously explicitly assessed in the EIA for the RSA, but are assessed here to increase the clarity of the assessment (Section 3.4.3.1.1). Effects to wood bison were not originally assessed in the EIA because bison were not selected as a KIR. However, the effects on wood bison are assessed in the *November 2011 Submission of Information to the Joint Review Panel*, Appendix 2. Wood bison do not occur on the east side of the Athabasca River, but do occur on the west side of the Athabasca River, including in the LSA. Effects on woodland caribou habitat were not previously assessed because woodland caribou are virtually absent in the LSA. However, woodland caribou have been added as a KIR as part of this supplemental assessment to evaluate the potential contribution of PRM and other planned developments to broad scale cumulative effects to regional caribou populations.

The effects of PRM and other planned developments on wildlife movement were not explicitly assessed in the EIA PDC for Canadian toad, barred owl, beaver, black-throated green warbler and western toad but have been assessed in this submission to increase the clarity of the assessment (Section 3.4.3.1.3). In the EIA, the effects of habitat fragmentation were combined with the results of the linkage zone analysis to assess the environmental consequence of the EIA PDC on wildlife movement. Fragmentation metrics may be useful indicators of effects on wildlife movement, but should not be considered in isolation because wildlife are often able to move around or in some cases through disturbances. Areas of suboptimal habitat may facilitate movement rather than inhibiting it (Andreassen et al. 1996), provided barriers to movement are not present. Environmental consequences for the effects of landscape change on wildlife movement were assessed in the EIA using fragmentation metrics and linkage zone analysis results separately. For the 2013 PDC, the outputs of these quantitative tools are combined with ecological context based on available data and peer-reviewed literature to result in one environmental consequence for each wildlife KIR for which movement may be affected.

3.4.3.1 Assessment Results

3.4.3.1.1 Wildlife Abundance

The effects of PRM and other planned developments on wildlife abundance were assessed in the EIA and the *November 2011, Submission of Information to the Joint Review Panel,* Appendix 2. The assessed environmental consequences of the 2013 PDC on the abundance of wildlife SAR are similar to those previously assessed (*November 2011, Submission of Information to the Joint Review Panel*). Impacts affecting the abundance of

Eskimo curlew and northern leopard frog are not predicted because these species have not been recorded in the RSA.

For wildlife KIRs, the effects of development in the RSA on abundance were previously assessed explicitly for black bear and moose through the use of a Population Viability Analysis (PVA). A PVA was also conducted for the PIC, 2013 Base Case, 2013 PRM Application Case and 2013 PDC (Appendix 3.7, Section 3). A low magnitude reduction in the carrying capacity of the RSA was predicted for black bear and moose in both the EIA PDC and the 2013 PDC, resulting in a low environmental consequence. Although it is likely that black bear and moose are held below the food limited carrying capacity of the RSA, primarily due to human harvest, to be conservative it is assumed that the reduction in abundance is equivalent to the reduction in carrying capacity.

The effects of landscape changes on the abundance of wildlife from the 2013 Base Case to the 2013 PDC are assessed by considering available information on population trends and the factors that are known or suspected to limit populations of KIRs and SAR in the RSA. Details regarding population trends and factors limiting populations are summarized for each KIR in Section 4.2.3.1.1. Quantitative modelling (i.e., a PVA; Appendix 3.7, Section 3) is used for estimating the effects of landscape change on moose and black bear populations, for which sufficient data on demographic rates exist to conduct such an analysis. Reliable data regarding historical population trends are not available for most wildlife species in the RSA. Where sufficient information is not available to assess the effects of landscape change on wildlife abundance, the results of habitat modelling (Appendix 3.7, Section 1) predictions regarding effects to high suitability habitat are used as a proxy, under the conservative assumption that abundance is directly related to the availability of habitat. In reality, many wildlife KIRs are not likely to be directly limited by habitat in the RSA. For example, rusty blackbird and yellow rail are likely limited by factors affecting their populations on southern wintering grounds, while horned grebe is likely limited by the availability of wetlands in the prairies (Section 4.2.3.1.1). Therefore, predicted effects to abundance based on effects to high suitability habitat are likely over estimations of actual effects to abundance for some KIRs.

Of the wildlife KIRs that may be sensitive to the availability of habitat in the RSA (Section 4.2.3.1.1), habitat suitability modelling results suggest declines in abundance from the 2013 Base Case to the 2013 PDC that are high in environmental consequence for Canada warbler, rusty blackbird and yellow rail; moderate for Canada lynx, fisher and black-throated green warbler, and low for barred owl, beaver, Canadian toad, common nighthawk, horned grebe, olive-sided flycatcher, short-eared owl and wolverine (Appendix 3.7, Section 1). For the wildlife SAR KIRs for which effects to abundance had previously been assessed (*May 2011, Submission of Information to the Joint Review Panel*), the 2013 PDC represents an increase in environmental consequence from negligible to high for Canada warbler, from negligible to low for common nighthawk and short-eared owl, and from low to moderate for rusty blackbird and yellow rail.

The combined effects of interactions with infrastructure and vehicle collisions are likely to have a negligible magnitude effect on the abundance of peregrine falcon, red knot and whooping crane, which are migratory in the RSA.

Little brown myotis and northern myotis abundance is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, these species are opportunistic in their selection of summer foraging and roosting habitat, and the disease WNS is the primary limitation on abundance across their range. Effects to abundance may be assessed qualitatively by taking into consideration the small risks of mortality due to development in the RSA, which are predicted to be limited to the effects of sensory disturbance on population abundance. Interactions with infrastructure, and direct mortality due to site clearing and vehicle collisions are unlikely to affect the abundance of little brown myotis or northern myotis in the RSA. Development in the RSA is predicted to result in a decline of negligible environmental consequence in little brown myotis and northern myotis abundance from the 2013 Base Case to the 2013 PDC.

The abundance of wood bison may be limited by disease, and potentially unregulated hunting. The combined effects of incidental sources of mortality associated with changes in the RSA between the 2013 Base Case and the 2013 PDC are predicted to result in a low magnitude effect on wood bison abundance.

Although western toad population declines in the RSA appear to be due to disease rather than habitat loss, soil disturbance in the RSA in the 2013 PDC may result in a negligible magnitude effect on western toad abundance.

Woodland caribou are virtually absent from the LSA, and provincially recognized herd boundaries do not overlap with the LSA (ESRD 2013, internet site). The closest herds on the west side of the Athabasca River are the Red Earth range 12 km west of the LSA and the West Side of the Athabasca River (WSAR) range 33 km southwest of the LSA. Construction of PRM and other planned developments in the 2013 PDC may indirectly affect woodland caribou abundance by displacing wolves and alternate prey (i.e., moose, deer) into woodland caribou ranges during construction and operations, and through the production of early seral habitat attractive to moose, white-tailed deer and beaver after reclamation.

The displacement of wolves and alternate prey species from development areas into adjacent habitats during construction may adversely affect caribou. White-tailed deer are much more prevalent in upland habitats in summer and winter (Latham et al. 2013), but the overall abundance of deer in peatland habitats preferred by caribou has been shown to be increasing (Latham et al. 2011). Moose are more prevalent in upland habitats in winter, but appear to prefer peatlands in summer (Latham et al. 2013). Beaver appear to be more common in caribou ranges than in adjacent upland habitats (Latham et al. 2013). Wolves have been shown to generally select habitat that is selected by primary prey species, which include moose, deer and beaver (Latham et al. 2013). In general, wolves show avoidance of habitat preferred by woodland caribou, although pack-specific exceptions occur (Latham et al. 2013). Therefore, displaced deer, moose and beaver may increase population densities in habitat outside of development areas, and possibly within woodland caribou ranges. Displaced wolves may or may not be able to hunt effectively on existing adjacent territories due to inter-pack aggression, but the overall wolf population density may nonetheless increase due to increased prey density (Mech and Boitani 2003). Increases in wolf population densities pose a threat to woodland caribou (Latham et al. 2011).

Forest fragmentation due to oil and gas, forestry and other developments creates early seral vegetation communities that are thought to support higher densities of ungulates such as moose and white-tailed deer (Rettie and Messier 1998; Wittmer et al. 2007). Deer are at the northern end of their range in the Oil Sands Region and historical populations tended to be small and localized (Smith 1993). However, white-tailed deer have been expanding their range and increasing in number in northeastern Alberta during the last 5 to 10 years (Latham et al. 2011). Largely as a result of increasing white-tailed deer populations, wolf populations are also increasing in northeastern Alberta, and increasing wolf populations pose a threat to woodland caribou abundance (Latham et al. 2011). Anthropogenic disturbances in the 2013 PDC will contribute to increased early seral habitat during construction and operations, as well as a temporary increase in early seral communities after reclamation until mature forest communities develop over time.

The combined effects of displaced alternate prey populations during construction and operations and increased forage for moose and deer in vegetated clearings as well as in young reclaimed habitats are likely to result in increased alternate prey and wolf population densities in the absence of management intervention. Woodland caribou are declining to extirpation in the RSA with or without the addition of additional industrial developments (Schneider et al. 2010). Therefore, the cumulative effects of development in the RSA due to the 2013 PDC result in a high magnitude effect on abundance.

3.4.3.1.2 Wildlife Habitat

The effects of JME and PRM and planned developments on wildlife habitat were assessed in the EIA and the Species at Risk Assessment (*May 2011, Submission of Information to the Joint Review Panel*). Changes in the RSA due to the PRM and planned developments from the 2013 Base Case to the 2013 PDC before reclamation result in environmental consequences that are high at the RSA scale for rusty blackbird, yellow rail, and Canada warbler, moderate for barred owl, black-throated green warbler, Canada lynx, fisher, moose, western toad and wood bison, and low for all remaining KIRs (Table 3.4-10).

Changes in predicted environmental consequences from those previously assessed are due in part to the simulation of forest fires and forest harvest outside of 2013 PDC development footprints, and the increased disturbance footprints of planned developments in the 2013 PDC relative to the 2013 Base Case. The simulation of forest fires and forest harvest increased from 10% of the RSA (approximately 220,000 ha) in the EIA (Volume 5, Section 7.6.2) to 21% of the RSA (approximately 500,000 ha) in the 2013 PDC, reducing the amount of high suitability habitat in the 2013 Base Case, particularly for forest-dependent species such as the black-throated green warbler and Canada warbler. In addition, the 2013 PDC represents an increase in industrial disturbance of about 91,000 ha (4% of the RSA) relative to the EIA PDC.

Some wildlife species are dependent upon wetlands, including peatlands. For example, rusty blackbird, yellow rail and woodland caribou are all associated with peatlands. However, rusty blackbird (COSEWIC 2006) and yellow rail (COSEWIC 2009c) are also associated with non-peatland wetlands types, and woodland caribou will utilize upland forest stands rich in lichen (COSEWIC 2002a; Jones 2007). Therefore, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”. However, woodland caribou are unlikely to be affected by PRM because they are virtually absent from the LSA.

The predicted effects of the 2013 PDC represent a reasonable worst-case scenario, because habitat suitability modelling in the 2013 PDC assumes that disturbances from construction occur simultaneously and no reclamation will occur. The actual loss of habitat at any point in time will be less, due to the phased nature of developments and reclamation. Reclamation is not represented because the precise locations and size of some planned projects and the associated reclamation and revegetation plans are unknown. However, there is a regulatory requirement to reclaim habitats. Therefore, predicted environmental consequences are likely greater than what may actually take place. There will be a reduction in environmental consequence as wildlife habitat redevelops and wildlife populations return to the reclaimed landscape from neighbouring source populations.

Table 3.4-10 Residual Impact Classification for Effects on Wildlife in the Regional Study Area – 2013 Base Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[(a)]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Wildlife Abundance							
Canadian toad, barred owl	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)
beaver, black bear, moose	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
Canada lynx, fisher	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
black-throated green warbler	negative	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)
little brown myotis, northern myotis, peregrine falcon, red knot, western toad, whooping crane,	negative	negligible (0)	local to beyond regional (0 to +2)	long-term (+2)	reversible (-3)	high (+2)	negligible (1 to +3)
common nighthawk, horned grebe, olive-sided flycatcher, short-eared owl, wolverine, wood bison	negative	low (+5)	regional to beyond regional (+1 to +2)	long-term (+2)	reversible (-3)	high (+2)	low (+7 to +8)
rusty blackbird, yellow rail	negative	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)
Canada warbler	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)
woodland caribou	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)
Wildlife Habitat (Including Fragmentation)							
Canadian toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)
beaver, black bear	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
barred owl	negative	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)
Canada lynx, fisher, moose	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
black-throated green warbler	negative	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)
common nighthawk, little brown myotis, northern myotis, olive-sided flycatcher, short-eared owl	negative	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)
wolverine	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
horned grebe	negative	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)
western toad	negative	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)
woodland caribou	negative	low (+5)	regional (+1)	long-term (+2)	reversible/ irreversible (0)	high (+2)	low (+10)

Table 3.4-10 Residual Impact Classification for Effects on Wildlife in the Regional Study Area – 2013 Base Case to 2013 Planned Development Case: During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude[(a)]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
wood bison	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
rusty blackbird, yellow rail	negative	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)
Canada warbler	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)
Wildlife Movement							
Canadian toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)
barred owl	negative	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)
black-throated green warbler	negative	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)
beaver, black bear, Canada lynx, fisher, moose	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
western toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)
Canada warbler, common nighthawk, horned grebe, little brown myotis, northern myotis, olive-sided flycatcher, rusty blackbird, short-eared owl, yellow rail	negative	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)
wolverine, wood bison	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)

(a) Magnitude for wildlife habitat is defined through habitat suitability modelling (Appendix 3.7).

Note: Numerical scores for ranking of environmental consequence are explained in Volume 3, Section 1.3.6.

The estimated effects of the 2013 PDC on wildlife SAR KIRs are largely due to the use of setback distances recommended by Environment Canada (2009) as disturbance zones of influence for estimating the effects of sensory disturbance on habitat suitability (*November 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Part A, Appendix B). However, the effects of sensory disturbance on these species are relatively unknown (Environment Canada 2009) and recent research indicates that these setbacks are likely conservative. For example, using point counts, Bayne et al. (2011) reported that of 34 bird species evaluated, 16 species showed significant differences in the use of seismic line edges relative to forest interiors and of those 16, only three showed negative behavioural responses to seismic line edges. In addition, the Alberta Biodiversity Monitoring Institute (ABMI) has reported that there is little difference between the abundance of Canada warbler (100% intact) and olive-sided flycatcher (91% intact) in the boreal forest of Alberta relative to undisturbed forest, although rusty blackbird may be more affected by disturbance (61% intact) (ABMI 2012). Overall, the ABMI (2012) found populations of migratory land birds in the Oil Sands Region to be 85% intact. Therefore in general, sensory disturbance and habitat fragmentation effects that are predicted due to the 2013 PDC are likely greater than what may actually occur.

Little brown myotis and northern myotis are unlikely to be limited by habitat in the RSA. Prior to the arrival of WNS in Alberta, the availability of hibernacula may be limiting regional abundance of these species. However, winter hibernacula in the Alberta Oil Sands Region are only known from outside the RSA in Cadomin Cave and Wood Buffalo National Park (ASRD and ACA 2009; Barclay 2012, pers. comm.), and will not be affected by the PRM or development in the RSA. Little brown myotis and northern myotis are considered to be habitat generalists with respect to their summer roosting and foraging habitat, typically using a range of mixedwood and coniferous forests (ASRD and ACA 2009; Crampton and Barclay 1998). Therefore, habitat change for little brown and northern myotis may be generalized from changes to the areal extent of mixedwood and coniferous forests in the RSA. Mixedwood and coniferous forests show a 7% decline from the 2013 Base Case to the 2013 PDC prior to reclamation (Table 3.4-5), resulting in a low magnitude and environmental consequence for little brown myotis and northern myotis summer roosting and foraging habitat.

3.4.3.1.3 Wildlife Movement

The effects of PRM and other planned developments on wildlife movement were assessed in the EIA and the Species at Risk Assessment (*May 2011, Submission of Information to the Joint Review Panel,* Appendix 2). The effects of the EIA PDC on wildlife movement were not previously explicitly assessed for Canadian toad, barred owl, beaver, black-throated green warbler, little brown myotis, northern myotis and western toad, but are assessed for the 2013 PDC. The effects on woodland caribou movement are not assessed because caribou are virtually absent from the LSA and are unlikely to be affected by PRM.

Planned developments in the RSA will increase barriers to movement for wildlife, although this effect will be reduced through mitigations such as the creation of passageways for wildlife KIRs under the Athabasca River bridge in the LSA, and the retention of vegetated buffers along the Athabasca River and other large rivers in the RSA. The degree to which wildlife movement may be restricted in the RSA will be determined in part by the timing of currently approved and future projects. Any barrier or filter effect will be reduced if all projects do not proceed on similar schedules. Progressive reclamation on the LSA as well as on neighbouring developments will further reduce the cumulative impact. After mitigation but before reclamation, wildlife will be able to move around developments.

The assessed environmental consequences of the 2013 PDC on wildlife movement are low for terrestrial KIRs (i.e., beaver, black bear, Canada lynx, Canadian toad, fisher, moose, western toad, wolverine and wood bison), and negligible for volant KIRs (i.e., able to fly, all remaining wildlife KIRs) (Table 3.4-10).

3.4.3.2 Summary of Results

The effects of PRM and other planned developments on wildlife abundance, habitat and movement were previously assessed in the EIA and the Species at Risk Assessment (*May 2011, Submission of Information to the Joint Review Panel,* Appendix 2).

Impacts affecting the abundance of Eskimo curlew and northern leopard frog are not predicted because these species have not been recorded in the RSA. Woodland caribou are declining to extirpation in the RSA with or without the addition of additional industrial developments. The combined effects of displaced alternate prey populations during construction and an increase in forage for moose and deer in vegetated clearings and young reclaimed habitats are likely to result in increases in alternate prey and wolf population densities in the absence of management intervention. Therefore, the cumulative effects of development in the RSA due to the 2013 PDC on woodland caribou may result in a high magnitude effect on abundance. For black bear and moose, a low magnitude reduction in the carrying capacity of the RSA was predicted using a PVA for both the EIA PDC and the 2013 PDC. Although it is likely that black bear and moose populations are held below the food limited carrying capacity of the RSA, primarily due to human harvest, to be conservative it is assumed that the reduction in abundance is equivalent to the reduction in carrying capacity, resulting in a low environmental consequence. Where sufficient information is not available to assess the effects of landscape change on wildlife abundance, the results of habitat modelling (Appendix 3.7, Section 1) predictions regarding effects to high suitability habitat are used as a proxy, under the conservative assumption that abundance is directly related to the availability of habitat. However, as many wildlife KIRs are not likely to be directly limited by habitat in the RSA, this conservative assumption is likely to result in overestimations of actual effects to abundance.

Of the wildlife KIRs that may be sensitive to the availability of habitat in the RSA (Section 4.2.3.1.1), habitat suitability modelling results suggest declines in abundance from the 2013 Base Case to the 2013 PDC that are high in environmental consequence for Canada warbler, rusty blackbird and yellow rail; moderate for Canada lynx, fisher, black-throated green warbler; and low for barred owl, beaver, Canadian toad, common nighthawk, horned grebe, olive-sided flycatcher, short-eared owl and wolverine (Appendix 3.7, Section 1).

The combined effects of interactions with infrastructure and vehicle collisions are likely to have a negligible magnitude effect on the abundance of peregrine falcon, red knot and whooping crane, which seasonally migrate through the RSA.

Little brown myotis and northern myotis abundance is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, these species are opportunistic in their selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across their range. Effects to abundance may be assessed qualitatively by taking into consideration the small risks of mortality due to development in the RSA, which are predicted to be of negligible environmental consequence in the 2013 PDC.

The abundance of wood bison may be limited by disease, and potentially unregulated hunting. The combined effects of incidental sources of mortality associated with changes in the RSA between the 2013 Base Case and the 2013 PDC are predicted to result in a low magnitude effect on wood bison abundance.

Although western toad population declines in the RSA appear to be due to disease rather than habitat loss, soil disturbance in the RSA in the 2013 PDC may result in a negligible magnitude effect on western toad abundance.

The assessed environmental consequences of the 2013 PDC on wildlife habitat are similar to those previously assessed (*May 2011, Submission of Information to the Joint Review Panel*, Appendix 2). Changes in the RSA due to the PRM and planned developments from the 2013 Base Case to the 2013 PDC before reclamation result in environmental consequences that are high at the RSA scale for rusty blackbird, yellow rail, Canada warbler, moderate for barred owl, black-throated green warbler, Canada lynx, fisher, moose, western toad and wood bison, and low for all remaining KIRs.

The predicted effects of the 2013 PDC represent a reasonable worst-case scenario, because habitat suitability modelling in the 2013 PDC assumes that disturbances from construction occur simultaneously and no reclamation will occur. The actual loss of habitat at any point in time will be less, due to the phased nature of developments and reclamation. Reclamation is not represented because the precise locations and size of some planned projects and the associated reclamation and revegetation plans are unknown. However, there is a regulatory requirement to reclaim wildlife habitat. Therefore, predicted environmental consequences are likely greater than what may actually take place. There will be a reduction in environmental consequence as wildlife habitat redevelops and wildlife populations return into the reclaimed landscape from neighbouring source populations.

The estimated effects of the 2013 PDC on wildlife species at risk are also conservative in that they are largely due to the use of setback distances recommended by Environment Canada (2009) as disturbance zones of influence for estimating the effects of sensory disturbance on habitat suitability (*May 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Part A, Appendix B). However, the effects of sensory disturbance on these species are relatively unknown (Environment Canada 2009) and recent research indicates that these setbacks are likely conservative. For example, the results of analyses by Bayne et al. (2011) suggest that very few migratory bird species (i.e., three of 34 species evaluated) show negative behavioural responses to seismic line edges. In addition, the results of analyses by the ABMI (2012) suggest that populations of migratory land birds in the Oil Sands Region are 85% intact relative to populations in undisturbed forest. Therefore, in general sensory disturbance and habitat fragmentation effects of this 2013 PDC are likely greater than what may actually occur.

The assessed environmental consequences of the 2013 PDC on wildlife movement are low for beaver, black bear, Canada lynx, Canadian toad, fisher, moose, western toad, wolverine and wood bison, and negligible for all remaining wildlife KIRs and SAR (Table 3.4-10).

3.4.4 Biodiversity Assessment

The effects of PRM and other existing and planned developments on biodiversity were assessed relative to the EIA Base Case in the EIA, Volume 5, Section 7.6.4. The following section presents the effects to biodiversity in the RSA related to changes from the 2013 Base Case to the 2013 PDC.

The 2013 PDC assessment is completed for those components that had a negative low, moderate or high environmental consequence within the LSA in the 2013 PRM Application Case assessment. Greater than negligible negative environmental consequences were predicted for all levels of biodiversity (Appendix 1, Table 4.5-11). Biodiversity is assessed using the same assessment methods described in the EIA, Volume 5, Section 7.6.4, where appropriate. Any notable deviations from the EIA assessment methods are described in Appendix 3.1, Section 2.9.

3.4.4.1 Assessment Results

Species-Level Biodiversity Impact Analysis

Species-level biodiversity effects of the 2013 PDC relative to the 2013 Base Case are addressed in Sections 3.3.5, 3.4.2 and 3.4.3 of this submission for fish, vegetation and wildlife, respectively. The 2013 PDC is predicted to have no environmental consequences on fish and fish habitat, so these KIRs are not considered in the species-level biodiversity impact analysis. Potential species-level effects to vegetation and wildlife resources are summarized as follows:

- High rare plant potential is predicted to experience a negative residual impact with moderate environmental consequence during construction and operations in the 2013 PDC (Table 3.4-8). In the Far Future, a positive low environmental consequence is predicted (Table 3.4-9).

- During construction and operations, the predicted residual impacts on wildlife abundance, habitat and movement in the 2013 PDC are negative for all wildlife KIRs, with the majority of environmental consequences predicted to be low (Table 3.4-10). Only Canada warbler, rusty blackbird and yellow rail are predicted to experience high environmental consequences, on both abundance and habitat, as a result of the 2013 PDC (Table 3.4-10). Woodland caribou are predicted to experience high environmental consequences on abundance. The wildlife assessment assumes that disturbances from construction occur simultaneously and no reclamation will occur. Therefore, the predicted impacts of the 2013 PDC represent worst-case scenarios (Section 3.4.3.1).

Ecosystem-Level Biodiversity Impact Analysis

Effects of the 2013 PDC on RLCCs in the RSA relative to the 2013 Base Case are presented according to biodiversity potential in Figure 3.4-1 and Table 3.4-11, and are summarized according to rank below:

- During construction and operations, high biodiversity potential areas will decrease by 45,975 ha (10%). The majority of this loss (58%) will occur to the treed fen RLCC, which decreases by 12%. In the Far Future, high biodiversity potential areas will increase by 14,398 ha (3%) (Figure 3.4-1). This increase is mainly a consequence of certain non-treed wetlands (i.e., shrubland and littoral zone reclamation types) being added to the landscape. The treed fen RLCC will experience a negative net change due to the 2013 PDC because peatland wetlands currently cannot be reclaimed in areas where the soil has been disturbed (e.g., open-pit mines).

- Moderate biodiversity potential areas will decrease by 49,438 ha (7%) during construction and operations. The mixedwood aspen–white spruce and coniferous white spruce RLCCs are affected to the greatest extent (11% and 10% losses, respectively) relative to 2013 Base Case conditions. In the Far Future, moderate biodiversity potential areas will increase by 98,092 ha (14%) (Figure 3.4-1). Treed bog/poor fen is the only moderate-ranked RLCC that will experience a net decrease relative to the 2013 Base Case. As previously stated, peatlands currently cannot be reclaimed where the soil has been disturbed.

- During construction and operations, low biodiversity potential areas will decrease by 49,038 ha (4%). Each RLCC is affected by 4% or less compared to 2013 Base Case conditions, with the exception of deciduous aspen–balsam poplar (13%). In the Far Future, low biodiversity potential areas will decrease by 112,490 ha (10%) (Figure 3.4-1). Disturbances comprise the majority of this loss because project infrastructure, as well as much of the existing disturbances, will be reclaimed to natural land cover classes.

Figure 3.4-1 Change in Biodiversity Potential in the Regional Study Area – 2013 Base Case to the 2013 Planned Development Case: Far Future

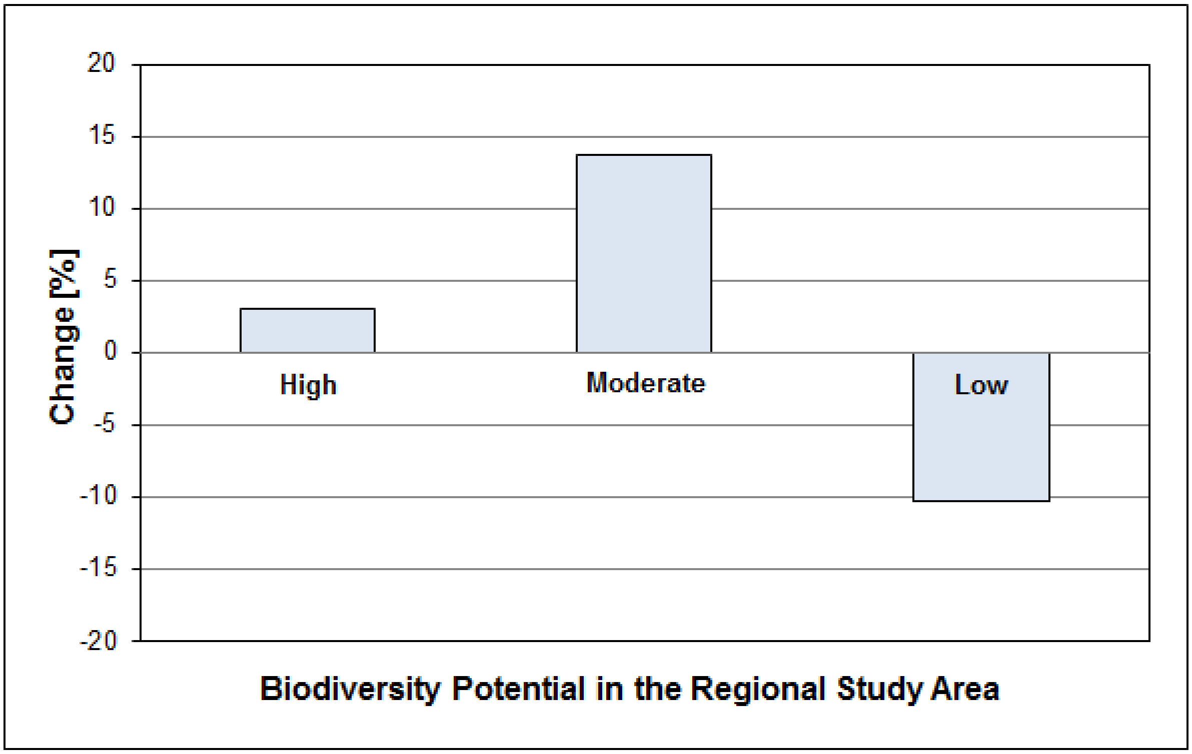

Table 3.4-11 Change in Biodiversity Potential in the Regional Study Area – 2013 Base Case to 2013 Planned Development Case

Regional Land Cover Class	2013 Base Case	Loss/Alteration due to 2013 Planned Development Case[a]		Loss/Alteration due to 2013 PRM Application Case		Pierre River Mine Contribution to 2013 Planned Development Case [%][c]	Far Future	Net Change due to 2013 Planned Development Case[b]	
	Area [ha]	Area [ha]	% of Resource[c]	Area [ha]	% of Resource[c]		Area [ha]	Area [ha]	% of Resource[c]
High Biodiversity Potential									
non-treed wetlands	241,110	-19,148	-8	-2,512	-1	13	278,607	37,497	16
treed fen	230,369	-26,828	-12	-5,014	-2	19	207,270	-23,099	-10
subtotal	*471,479*	*-45,975*	*-10*	*-7,526*	*-2*	*16*	*485,877*	*14,398*	*3*
Moderate Biodiversity Potential									
coniferous white spruce	52,386	-5,154	-10	-622	-1	12	90,754	38,368	73
mixedwood aspen−jack pine	39,033	-2,341	-6	0	0	0	59,217	20,185	52
mixedwood aspen−white spruce	144,759	-16,057	-11	-1,643	-1	10	187,176	42,417	29
treed bog/poor fen	423,855	-24,753	-6	-2,380	-<1	10	399,516	-24,340	-6
water	52,526	-1,132	-2	-52	-<1	4	73,988	21,462	41
subtotal	*712,559*	*-49,438*	*-7*	*-4,697*	*-<1*	*9*	*810,651*	*98,092*	*14*
Low Biodiversity Potential									
burn	396,125	-9,235	-2	-426	-<1	5	387,185	-8,940	-2
coniferous jack pine	166,332	-5,143	-3	-349	-<1	7	178,719	12,387	7
coniferous jack pine−black spruce	40,054	-1,621	-4	0	0	0	63,928	23,874	60
cutblock	100,160	-1,048	-1	0	0	0	99,112	-1,048	-1
deciduous aspen−balsam poplar	178,067	-23,307	-13	-506	-<1	2	229,061	50,994	29
disturbance	212,601	-8,686	-4	-420	-<1	5	22,843	-189,758	-89
subtotal	*1,093,338*	*-49,038*	*-4*	*-1,701*	*-<1*	*3*	*980,848*	*-112,490*	*-10*
Total	**2,277,376**	**-144,451**	**-6**	**-13,924**	**-<1**	**10**	**2,277,376**	**n/a**	**n/a**

(a) Loss/alteration is calculated as the difference between the 2013 Base Case and 2013 Planned Development Case; this is the value upon which the environmental consequence before reclamation is assessed.

(b) Net change is calculated as the difference between the 2013 Base Case and the 2013 Planned Development Case Far Future; this is the value upon which the environmental consequence after reclamation is assessed.

(c) Column is calculated as a percentage of 2013 Base Case area; the areas are not additive.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Landscape-Level Biodiversity Impact Analysis

Results at the landscape-level of biodiversity for the 2013 PDC relative to the 2013 Base Case are summarized as follows:

- Wetlands (including peatlands and patterned fens) are predicted to experience a negative residual impact with low environmental consequence during construction and operations in the 2013 PDC (Table 3.4-8). In the Far Future, the negative residual impact remains a low environmental consequence for this KIR (Table 3.4-9).
- During construction and operations, old growth forests are predicted to experience a negative residual impact with low environmental consequence (Table 3.4-8). In the Far Future, the negative residual impact remains a low environmental consequence for this KIR (Table 3.4-9).

Residual Impact Classification

The residual impacts to biodiversity in the RSA from 2013 Base Case to 2013 PDC are presented in Table 3.4-12. The species-level residual impact classification draws directly upon the Terrestrial Vegetation, Wetlands and Forest Resources, and Wildlife and Wildlife Habitat residual impacts (Sections 3.4.2.1 and 3.4.3.1, respectively). The ecosystem- and landscape-level residual impact classifications are based on the changes discussed in Section 3.4.4.1.

Table 3.4-12 Residual Impact Classification for Biodiversity in the Regional Study Area – 2013 Base Case to 2013 Planned Development Case

Biodiversity Criteria	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
During Construction and Operations							
species-level effects	negative	low (+5)	regional to beyond regional (+1 to +2)	long-term (+2)	reversible (-3)	high (+2)	low (+7 to +8)
ecosystem-level effects	negative	low (+5)	regional (+1)	long-term (+2)	reversible/ irreversible (0)	high (+2)	low (+10)
landscape-level effects	negative	low (+5)	regional (+1)	long-term (+2)	reversible/ irreversible (0)	high (+2)	low (+10)
Far Future							
species-level effects	negative	low (+5)	regional to beyond regional (+1 to +2)	long-term (+2)	reversible (-3)	high (+2)	low (+7 to +8)
ecosystem-level effects	negative	low (+5)	regional (+1)	long-term (+2)	reversible/ irreversible (0)	high (+2)	low (+10)
landscape-level effects	negative	low (+5)	regional (+1)	long-term (+2)	reversible/ irreversible (0)	high (+2)	low (+10)

n/a = Not applicable.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

During Construction and Operations

The residual impacts of the 2013 PDC on vegetation and wildlife KIRs are all negative during construction and operations. The overall magnitude of the residual impact at the species-level of biodiversity is considered low because the residual impacts on KIRs are mostly negligible or low, with some moderate or high. With the exception of some local effects to wildlife KIRs, the geographic extent of residual impacts ranges from regional to beyond regional. The residual impacts are long-term in duration for all vegetation and wildlife KIRs. The residual impacts on most species-level KIRs are considered reversible. All residual impacts on vegetation and wildlife KIRs occur with high frequency.

The overall magnitude of the residual impact of the 2013 PDC on the ecosystem-level of biodiversity is considered low because the changes in high, moderate and low biodiversity potential areas are 10% or less (Table 3.4-11). The residual impact is considered to be regional, because the scale of assessment is the RSA. Although the peatlands (i.e., fens and bogs) that make up approximately half of the high biodiversity potential category in the RSA cannot be reclaimed with current technologies if the soil has been disturbed, the RLCC that comprises the remainder of the high biodiversity potential category (i.e., non-treed wetlands) can be reclaimed. For this reason, the overall residual impact was scored as partially reversible (i.e., reversible/irreversible). The residual impact is also considered to be long-term in duration and high in frequency.

At the landscape-level of biodiversity, the residual impact of the 2013 PDC on both wetlands (including peatlands) and old growth forests is considered low magnitude, regional, long-term and high in frequency. Although there is uncertainty surrounding peatlands reclamation, other wetlands are reclaimable. As such, the residual impact is considered to be partially reversible (i.e., reversible/irreversible) for this KIR. Old growth forests will continue to develop in the Far Future. Therefore, the residual impact is also considered reversible/irreversible for this KIR due to the extended time frame.

Overall, the residual impacts of the 2013 PDC during construction and operations are predicted to have negative low environmental consequences for all levels of biodiversity.

Far Future

The residual impacts of the 2013 PDC on species-level KIRs are mostly negative in the Far Future. As stated in the construction and operations scenario, the wildlife assessment assumes that disturbances from construction occur simultaneously and no reclamation will occur. Therefore, the predicted impacts of the 2013 PDC represent worst-case scenarios in the reclamation scenario. The overall magnitude of the residual impact at the species-level of biodiversity is considered low because the residual impacts on KIRs are mostly negligible or low, with some moderate or high. With the exception of some local effects to wildlife KIRs, the geographic extent of residual impacts ranges from regional to beyond regional. The residual impacts are long-term in duration for all vegetation and wildlife KIRs. The residual impacts on most species-level KIRs are considered reversible. All residual impacts on vegetation and wildlife KIRs occur with high frequency.

The overall magnitude of the residual impact of the 2013 PDC on the ecosystem-level of biodiversity is scored as low because the negative change to the low biodiversity potential areas is 10% or less (Table 3.4-11). The residual impact is also considered to be regional, long-term, reversible/irreversible, and high in frequency as previously described for residual impacts during construction and operations.

At the landscape level, the residual impacts of the 2013 PDC on wetlands (including peatlands) and old growth forests are considered low magnitude because the changes to these resources are less than 10% relative to the 2013 Base Case. Residual impacts on these KIRs are also considered to be regional, long-term, high in frequency, and partially reversible (i.e., reversible/irreversible) as previously described for residual impacts during construction and operations.

Overall, the residual impacts of the 2013 PDC in the Far Future are predicted to have a negative low environmental consequence for all levels of biodiversity. At the species-level, a positive low environmental consequence is predicted.

3.4.4.2 Summary of Results

Greater than negligible negative environmental consequences were predicted in the 2013 PRM Application Case for all levels of biodiversity (Appendix 1, Table 4.5-11), so all KIRs were brought forward for assessment in the 2013 PDC. The 2013 PDC assessment predicted an overall negative low environmental consequence for all levels of biodiversity (Table 3.4-12) during construction and operations. In the Far Future, the environmental consequences were predicted to remain the same for all levels of biodiversity (Table 3.4-12). This result is the same as what was predicted in the EIA PDC assessment (EIA, Volume 5, Section 7.6, Table 7.6-11).

3.5 Human Environment

The 2013 PDC assessment was completed to evaluate the potential for 2013 PDC effects on traditional harvesting opportunities within the Regional Study Area (RSA).

3.5.1 Traditional Knowledge and Land Use

3.5.1.1 Assessment Methods

The following sections assess the effects of the 2013 PDC on each of the potentially affected Aboriginal groups. For each group, an effects description is provided for each pathway followed by an effects classification for opportunities to undertake each traditional land use activity. As indicated earlier, there are other factors that can influence traditional harvesting activities, such as effects due to odour, noise, visual disturbances, human health factors and socio-economic factors. A description of these various factors as they relate to the 2013 PDC is provided in the sections that immediately follow. The effects assessment for each group will further discuss how these other factors relate to the respective group.

3.5.1.1.1 Data Limitations and Confidence in Predictions

The available data used in the assessment has some limitations. For example, information indicates that the majority of MCFN and ACFN members live in in Fort McMurray or other more southern communities, but there is no information to indicate the numbers or percentages of members living in the various communities. Other data limitations relate to the way in which land use activities are recorded. For example, Candler et al. (2012a,b) reference ‘subsistence values’ in various figures, but do not indicate which subsistence activities (e.g., hunting, fishing) those values represent. Other data limitations relate to the level of activities occurring within an area. For example, various site activities may be recorded at a site or larger area, but information is lacking about whether the use represents the activities of one or several individuals, and whether the use relates to a few uses, or ongoing use of the site or area. Differentiating between past and current use of an area is also a difficulty with much of the TLU information available. Other data limitations relate to the number of sources available to identify traditional activities. For example, while the communities of Fort McKay, MCFN, ACFN, FM468 and Fort McMurray Métis Local #125 provided information to Shell for use in the assessment, information used to assess the effects of the 2013 PDC and PRM on Fort McMurray Métis Local #1935 was based upon the *Mark of the Métis* (Fort McMurray Métis Local #1935 2012), a book generally focusing on the life of Métis in northeastern Alberta. The *Mark of the Métis* does not provide enough detail to determine whether activities shown within the RSA are related to members of the Fort McMurray Métis locals or other locals outside the RSA.

The assessment made some assumptions to address the various data limitations. For example, the assessment assumed that ACFN and MCFN members not living in Fort Chipewyan were living in Fort McMurray and would generally make use of the RSA as indicated in the respective studies. Where use areas were identified as having subsistence values, the assessment assumed that these values referred to hunting, fishing, and plant and berry harvesting. These assumptions are considered conservative because they may have the effect of over-representing the amount or type of traditional harvesting undertaken by the respective groups. Trapping was assumed to occur on RFMAs registered to the respective Aboriginal groups. In the case of FM468, trapping was assumed to generally occur in the southern portion of the RSA identified as a traditional furbearer harvesting area, to the extent it did not overlap with RFMAs known to be held by other groups. Other information related to FM468 identified areas where specific activities may be occurring, but did not provide information about how these activities relate to the FM468 as a whole. As a result, the 2013 PDC assumed that the identified activities related to the group as a whole.

Because of the conservative assumptions made in the assessment in combination with the information provided by the communities of Fort McKay, MCFN, ACFN, FM468 and Fort Chipewyan Métis Local #125, the level of confidence in the assessment is considered moderate to high. Because of the general nature of the single source used to assess the effects on Fort McMurray Métis, the level of confidence in the assessment for that group is considered low.

3.5.1.2 Other Factors Affecting Traditional Harvesting Activities

3.5.1.2.1 Odour

Odour has been noted as affecting the use and enjoyment of traditional lands. An analysis of the odour model predictions for the 2013 PDC found that peak odours may be detectable within approximately 20 km of emission sources. Peak predictions may occur for very brief periods, and while peak concentrations in excess of the threshold may be detectable to some individuals, the smell will dissipate quickly and will not be sustained (EIA Volume 3, Section 3.4.7). For example, the frequency of detectable peak odours at Fort McKay, which is about 4 km from the nearest emission sources, was predicted to be 4% of the time, or 351 hours per year in the 2013 PDC. The frequency of detectable odours diminishes with distance from the emission sources. As a result, locations more than 20 km from emission sources are not expected to experience detectable odours.

3.5.1.2.2 Noise

While noise from industrial facilities in Alberta is required to be in compliance with Directive 038 (EUB 2007) this does not guarantee that someone engaged in traditional land use will not hear noises from a facility. Noise from oil sands developments has been cited by Aboriginal groups as a concern in that it affects the sense of remoteness that is among the conditions used to define the meaningful practice of rights. A cumulative noise analysis was conducted, which indicated that noises may be heard within 0.9 km of an oil sands facility during the daytime and within 1.9 km of an oil sands facility during the night. Additional analysis was done to account for intermittent noise that would result from bird scare cannons, pile drivers and back-up alarms on large mining trucks. The results indicated that bird scare cannons and pile drivers may be heard about 4.0 km away and back-up alarms 1.0 km away from the source during the day under constant background noise level conditions. At night these distances increase to 6.7 km for bird cannons, 6.5 km for pile drivers and 2.1 km for back-up alarms.

3.5.1.2.3 Visual Impacts

The 2013 PDC includes developments located near the Athabasca River, MacKay River, Muskeg River and neighbouring the community of Fort McKay. Additional 2013 PDC disturbances include those within the immediate vicinity of PRM and areas south of Namur Lake. Key visual disturbances associated with development are related to infrastructure. The quality of TLU, related to visual disturbance, is expected to be negligibly impacted by visual disturbances for most locations in the study area. Visual impacts of mining landforms are anticipated to be minimal for cabins, communities, and trapping and hunting activities due to flat terrain and vegetative screening effects on visibility. Visual impacts of processing areas are anticipated to be more moderate at certain sites along the Athabasca River due to closer proximity and increased amount of vegetation clearing resulting in more open viewing opportunities. Water intakes are likely to be visible at sites along the water's edge for river users. Impacts of plumes are expected to be the most visible element as they are widely dispersed and visible at any location with a view of the horizon. However, plumes are most distinct seasonally in winter, and forest cover limits views of the horizon from many locations.

As distance from the Athabasca River and other localized development settings increases beyond 20 km, the likelihood of encountering visible development decreases appreciably. Although features such as active well sites and high-pressure pipelines are present in these more remote areas, most of the visual disturbance is related to features such as cutlines which result in a lower level of visual disturbance.

3.5.1.2.4 Effects to Human Health

The effects of the 2013 PDC on human health were considered as part of the Human Health Risk Assessment (Appendix 3.3), and included inhalation of air and dust, and ingestion of water and a variety of country foods (e.g., game, plants). The assessment determined that cumulative environmental risks associated with the additional projects and activities planned for the region are not expected to result in adverse health effects (Section 3.2.2).

3.5.1.2.5 Socio-Economic Effects to Traditional Land Use

A variety of socio-economic factors may also affect, positively and negatively, the continuance of traditional land use harvesting. Increased training and new economic activities have implications for traditional culture and quality of life. Increased income and rotational work may provide resources and opportunities that can be used to undertake traditional activities; however, a cultural shift can result in a reduction of the practice of a traditional activity, more use of non-Aboriginal languages, and a decline in the application of traditional values and knowledge. Increased costs and travel time associated with the need to travel farther distances to access abundant or healthy resources may reduce the ability or influence the decision by traditional land users to undertake harvesting activities. Reduced motivations to participate in harvesting activities may also result from a lessening of confidence in the quality of harvested foods from such factors as contamination.

The increase in the non-Aboriginal population is reported to have increased the competition for traditionally harvested resources. The negative effects of increased competition for traditional resources may be compounded by the loss of other accessible areas due to industrial development. Concerns have been raised by Aboriginal groups regarding differing perceptions in land stewardship, damages to Aboriginal land user property (e.g., cabins) and increased security concerns, all which may affect desire to continue traditional land use activities (FMSD 2010).

The sense of disempowerment, stress and concerns about health effects are all factors in the decision of many Aboriginal individuals to move away from areas of high development or to reduce participation in traditional activities on the land. Quantifiable data regarding these responses to observed effects and how they affect the maintenance of traditional knowledge and the continuation of traditional land use is unavailable, but existing adverse effects to the maintenance of traditional land use opportunities and traditional knowledge, at a regional and cumulative scale, are reported by First Nations and Métis groups. While it is impossible to attribute these effects on a project by project basis, existing responses are considered in the assessment of effects to traditional land use opportunities and Aboriginal and Treaty Rights.

The following sections describe the effects of the 2013 PDC on the following Aboriginal groups:

- Community of Fort McKay (Fort McKay First Nation and Fort McKay Métis);
- Mikisew Cree First Nation (MCFN);
- Athabasca Chipewyan First Nation (ACFN);
- Fort McMurray #468 First Nation (FM468);
- Fort Chipewyan Métis Local #125; and
- Fort McMurray Métis Local #1935.

3.5.1.3 The Community of Fort McKay

The Community of Fort McKay includes both the Fort McKay First Nation (FMFN) and the Fort McKay Métis. The Community of Fort McKay has identified their intense, moderate, and low use areas for traditional activities, referred to as Culturally Significant Ecosystems (CSEs). The CSEs were developed in McKillop (2002) and also used by the community in its Fort McKay Specific Assessment (Fort McKay 2010) and submission for the Lower Athabasca Regional Plan (LARP) (FMSD 2010). For the purposes of this assessment, the moderate and intense use portions of each CSE have been used as a basis for assessing Fort McKay's preferred harvesting areas.

The effects classification will consider the effects to traditional hunting opportunities and the presence of other factors affecting traditional hunting, such as odour, noise, visual effects, human health effects and socio-economic effects. Because these other factors are common to each of Fort McKay's harvesting activities, they are described in this introduction.

In addition to the opportunities to undertake traditional harvesting, effects to harvesting also consider the added impacts of odour, noise and visual effects. For example, the effects of odour, noise and visual disturbances are expected to have the effect of increasing the radius of the impacts to areas used for traditional harvesting. Although the Human Health Risk Assessment did not determine any adverse impacts to human health for the 2013 PDC, concerns about environmental contamination held by members of Aboriginal communities in combination with other socio-economic factors described above can affect the participation in traditional land use activities and the exercise of Treaty and Aboriginal rights. These other effects on traditional activities may further affect the culture and quality of life of the Community of Fort McKay. Although it is not possible to determine the degree to which individual traditional land users may be affected by these additional impacts, the impacts have been reported by Aboriginal groups and are assessed as occurring under the 2013 PDC.

The following describes the effects of the 2013 PDC on Fort McKay's traditional harvesting activities and the significance of the effects.

3.5.1.3.1 Traditional Hunting Opportunities (Fort McKay Community)

Cumulative effects to traditional hunting opportunities are considered to be a combination of the effects of existing, proposed and planned development on Large Game Key Indicator Resources (KIRs), disturbance to preferred hunting areas and changes in access to these preferred areas.

3.5.1.3.1.1 Effects to Large Game (Fort McKay Community)

Wildlife considered as KIRs for large game hunting are moose, black bear, and wood bison. The residual impact classification for effects on wildlife in the RSA at the 2013 PDC (before Closure) are reported in Section 3.4.3.1. The effects on moose abundance and movement were assessed to be negative in direction and low magnitude, and effects to moose habitat (including fragmentation) were assessed as negative in direction and moderate in magnitude. The effects on black bear abundance, habitat (including fragmentation) and movement were assessed as negative in direction and low in magnitude. The effects on wood bison abundance and movement were assessed as negative in direction and low in magnitude, and effects to wood bison habitat were assessed as negative in direction and moderate in magnitude.

3.5.1.3.1.2 Disturbance to Preferred Hunting Areas (Fort McKay Community)

The moderate and intense use areas of the Fort McKay Large Game and Bird Harvesting CSEs are considered to represent the Community of Fort McKay's preferred hunting areas (Appendix 3.8, Figures 2.1-2, 2.1-3). Intense and moderate use large game areas cover the majority of the RSA, with no or low use areas occurring along the southwest portion and the eastern edge. Intense use areas are found surrounding the Namur Lake and Gardiner Lakes region, and throughout a large area from Fort McMurray north following the Athabasca River. Similarly, the moderate and intense use areas for bird harvesting include the Namur and Gardiner lakes region, and a wide area from Fort McMurray north along the Athabasca River to the northern edge of the RSA.

A summary of 2013 PDC disturbance affecting the Fort McKay Large Game and Bird Harvesting CSEs is provided in Table 3.5-1.

Disturbances to the moderate and intense use areas of the Fort McKay Large Game Harvesting CSEs are expected to increase at 2013 PDC. Disturbance to the Large Game Harvesting intense use areas are expected to increase 7% (69,808 ha) from 2013 PRM Application Case conditions to a total disturbance of 29% (294,192 ha). Moderate use areas are predicted to undergo an increase in disturbance of 3% (43,123 ha) from 2013 PRM Application Case conditions resulting in a total disturbance of 8% (132,394 ha) at 2013 PDC. Combined, disturbances to these preferred large game harvesting areas are expected to increase from 11% (313,627 ha) at 2013 PRM Application Case to 16% (426,556 ha) at 2013 PDC.

Disturbance within the moderate and intense use areas of the Fort McKay Bird Harvesting CSE are also predicted to increase. Combined, these preferred bird harvesting areas are expected to increase in disturbance from 19% (195,184 ha) at 2013 PRM Application Case to 24% (251,224 ha) at 2013 PDC.

Table 3.5-1 Development in the Fort McKay Culturally Significant Large Game and Bird Harvesting Ecosystems

CSE	Total Area of CSE [ha][a]	2013 PRM Application Case Total Disturbance Area[b]		2013 Planned Development Case Total Disturbance Area		Change		Percentage Increase [%]
		[ha]	% of CSE	[ha]	% of CSE	[ha]	% of CSE	
Large Game Harvesting								
Low use	1,347,998	18,707	1	26,990	2	8,283	1	44
Moderate use	1,723,226	89,242	5	132,364	8	43,123	3	48
Intense use	1,018,146	224,385	22	294,192	29	69,808	7	31
Moderate and Intense use combined	**2,741,372**	**313,627**	**11**	**426,556**	**16**	**112,931**	**4**	**36**
Total low, moderate and intense use	**4,089,370**	**332,333**	**8**	**453,547**	**11**	**121,214**	**3**	**37**
Bird Harvesting								
Low use	1,187,461	110,828	9	160,064	14	49,237	4	44
Moderate use	694,010	133,546	19	171,440	25	37,894	6	28
Intense use	354,791	61,638	17	79,784	23	18,147	5	29
Moderate and Intense use combined	**1,048,801**	**195,184**	**19**	**251,224**	**24**	**56,041**	**5**	**29**
Total low, moderate and intense use	**2,236,263**	**306,012**	**14**	**411,289**	**18**	**105,277**	**5**	**34**

(a) Reflects the total area of the CSE, including portions which fall outside RSA and provincial boundaries.

(b) Application Case includes all existing and approved projects plus PRM.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.5.1.3.1.3 Effects on Access to Preferred Hunting Areas (Fort McKay Community)

Access to preferred hunting areas may be affected by land disturbance, loss of trails, changes in water navigability, or restrictions on movements due to barriers or access controls. The loss of land due to disturbance has been described in the preceding section.

Preferred Fort McKay hunting areas are found throughout the RSA, with intense use areas concentrated around the community of Fort McKay, the Athabasca River and the Namur Lake Region (including Fort McKay's IR 174A and IR174B). An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay (Figure 9-4 in Fort McKay 2010). Much of 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of Fort McKay. As a result, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay, thereby interrupting the use of trails near their point of origin and resulting access limitations to the undisturbed portions of the trail.

At 2013 PDC, trails connecting areas northeast of Fort McKay, including McClelland Lake and the Firebag River, and Fort McKay's IR 174C are adversely impacted although access continues to be available from areas along the Athabasca River and along the Canterra Road. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River.

At 2013 PDC trails connecting areas north and west of the PRM, including Sand Lake and Eaglenest Lake, to the Athabasca River, will be disturbed. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is also expected, although alternative trails and upgraded access continues to be available. Trails accessing areas south of Fort McKay on both the east and west sides of the Athabasca River are also disrupted. Fort McKay Community members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts result in “frustration and real obstacles” in the access of traditional land use areas (Fort McKay 2010, p. 48). Generally members of the Fort McKay community have indicated that they need to travel further from their community to access hunting areas.

The Athabasca River provides important water access routes during summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca River. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are calculated to be less than 2 cm of the mean seasonal flow depths.

3.5.1.3.1.4 Effects Classification for Traditional Hunting (Fort McKay Community)

The effects classification on traditional hunting for the community of Fort McKay considers the effects on traditional hunting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to human health, and socio-economic factors.

Regarding the effects to traditional hunting opportunities, the wildlife assessment measured the effects to TLU hunting KIRs (moose, black bear and wood bison) as ranging from low to moderate for abundance, habitat and movement (Section 3.4.3.1). The 2013 PDC disturbances to the Fort McKay preferred harvesting areas, represented by the Large Game Harvesting CSE (combined moderate and intense use areas) and the Bird Harvesting CSE (combined moderate and intense use areas) represent 16% and 24% of the CSEs, respectively. These effects are considered adverse and moderate (Large Game Harvesting CSE) and high (Bird Harvesting CSE) in magnitude. The changes in access to the combined moderate and intense use areas of the two CSEs are considered to substantially interfere with people’s access to preferred hunting areas and are therefore assessed as adverse in direction and high in magnitude. As a result of the above factors, the effects to traditional hunting opportunities for the Fort McKay Community are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude impact to traditional hunting opportunities, and the additional effects of odours, noise, visual impacts and other socio-economic effects, the effects to traditional hunting for the Fort McKay Community at 2013 PDC are assessed as negative in direction, high in magnitude, regional in extent, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible because the length of duration is likely to interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.3.2 Traditional Trapping Opportunities (Fort McKay Community)

The effects of the 2013 PDC on traditional trapping opportunities consider the effect to furbearer abundance, effects to preferred trapping areas within the RSA and effects on access to the preferred areas.

3.5.1.3.2.1 Effects to Furbearer Abundance (Fort McKay Community)

Furbearers considered to be KIRs for traditional trapping include beaver, fisher and Canada lynx. The effects on these resources were assessed in the residual impact classification for effects on wildlife in the RSA for the 2013 PDC (Section 3.4.3.1). The effects to beaver abundance, habitat and movement were assessed as negative in direction and low in magnitude. The effects of the PDC on fisher and Canada lynx were assessed as negative in direction and moderate in magnitude for abundance and habitat, and negative in direction and low in magnitude for movement.

3.5.1.3.2.2 Effects to Preferred Trapping Areas (Fort McKay Community)

For the purposes of this assessment, the moderate and intense use areas of the Fort McKay Furbearer Harvesting CSE are considered to represent Fort McKay's preferred trapping areas (Appendix 3.8, Figures 2.1-2 and 2.1-3). The moderate and intense use areas overlap the majority of the RSA, with low or no use areas occurring west and east of Fort McMurray, and along the very eastern edges of the RSA.

A summary of 2013 PDC disturbance affecting the Fort McKay Furbearer Harvesting CSE is provided in Table 3.5-2.

Disturbance is predicted to impact both the moderate and intense use areas of the Fort McKay Furbearer Harvesting CSE. Within the moderate use area, disturbance is expected to increase to 13% (225,726 ha) at 2013 PDC from 9% (156,805 ha) at 2013 PRM Application Case. Disturbance affecting intense use furbearer harvesting areas is predicted to be 18% (178,322 ha) at 2013 PDC, an increase of 4% (34,902 ha) from 2013 PRM Application Case conditions. When the preferred intense and moderate use areas are combined, disturbance at 2013 PDC for these areas is predicted to be 15% (404,048 ha).

Table 3.5-2 Disturbance in the Fort McKay Furbearer Harvesting Culturally Significant Ecosystem – 2013 PRM Application Case to 2013 Planned Development Case

CSE	Total Area of CSE [ha][(a)]	2013 PRM Application Case Total Disturbance Area[(b)]		2013 Planned Development Case Total Disturbance Area		Change		Percentage Increase [%]
		[ha]	% of CSE	[ha]	% of CSE	[ha]	% of CSE	
Furbearer Harvesting								
Low use	1,156,838	28,133	2	41,704	4	13,570	1	48
Moderate use	1,691,405	156,805	9	225,726	13	68,921	4	44
Intense use	1,000,784	143,420	14	178,322	18	34,902	4	24
Moderate and Intense Use Combined	**2,692,189**	**300,225**	**11**	**404,048**	**15**	**103,823**	**4**	**35**
Total low, moderate and intense use	**3,849,026**	**328,358**	**9**	**445,751**	**12**	**117,394**	**3**	**36**

(a) Reflects the total area of the CSE, including portions which fall outside RSA and provincial boundaries.

(b) Application Case includes all existing and approved projects plus PRM.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Disturbance affecting Fort McKay RFMAs within the RSA was also calculated for 2013 PRM Application Case and 2013 PDC conditions. A summary of the predicted increases in disturbance within these RFMAs is provided in Table 3.5-3.

Table 3.5-3 Disturbance Affecting Fort McKay Registered Fur Management Areas Within the Regional Study Area – 2013 PRM Application Case to 2013 Planned Development Case

Fort McKay RFMAs [ha][(a)]	2013 PRM Application Case Total Disturbance Area[(b)]		2013 Planned Development Case Total Disturbance Area		Change		Percentage Increase [%]
	[ha]	%	[ha]	%	[ha]	%	
912,603	197,500	22	248,328	27	50,828	6	26

(a) Reflects only the RFMA portions that fall within the RSA.

(b) Application Case includes all existing and approved projects plus PRM.

The majority of disturbance affecting Fort McKay's RFMAs is pre-existing at the 2013 PRM Application Case, but a 6% (50,828 ha) increase is predicted between 2013 PRM Application Case and 2013 PDC conditions, resulting in 27% (248,328 ha) of disturbed area at 2013 PDC.

3.5.1.3.2.3 Effects on Access to Preferred Trapping Areas (Fort McKay Community)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, water navigability, and restrictions due to barriers or areas access controls. The loss of land due to disturbance has been described in the preceding section.

Similar to the preferred hunting areas, preferred Fort McKay trapping areas are found throughout the RSA, with intense use areas concentrated around the community of Fort McKay, the McClelland Lake area and east, and the Namur Lake Region. A review of RFMAs registered to Fort McKay community members (Figure 9-4 in Fort McKay 2010) shows a cluster of RFMAs surrounding the hamlet of Fort McKay. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay. The 2013 PDC developments are also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay, thereby interrupting the use of trails near their point of origin and causing limitations in access to the undisturbed portions of the trail.

At 2013 PDC, overland trails connecting areas northeast of Fort McKay including McClelland Lake and Kearl Lake, Fort McKay IR 174C and the Firebag River are adversely impacted although alternative access continues to be available from areas along the Athabasca River and the Canterra Road. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River.

At 2013 PDC trails connecting areas north and west of the PRM, including Sand Lake and Eaglenest Lake, to the Athabasca River, will be disturbed. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region (including Fort McKay IR 174A and IR 174B) is also expected, although alternative trails and upgraded access continues to be available. Trails accessing areas south of Fort McKay on both the east and west sides of the Athabasca River are also disrupted. Fort McKay Community members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in “frustration and real obstacles” in the access of traditional land use areas (Fort McKay 2010, p. 48).

Rivers, particularly the Athabasca River, provide important access routes during summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.3.2.4 Effects Classification on Traditional Trapping (Fort McKay Community)

The effects classification to traditional trapping for the community of Fort McKay considers the effects to traditional trapping opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to socio-economic factors.

Regarding the effects to traditional trapping opportunities, the wildlife assessment measured the effects to TLU trapping KIRs (beaver, fisher and Canada lynx) as ranging from low to moderate for abundance, habitat and movement (Section 3.4.3.1). The 2013 PDC disturbances to the Fort McKay preferred harvesting areas, represented by the Furbearer Harvesting CSE (combined moderate and intense use areas) and the Fort McKay RFMAs (within the RSA) represent 15% and 27% of the respective area. These effects are considered adverse and moderate (Furbearer Harvesting CSE) and high (Fort McKay RFMAs) in magnitude. The changes in access to the combined moderate and intense use areas of the CSE and RFMA locations are considered to substantially interfere with people’s access to preferred trapping areas and are therefore assessed as adverse in direction and high in magnitude. As a result of the above factors, the effects to traditional trapping opportunities are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude impacts to traditional trapping opportunities, the effects to Fort McKay traditional trapping at 2013 PDC are assessed as negative in direction, high in magnitude, regional in extent, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.3.3 Traditional Fishing Opportunities (Fort McKay Community)

The effects of the 2013 PDC on traditional fishing opportunities consider the effect to fish abundance, effects to preferred fishing areas within the RSA and effects on access to the preferred areas.

3.5.1.3.3.1 Effects to Fish Habitat and Abundance (Fort McKay Community)

The effects of PRM on fish habitat and fish abundance were assessed in the EIA, Volume 4, Section 6.7.6. Within the boundary of the LSA, fish habitat within Eymundson Creek and Pierre River was considered to be lost due to the diversion of these watercourses to diversion channels during operations of the PRM. However, once mitigation and habitat compensation were considered, the residual impacts to fish habitat and fish abundance at 2013 PRM Application Case were classified as having no environmental consequence.

The 2013 PDC assessment of effects considered the Water Management Framework for the Lower Athabasca River (AENV and DFO 2007). The Framework was developed to manage cumulative withdrawals from the Athabasca River and protect the aquatic ecosystem, while allowing industry to operate, which would include the planned projects in the 2013 PDC. Because the Framework is adaptive, it will be informed by ongoing scientific study, and modified as necessary to maintain protection of the river. Accordingly, no cumulative effects to fish habitat, beyond those outlined in the Framework, would be expected from changes to stream flow in the Athabasca River in the 2013 PDC. Once mitigation and compensation are taken into account for valid linkages, all residual effects on fish and fish habitat are negligible and considered to have no environmental consequence.

3.5.1.3.3.2 Effects to Preferred Fishing Areas (Fort McKay Community)

The moderate and intense use areas of the Fort McKay Fishing CSE are considered to represent the Fort McKay Community's preferred fishing areas (Appendix 3.8, Figure 2.1-5). Areas of preferred fishing within the RSA include the Namur Lake and Gardiner Lakes region, and from Fort McMurray to the northern edge of the RSA along the Athabasca River.

The disturbances affecting the intense, moderate and low use areas of the Fort McKay Fishing CSE at 2013 PRM Application Case and 2013 PDC are summarized in Table 3.5-4.

Increases in disturbance are predicted for both the moderate and intense use areas of the Fort McKay Fishing CSE between the 2013 PRM Application Case and 2013 PDC. Disturbances within moderate use areas are expected to increase from 22% (137,471 ha) at 2013 PRM Application Case to 28% (171,344 ha) at 2013 PDC. Disturbances within intense use areas are predicted to increase from 3% (4,163 ha) at 2013 PRM Application Case to 4% (5,783 ha) at 2013 PDC. Combined, the disturbance to Fort McKay preferred fishing areas (moderate and intense use areas combined) will increase from 19% (141,634 ha) at 2013 PRM Application Case to 24% (177,127 ha) at 2013 PDC.

Table 3.5-4 Disturbance Affecting Fort McKay Fish Culturally Significant Ecosystem – 2013 PRM Application Case to 2013 Planned Development Case

CSE	Total Area of CSE [ha][a]	2013 PRM Application Case Total Disturbance Area[b]		2013 Planned Development Case Total Disturbance Area		Change		Percentage Increase [%]
		[ha]	% of CSE	[ha]	% of CSE	[ha]	% of CSE	
Fish Harvesting								
Low use	1,773,585	159,325	9	222,915	13	63,590	4	40
Moderate use	620,004	137,471	22	171,344	28	33,873	6	25
Intense use	132,437	4,163	3	5,783	4	1,620	1	39
Moderate and Intense use combined	**752,441**	**141,634**	**19**	**177,127**	**24**	**35,493**	**5**	**25**
Total low, moderate and intense use	**2,526,027**	**300,958**	**12**	**400,041**	**16**	**99,083**	**4**	**33**

(a) Reflects the total area of the CSE, including portions which fall outside RSA and provincial boundaries.

(b) Application Case includes all existing and approved projects plus PRM.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.5.1.3.3.3 Effects on Access to Preferred Fishing Areas (Fort McKay Community)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, water navigability, or restrictions due to barriers or access controls. The loss of land due to disturbance has been described in the preceding section.

Preferred Fort McKay fishing areas are concentrated along the Athabasca River and in the Namur Lake region, with intense use areas concentrated around the community of Fort McKay. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay (Fort McKay 2010). The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of Fort McKay. As a result, the majority of disturbance to Fort McKay fishing areas is caused by direct disturbance. For those fishing areas located beyond disturbed areas, the interruption of trailheads located near the community of Fort McKay may impact the use of trails at their point of origin and result in access limitations to the use of undisturbed portions of the trail.

At 2013 PDC, trails connecting areas northeast of Fort McKay including McClelland Lake and Kearl Lake are adversely impacted although access to McClelland Lake continues to be available from areas along the Athabasca River. Upgraded access east of the Athabasca River is also available along the Canterra Road. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River.

At 2013 PDC, a reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region, including Fort McKay's IR 174A and IR 174B, is expected, although alternative trails and upgraded access continues to be available. Trails accessing areas south of Fort McKay on both the east and west sides of the Athabasca River (including Fort McKay's IR 174C) are also disrupted and are likely to adversely impact intense use fishing areas. Fort McKay Community members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in impeded access to traditional land use areas (Fort McKay 2010, p. 48).

The Athabasca River and other waterbodies, provide important access routes during summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca River. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.3.3.4 Effects Classification for Traditional Fishing (Fort McKay Community)

The effects classification to traditional fishing for the community of Fort McKay considers the effects on traditional fishing opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to socio-economic factors.

Regarding the effects to traditional fishing opportunities, effects to fish and fish habitat at 2013 PDC were assessed as negligible after mitigation and compensation were applied. The 2013 PDC disturbances to Fort

McKay preferred fishing areas, represented by combined moderate and intense use areas in the Fish CSE represent 24% of the CSE. These effects are considered adverse and high in magnitude. The changes in access to the combined moderate and intense use areas of the CSE are considered to substantially interfere with people's access to preferred fishing areas and are therefore assessed as adverse in direction and high in magnitude. As a result of the above factors, the effects to traditional fishing opportunities are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude effect on traditional fishing opportunities and the effects of odour, noise, visual and socio-economic factors, the effects to Fort McKay traditional fishing at 2013 PDC are assessed as negative in direction, high in magnitude, regional in extent, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.3.4 Traditional Plant and Berry Harvesting (Fort McKay Community)

The effects of the 2013 PDC on traditional plant and berry harvesting opportunities consider the effect to traditional vegetation, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.3.4.1 Effects to Traditional Plants (Fort McKay Community)

The effects to traditional use plant potential under the 2013 PDC were not assessed within the vegetation assessment due to the negligible environmental consequence determination for the 2013 PRM Application Case.

3.5.1.3.4.2 Effects to Preferred Plant and Berry Harvesting Areas (Fort McKay Community)

Preferred plant and berry harvesting areas for the community of Fort McKay are considered to be the moderate and intense use areas in the Fort McKay Traditional Plant (Berry) CSE. Preferred areas include a limited area around Namur Lake and Gardiner Lakes, including Fort McKay's IR 174A and IR 174B, and a wide area from Fort McMurray north beyond the northern RSA boundary (Appendix 3.8, Figure 2.1-6). The intense use portion of the CSE is located near the community of Fort McKay.

A summary of the disturbance predicted at 2013 PRM Application Case and 2013 PDC for the Fort McKay Traditional Plant (Berry) Harvesting CSE is provided in Table 3.5-5.

At 2013 PDC, disturbance affecting traditional plant and berry harvesting is predicted to impact 38% (148,939 ha) of moderate use areas and 54% (40,277 ha) of intense use areas. Combined to represent all preferred traditional plant and berry harvesting areas, disturbance is expected to increase from 33% (156,206 ha) at 2013 PRM Application Case to 40% (189,216 ha) at 2013 PDC.

Table 3.5-5 Disturbance Affecting Fort McKay Traditional Plant (Berry) Harvesting Culturally Significant Ecosystem – 2013 PRM Application Case to 2013 Planned Development Case

CSE	Total Area of CSE [ha][a]	2013 PRM Application Case Total Disturbance Area[b]		2013 Planned Development Case Total Disturbance Area		Change		Percentage Increase [%]
		[ha]	% of CSE	[ha]	% of CSE	[ha]	% of CSE	
Traditional Plant (Berry) Harvesting								
Low use	1,396,491	138,723	10	214,258	15	75,535	5	55
Moderate use	396,759	121,443	31	148,939	38	27,496	7	23
Intense use	74,917	34,763	46	40,277	54	5,513	7	16
Moderate and intense use combined	**471,676**	**156,206**	**33**	**189,216**	**40**	**33,009**	**7**	**21**
Total low, moderate and intense use	**1,868,167**	**295,255**	**16**	**403,799**	**22**	**108,544**	**6**	**37**

(a) Reflects the total area of the CSE, including portions which fall outside RSA and provincial boundaries.

(b) Application Case includes all existing and approved projects plus PRM.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.5.1.3.4.3 Effects on Access to Preferred Plant and Berry Harvesting Areas (Fort McKay Community)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, water navigability, or restrictions due to barriers or access controls. The loss of land due to disturbance is described in the preceding section. Preferred Fort McKay plant and berry harvesting areas are found within the RSA, including the Namur Lake region and from Fort McMurray north to the RSA boundary, generally following the Athabasca River. An intense use area is concentrated around the community of Fort McKay. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay. The 2013 PDC development is concentrated along the Athabasca River and particularly to the north, east and south of Fort McKay. Therefore, the greater majority of disturbance to Fort McKay traditional trails occurs within near the community of Fort McKay, thereby interrupting the use of trails close to their point of origination and also causing access limitations to the undisturbed portions of the trail.

At 2013 PDC, overland trails connecting areas northeast of Fort McKay including McClelland Lake and Fort McKay's IR 174C are adversely impacted although access continues to be available from areas along the Athabasca River and the Canterra Road.

At 2013 PDC trails connecting areas north and west of the PRM, including Sand Lake and Eaglenest Lake, to the Athabasca River, will be disturbed. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region (including Fort McKay's IR 174A and IR 174B) is also expected, although alternative trails and upgraded access continues to be available. Fort McKay community members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in frustration (Fort McKay 2010, p. 48). Trails accessing intense use areas south of Fort McKay on both the east and west sides of the Athabasca River are also partially disrupted at 2013 PDC although access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay.

The Athabasca River provides important water access during summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca River. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.3.4.4 Effects Classification for Traditional Plant and Berry Harvesting (Fort McKay Community)

The effects classification to traditional plant and berry harvesting for the community of Fort McKay considers the effects to traditional plant and berry harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to socio-economic factors.

The vegetation assessment determined there were no residual effects to high Traditional Plant Potential under the 2013 PRM Application Case. Therefore, high Traditional Plant Potential was not carried forward to the 2013 PDC. The 2013 PDC disturbances to Fort McKay preferred plant gathering areas, represented by combined moderate and intense use areas in the Plant (Berry) CSE represent 40% of the CSE. These effects are considered adverse and high in magnitude, although it is noted that 31% of this disturbance exists at 2013 Base Case conditions. The changes in access to the combined moderate and intense use areas of the CSE are considered to substantially interfere with people’s access to preferred harvesting areas and are therefore assessed as adverse in direction and high in magnitude. As a result of the above factors, the effects to traditional plant and berry harvesting opportunities are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude effect to traditional plant and berry harvesting opportunities and effects of odour, noise, visual and socio-economic factors, the effects to Fort McKay traditional plant and berry harvesting at 2013 PDC are assessed as negative in direction, high in magnitude, regional in extent, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.4 Mikisew Cree First Nation

Fort Chipewyan is the administrative base for the Mikisew Cree First Nation (MCFN), but the majority of members are reported to live off reserve in Fort McMurray or other more southern areas (Candler et al. 2012b). “Members living in southern areas tend to use nearby resources, though many return to Fort Chipewyan and surrounding territories on a regular basis…” (Candler et al. 2012b, p. 34). For the purpose of this assessment, the preferred MCFN traditional hunting, and plant and berry harvesting locations within the RSA are considered to be that portion of the MCFN traditional territory overlapping the RSA. The effects classification will consider the effects to traditional harvesting opportunities in the RSA and the presence of other factors affecting traditional hunting, such as odour, noise, visual effects, human health effects and socio-economic effects.

In addition to the opportunities to undertake traditional land use activities, effects to traditional hunting also consider the added impacts of odour, noise and visual effects. For example, within the RSA, the effects of odour, noise and visual disturbances are expected to have the effect of increasing the radius of the impacts to areas used for traditional activities. These effects are not expected to affect traditional activities north of the RSA in the larger Fort Chipewyan area. Although the Human Health Risk Assessment did not determine any adverse impacts to human health for the 2013 PDC, the concerns related to environmental contamination held by members of Aboriginal communities in combination with other socio-economic factors described above can affect the undertaking of traditional land use activities and the exercise Treaty and Aboriginal rights. These other effects on traditional activities may further affect the culture and quality of life of the MCFN. Although it is not possible to determine the degree to which individual traditional land users may be affected by these additional impacts, the impacts have been reported by Aboriginal groups and are considered to occur under the 2013 PDC.

3.5.1.4.1 Traditional Hunting Opportunities (Mikisew Cree First Nation)

The effects of the 2013 PDC on traditional hunting opportunities consider the effects to large game Key Indicator Resources (KIRs), effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.4.1.1 Effects to Large Game (Mikisew Cree First Nation)

Wildlife considered as Key Indicator Resources (KIRs) for large game hunting are moose, black bear, and wood bison. The effects classification for impacts to wildlife in the RSA at 2013 PDC (before Closure) are reported in Section 3.4.3.1. Under the 2013 PDC, effects to moose abundance and movement were predicted to be negative in direction and low in magnitude, and effects to moose habitat (including fragmentation) were assessed as negative in direction and moderate in magnitude. The effects to black bear abundance, habitat (including fragmentation) and movement were all assessed negative in direction, and low in magnitude. The PDC effects on wood bison abundance and movement were assessed as negative in direction and low in magnitude, and negative in direction, and moderate in magnitude for effects to habitat.

3.5.1.4.1.2 Effects to Preferred Hunting Areas (Mikisew Cree First Nation)

The majority of recorded large game hunting documented by MCFN Community members occurs north of the RSA, in the area of Fort Chipewyan, Lake Claire and the Athabasca delta (Elias 2011; Candler et al. 2012b). Within the RSA, high usage areas are concentrated along the Athabasca, MacKay, Dover, Ells, Muskeg and Firebag rivers, and near the community of Fort McKay (Elias 2011; Candler et al. 2012b). Elias (2011) also suggests that larger portions of the RSA may be used by the MCFN for traditional hunting. As a result, the portion of MCFN traditional territory that overlaps the RSA will be considered in the assessment of effects to MCFN traditional hunting opportunities in the RSA.

At 2013 PDC, planned or existing developments are expected along portions of the Athabasca River, portions of the MacKay River, and a large portion of the Muskeg River. Planned developments are located in the Namur Lake region, and the upstream portion of the Dover River. Development also affects a small portion of the Ells River. The Firebag River should remain relatively undisturbed at 2013 PDC. The 2013 PDC disturbances will affect 24% of the portion of MCFN traditional territory that overlaps the RSA (Table 3.5-6).

Table 3.5-6 Disturbance Within Mikisew Cree First Nation Traditional Territory That Overlaps the Regional Study Area – 2013 PRM Application Case to 2013 Planned Development Case

First Nation Traditional Territories	Traditional Territory Area Within RSA [ha]	2013 PRM Application Case Disturbance Area[(a)]		2013 Planned Development Case Disturbance Area		Change		Percentage Increase [%]
		[ha]	% area	[ha]	% area	[ha]	% area	
MCFN	1,673,308	296,435	18	407,267	24	110,832	7	37

(a) Application Case includes all existing and approved projects plus PRM.

3.5.1.4.1.3 Effects to Access of Preferred Hunting Areas (Mikisew Cree First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, or restrictions due to barriers or access controls. The loss of land due to disturbance has been described in the preceding section.

The 2013 PDC is not expected to have an effect on access to preferred hunting areas north of the RSA in the larger Fort Chipewyan area (Including MCFN's reserves). As the MCFN have indicated that the majority of members live off reserve in Fort McMurray or other more southern areas, access from Fort McKay (the main access point into the RSA for these members) has also been addressed.

A review of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay. For the purposes of this assessment, it is assumed that MCFN traditional land users living in Fort McMurray will use the Fort McKay trail network for many of their traditional activities. The 2013 PDC developments are also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails at their point of origination and resulting in limitations to use undisturbed portions of the trail as well.

At 2013 PDC, overland trails connecting areas northeast of Fort McKay including the Muskeg and Firebag rivers are adversely impacted. Access to the Firebag River continues to be available from areas along the Athabasca River and is not considered impacted for those land users travelling from reserves and communities north of the RSA. The Canterra Road also provides improved access to some areas northeast of Fort McKay. Mikisew Cree First Nation members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in impediments to the access of traditional land use areas (Candler et al. 2012b).

Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River. Trail access to the MacKay River from south of Fort McKay will be impacted at 2013 PDC, and trails paralleling the river may be interrupted. Minimal impacts to trails accessing the Ells River and Dover River are expected. 2013 PDC projects will interrupt trails northwest of Fort McKay that may be used in accessing preferred bison hunting locations.

The Athabasca River provides an important water access route during summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The 2013 PDC is not expected to have an effect on water levels in the Peace-Athabasca Delta.

3.5.1.4.1.4 Effects Classification for Traditional Hunting (Mikisew Cree First Nation)

The effects classification on traditional hunting for the MCFN considers the effects to traditional hunting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to socio-economic factors.

Regarding the effects to traditional hunting opportunities, the wildlife assessment measured the effects to TLU hunting KIRs (moose, black bear and wood bison) as ranging from low to moderate for abundance, habitat and movement. The MCFN preferred harvesting areas are considered to be the portion of the MCFN traditional territory that overlaps the RSA. At 2013 PDC, 24% of the MCFN traditional territory within the RSA is expected to be disturbed. This effect is considered adverse in direction and high in magnitude. The administration centre for the MCFN is Fort Chipewyan but they have indicated that many of their members reside in Fort McMurray or communities farther south, therefore access is considered from both north of the RSA and from Fort McKay. It is assumed that MCFN members travelling south into the RSA are using the northern portions of the RSA for harvesting.

Effects on access to MCFN lands within the RSA for MCFN members from reserves and communities north of the RSA may be discernible but are not considered substantial. Therefore the effect on access to MCFN lands for hunting in the northern portion of the RSA for MCFN members living in Fort Chipewyan and other areas north of the RSA is assessed as an adverse and low magnitude effect.

Effects on access to MCFN lands within the RSA for MCFN members living in Fort McMurray and southern communities are considered substantial. Therefore, the effect on access to MCFN lands for hunting in the RSA for MCFN members living in Fort McMurray is considered an adverse and high magnitude effect.

As a result of the high magnitude effect to MCFN lands within the RSA, the effects to traditional hunting opportunities in the RSA for MCFN members are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude effects to MCFN lands within the RSA, and the above, the effects to traditional hunting in the RSA at 2013 PDC for the MCFN are assessed as high. The effects are considered long term in duration because they are expected to occur for longer than one generation. They are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.4.2 Traditional Trapping Opportunities (Mikisew Cree First Nation)

The effects of the 2013 PDC on traditional trapping opportunities consider the effects to furbearer abundance, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.4.2.1 Effects to Furbearer Abundance (Mikisew Cree First Nation)

Furbearers considered to be Key Indicator Resources (KIRs) for traditional trapping include beaver, fisher and Canada lynx. These resources were assessed in the residual impact classification for effects on wildlife in the

RSA for the 2013 PDC in Section 3.4.3.1. Effects to beaver were assessed as negative in direction and low in magnitude for abundance, habitat and movement. Effects to fisher and Canada lynx were assessed as negative in direction and moderate in magnitude for abundance and habitat, and negative in direction and low in magnitude for movement.

3.5.1.4.2.2 Effects to Preferred Trapping Areas (Mikisew Cree First Nation)

One RFMA in the RSA is registered to a member of the MCFN (RFMA #2892) and it partially overlaps the northern portion of the RSA (Candler et al. 2012b, Figure 1). It is also partially overlapped by 2013 PDC development (Table 3.5-7).

Table 3.5-7 Disturbance Within Registered Fur Management Area #2892 – 2013 PRM Application Case to 2013 Planned Development Case.

RFMA [#]	Total Area [ha]	2013 PRM Application Case Total Disturbance Area[(a)]		2013 Planned Development Case Total Disturbance Area		Change		Percentage Increase [%]
		[ha]	% of RFMA	[ha]	% of RFMA	[ha]	% of RFMA	
2892	52,840	722	1	4,616	9	3,893	7	700

[(a)] Application Case includes all existing and approved projects plus PRM.

Note: Percentages have been rounded to the nearest whole percent.

3.5.1.4.2.3 Effects on Access to Preferred Trapping Areas (Mikisew Cree First Nation)

The 2013 PDC is not expected to have an appreciable effect on MCFN trapping areas located north of and outside the RSA. The winter road between Fort McKay and Fort Chipewyan will provide access to RFMA #2892 from the south. The 2013 PDC disturbance will have some effect on some traditional trails within the southern portion of the RFMA. In summary, the 2013 PDC is not expected to cause substantial effects on access to the RFMA.

3.5.1.4.2.4 Effects Classification for Traditional Trapping (Mikisew Cree First Nation)

The effects classification to traditional trapping for the MCFN considers the effects traditional trapping opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to socio-economic factors.

Regarding the effects to traditional trapping opportunities, the wildlife assessment measured the effects to TLU trapping KIRs (beaver, fisher and Canada lynx) as ranging from low to moderate for abundance, habitat and movement. Registered Fur Management Area #2892 is the only MCFN registered trapping area within the RSA. The RFMA partially overlaps the northern area of the PDC and based upon the area of overlap, the disturbance effects to the RFMA are considered adverse and moderate in magnitude. The 2013 PDC is not expected to cause substantial effects on access to the RFMA. Therefore the effects of the 2013 PDC on access to the RFMA are considered adverse and low in magnitude. As a result of the above, the 2013 PDC effects on traditional trapping opportunities are considered low to moderate to the users of RFMA #2892.

As a result of the above and considering the added visual, odour, noise and social factors, the effects to MCFN traditional trapping at 2013 PDC are considered negative in direction and moderate to high in magnitude. The effects are limited to the individual trapper(s) on RFMA #2892. The effects are considered long term in duration because they are expected to occur for longer than one generation, and thereby irreversible, because the length of duration may interfere with the ability for traditional knowledge related to use of the RFMA to be passed intergenerationally.

3.5.1.4.3 Traditional Fishing Opportunities (Mikisew Cree First Nation)

The effects of the 2013 PDC on traditional fishing opportunities consider the effects to fish abundance, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.4.3.1 Effects to Fish Abundance and Habitat (Mikisew Cree First Nation)

The effects of PRM on fish habitat and fish abundance were assessed in the EIA, Volume 4, Section 6.7.6. Within the boundary of the LSA, fish habitat within Eymundson Creek and Pierre River was considered to be lost due to the diversion of these watercourses to diversion channels during operations of the PRM. Once mitigation and habitat compensation associated with the PRM was accounted for, the residual impacts to fish habitat and fish abundance in 2013 PRM Application Case were classified as having no environmental consequence. In the 2013 PRM Application Case, effects to fish habitat that may result from changes in Athabasca River flow or water level, as a result of PRM, are predicted to be negligible.

The 2013 PDC assessment of effects considers the Water Management Framework for the Lower Athabasca River (AENV and DFO 2007). The Framework was developed to manage cumulative withdrawals from the Athabasca River and protect the aquatic ecosystem, while allowing industry to operate, which would include the planned projects in the 2013 PDC. Because the Framework is adaptive, it will be informed by ongoing scientific study, and modified as necessary to maintain protection of the river. Accordingly, no cumulative effects to fish habitat, beyond those outlined in the Framework, would be expected from changes to stream flow in the Athabasca River in the 2013 PDC. Once mitigation and compensation are taken into account for valid linkages, all residual effects on fish and fish habitat were negligible and considered to have no environmental consequence.

3.5.1.4.3.2 Effects to Preferred Fishing Areas (Mikisew Cree First Nation)

Fishing locations documented by MCFN members within the RSA include the Athabasca River, Firebag River, Namur and Gardiner lakes region, Ells River and Dover River (Elias 2011).

At 2013 PDC, developments are expected along portions of the Athabasca River within the RSA. The 2013 PDC developments are also located in the Namur Lake region, the Ells River and the upstream portion of the Dover River. The Firebag River is expected to remain relatively undisturbed at 2013 PDC.

The 2013 PDC is not expected to affect preferred fishing areas north of the RSA in the larger Fort Chipewyan area.

3.5.1.4.3.3 Effects to Access of Preferred Fishing Areas (Mikisew Cree First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, or restrictions due to barriers or access controls. The loss of land due to disturbance has been described in the preceding section.

The 2013 PDC is not expected to affect access to preferred fishing areas north of the RSA in the larger Fort Chipewyan area.

Within the RSA, preferred MCFN fishing areas were identified along the Athabasca River, Namur and Gardiner lakes region, Ells River and Dover River. Fort Chipewyan is the administrative base for the MCFN, but the majority of members are reported to live off reserve in Fort McMurray or other more southern areas (Candler et al. 2012b). "Members living in southern areas tend to use nearby resources, though many return to Fort Chipewyan and surrounding territories on a regular basis…" (Candler et al. 2012b, p. 34).

An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that traditional land users living in Fort McMurray will generally travel north to access this trail network for many of their traditional activities. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the majority of disturbance to Fort McKay area traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails at their point of origin and resulting in access limitations to undisturbed portions of the trail as well.

A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is expected at 2013 PDC, although alternative trails and upgraded access continues to be available. Additionally, a minimal reduction in the number of trails between the Namur Lake and Gardiner Lakes region and reserves north of the RSA is expected. Mikisew Cree First Nation members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in impediments to the access of traditional land use areas (Candler et al. 2012b).

Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River. Trail access to the MacKay River from south of Fort McKay will be impacted at 2013 PDC, and trails paralleling the river may be interrupted. Minimal impacts to trails accessing the Ells River and Dover River are expected.

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions due to planned developments in the Athabasca River are less than 2 cm of the mean seasonal flow depths. The 2013 PDC is not expected to have an effect on water levels in the Peace-Athabasca Delta.

3.5.1.4.3.4 Effects Classification for Traditional Fishing (Mikisew Cree First Nation)

The effects classification on traditional fishing for the MCFN considers the effects on traditional fishing opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects on access to preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to socio-economic factors.

Regarding the effects to traditional fishing opportunities, residual effects to fish and fish habitat at 2013 PDC were assessed as negligible after mitigation and compensation was applied. Within the RSA, the MCFN identified the Ells, Dover, Athabasca and Firebag rivers, and the Namur Lake and Gardiner Lakes as fishing areas. There will be minimal impacts to traditional trails accessing the Ells and Dover rivers. The administration centre for the MCFN is Fort Chipewyan but they have indicated that many of their members reside in Fort McMurray or communities farther south, therefore access is considered from both north of the RSA and from

Fort McKay. It is assumed that MCFN members travelling south into the RSA are using the northern portions of the RSA for fishing (i.e., the Firebag and Athabasca rivers, and Namur Lake and Gardiner Lakes).

The 2013 PDC is not expected to affect the Firebag River nor the Athabasca River. The 2013 PDC is expected to reduce the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region, although upgraded access will remain. The 2013 PDC effects on access to fishing areas in the RSA for MCFN members living in Fort McMurray are assessed as being potentially detrimental, and are therefore assessed as negative in direction and moderate in magnitude.

The effects of the 2013 PDC on access to fishing areas in the RSA for MCFN members living in Fort Chipewyan are not expected to be substantial, and are therefore assessed as negative in direction and low in magnitude.

Therefore, the effects of the 2013 PDC on traditional fishing opportunities for MCFN in the RSA are assessed as adverse and moderate in magnitude for MCFN members living in Fort McMurray, and adverse and low for MCFN members living in Fort Chipewyan.

As a result of the low and moderate impacts to traditional fishing opportunities combined with the air, noise, visual and social factors identified above, the effects to MCFN traditional fishing at 2013 PDC are assessed as negative in direction and high in magnitude for fishing in the RSA by MCFN members living in Fort McMurray, and negative in direction and moderate in magnitude for fishing in the RSA by MCFN members living in Fort Chipewyan. The effects are considered long term in duration because they are expected to occur for longer than one generation, and thereby irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.4.4 Traditional Plant and Berry Harvesting Opportunities (Mikisew Cree First Nation)

The effects of the 2013 PDC on traditional plant and berry harvesting opportunities consider the effects to traditional plants, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.4.4.1 Effects to Traditional Plants and Berries (Mikisew Cree First Nation)

The effects to traditional use plant potential under the 2013 PDC were not assessed within the vegetation assessment due to the negligible environmental consequence determination at 2013 PRM Application Case.

3.5.1.4.4.2 Effects to Preferred Plant and Berry Harvesting Areas (Mikisew Cree First Nation)

The highest concentration of important plants, berries and medicines, identified by MCFN members, lies north of the RSA within the area of Lake Claire and Lake Athabasca (MCFN n.d.). Berry and plant harvesting sites are also located within the RSA along the Athabasca River, south of McClelland Lake, along the Muskeg River, around the community of Fort McKay, and west of the Athabasca River towards the Namur Lake region (Elias 2011). Elias (2011) suggests that larger portions of the RSA may also be used by members of the MCFN for traditional plant and berry harvesting. As a result, the portion of MCFN traditional territory that overlaps the RSA will be considered in the assessment of effects to MCFN traditional plant and berry harvesting opportunities in the RSA.

At 2013 PDC, planned or existing developments are expected or already existing along portions of the Athabasca River within the RSA and a large portion of the Muskeg River. Planned developments are located in the Namur Lake region. No developments are planned or existing within the immediate vicinity of McClelland Lake, although existing and planned developments are located within the surrounding area.

The 2013 PDC disturbances will affect 24% of the portion of MCFN traditional territory that overlaps the RSA (Table 3.5-6).

3.5.1.4.4.3 Effects on Access to Preferred Plant and Berry Harvesting Areas (Mikisew Cree First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions on movements and barrier or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

The 2013 PDC is not expected to affect access to preferred plant and berry harvesting locations north of the RSA in the larger Fort Chipewyan area.

Fort Chipewyan is the administrative base for the MCFN, but the majority of members are reported to live off reserve in Fort McMurray or other more southern areas (Candler et al. 2012b). "Members living in southern areas tend to use nearby resources, though many return to Fort Chipewyan and surrounding territories on a regular basis…" (Candler et al. 2012b, p. 34).

An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that traditional land users living in Fort McMurray will generally travel north to access this trail network for many of their traditional activities. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails at their point of origination and resulting in limitations to use undisturbed portions of the trail as well. For preferred use areas surrounding the hamlet of Fort McKay, access to areas is limited more by direct disturbance than loss of trails.

At 2013 PDC, overland trails connecting areas northeast of Fort McKay including the Muskeg River and McClelland Lake are adversely impacted. Access to McClelland Lake continues to be available from areas along the Athabasca River and is not considered impacted for those land users travelling from reserves and communities north of the RSA. The Canterra Road provides improved access northeast of Fort McKay towards Kearl Lake. Certain areas within the RSA, including Kearl (Muskeg) Lake, which MCFN members once used for berry harvesting, are no longer considered accessible due to development (Candler et al. 2012b). A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is also expected, although alternative trails and upgraded access continues to be available. Additionally, a minimal reduction in the number of trails between the Namur Lake and Gardiner Lakes region and reserves north of the RSA is expected. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River.

Mikisew Cree First Nation members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in impediments to the access of traditional land use areas (Candler et al. 2012b).

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The PDC is not expected to affect water levels in the Peace-Athabasca Delta.

3.5.1.4.4.4 Effects Classification for Traditional Plant and Berry Harvesting (Mikisew Cree First Nation)

The effects classification to traditional plant and berry harvesting for the MCFN considers the effects on traditional plant and berry harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

The vegetation assessment determined there were no residual effects to high Traditional Plant Potential under the 2013 PRM Application Case. Therefore, an assessment of Traditional Plant Potential was not carried forward to the 2013 PDC. The MCFN preferred harvesting areas are considered to be the portion of the MCFN traditional territory that overlaps the RSA. At 2013 PDC, 24% of the MCFN traditional territory within the RSA is expected to be disturbed. This effect is considered adverse in direction and high in magnitude. The administration centre for the MCFN is Fort Chipewyan but they have indicated that many of their members reside in Fort McMurray or communities farther south. Therefore access is considered from both north of the RSA and from Fort McKay (the main access point into the RSA for members living in Fort McMurray or farther south). It is assumed that MCFN members travelling south into the RSA are using the northern portions of the RSA for harvesting. Access from reserves and communities north of the RSA is likely to be discernibly affected but is not expected to materially affect access to the northern part of the RSA, and therefore is assessed as an adverse and low magnitude effect. The 2013 PDC disturbances in the RSA are such that they are predicted to substantially interfere with access to preferred plant and berry harvesting areas for individuals living in Fort McMurray and more southern communities. Therefore, the effect on access is assessed as adverse and high in magnitude for MCFN members living in Fort McMurray.

As a result of the high magnitude disturbance to the portion of the MCFN traditional territory within the RSA, the effects to traditional plant and berry harvesting opportunities are assessed as negative in direction and high in magnitude.

As a result of the high impacts to the MCFN lands within the RSA, and the above, the effects to MCFN traditional plant and berry harvesting at 2013 PDC are assessed as negative in direction, high in magnitude, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.5 Athabasca Chipewyan First Nation

The Athabasca Chipewyan First Nation (ACFN) has developed three types of cultural protection zones within their traditional territory: homeland zones, proximate zones, and critical waterway zones (ACFN 2010;

Larcombe 2012; Marcel et al. 2012). Homeland zones are identified as “specific areas that are of critical importance to past, present and future practice of ACFN rights” (ACFN 2010, p.9). Proximate zones are those areas “relied upon for the practice of rights by an increasing number of ACFN members living in and around Fort Chipewyan, Fort McKay, and Fort McMurray” (ACFN 2010, p.9). Critical waterway zones extend 5 km on either side of waterways considered critical for the practice of ACFN rights and “recognize the integral importance of water quality and quantity to the ACFN membership and their practice of rights” (ACFN 2010, p.12). A comparison of the ACFN Cultural Protection Areas (Map 1 in ACFN 2010; Figure 2-2 in Larcombe 2012) and the 2013 RSA shows it overlaps portions of the k’es hochela nene (Poplar Point) Homeland Zone, Fort McKay Proximate Zone, and a very small portion of the Fort McMurray Proximate Zone. The 2013 RSA partially overlaps about 381,728ha of the ACFN critical waterway zones, which represents about 17% of the area of the 2013 RSA. A summary of disturbances within the RSA portions of the ke’s hochela nene Homeland Zone and the Fort McKay Proximate Zone (including the small portion of the Fort McMurray Proximate Zone) is provided in Table 3.5-8. These zones are considered in the assessment of the 2013 PDC on ACFN hunting and plant harvesting within the RSA.

Table 3.5-8 Disturbances Within the Regional Study Area Portions of the Homeland and Proximate Zones

ACFN Protection Zone	Zone Area Within RSA [ha]	2013 PRM Application Case Disturbance Area		2013 Planned Development Case Disturbance Area		Change		Percentage Increase [%]
		[ha]	% area	[ha]	% area	[ha]	% area	
Homeland Zone	607,703	26,396	4	57,662	10	31,266	5	119
Proximate Zone	635,626	188,738	30	219,435	35	30,697	5	26
Total	1,243,329	215,134	17	277,096	22	61,962	5	29

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The ACFN k’es hochela nene homeland zone partially overlaps the northern portion of the RSA and extends north to just south of Mamawi Lake. At 2013 PDC, 10% of the portion of the homeland zone within the RSA is disturbed and 35% of the proximate zone within the RSA is disturbed.

The proximate zones were defined as important for:

> “…ACFN members who cannot easily access the homeland zones. While not necessarily ‘prime’ lands in terms of quantity or quality of resources, proximate zones are critical for providing ACFN members living away from the homelands, with accessible areas for harvesting resources and reconnecting with the land. For those members, the Proximate Zones are important not only based on where they live, but because financial, time and other constraints may prevent them from exercising their rights in the Homeland Zone on a regular basis” (ACFN 2010, p. 17).

For the purposes of this assessment, ACFN preferred traditional land use areas within the RSA have been identified as the k’es hochela nene homeland zone and the Fort McKay proximate zone, which roughly correspond with the mapped portions of the ACFN traditional territory that fall within the RSA. Traditional Land Use data provided by the ACFN in Candler et al. (2011 and 2012a) defined local and regional study areas geographically different from the LSA and RSA used in this assessment. To avoid confusion, within the following sections, the ACFN LSA or ACFN RSA refers to those presented in the Candler et al. (2011 and 2012a).

In addition to the opportunities to undertake traditional harvesting activities, effects to traditional harvesting also consider the added impacts of odour, noise and visual effects. For example, within the RSA, the effects of odour, noise and visual disturbances are expected to have the effect of increasing the radius of the impacts to areas used for traditional land use. These effects are not expected to affect traditional land uses north of the RSA in the larger Fort Chipewyan area. Although the Human Health Risk Assessment did not determine any adverse impacts to human health for the 2013 PDC, the concerns related to environmental contamination held by members of Aboriginal communities in combination with other socio-economic factors described above can affect participation in traditional land use activities and the exercise of Treaty and Aboriginal rights. These other effects on traditional activities may further affect the culture and quality of life of the ACFN. Although it is not possible to determine the degree to which individual traditional land users may be affected by these additional impacts, the impacts have been reported by Aboriginal groups and are considered to occur under the 2013 PDC.

3.5.1.5.1 Traditional Hunting Opportunities (Athabasca Chipewyan First Nation)

The effects of the 2013 PDC on traditional hunting opportunities consider the effects to large game, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.5.1.1 Effects to Large Game (Athabasca Chipewyan First Nation)

Wildlife considered as Key Indicator Resources (KIRs) for ACFN large game hunting are moose, black bear, and wood bison. The residual impact classification for effects on wildlife in the RSA at 2013 PDC (before Closure) were reported in Section 3.4.3.1. The effects on moose abundance and movement was predicted to be negative in direction and low in magnitude, and negative in direction and moderate in magnitude for moose habitat (including fragmentation). The effects on black bear abundance, habitat (including fragmentation) and movement were all assessed as negative in direction and low in magnitude. The effects on wood bison abundance and movement were assessed as negative in direction and low in magnitude, and negative in direction and moderate in magnitude for habitat.

3.5.1.5.1.2 Effects to Preferred Hunting Areas (Athabasca Chipewyan First Nation)

The RSA overlaps the k'es hochela nene (Poplar Point Homeland Zone).

> "…West of the Athabasca River, the southern and western boundaries of this homeland are defined by wood bison range extending south and west from the area of Ronald Lakes, extending into the Birch Mountains. Bison from this area are relied upon heavily by ACFN members, and are especially critical to those families affiliated with the Poplar Point and Point Brule areas" (ACFN 2010, p.15-16)

Additionally, ACFN members have recorded multiple hunting and kills sites, particularly for moose, within the RSA including along the Athabasca River. Portions of the RSA have also been identified as high value moose habitat, and known and observed core wood bison habitat for the Ronald Lake Bison herd (Candler et al. 2011). Subsistence value locations and important environmental value locations are shown in Figure 7 in Candler et al. (2012a). While Candler et al. (2012a) reported that 1,615 subsistence values fall within the ACFN RSA, a large portion of the ACFN RSA falls outside the northern boundary of the RSA.

The 2013 PDC developments disturb 10% of the ACFN k'es hochele nene Homeland Zone, and 35% of the ACFN Fort McKay Proximate Zone.

3.5.1.5.1.3 Effects on Access to Preferred Hunting Areas (Athabasca Chipewyan First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions on movements, and barrier or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

For the purpose of this assessment, preferred ACFN hunting areas within the RSA are considered to be the k'es hochela nene (Poplar Point Homeland) Zone and the Fort McKay Proximate Zone. Within the RSA, preferred hunting areas were identified within the k'es hochela nene (Poplar Point Homeland) Zone in the northern portion of the RSA, the Fort McKay Proximate Zone and along the Athabasca River. Fort Chipewyan is the administrative base for the ACFN, but with "the majority of members living in Fort McMurray or other more southern areas" (Candler et al. 2012a, p.29). "Members living in southern areas tend to use nearby resources, though many return to Fort Chipewyan and surrounding territories on a regular basis" (Candler et al. 2012a, p.29).

An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that ACFN traditional land users living in Fort McMurray will generally travel north to access this trail network for traditional activities. The 2013 PDC development is concentrated along the Athabasca River and particularly to the north, east and south of Fort McKay. The majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails near their point of origin and resulting in limitations to use of undisturbed portions of the trail as well.

At 2013 PDC, overland trails connecting Fort McKay to the northeast portions of the Poplar Point Homeland Zone are adversely impacted. Access to this area continues to be available from northern portions of the Athabasca River and is not considered impacted for those land users travelling from reserves and communities north of the RSA. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails within the Poplar Point Homeland Zone (including ACFN's IR 201F and IR 201G). Trail access to the portions of the Poplar Point Homeland Zone west of the Athabasca River from Fort McKay will be adversely affected at 2013 PDC. Development interrupts several trails originating along the Athabasca River. The 2013 PDC is expected to have no effect on trails accessing the Poplar Point Homeland Zone from Fort Chipewyan and other areas north of the RSA (including ACFN's IR 201F and IR 201G).

Overland access to areas east of the Athabasca River within the Fort McKay Proximate Zone, including McClelland Lake and the Muskeg River, will be adversely impacted. Access to the more northern portions of this zone will continue to be accessible via access points from the Athabasca River. Overland access to areas west of the Athabasca River within the Fort McKay Proximate Zone will also be adversely affected. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is expected, although alternative trails and upgraded access continue to be available. Additionally, a minimal reduction in the number of trails between the Namur Lake and Gardiner Lakes region and reserves north of the RSA is expected under 2013 PDC.

Athabasca Chipewyan First Nation members have noted that even where access has been preserved or upgraded through development areas, the restrictions, check-ins, escorts and installation of gates results in impediments to the access of traditional land use areas (Candler et al. 2012a).

The Athabasca River provides important access routes during summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca River. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The 2013 PDC is not expected to have an effect on water levels in the Peace-Athabasca Delta.

3.5.1.5.1.4 Effects Classification for Traditional Hunting (Athabasca Chipewyan First Nation)

The effects classification to traditional hunting for the Athabasca Chipewyan First Nation considers the effects to traditional hunting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

Regarding the effects to traditional hunting opportunities, the wildlife assessment measured the effects to TLU hunting KIRs (moose, black bear and wood bison) as ranging from low to moderate for abundance, habitat and movement (Section 3.4.3.1). At 2013 PDC, disturbance to the ACFN Homeland Zone within the RSA is 10% (57,662 ha) while the disturbance to the ACFN Proximate Zones within the RSA is 35% (219,435 ha). While the Homeland Zone has been identified particularly for its importance as wood bison habitat, proximate zones are "relied upon by ACFN members living in and around the Fort McKay settlement, or in Fort McMurray" (Candler et al. 2012, p.17). Therefore, disturbance to ACFN homeland zones within the RSA under the 2013 PDC are assessed as adverse in direction and low to moderate in magnitude. Disturbance to ACFN proximate zones in the RSA are considered adverse in direction and high in magnitude.

The administration centre for the ACFN is Fort Chipewyan but they have indicated that many of their members reside in Fort McKay, Fort McMurray or communities farther south; therefore access is considered from both north of the RSA and from Fort McKay. It is assumed that ACFN members travelling south into the RSA are using the northern portions of this RSA for harvesting. Access from reserves and communities north of the RSA is likely to be discernibly affected but is not expected to materially affect access to preferred areas and therefore is assessed as a low magnitude. Changes in access for individuals living in Fort McKay, Fort McMurray and southern communities are predicted to substantially interfere with people's ability to use preferred hunting areas and are therefore assessed as an adverse high magnitude effect. As a result of the high magnitude effects to the portion of the Fort McKay Proximate Zone within the RSA, the effects to traditional hunting opportunities for ACFN members are assessed as adverse in direction and high in magnitude.

As a result, the effects to ACFN traditional hunting in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude and long term in duration because the effects are expected to occur for longer than one generation. They are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.5.2 Traditional Trapping Opportunities (Athabasca Chipewyan First Nation)

The effects of the 2013 PDC on traditional trapping opportunities consider the effects to furbearers, effects to preferred harvesting areas within the RSA, and effects on access to the preferred areas.

3.5.1.5.2.1 Effects to Furbearer Abundance (Athabasca Chipewyan First Nation)

Furbearers considered to be Key Indicator Resources (KIRs) for traditional trapping include beaver, fisher and Canada lynx. These resources were assessed in the residual impact classification for effects on wildlife in the RSA for the 2013 PDC in Section 3.4.3.1. The effects on beaver were assessed as negative in direction and low in magnitude for abundance, habitat and movement. The effects on fisher and Canada lynx were assessed as negative in direction and moderate in magnitude for abundance and habitat, and negative in direction and low in magnitude for movement.

3.5.1.5.2.2 Effects to Preferred Trapping Areas (Athabasca Chipewyan First Nation)

The majority of historical ACFN-recorded trapping locations recorded in ACFN (2003), are found north of the RSA. Within the RSA traditional ACFN trapping locations have been identified along the Athabasca River, in the Namur Lake and Gardiner Lakes region, and along the Muskeg River (ACFN 2003). Identified RFMAs held by ACFN members within the RSA include RFMAs #1714 and #2863. Under the 2013 PDC, approximately 60% of the area of RFMA #1714 would be disturbed. Registered Fur Management Area #2863 partially overlaps the northern portion of the RSA and will not have any disturbance under the 2013 PDC.

3.5.1.5.2.3 Effects on Access to Preferred Trapping Areas (Athabasca Chipewyan First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails or restrictions due to barriers or access control. The loss of land due to disturbance has been described in the preceding section.

Registered Fur Management Area #2863 partially overlaps the northern portion of the RSA on the east side of the Athabasca River. None of the 2013 PDC developments overlap RFMA #2863. The PDC does not affect access to RFMA #2863 from north of the RSA, and access from the south is available along the winter road between Fort McKay and Fort Chipewyan. The PDC is not expected to affect water levels in the Athabasca River, which can also be used to access RFMA #2863.

Access to RFMA #1714 is via a combination of travel along the Canterra Road and through existing developments (EIA, Volume 5, Section 3.4.3). Athabasca Chipewyan First Nation members have noted that even where access has been preserved or upgraded through development areas, the restrictions, check-ins and installation of gates have affected access to traditional land use areas, including access to RFMA #1714 (Candler et al. 2012a).

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The 2013 PDC is not expected to have an effect on water levels in the Peace-Athabasca Delta.

3.5.1.5.2.4 Effects Classification for Traditional Trapping (Athabasca Chipewyan First Nation)

The effects classification to traditional trapping for the ACFN considers the effects traditional trapping opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

Regarding the effects to traditional trapping opportunities, the wildlife assessment measured the effects to TLU trapping KIRs (beaver, fisher and Canada lynx) as ranging from low to moderate for abundance, habitat and movement. At 2013 PDC, disturbance to RFMA #1714 is 60% which is considered a high magnitude effect. There is no 2013 PDC disturbance effect to RFMA #2863.

Access to RFMA #1714 requires travel through developments with access controls. Therefore, the effects of 2013 PDC on access to this RFMA is considered moderate. Access to RFMA #2863 from reserves and communities north of the RSA is not expected to be affected. During winter, the RFMA is accessible from the winter road between Fort McKay and Fort Chipewyan. During the summer, the RFMA is accessible via the Athabasca River, and trail access is not expected to be materially affected by PDC development. As a result, the effects of the 2013 PDC on access to RFMA #2863 are considered low in magnitude.

As a result of the high magnitude disturbance effects to RFMA #1714, the effects of the 2013 PDC on opportunities for ACFN trapping in the RSA are considered negative in direction and high in magnitude. These effects are limited to individuals using RFMA #1714.

As a result, the effects to ACFN traditional trapping in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude, and long term in duration because they are expected to occur for longer than one generation, The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.5.3 Traditional Fishing Opportunities (Athabasca Chipewyan First Nation)

The effects of the 2013 PDC on traditional fishing opportunities consider the effects to fish, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.5.3.1 Fish Abundance and Fish Habitat (Athabasca Chipewyan First Nation)

The effects of PRM on fish habitat and fish abundance were assessed in the EIA, Volume 4, Section 6.7.6. Within the boundary of the LSA, fish habitat within Eymundson Creek and Pierre River was considered to be lost due to the diversion of these watercourses to diversion channels during operations of the PRM. Once mitigation and habitat compensation associated with the PRM was accounted for, the residual impacts to fish habitat and fish abundance under the 2013 PRM Application Case were classified as having no environmental consequence. In the 2013 PRM Application Case, effects to fish habitat that may result from changes in Athabasca River flow or water level, as a result of PRM, are predicted to be negligible.

The 2013 PDC assessment of effects considers the Water Management Framework for the Lower Athabasca River (AENV and DFO 2007). The Framework was developed to manage cumulative withdrawals from the Athabasca River and protect the aquatic ecosystem, while allowing industry to operate, which would include the planned projects in the 2013 PDC. Because the Framework is adaptive, it will be informed by ongoing scientific study, and modified as necessary to maintain protection of the river. Accordingly, no cumulative effects to fish habitat, beyond those outlined in the Framework, would be expected from changes to stream flow in the Athabasca River in the 2013 PDC. Once mitigation and compensation are taken into account for valid linkages, all residual effects on fish and fish habitat were negligible and considered to have no environmental consequence.

3.5.1.5.3.2 Effects to Preferred Fishing Areas (Athabasca Chipewyan First Nation)

In the ACFN's TLU study (ACFN 2003), the large majority of the ACFN fishing sites are located north of the RSA, in the larger region around Fort Chipewyan. Within the RSA, some fishing is indicated near Gardiner Lakes and at Kearl Lake. More recently, the ACFN have reported that within the RSA, subsistence fishing occurs along the Athabasca and Firebag rivers, although other ACFN members have noted that, due to contamination concerns, they no longer fish on the Athabasca River (Candler et al. 2011). "There appears to be an adaptive trend towards reliance on accessible inland lakes for food fishing" (Larcombe 2012, pp. 5-19).

At 2013 PDC, planned or existing developments are expected along portions of the Athabasca River within the RSA, and will surround Kearl Lake. The Firebag River is expected to remain relatively undisturbed at 2013 PDC.

3.5.1.5.3.3 Effects on Access to Preferred Fishing Areas (Athabasca Chipewyan First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions on movements, and barrier or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

Fort Chipewyan is the administrative base for the ACFN, but with "the majority of members living in Fort McMurray or other more southern areas" (Candler et al. 2012a, p.29). "Members living in southern areas tend to use nearby resources, though many return to Fort Chipewyan and surrounding territories on a regular basis" (Candler et al. 2012a, p.29). At 2013 PDC, traditional trails connecting areas near Fort McKay to the northeastern portions of the Poplar Point Homeland Zone, including the Firebag River are adversely impacted. Access to this area continues to be available from northern portions of the Athabasca River and is not considered impacted for those land users travelling from reserves and communities north of the RSA. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. In winter, road access connects Fort McKay with Fort Chipewyan.

Overland access to areas west of the Athabasca River within the Fort McKay Proximate Zone will also be adversely affected. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is expected, although alternative trails and upgraded access continues to be available. A minimal reduction in the number of trails between the Namur Lake and Gardiner Lakes region and reserves north of the RSA is expected.

Athabasca Chipewyan First Nation members have noted that even where access has been preserved or upgraded through development areas, the restrictions, check-ins, escorts and installation of gates result in impediments to the access of traditional land use areas (Candler et al. 2012a).

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The 2013 PDC is not expected to have an effect on water levels in the Peace-Athabasca Delta.

3.5.1.5.3.4 Effects Classification for Traditional Fishing (Athabasca Chipewyan First Nation)

The effects classification to traditional fishing for the ACFN considers the effects on traditional fishing opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

Regarding the effects to traditional fishing opportunities, residual effects to fish and fish habitat at 2013 PDC were assessed as negligible after mitigation and compensation was applied.

Within the RSA, fishing was indicated near Gardiner Lakes and at Kearl Lake. More recently, the ACFN have reported that subsistence fishing occurs along the Athabasca and Firebag rivers, although other ACFN members have noted that, due to contamination concerns, they no longer fish on the Athabasca River (Candler et al. 2011).

The administration centre for the ACFN is Fort Chipewyan but they have indicated that many of their members reside in Fort McKay, Fort McMurray or communities farther south. Therefore access is considered from both north of the RSA and from Fort McKay. It is assumed that ACFN members travelling south into the RSA are using the northern portions of the RSA for harvesting. Access from reserves and communities north of the RSA is likely to be discernibly affected but is not expected to materially affect access to preferred areas and therefore is assessed as an adverse and low magnitude effect. For individuals living in Fort McKay, Fort McMurray and southern communities the 2013 PDC is predicted to substantially interfere with people's access to preferred fishing areas near Gardiner Lakes and the Firebag Rivers, and therefore changes in access were assessed as an adverse high magnitude effect. As a result of the above factors, the effects to traditional fishing opportunities in the RSA for ACFN members are assessed as adverse in direction and high in magnitude.

As a result of the above, the effects to ACFN traditional fishing in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude, and long term in duration, because they are expected to occur for longer than one generation. The effects are considered to be irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.5.4 Traditional Plant and Berry Harvesting Opportunities (Athabasca Chipewyan First Nation)

The effects of the 2013 PDC on traditional plant and berry harvesting opportunities consider the effects to traditional plants, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.5.4.1 Effects to Traditional Plants and Berries (Athabasca Chipewyan First Nation)

The vegetation assessment determined there were no residual effects to high Traditional Plant Potential under the 2013 PRM Application Case. Therefore, high Traditional Plant Potential was not carried forward to the 2013 PDC.

3.5.1.5.4.2 Effects to Preferred Plant and Berry Harvesting Areas (Athabasca Chipewyan First Nation)

Locations of plant and berry harvesting identified in ACFN (2003) demonstrate a majority of plant and berry harvesting sites north of the RSA and only limited instances of gathering within the RSA. Subsistence values mapped in the Figure 7 of Candler et al. (2012a) that may represent plant gathering areas also show a concentration of values north of the RSA along the Athabasca River, and west and south of Lake Athabasca. Within the RSA, subsistence values are concentrated along the Athabasca River, in the Namur Lake and Gardiner Lakes region, around the hamlet of Fort McKay, and along the Firebag and Muskeg rivers.

At 2013 PDC, developments are generally expected along portions of the Athabasca River, the Namur Lake region, and generally surrounding the community of Fort McKay and the Muskeg River. The Firebag River is expected to remain relatively undisturbed at 2013 PDC.

3.5.1.5.4.3 Effects on Access to Preferred Plant and Berry Harvesting Areas (Athabasca Chipewyan First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, or restrictions due to barriers or access controls. The loss of land due to disturbance has been described in the preceding section.

Fort Chipewyan is the administrative base for the ACFN, however “the majority of members are reported to be living off reserve in Fort McMurray or other more southern areas” (Candler et al. 2012a, p.29). Many of the ACFN members living in Fort McMurray or more southern communities return to Fort Chipewyan on a regular basis; ”Members living in southern areas tend to use nearby resources, though many return to Fort Chipewyan and surrounding territories on a regular basis” (Candler et al. 2012a, p.29). For the purposes of this assessment preferred ACFN plant and berry harvesting areas within the RSA are considered to include the k’es hochela nene (Poplar Point Homeland) zone in the northern portion of the RSA, the Fort McKay Proximate Zone, and along the Athabasca River. Possible berry and plant harvesting locations identified by ACFN members include the Namur Lake region, Muskeg River, the area around Fort McKay and the Firebag River. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that traditional land users living in Fort McMurray will generally travel north to access this trail network for many of their traditional activities. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay, thereby interrupting the use of trails close to their point of origin and resulting in limitations to the use of undisturbed portions of the trail as well.

At 2013 PDC, overland trails connecting Fort McKay to the northeast portions of the Poplar Point Homeland Zone, including the Firebag River are adversely impacted. Access to this area continues to be available from northern portions of the Athabasca River and is not considered impacted for those land users travelling from reserves and communities north of the RSA. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. Trail access to the portions of the Poplar Point Homeland

Zone west of the Athabasca River from Fort McKay will be adversely affected at 2013 PDC. Development interrupts several trails originating along the Athabasca River. The 2013 PDC is expected to have minimal effects on trails into these areas from north of the RSA.

Overland access to areas east of the Athabasca River within the Fort McKay Proximate Zone, such as the Muskeg River, will also be adversely affected. Access to the more northern portions of this zone will continue to be accessible via access points from the Athabasca River. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is expected, although alternative trails and upgraded access continues to be available. Additionally, a minimal reduction in the number of trails between the Namur Lake and Gardiner Lakes region and reserves north of the RSA is expected.

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca River. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The 2013 PDC is not expected to have an effect on water levels in the Peace-Athabasca Delta.

3.5.1.5.4.4 Effects Classification for Traditional Plant and Berry Harvesting (Athabasca Chipewyan First Nation)

The effects classification to traditional plant and berry harvesting for the ACFN considers the effects to traditional plant and berry harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

The vegetation assessment determined there were no residual effects to high Traditional Plant Potential under the 2013 PRM Application Case. Therefore, an assessment of Traditional Plant Potential was not carried forward to the 2013 PDC. Preferred ACFN plant and berry harvesting areas are considered to include the k'es hochela nene (Poplar Point Homeland) zone in the northern portion of the RSA, the Fort McKay Proximate Zone, and along the Athabasca River. Other berry and plant harvesting locations identified by ACFN members include the Namur Lake region, the area around Fort McKay and the Firebag and Muskeg rivers.

At 2013 PDC, disturbance to the ACFN Homeland Zone within the RSA is 10% (57,662 ha), while the disturbance to the ACFN Proximate Zones within the RSA is 35% (219,435 ha). Therefore, disturbance to ACFN homeland zones are assessed as adverse in direction and low to moderate in magnitude. Disturbance to ACFN proximate zones are considered adverse in direction and high in magnitude.

The administration centre for the ACFN is Fort Chipewyan but they have indicated that many of their members reside in Fort McKay, Fort McMurray or communities farther south, therefore access is considered from both north of the RSA and from Fort McKay. It is assumed that ACFN members travelling south into the RSA are using the northern portions of the RSA for harvesting. Access from reserves and communities north of the RSA is likely to be discernible but not materially affected. Therefore, access to the Poplar Point Homeland Zone from north of the RSA is assessed as an adverse and low magnitude effect. For individuals living in Fort McKay, Fort McMurray and southern communities the 2013 PDC is predicted to substantially interfere with people's access to preferred plant and berry harvesting areas, and therefore assessed as an adverse high magnitude effect. As a result of the high magnitude effects to the Fort McKay Proximate Zone and access, the effects to traditional plant harvesting opportunities in the RSA for ACFN members are assessed as adverse in direction and high in magnitude.

Therefore, the effects to ACFN traditional plant and berry harvesting in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude and long term in duration because they are expected to occur for longer than one generation. Therefore, the effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.6 Fort McMurray #468 First Nation

A review of Fort McMurray #468's (FM468's) TLU study (FM468 2006) indicates that while the majority of their traditional activities occur south of the RSA, traditional harvesting may take place in other locations in the portion of their traditional territory that overlaps the RSA. Therefore, an analysis of the 2013 PDC effects to preferred harvesting areas will include qualitative information regarding traditional land use (e.g., preferred fishing and trapping areas) and quantifiable disturbance affecting the portion of FM468's traditional territory that overlaps the RSA (for preferred hunting and plant harvesting areas). The amount of disturbance for the 2013 PDC for that portion of the FM468 traditional territory that overlaps the RSA is shown in Table 3.5-9.

Table 3.5-9 Disturbance Within the Fort McMurray #468 First Nation Traditional Territory that Overlaps the Regional Study Area – 2013 PRM Application Case to 2013 Planned Development Case

First Nation Traditional Territories	Traditional Territory Area Within RSA [ha]	2013 PRM Application Case Disturbance Area[(a)]		2013 Planned Development Case Disturbance Area		Change		Percentage Increase [%]
		[ha]	% area	[ha]	% area	[ha]	% area	
FM468	1,570,098	290,707	19	381,059	24	90,352	6	31

(a) Application Case includes all existing and approved projects plus PRM.

At 2013 PDC, disturbance affecting the areas of overlap between the FM468 traditional territory and the RSA are predicted to be 24% (381,059 ha), an increase of 6% (90,352 ha) over 2013 PRM Application Case conditions.

In addition to the opportunities to undertake traditional plant and berry harvesting, effects to traditional harvesting also consider the added impacts of odour, noise and visual effects. For example, within the RSA, the effects of odour, noise and visual disturbances are expected to have the effect of increasing the radius of the impacts to areas used for traditional harvesting. These 2013 PDC effects are not expected to affect access to the FM468 reserves or traditional harvesting south of the RSA. Although the Human Health Risk Assessment did not determine any adverse impacts to human health for the 2013 PDC, concerns related to environmental contamination held by members of Aboriginal communities in combination with other socio-economic factors described above can affect the ability to undertake traditional land use activities and to exercise Treaty and Aboriginal rights. These other effects on traditional activities may further affect the culture and quality of life of the FM468. Although it is not possible to determine the degree to which individual traditional land users may be affected by these additional impacts, the impacts have been reported by Aboriginal groups and are considered to occur under the 2013 PDC.

3.5.1.6.1 Traditional Hunting Opportunities (Fort McMurray #468 First Nation)

The effects of the 2013 PDC on traditional hunting opportunities consider the effects to large game, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.6.1.1 Effects to Large Game (Fort McMurray #468 First Nation)

Wildlife considered as Key Indicator Resources (KIRs) for large game hunting are moose, black bear, and wood bison. The residual impact classification for effects on wildlife in the RSA at 2013 PDC (before Closure) was reported in Section 3.4.3.1. The effects to moose abundance and movement was predicted to be negative in direction and low in magnitude, and negative in direction and moderate in magnitude for moose habitat (including fragmentation). The effects on black bear abundance, habitat (including fragmentation) and movement were all assessed as negative in direction and in low magnitude. Wood bison abundance and movement were assessed as negative in direction and low in magnitude, and negative in direction and moderate in magnitude for habitat.

3.5.1.6.1.2 Effects to Preferred Hunting Areas (Fort McMurray #468 First Nation)

Within the RSA, large game hunting areas noted by FM468 members are concentrated in the southern portion of the RSA, around Fort McMurray, the Steepbank River and the Clearwater River. The FM468 members have reported harvesting activities from the Clearwater watershed downstream along the Athabasca River corridor, including within the vicinity of the LSA (Labour et al. 2012). Hunting locations were also recorded at Namur Lake and Gardiner Lakes, McClelland Lake, and along the Athabasca, MacKay and Firebag rivers (FM468 2006). Bird harvesting occurs between Kearl and McClelland lakes, and adjacent to the LSA along the Athabasca River (Labour et al. 2012).

A review of FM468's TLU study (FM468 2006) also suggested that traditional hunting may take place in other locations in the portion of their traditional territory that overlaps the RSA, therefore preferred hunting areas are considered to be the overlapping area of the FM468 traditional territory and the RSA. The amount of 2013 PDC disturbance to the portion of FM468 traditional territory that overlaps the RSA is 24% (Table 3.5-8).

At 2013 PDC, developments are expected to overlap large game hunting sites around Fort McMurray, including some portions of the Clearwater River. The 2013 PDC will also overlap large game hunting sites along the Steepbank, MacKay, and Athabasca rivers, and south of Namur Lake. No 2013 PDC developments are expected within the vicinity of the Firebag River.

3.5.1.6.1.3 Effects on Access to Preferred Hunting Areas (Fort McMurray #468 First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions on movements and barrier or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

Preferred FM468 hunting areas are found throughout the RSA, the Clearwater and Steepbank rivers, the Athabasca River, the Namur Lake region, and northeast of Fort McKay. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that members of FM468 will travel to Fort McKay to use this trail network if using areas north of Fort McKay, or may access these trails in the area of Fort McMurray or Clearwater IR 175. The 2013 PDC developments are also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the greater majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay and in the general area between Fort McKay and Fort McMurray.

At 2013 PDC, overland trails connecting areas northeast of Fort McKay are adversely impacted although access to areas north of McClelland Lake continue to be available from areas along the Athabasca River. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. Interruption of trails connecting Fort McMurray and Fort McKay to the Steepbank River is expected. Access to the Clearwater River from Fort McMurray should not be impacted.

At 2013 PDC trails connecting the Athabasca River to areas northwest of PRM will be disturbed. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is also expected, although alternative trails and upgraded access continues to be available. Trails accessing areas south of Fort McKay on both the east and west sides of the Athabasca River are also disrupted. Fort McMurray #468 members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in “frustration and real obstacles” in the access of traditional land use areas (Labour et al. 2012).

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.6.1.4 Effects Classification for Traditional Hunting (Fort McMurray #468 First Nation)

The effects classification to traditional hunting for the Fort McMurray #468 First Nation considers the effects to traditional hunting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

Regarding the effects to traditional hunting opportunities, the wildlife assessment measured the effects to TLU hunting KIRs (moose, black bear and wood bison) as ranging from low to moderate for abundance, habitat and movement. The FM468 preferred harvesting areas within the RSA are considered to be the area of the FM468 traditional territory that overlaps the RSA, although the literature reviewed did indicate that the majority of FM468 harvesting occurs south of the RSA. At 2013 PDC, 24% of the FM468 traditional territory within the RSA is expected to be disturbed. This effect is considered adverse in direction and high in magnitude. Access limitations to the trail network radiating from Fort McKay is predicted to substantially interfere with people’s access to preferred hunting areas in the RSA and is therefore assessed as an adverse high magnitude effect. As a result of the above factors, the effects to traditional hunting opportunities in the RSA for FM468 members are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude effects on traditional hunting opportunities in the RSA, the residual effects to FM468 traditional hunting in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.6.2 Traditional Trapping Opportunities (Fort McMurray #468 First Nation)

The effects of the 2013 PDC on traditional trapping opportunities consider the effects to furbearers, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.6.2.1 Effects to Furbearer Abundance (Fort McMurray #468 First Nation)

Furbearers considered to be Key Indicator Resources (KIRs) for traditional trapping include beaver, fisher and Canada lynx. These resources were assessed in the residual impact classification for effects on wildlife in the RSA for the 2013 PDC in Section 3.4.3.1. The effects to beaver were assessed as negative in direction and low in magnitude for abundance, habitat and movement. The effects to fisher and Canada lynx were assessed as negative in direction and moderate in magnitude for abundance and habitat, and negative in direction and low in magnitude for movement.

3.5.1.6.2.2 Effects to Preferred Trapping Areas (Fort McMurray #468 First Nation)

A review of FM468 (2006) indicates that the majority of FM468 traditional furbearer harvesting locations are located south of the RSA, and within the RSA there is a concentration of harvesting locations east of the Athabasca River between Fort McKay and the Clearwater River. Although there is no available information on the location of RFMAs in the RSA that are registered to members of FM468, review of information in FM468 (2006) and the known location of RFMAs registered to members of the FMFN (FMFN 1994) strongly suggests that RFMAs in the RSA that are registered to FM468 members are located east of Fort McMurray, and between the Clearwater River and the southern boundaries of RFMA #s1582, 2925 and 2926.

The 2013 PDC developments in this general area are located in the immediate area surrounding Fort McMurray. There may be an overlap of 2013 PDC development in the area east and south of Fort McMurray with RFMAs in or partially overlapping the RSA held by members of FM468.

3.5.1.6.2.3 Effects to Access of Preferred Trapping Areas (Fort McMurray #468 First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions on movements and barrier or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

This assessment assumes that access to RFMAs in the RSA held by members of FM468 is via existing trails or roads from Fort McMurray, the Clearwater River and via existing access from Clearwater IR175.

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.6.2.4 Effects Classification for Traditional Trapping (Fort McMurray #468 First Nation)

The effects classification to traditional trapping for the Fort McMurray #468 First Nation considers the effects to traditional trapping opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

Regarding the effects to traditional trapping opportunities, the wildlife assessment (Section 3.4.3.1) measured the effects to furbearers (beaver, fisher and Canada lynx). The effects to beaver were assessed as negative in direction and low in magnitude for abundance, habitat and movement. The effects to fisher and Canada lynx were assessed as negative in direction and moderate in magnitude for abundance and habitat, and negative in direction and low in magnitude for movement.

The assessment assumes that RFMAs in the RSA held by members of FM468 are located east of Fort McMurray and south of RFMAs #s 1582, 2925 and 2926, in the general area south of the Steepbank River. A review of the location of 2013 PDC developments in this portion of the RSA indicates that 2013 PDC disturbance to FM468-held RFMAs in the RSA will be negative in direction and low in magnitude. The 2013 PDC disturbances may also cause an adverse effect on access to RFMAs in the RSA, but the effect is not expected to have a material effect. As a result, the effect of the 2013 PDC on access to FM468 traplines in the RSA is considered low.

As a result of the low to moderate effects on furbearer abundance and habitat, the effects of the 2013 PDC on traditional trapping opportunities for members of the FM468 in the RSA are considered negative in direction and low to moderate in magnitude.

As a result of the low to moderate magnitude effects on traditional trapping opportunities and the added effects of odour, noise, visual and socio-economic factors, the effects to FM468 trapping in the RSA at 2013 PDC are assessed as negative in direction, moderate to high in magnitude and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.6.3 Traditional Fishing Opportunities (Fort McMurray #468 First Nation)

The effects of the 2013 PDC on traditional fishing opportunities consider the effects to fish, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.6.3.1 Effects to Fish Abundance and Fish Habitat (Fort McMurray #468 First Nation)

The effects of PRM on fish habitat and fish abundance were assessed in the EIA, Volume 4, Section 6.7.6. Within the boundary of the LSA, fish habitat within Eymundson Creek and Pierre River was considered to be lost due to the diversion of these watercourses to diversion channels during operations of the PRM. Once mitigation and habitat compensation associated with the PRM was accounted for, the residual impacts to fish habitat and fish abundance in 2013 PRM Application Case were classified as having no environmental consequence. In the 2013 PRM Application Case, effects to fish habitat that may result from changes in Athabasca River flow or water level, as a result of PRM, are predicted to be negligible.

The 2013 PDC assessment of effects considers the Water Management Framework for the Lower Athabasca River (AENV and DFO 2007). The Framework was developed to manage cumulative withdrawals from the

Athabasca River and protect the aquatic ecosystem, while allowing industry to operate, which would include the planned projects in the 2013 PDC. Because the Framework is adaptive, it will be informed by ongoing scientific study, and modified as necessary to maintain protection of the river. Accordingly, no cumulative effects to fish habitat, beyond those outlined in the Framework, would be expected from changes to stream flow in the Athabasca River in the 2013 PDC. Once mitigation and compensation are taken into account for valid linkages, all residual effects on fish and fish habitat were negligible and considered to have no environmental consequence.

3.5.1.6.3.2 Effects to Preferred Fishing Areas (Fort McMurray #468 First Nation)

The majority of fishing sites identified in FM468 (2006) are located south of the RSA. Within the RSA, fishing locations were identified at Namur Lake and Gardiner Lakes, and along the Athabasca, Steepbank and Clearwater rivers. Available information suggests that other locations north of Fort McMurray and further east of the Athabasca River are also traditional fishing locations (FM468 2006). At 2013 PDC, developments are located along the Athabasca, the downstream portions of the Steepbank and Clearwater rivers, and south of Namur Lake.

3.5.1.6.3.3 Effects on Access to Preferred Fishing Areas (Fort McMurray #468 First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions on movements and barrier or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

Preferred FM468 fishing areas within the RSA include the Clearwater and Steepbank rivers, the Athabasca River, and the Namur Lake region. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that FM468 members will travel to Fort McKay to use this trail network when accessing areas north of Fort McKay. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. Therefore, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails at their point of origin and resulting in access limitations to undisturbed portions of the trail as well. Access to the Clearwater River from Fort McMurray should not be impacted and access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay.

A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is also expected, although alternative trails and upgraded access continues to be available. Fort McMurray #468 members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in “frustration and real obstacles” in the access of traditional land use areas (Labour et al. 2012).

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.6.3.4 Effects Classification for Traditional Fishing (Fort McMurray #468 First Nation)

The effects classification to traditional fishing for the FM468 considers the effects traditional fishing opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

Regarding the effects to traditional fishing opportunities, residual effects to fish and fish habitat at 2013 PDC were assessed as negligible after mitigation and compensation was applied. The 2013 PDC is not expected to affect the Namur Lake and Gardiner Lakes or the Athabasca, Clearwater and Steepbank rivers. The 2013 PDC developments are expected to affect traditional trails leading from the Fort McMurray Fort McKay area to the Namur Lake and Gardiner Lakes region. As a result, the 2013 PDC may substantially interfere with FM468 access to those areas for fishing.

As a result of the above, the effects of the 2013 PDC on FM468 fishing opportunities in the RSA are considered negative in direction and high in magnitude.

Therefore, the effects to FM468 traditional fishing in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude, regional in extent and long term in duration because they are expected to occur for longer than one generation. They are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.6.4 Traditional Plant and Berry Harvesting Opportunities (Fort McMurray #468 First Nation)

The effects of the 2013 PDC on traditional plant and berry harvesting opportunities consider the effects to traditional plants, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.6.4.1 Effects to Traditional Plants (Fort McMurray #468 First Nation)

The effects to traditional use plant potential at 2013 PDC were not assessed within the vegetation assessment due to the negligible environmental consequence determination at 2013 PRM Application Case.

3.5.1.6.4.2 Effects to Preferred Plant and Berry Harvesting Areas (Fort McMurray #468 First Nation)

The majority of berry and medicinal plant harvesting sites identified in FM468 (2006) are found south of the RSA. Within the RSA, FM468 members identified berry picking locations around the hamlet of Fort McKay and ranging southeast from Fort McKay beyond the Clearwater River (FM468 2006). Areas of medicinal plant and berry collection sites include large areas around the Steepbank River, Fort McMurray and the western area of the RSA, south of Namur Lake (FM#468 2006).

The 2013 PDC developments will be within the berry picking locations east of the Athabasca River. These same developments also fall within a medicinal plant gathering area overlapping the Steepbank River. The 2013 PDC developments will overlap berry and medicinal plant gathering areas in the area around Fort McMurray and may overlap the identified medicinal plant areas south of Namur Lake.

3.5.1.6.4.3 Effects to Access of Preferred Plant and Berry Harvesting Areas (Fort McMurray #468 First Nation)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions due to barriers or access controls. The loss of land due to disturbance has been described in the preceding section.

Preferred FM468 plant and berry harvesting areas are found southeast of Fort McKay. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and several trails originating from points along the Athabasca that would be used to access areas east between Fort McKay and Fort McMurray. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. Therefore, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay, thereby interrupting the use of trails close to their point of origin and resulting in access limitations to undisturbed portions of the trail as well. For example, at 2013 PDC development several developments are located east of the Athabasca River effectively interrupting trails used to access the Steepbank River area close to their point of origin. Trails originating in Fort McMurray used to access this same area of the Steepbank River are similarly impacted. Access to the Clearwater River from Fort McMurray should not be impacted and access between Fort McMurray and Fort McKay is facilitated by Highway 63.

Fort McMurray #468 members have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in “frustration and real obstacles” in the access of traditional land use areas (Labour et al. 2012).

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.6.4.4 Effects Classification for Traditional Plant and Berry Harvesting (Fort McMurray #468 First Nation)

The effects classification to traditional plant and berry harvesting for the FM468 considers the effects traditional plant and berry harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

The effects to traditional use plant potential were at 2013 PDC were not assessed within the vegetation assessment due to the negligible environmental consequence determination at 2013 PRM Application Case.

For purposes of this assessment, the FM468 preferred harvesting areas within the RSA are considered to be the area of the FM486 traditional territory that overlaps the RSA. At 2013 PDC, 24% of the FM468 traditional territory within the RSA is expected to be disturbed. This effect is considered adverse in direction and high in magnitude. Access limitations to the trail network radiating from Fort McKay for individuals living in

Fort McMurray is predicted to substantially interfere with people's access to preferred harvesting areas and is therefore assessed as an adverse high magnitude effect within the RSA. As a result of the above factors, the effects to traditional plant and berry harvesting opportunities for FM468 members are assessed as adverse in direction and high in magnitude.

As a result the effects to FM468 traditional plant and berry harvesting in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.7 Fort Chipewyan Métis Local #125

The Fort Chipewyan Métis Local #125 traditional territory, mapped in Synenco (2006, Figure 4.4-5), is located east of the Athabasca River and overlaps the northeast portion of the RSA. Further information regarding TLU activities within the RSA by Fort Chipewyan #125 members was provided in Fort Chipewyan Métis (2012) and Labour and Hermansen (2010).

In addition to the opportunities to undertake traditional hunting, effects to traditional hunting also consider the added impacts of odour, noise and visual effects. For example, within the RSA, the effects of odour, noise and visual disturbances are expected to have the effect of increasing the radius of the impacts to areas used for traditional harvesting. These effects are not expected to affect traditional harvesting north of the RSA in the larger Fort Chipewyan area, and will affect the individuals harvesting in the RSA. Although the Human Health Risk Assessment did not determine any adverse impacts to human health for the 2013 PDC, concerns related to environmental contamination held by members of Aboriginal communities in combination with other socio-economic factors described above can affect the participation in traditional land use activities and the exercise Treaty and Aboriginal rights. These other effects on traditional activities may further affect the culture and quality of life of Fort Chipewyan Métis Local #125. Although it is not possible to determine the degree to which individual traditional land users may be affected by these additional impacts, the impacts have been reported by Aboriginal groups and are considered to occur under the 2013 PDC.

3.5.1.7.1 Traditional Hunting Opportunities (Fort Chipewyan Métis Local #125)

The effects of the 2013 PDC on traditional hunting opportunities consider the effects to large game, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.7.1.1 Effects to Large Game (Fort Chipewyan Métis Local #125)

Wildlife considered as Key Indicator Resources (KIRs) for large game hunting are moose, black bear, and wood bison. The residual impact classification for effects on wildlife in the RSA at 2013 PDC (before Closure) were reported in Section 3.4.3.1. Effects to moose abundance and movement was predicted to be negative in direction and low in magnitude, and negative in direction and moderate in magnitude for moose habitat (including fragmentation). Effects to black bear abundance, habitat (including fragmentation) and movement were all assessed as negative in direction and low in magnitude. Effects to wood bison abundance and movement were assessed as negative in direction and low in magnitude, and negative in direction and moderate in magnitude for habitat.

3.5.1.7.1.2 Effects to Preferred Hunting Areas (Fort Chipewyan Métis Local #125)

The majority of large game and bird harvesting by Fort Chipewyan Métis #125 members occurs north of the RSA (Fort Chipewyan Métis 2006). Within the RSA, harvesting of moose and bison has been noted on RFMA #1275, just north of Kelly Lake. Moose, bear and waterfowl are also harvested along the Athabasca River adjacent to the LSA (Fort Chipewyan Métis 2012; Labour and Hermansen 2010). Additionally, the area just north of McClelland Lake has been identified for caribou harvesting (Fort Chipewyan Métis 2006) and the Firebag River was noted as a good area for moose hunting (Synenco 2006).

The 2013 PDC developments will affect the area north of Kelly Lake, and are also generally located along the Athabasca River within the RSA. Areas north of McClelland Lake, including the Firebag River are not expected to be disturbed at 2013 PDC. The portion of the Fort Chipewyan Métis Local #125 traditional territory that overlaps the RSA is not disturbed under the 2013 PDC.

3.5.1.7.1.3 Effects to Access of Preferred Hunting Areas (Fort Chipewyan Métis Local #125)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails or water access, restrictions on movements and barriers or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

Fort Chipewyan Métis #125 hunting areas were identified north of the LSA, north of McClelland Lake and along the Firebag River. The literature reviewed did not indicate where the majority of Fort Chipewyan Métis members resided, therefore access is considered for land users accessing the RSA from the north and from Fort McKay, considered to be the main access point for those individuals residing in Fort McMurray and communities further south.

For those land users who may access the harvesting areas from Fort McKay or areas south, an overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of Fort McKay. Therefore, the majority of disturbance to traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails near their point of origin and resulting in limitations on access to the undisturbed portions of the trails as well.

At 2013 PDC, overland trails connecting areas northeast of Fort McKay including the Firebag River are adversely impacted. Access to the Firebag River continues to be available from areas along the Athabasca River and is not considered impacted for those land users travelling from communities north of the RSA. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River. At 2013 PDC trails connecting the Athabasca River to areas northwest of PRM will be disturbed although only minimal impacts are expected for land users travelling from to this area from north of the RSA.

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. For example, concerns have been raised by Fort Chipewyan Métis #125 land users that existing low water levels on the Athabasca are already affecting their ability to use this watercourse as an effective access route (Synenco 2006).Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The PDC is not expected to affect water levels in the Peace-Athabasca Delta.

3.5.1.7.1.4 Effects Classification for Traditional Hunting (Fort Chipewyan Métis Local #125)

The effects classification to traditional hunting for the Fort Chipewyan Métis Local #125 considers the effects to traditional hunting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

The large majority of traditional hunting by members of Fort Chipewyan Métis Local #125 occurs north of the RSA in the region around Fort Chipewyan. Hunting within the RSA appears to mostly be undertaken by individuals associated with RFMA #1275 and other individuals who may use McClelland Lake and portions of the Firebag River. Under the 2013 PDC, 70% of RFMA #1275 will be disturbed, and this is expected to have a large effect on individuals hunting in that area. The Métis trapper on RFMA #1275 indicated that during the time she spent on the trapline, she did not observe other community members using her trapline (AER 2013, Volume 4, p. 629). Therefore, hunting activities on RFMA #1275 are assumed to be those of the RFMA holders. The 2013 PDC is also expected to have a detrimental effect on access to the McClelland Lake area and Firebag River from Fort McMurray. As a result, the effects on traditional hunting opportunities within the RSA are considered negative in direction and high in magnitude, but will be limited to the individuals using these areas.

As a result of the high magnitude effects to traditional hunting opportunities in the RSA, the effects to Fort Chipewyan Métis Local #125 traditional hunting in the RSA under the 2013 PDC are considered high in magnitude and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally. The effects are limited to individuals using the RFMA.

3.5.1.7.2 Traditional Trapping Opportunities (Fort Chipewyan Métis Local #125)

The effects of the 2013 PDC on traditional trapping opportunities consider the effects to furbearers, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.7.2.1 Effects to Furbearer Abundance (Fort Chipewyan Métis Local #125)

Furbearers considered to be Key Indicator Resources (KIRs) for traditional trapping include beaver, fisher and Canada lynx. These resources were assessed in the residual impact classification for effects on wildlife in the RSA for the 2013 PDC in Section 3.4.3.1. Beaver were assessed as potentially experiencing negative direction low magnitude effects for abundance, habitat and movement. Fisher and Canada lynx were assessed as potentially undergoing negative direction moderate magnitude effects for abundance and habitat, and negative direction low magnitude effects for movement.

3.5.1.7.2.2 Effects to Preferred Trapping Areas (Fort Chipewyan Métis Local #125)

Within the RSA, Fort Chipewyan Métis (2012) indicates five RFMAs held by Métis trappers. Of these, RFMA #s 1275 and 2400 are considered to be trapped by members of Fort Chipewyan Métis Local #125. The other three traplines identified as Métis RFMAs are held by Fort McKay community members and have been considered as part of the Fort McKay community assessment.

The amount of disturbance on RFMA #1275 as a result of the 2013 PDC represents 70% of the area of the RFMA (Table 3.5-10).

Table 3.5-10 Disturbance Affecting Registered Fur Management Area #1275 – 2013 PRM Application Case to 2013 Planned Development Case

RFMA [#]	Total Area [ha][(a)]	2013 PRM Application Case Total Disturbance Area[(b)]		2013 Planned Development Case Total Disturbance Area		Change		Percentage Increase [%]
		[ha]	% of RFMA	[ha]	% of RFMA	[ha]	% of RFMA	
1275	55,403	12,097	22	38,710	70	26,612	48	220

(a) Includes both LSA and RSA components of the RFMA.

(b) Application Case includes all existing and approved projects plus PRM.

Registered Fur Management Area #2932 partially overlaps the northern boundary of the RSA and there is no disturbance to it under the 2013 PDC.

3.5.1.7.2.3 Effects on Access to Preferred Trapping Areas (Fort Chipewyan Métis Local #125)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails or water access, restrictions on movements and barriers or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

The holder of RFMA #1275 indicated that in the summer, he accesses his trapline by boat along the Athabasca River from Fort McMurray. Winter access is via a combination of upgraded roads and snowmobile trails. Under the 2013 PDC, there will be additional disturbance to trails going from Fort McKay to the area of RFMA #1275.

Access to RFMA #2932 from the Fort Chipewyan area will not be affected under the 2013 PDC. Regarding access to the RFMA from the Fort McMurray area, additional disturbances to traditional trails under the PDC may affect land access to the RFMA. Access to the RFMA from the Athabasca River may also be slightly affected by additional 2013 PDC disturbance.

For those land users who may access these preferred areas from Fort McKay or south, an overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the great majority of disturbance to traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails at their point of origination and resulting in limitations to the use of undisturbed portions of the trails as well.

At 2013 PDC, trails connecting the Athabasca River to areas northwest of the PRM will be disturbed although only minimal impacts are expected for land users travelling from to this area from north of the RSA.

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The PDC is not expected to affect water levels in the Peace-Athabasca Delta.

3.5.1.7.2.4 Effects Classification for Traditional Trapping (Fort Chipewyan Métis Local #125)

The effects classification on traditional trapping for the Fort Chipewyan Métis Local #125 considers the effects traditional trapping opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

Regarding the effects to traditional trapping opportunities, the wildlife assessment measured the effects to TLU trapping KIRs (beaver, fisher and Canada lynx) as ranging from low to moderate for abundance, habitat and movement. Under the 2013 PDC, 70% of RFMA #1275 will be disturbed. There will be no disturbance to RFMA #2932 under the 2013 PDC, although there may be some detrimental effects on access to the RFMA from Fort McMurray.

As a result of the moderate effects on trapping KIRs, disturbances to the RFMAs and detrimental access to RFMA #2932, the effects of the 2013 PDC on trapping opportunities in the RSA are assessed as negative in direction, and high in magnitude for RFMA #1275 and moderate in magnitude for RFMA #2932. The effects are limited to the trappers of the respective traplines and do not extend to trapping opportunities north of the RSA.

Therefore, the effects to Fort Chipewyan Métis Local #125 traditional trapping in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally. The effects are limited to the individuals using RFMA #s 1275 and 2932 and do not extend to trapping north of the RSA.

3.5.1.7.3 Traditional Fishing Opportunities (Fort Chipewyan Métis Local #125)

The effects of the 2013 PDC on traditional fishing opportunities consider the effects to fish, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.7.3.1 Effects to Fish Abundance and Fish Habitat (Fort Chipewyan Métis Local #125)

The effects of PRM on fish habitat and fish abundance were assessed in the EIA, Volume 4, Section 6.7.6. Within the boundary of the LSA, fish habitat within Eymundson Creek and Pierre River was considered to be lost due to the diversion of these watercourses to diversion channels during operations of the PRM. Once mitigation and habitat compensation was accounted for, the residual impacts to fish habitat and fish abundance in 2013 PRM Application Case were classified as having no environmental consequence. In the 2013 PRM Application Case, effects to fish habitat that may result from changes in Athabasca River flow or water level, as a result of PRM, are predicted to be negligible.

The 2013 PDC assessment of effects considers the Water Management Framework for the Lower Athabasca River (AENV and DFO 2007). The Framework was developed to manage cumulative withdrawals from the Athabasca River and protect the aquatic ecosystem, while allowing industry to operate, which would include the planned projects in the 2013 PDC. Because the Framework is adaptive, it will be informed by ongoing scientific study, and modified as necessary to maintain protection of the river. Accordingly, no cumulative effects to fish habitat, beyond those outlined in the Framework, would be expected from changes to stream flow in the Athabasca River in the 2013 PDC. Once mitigation and compensation are taken into account for valid linkages, all residual effects on fish and fish habitat were negligible and considered to have no environmental consequence.

3.5.1.7.3.2 Effects to Preferred Fishing Areas (Fort Chipewyan Métis Local #125)

Within the RSA, fishing was reported to occur along the Athabasca River as families travelled to Fort McMurray to shop and trade (Labour and Hermansen 2010).

3.5.1.7.3.3 Effects to Access of Preferred Fishing Areas (Fort Chipewyan Métis Local #125)

Within the RSA, the Athabasca River was the only preferred fishing area identified by Fort Chipewyan Métis #125.

Concerns have been raised by Fort Chipewyan Métis #125 land users that existing low water levels on the Athabasca are already affecting their ability to use this watercourse as an effective access route (Synenco 2006). Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. The PDC is not expected to affect water levels in the Peace-Athabasca Delta.

3.5.1.7.3.4 Effects Classification for Traditional Fishing (Fort Chipewyan Métis Local #125)

The effects classification on traditional fishing for the Fort Chipewyan Métis Local #125 considers the effects traditional fishing opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to human health, and individual or community responses to observed environmental effects.

Regarding the effects to traditional fishing opportunities, residual effects to fish and fish habitat at 2013 PDC were assessed as negligible after mitigation and compensation was applied. The large majority of traditional fishing by members of Fort Chipewyan Métis Local #125 occurs north of the RSA in the larger area around Fort Chipewyan. Available information indicated that fishing within the RSA occurs in the Athabasca River as people travel between Fort Chipewyan and areas south, such as Fort McMurray. The 2013 PDC is not expected to affect fishing areas within the RSA or north of the RSA. Under the 2013 PDC, water access along the Athabasca River is not expected to be affected. Therefore, the 2013 PDC is not expected to have an effect on traditional fishing opportunities in the RSA by members of Fort Chipewyan Métis Local #125.

As a result of the above and considering the added effects of noise, visual, odour and social factors, the effects to Fort Chipewyan Métis Local #125 traditional fishing in the RSA at 2013 PDC are assessed as negative in direction low in magnitude and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.7.4 Traditional Plant and Berry Harvesting Opportunities (Fort Chipewyan Métis Local #125)

The effects of the 2013 PDC on traditional plant and berry harvesting opportunities consider the effects to traditional plants, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.7.4.1 Effects to Traditional Plants and Berries (Fort Chipewyan Métis Local #125)

The effects to traditional use plant potential were at 2013 PDC were not assessed within the vegetation assessment due to the negligible environmental consequence determination at 2013 PRM Application Case.

3.5.1.7.4.2 Effects to Preferred Plant and Berry Harvesting Areas (Fort Chipewyan Métis Local #125)

Within the RSA, plant and berry collection sites are recorded near the Athabasca River (Fort Chipewyan Métis 2012; Labour and Hermansen 2010). Bear Island has been noted for its bearberry habitat and Sled Island, traditionally, was used to collect material for building dog sleds. Both of these locations are located on the Athabasca River adjacent to RFMA #1275 (Labour and Hermansen 2010). Kelly Lake, situated on RFMA #1275 was noted as an area for fall berry picking (Labour and Hermansen 2010). The Firebag River and McClelland Lake were also noted as areas where medicinal plants and berries are located and gathered (Fort Chipewyan Métis 2012; Labour and Hermansen 2010). Medicinal plant gathering has been recorded on RFMA #1275 at Big Lake and on the east edge of the Athabasca River adjacent to the LSA (Labour and Hermansen 2010).

The 2013 PDC is expected to disturb plant and berry harvesting areas located on RFMA #1275. Harvesting areas located on Bear and Sled islands are not expected to be affected under the 2013 PDC. Harvesting areas identified along the east shore of the Athabasca River, across from RFMA #1275 may have a small overlap with 2013 PDC disturbances. Identified harvesting areas in the area around McClelland Lake and along the Firebag River will not be affected by the 2013 PDC.

3.5.1.7.4.3 Effects on Access to Preferred Plant and Berry Harvesting Areas (Fort Chipewyan Métis Local #125)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails or water access, restrictions on movements and barriers or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

Preferred Fort Chipewyan Métis #125 plant and berry harvesting areas are considered to be located along the Athabasca River, north of the LSA, and northeast of Fort McKay including McClelland Lake and the Firebag River.

Under the 2013 PDC, land access from Fort Chipewyan to the harvesting areas along the Firebag River or around McClelland Lake will not be affected. At 2013 PDC, overland trails connecting to areas northeast of Fort McKay, including McClelland Lake and the Firebag River, are adversely impacted. This will adversely affect Chipewyan Métis #125 members who access these areas from Fort McMurray.

Concerns have been raised by Fort Chipewyan Métis #125 land users that existing low water levels on the Athabasca are already affecting their ability to use this watercourse as an effective access route (Synenco 2006). Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths. Therefore, river access to plant harvesting areas along the Athabasca River not expected to be affected under the 2013 PDC. The PDC is not expected to affect water levels in the Peace-Athabasca Delta.

3.5.1.7.4.4 Effects Classification for Traditional Plant and Berry Harvesting (Fort Chipewyan Métis Local #125)

The effects classification to traditional plant and berry harvesting in the RSA for the Fort Chipewyan Métis #125 considers the effects on traditional plant and berry harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, human health, and individual or community responses to observed environmental effects.

The effects to traditional use plant potential at the 2013 PDC were not assessed within the vegetation assessment due to the negligible environmental consequence determination at 2013 PRM Application Case.

The available information indicates that the large majority of Fort Chipewyan Métis Local #125 traditional plant harvesting occurs north of the RSA in the larger area around Fort Chipewyan. Within the RSA, plant harvesting locations on RFMA #1275 are expected to have large impacts as a result of 2013 PDC disturbances that will result in 70% of the RFMA being disturbed. The Métis trapper on RFMA #1275 indicated that during the time she spent on the trapline, she did not observe other community members using her trapline (AER 2013, Volume 4, p. 629). Therefore, plant harvesting activities on RFMA #1275 are assumed to be those of the RFMA holders. Other smaller disturbances will occur to plant harvesting areas along the east side of the Athabasca River. While access to the Firebag River and McClelland Lake for Fort Chipewyan Métis Local #125 members travelling from Fort Chipewyan will not be affected, access may be discernibly affected for members travelling to those areas from Fort McMurray. As a result of the large disturbances to RFMA #1275, the effects to traditional plant harvesting opportunities within the RSA are considered negative in direction and high in magnitude. The effects are limited to the users of RFMA #1275 and individuals who use the McClelland Lake and Firebag River area.

As a result of the high impacts to traditional plant harvesting opportunities within the RSA, the effects to Fort Chipewyan Métis Local #125 traditional plant and berry harvesting in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.8 Fort McMurray Métis Local #1935

Information regarding the preferred harvesting areas of the Fort McMurray Métis Local #1935 (Fort McMurray Métis) was gathered from the *Mark of the Métis* (Fort McMurray Métis Local #1935 2012). The TLU information presented in the document is an aggregate of information from Métis of various groups in Northeastern Alberta. Therefore, while it presents an overview of the types and general locations of traditional activities within the RSA, it does not provide enough detail to differentiate the activities of Fort McMurray Métis from other groups that are located outside the RSA. For the purpose of this assessment, it is assumed that the activities identified within the RSA are representative of Fort McMurray Métis activities within the RSA. In addition to the opportunities to undertake traditional harvesting, effects to traditional harvesting also consider the added impacts of odour, noise and visual effects.

Although the Human Health Risk Assessment did not determine any adverse impacts to human health for the 2013 PDC, concerns related to environmental contamination held by members of Aboriginal communities in combination with other socio-economic factors described above can affect the participation in traditional land use activities and the exercise of Treaty and Aboriginal rights. These other effects on traditional activities may further affect the culture and quality of life of the Fort McMurray Métis. Although it is not possible to determine the degree to which individual traditional land users may be affected by these additional impacts, the impacts have been reported by Aboriginal groups and are considered to occur under the 2013 PDC.

3.5.1.8.1 Traditional Hunting Opportunities (Fort McMurray Métis Local #1935)

The effects of the 2013 PDC on traditional hunting opportunities consider the effects to large game, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.8.1.1 Effects to Wildlife Abundance (Fort McMurray Métis Local #1935)

Wildlife considered as Key Indicator Resources (KIRs) for large game hunting are moose, black bear, and wood bison. The residual impact classification for effects on wildlife in the RSA at 2013 PDC (before Closure) were reported in Section 3.4.3.1. The effects to moose abundance and movement was predicted to be negative in direction and low in magnitude, and negative in direction and moderate in magnitude for moose habitat (including fragmentation). Effects to black bear abundance, habitat (including fragmentation) and movement were all assessed as negative direction in direction and low in magnitude effects. The effects to wood bison abundance and movement were assessed as negative in direction and low magnitude, and negative in direction and moderate in magnitude for habitat.

3.5.1.8.1.2 Effects to Preferred Hunting Areas (Fort McMurray Métis Local #1935)

Harvesting of moose and bison was identified between the Namur Lake and Gardiner Lakes region to the western edge of the Athabasca River, and moose hunting was reported east of the Athabasca River (Fort McMurray Métis Local 1935 #2012). Deer are harvested in the vicinity of Namur Lake, and large game and bird harvesting occurs south of Fort McKay on both sides of the Athabasca River (Fort McMurray Métis Local #1935 2012).

At 2013 PDC moose harvesting areas east of the Athabasca River and south of McClelland Lake will be directly impacted. Large game harvesting locations on both sides of the Athabasca River south of Fort McKay will be similarly impacted.

3.5.1.8.1.3 Effects on Access to Preferred Hunting Areas (Fort McMurray Métis Local #1935)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions on movements, and barrier or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

Preferred Fort McMurray Métis hunting areas are located in the Namur Lake region, and west to the Athabasca River, along the Athabasca River, to the east of the Athabasca River south of McClelland Lake, and surrounding Fort McMurray north to Fort McKay. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that land users located in Fort McMurray will travel to Fort McKay to use this trail network if using areas north of Fort McKay. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails at their point of origin and resulting in limitations to the use of undisturbed portions of the trail as well.

At 2013 PDC, overland trails connecting areas northeast of Fort McKay are adversely impacted although access to areas north of McClelland Lake continue to be available from areas along the Athabasca River and along the Canterra Road. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. Interruption of trails connecting Fort McMurray and Fort McKay to the Steepbank River is expected. Access to the Clearwater River from Fort McMurray should not be impacted.

At 2013 PDC trails connecting the bison hunting locations west of the PRM to the Athabasca River will be disturbed. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is also expected, although alternative trails and upgraded access continues to be available. Trails accessing areas south of Fort McKay on both the east and west sides of the Athabasca River are also disrupted. Members of Aboriginal communities have noted that even where access has been preserved or upgraded through development areas, the installation of gates and access controls has adversely affected travel through these areas (Candler et al. 2012b; Fort McKay IRC 2010) and it is assumed that Fort McMurray Métis would experience the same.

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca River. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.8.1.4 Effects Classification for Traditional Hunting (Fort McMurray Métis Local #1935)

The effects classification on traditional hunting for Fort McMurray Métis considers the effects traditional hunting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

Regarding the effects to traditional hunting opportunities, the wildlife assessment measured the effects to TLU hunting KIRs (moose, black bear and wood bison) as ranging from low to moderate for abundance, habitat and movement. No spatially defined traditional territory has been indicated by the Fort McMurray Métis Local #1935 to represent their preferred harvesting areas other than point specific information. Therefore, the assessment of disturbance to preferred harvesting areas for Fort McMurray Métis Local #1935 relies on qualitative information and professional judgement. Areas identified as hunting regions include the Namur Lake region east to the Athabasca River which is expected to be impacted at 2013 PDC, as are other identified areas east of the Athabasca and south of Fort McKay. Therefore, effects to preferred harvesting areas are considered to be adverse in direction and moderate-high at 2013 PDC. Access limitations to the trail network radiating from Fort McKay likely used by individuals living in Fort McMurray is predicted to substantially interfere with people's access to preferred hunting areas and is therefore assessed as an adverse high magnitude effect within the RSA. As a result of the above factors, the effects to traditional hunting opportunities within the RSA for Fort McMurray Métis are assessed as adverse in direction and high in magnitude.

As a result, the effects to traditional hunting in the RSA at 2013 PDC for Fort McMurray Métis #1935 are assessed as negative in direction, high in magnitude, and long term in duration because they are expected to occur for longer than one generation, and thereby irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.8.2 Traditional Trapping Opportunities (Fort McMurray Métis Local #1935)

The effects of the 2013 PDC on trapping opportunities consider the effects to furbearers, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.8.2.1 Effects to Furbearer Abundance (Fort McMurray Métis Local #1935)

Furbearers considered to be Key Indicator Resources (KIRs) for traditional trapping include beaver, fisher and Canada lynx. These resources were assessed in the residual impact classification for effects on wildlife in the RSA for the 2013 PDC in Section 3.4.3.1. The effects to beaver were assessed as negative direction in direction and low in magnitude for abundance, habitat and movement. The effects to fisher and Canada lynx were assessed negative in direction and moderate in magnitude for abundance and habitat, and negative in direction and low in magnitude for movement.

3.5.1.8.2.2 Effects to Preferred Trapping Areas (Fort McMurray Métis Local #1935)

The available information does not identify RFMAs in the RSA that are held by Fort McMurray Métis, nor the locations of traditional trapping resources within the RSA.

3.5.1.8.2.3 Effects to Access of Preferred Trapping Areas (Fort McMurray Métis Local #1935)

Because the available information does not provide information on traditional trapping within the RSA by Fort McMurray Métis, it is not possible to determine the effects on access to trapping areas within the RSA.

3.5.1.8.2.4 Effects Classification for Traditional Trapping (Fort McMurray Métis Local #1935)

Due to the lack of information on trapping in the RSA by Fort McMurray Métis Local #1935, it is not possible to undertake an effects classification on this activity.

3.5.1.8.3 Traditional Fishing Opportunities (Fort McMurray Métis Local #1935)

The effects of the 2013 PDC on traditional fishing opportunities consider the effects to fish, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.8.3.1 Effects to Fish Abundance and Fish Habitat (Fort McMurray Métis Local #1935)

The effects of PRM on fish habitat and fish abundance were assessed in the EIA, Volume 4, Section 6.7.6. Within the boundary of the LSA, fish habitat within Eymundson Creek and Pierre River was considered to be lost due to the diversion of these watercourses to diversion channels during operations of the PRM. Once mitigation and habitat compensation associated with the PRM was accounted for, the residual impacts to fish habitat and fish abundance in 2013 PRM Application Case were classified as having no environmental consequence. In the 2013 PRM Application Case, effects to fish habitat that may result from changes in Athabasca River flow or water level, as a result of PRM, are predicted to be negligible.

The 2013 PDC assessment of effects considers the Water Management Framework for the Lower Athabasca River (AENV and DFO 2007). The Framework was developed to manage cumulative withdrawals from the

Athabasca River and protect the aquatic ecosystem, while allowing industry to operate, which would include the planned projects in the 2013 PDC. Because the Framework is adaptive, it will be informed by ongoing scientific study, and modified as necessary to maintain protection of the river. Accordingly, no cumulative effects to fish habitat, beyond those outlined in the Framework, would be expected from changes to stream flow in the Athabasca River in the 2013 PDC. Once mitigation and compensation are taken into account for valid linkages, all residual effects on fish and fish habitat were negligible and considered to have no environmental consequence.

3.5.1.8.3.2 Effects to Preferred Fishing Areas (Fort McMurray Métis Local #1935)

Within the RSA, fishing sites were reported along the Athabasca River, Firebag River, Ells River, Steepbank River, Clearwater River and in the Namur Lake and Gardiner Lakes region (Fort McMurray Métis Local #1935 2012).

Under 2013 PDC, developments are along portions of the Athabasca River within the RSA, the Namur Lake region, and the Ells River under 2013 Base Case conditions. The 2013 PDC developments are also located alongside the downstream portions of the Steepbank and Clearwater rivers. The Firebag River is expected to remain relatively undisturbed at 2013 PDC.

3.5.1.8.3.3 Effects on Access to Preferred Fishing Areas (Fort McMurray Métis Local #1935)

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails due to barriers or access restrictions. The loss of land due to disturbance has been described in the preceding section.

Fort McMurray Métis Local #1935 fishing areas within the RSA include the Clearwater, Ells, Firebag, Steepbank and the Athabasca rivers, and the Namur Lake region. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that land users located in Fort McMurray will travel to Fort McKay to use this trail network when accessing areas north of Fort McKay. The 2013 PDC developments are also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails nearby their point of origin and resulting in limitations to the use of undisturbed portions of the trail as well. For example, 2013 PDC developments are located east of the Athabasca River effectively interrupting trails used to access the Steepbank River area close to their point of origin. Trails originating in Fort McMurray used to access this same area of the Steepbank River are similarly impacted. Access to the Clearwater River from Fort McMurray should not be impacted, and access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay.

A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is also expected, although alternative trails and upgraded access continues to be available. Aboriginal groups have noted that even where access has been preserved or upgraded through development areas, access can still be restricted (Labour et al. 2012). It is assumed that Fort McMurray Métis would have similar experiences. At 2013 PDC, overland trails connecting areas northeast of Fort McKay are adversely impacted although access continues to be available north of McClelland Lake from areas along the Athabasca River. In winter, road access connects Fort McKay with Fort Chipewyan and provides access to trails north of McClelland Lake and along the Firebag River.

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca River. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.8.3.4 Effects Classification for Traditional Fishing (Fort McMurray Métis Local #1935)

The effects classification on traditional fishing for the Fort McMurray Métis considers the effects to traditional fishing opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

Regarding the effects to traditional fishing opportunities, residual effects to fish and fish habitat at 2013 PDC were assessed as negligible after mitigation and compensation was applied. Fort McMurray Métis fishing areas within the RSA include the Clearwater, Ells, Firebag, Steepbank and the Athabasca rivers, and the Namur Lake region. There are 2013 PDC developments along portions of the Athabasca River within the RSA, in the Namur Lake region, and along portions of the Ells River. There are 2013 PDC developments also located alongside the downstream portion of the Steepbank River. The Firebag River is expected to remain undisturbed at 2013 PDC. Therefore, effects to preferred fishing areas are assessed as adverse in direction and moderate-high in magnitude. Although access to the Clearwater River from Fort McMurray is not expected to be affected under the 2013 PDC, access limitations to the trail network radiating from Fort McKay likely used by individuals living in Fort McMurray is predicted to substantially interfere with people's access to preferred areas in the Namur Lake region and along the Firebag River. As a result of the moderate to high effects to preferred fishing areas and the effects on access, the effects to traditional fishing opportunities in the RSA for Fort McMurray Métis Local #1935 are assessed as adverse in direction and high in magnitude.

Therefore, the effects to Fort McMurray Métis Local #1935 traditional fishing in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.8.4 Traditional Plant and Berry Harvesting Opportunities (Fort McMurray Métis Local #1935)

The effects of the 2013 PDC on traditional plant and berry harvesting opportunities consider the effects to traditional plants, effects to preferred harvesting areas within the RSA and effects on access to the preferred areas.

3.5.1.8.4.1 Effects to Traditional Plants and Berries (Fort McMurray Métis Local #1935)

The effects to traditional use plant potential at 2013 PDC were not assessed within the vegetation assessment due to the negligible environmental consequence determination at 2013 PRM Application Case.

3.5.1.8.4.2 *Effects to Preferred Plant and Berry Harvesting Areas (Fort McMurray Métis Local #1935)*

Within the RSA, plant and berry collection sites are recorded near the Athabasca River throughout the RSA and surrounding the Hamlet of Fort McKay (Fort McMurray Métis Local #1935 2012). The Firebag River and McClelland Lake were also noted as areas where medicinal plants and berries are located and gathered (Fort McMurray Métis Local #1935 2012). The Namur Lake and Gardiner Lakes region also has been noted as an area for the collection of hazelnut, fiddlehead, fern and berry harvesting (Fort McMurray Métis Local #1935 2012).

At 2013 PDC, planned or existing developments are expected or already existing along portions of the Athabasca River within the RSA. Planned developments are located south of Namur Lake. No developments are planned or existing within the immediate vicinity of McClelland Lake, although existing and planned developments are located within the surrounding area.

3.5.1.8.4.3 *Effects on Access to Preferred Plant and Berry Harvesting Areas (Fort McMurray Métis Local #1935)*

Effects to access include both loss of land due to disturbance and the loss of access to areas due to loss of trails, restrictions on movements and barrier or bans on entry to areas. The loss of land due to disturbance has been described in the preceding section.

Within the RSA, preferred Fort McMurray Métis Local #1935 plant and berry harvesting area were identified along the Athabasca River, Firebag River, McClelland Lake, around Fort McKay and in the Namur Lake region. An overview of traditional trails within the RSA shows a dense network of trails radiating outward from Fort McKay and it is assumed that traditional land users living in Fort McMurray will generally travel north to access this trail network for many of their traditional activities. The 2013 PDC development is also concentrated along the Athabasca River and particularly to the north, east and south of the Fort McKay. As a result, the majority of disturbance to Fort McKay traditional trails occurs near the community of Fort McKay thereby interrupting the use of trails close to their point of origin and resulting in limitations to the use of undisturbed portions of the trail as well. For preferred use areas surrounding the hamlet of Fort McKay, access to areas is limited more by direct disturbance than loss of trails.

At 2013 PDC, overland trails connecting areas northeast of Fort McKay including the Firebag River and McClelland Lake are adversely impacted, although access continues to be available from areas along the Athabasca River. A reduction in the number of traditional trails between Fort McKay and the Namur Lake and Gardiner Lakes region is also expected, although alternative trails and upgraded access continues to be available. Additionally, a minimal reduction in the number of trails between the Namur Lake and Gardiner Lakes region and reserves north of the RSA is expected. Access between Fort McMurray and Fort McKay is facilitated by Highway 63, as is some access north of Fort McKay. Aboriginal groups have noted that even where access has been preserved or upgraded through development areas, the installation of gates, restrictions, check-ins and escorts results in impediments to the access of traditional land use areas.

The Athabasca River provides important water access during the summer. Concerns have been raised by Aboriginal land users regarding the access limitations that existing low water levels have on travel on the Athabasca River. Water flows were assessed in the Hydrology Assessment (Section 3.3.2.1) and the prediction for reductions in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions in the Athabasca River due to planned developments are less than 2 cm of the mean seasonal flow depths.

3.5.1.8.4.4 Effects Classification for Traditional Plant and Berry Harvesting (Fort McMurray Métis Local #1935)

The effects classification to traditional plant and berry harvesting for the Fort McMurray Métis Local #1935 considers the effects on traditional plant and berry harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

The effects to traditional use plant potential at 2013 PDC were not assessed within the vegetation assessment due to the negligible environmental consequence determination at 2013 PRM Application Case. Within the RSA, plant and berry collection sites are recorded near the Athabasca River throughout the RSA and surrounding the hamlet of Fort McKay (Fort McMurray Métis Local #1935 2012). The Firebag River and McClelland Lake were also noted as areas where medicinal plants and berries are located and gathered (Fort McMurray Métis Local #1935 2012). The Namur Lake and Gardiner Lakes region has also been noted as an area for the collection of hazelnut, fiddlehead, fern and berry harvesting (Fort McMurray Métis Local #1935 2012).

At 2013 PDC, developments are found along portions of the Athabasca River, south of Namur Lake and in the vicinity of McClelland Lake. The 2013 PDC developments are also located close to three sides of Fort McKay. Therefore, effects to preferred plant and berry harvesting area are considered adverse in direction and moderate to high in magnitude. Access limitations to the trail network radiating from Fort McKay likely used by individuals living in Fort McMurray is predicted to substantially interfere with people's access to preferred harvesting areas in the Namur Lake, McClelland Lake and Firebag River area, and is therefore assessed as an adverse high magnitude effect within the RSA. As a result of the above factors, the effects to traditional plant harvesting opportunities in the RSA for Fort McMurray Métis are assessed as adverse in direction and high in magnitude.

As a result, the effects to traditional plant and berry harvesting in the RSA at 2013 PDC are assessed as negative in direction, high in magnitude, and long term in duration because they are expected to occur for longer than one generation. The effects are considered irreversible, because the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

3.5.1.9 Summary of Results

The effects to traditional harvesting activities under the 2013 PDC were determined for each of the potentially affected Aboriginal groups (Table 3.5-11). The effects of the 2013 PDC were determined separately for hunting, trapping, fishing, and plant and berry harvesting opportunities. Harvesting opportunities were considered to be a combination of the availability of each underlying resource (e.g., wildlife, fish) and access to the resource. The assessment also considered the effects on traditional harvesting activities from odour, noise, visual effects, human health effects and socio-economic effects.

Table 3.5-11 Summary of 2013 PDC Regional Study Area Effects Classification by Aboriginal Group and TLU Activity Type

TLU Activity Type	Effects Classification[a]	Comments
Fort McKay First Nation		
Traditional Hunting	High	-
Traditional Trapping	High	-
Traditional Fishing	High	-
Traditional Plant and Berry Harvesting	High	-
Mikisew Cree First Nation		
Traditional Hunting	High	-
Traditional Trapping	Moderate to High	Limited to the trappers of RFMA #2892
Traditional Fishing	High	For MCFN members living in Fort McMurray or south
	Moderate	For MCFN members living in Fort Chipewyan
Traditional Plant and Berry Harvesting	High	-
Athabasca Chipewyan First Nation		
Traditional Hunting	High	-
Traditional Trapping	High	Limited to trappers of RFMA #1714
Traditional Fishing	High	-
Traditional Plant and Berry Harvesting	High	-
Fort McMurray #468 First Nation		
Traditional Hunting	High	-
Traditional Trapping	Moderate to High	-
Traditional Fishing	High	-
Traditional Plant and Berry Harvesting	High	-
Fort Chipewyan Métis Local #125		
Traditional Hunting	High	-
Traditional Trapping	High	Limited to trappers using RFMA #s 1275 and 2932
Traditional Fishing	Low	-
Traditional Plant and Berry Harvesting	High	-
Fort McMurray Métis Local #1935		
Traditional Hunting	High	-
Traditional Trapping	n/a	Unable to classify due to lack of information
Traditional Fishing	High	-
Traditional Plant and Berry Harvesting	High	-

(a) All effects classifications were assessed as negative in direction, regional in extent, long term in duration and irreversible, therefore only the magnitude has been provided within the table.

- = No comment.

3.5.2 Socio-Economic Assessment

3.5.2.1 Introduction

This section presents the population and community effects on the Study Area under the 2013 Base Case, 2013 PRM Application Case and 2013 PDC assumptions. Study area selection is discussed in the EIA, Volume 5, Section 8.7.1. Determination of the project inclusion list for the 2013 assessment scenarios is discussed in Appendix 3.1 of this submission.

3.5.2.2 Approach

Population Effects

2013 Base Case and 2013 Planned Development Case

The 2013 Base Case and 2013 PDC population projections presented below are derived from results generated by the RMWB Population and Employment Projection Model. The model, developed by the RMWB in 2009, was intended to be a single population forecasting tool that could be used for planning purposes by the RMWB and other agencies and stakeholders. The RMWB model forecasts population for urban and rural residents and for non-residents who reside primarily in project accommodation (i.e., work camps). Some aspects of the RMWB population model include the following:

- it forecasts employment growth in oil sands and related industries based on specified bitumen production forecasts and a listing of anticipated oil sands projects that captures construction and operating employment;
- it assumes net migration into the region to be equal to the number of new jobs created minus the natural growth of the resident labour force;
- it delineates population projections by permanent, non-permanent and project accommodations (rural) to account for the particularity of the population in the region; and
- it uses the standard component method (i.e., accounting for births, deaths, and migration) to project and age the permanent population.

The RMWB model output presents low, medium and high scenarios. The most recent RMWB model forecast available is a high scenario developed within the context of the Municipal Development Plan (MDP) in 2011 (RMWB 2011a). Among the more significant assumptions underlying this forecast are the following:

- no or limited camps near Fort McMurray; and
- a bitumen production forecast for the region of over seven million barrels per day (bpd) by 2030.

These two assumptions are open to considerable uncertainty. Current and planned industry activity and practices deviate from these assumptions. Specifically:

- While the RMWB model forecasts that the camp population in the region will hold relatively stable in the range of 25,000 over the forecast period (2012 to 2030), more recent population counts from the 2012 municipal census indicate that the regional camp population is nearly 40,000.
- A review of publicly available bitumen forecasts for the region (Table 3.5-12) suggests that the production level implied in the RMWB model population estimates is outside the range of forecasts by other organizations. The RMWB model estimates also do not reflect changes to the industry's growth outlook since 2011, including a move away from the development of upgraders in the region.

Table 3.5-12 Bitumen Production Forecasts in the Regional Municipality of Wood Buffalo

Source (Year)	2020	2030
	[Million bpd]	
RMWB MDP (2011)	5.6	6.9
AOSA CRISP (2011)[a]	3.2	5.0
ERCB (May 2013)[a]	2.7	n/a
CAPP (June 2013)[a]	2.6	4.5

[a] AOSA CRISP, ERCB, and CAPP Forecasts adjusted for RMWB boundaries by Nichols Applied Management Inc.

n/a = Not available.

Providing stakeholders with a way to run custom scenarios (e.g., in support of regulatory applications) using the RMWB Population Model has been discussed. As of October 2013, this discussion is still ongoing.

The 2013 Base Case and 2013 PDC population projections presented below for Fort McMurray are derived from the MDP forecast, the most recent forecast available, but adjusted based on the following:

- a 2013 PDC production curve that is below the forecast used for the RMWB MDP, more comparable to the AOSA CRISP forecast;
- recent 2012 Municipal Census results which indicate a lower actual count of residents than the forecasted estimate; and
- current industry practices and plans for project accommodations near Fort McMurray.

2013 PRM Application Case

The 2013 PRM Application Case population projections rely on Project construction and operations workforce estimates. The workforce estimates presented to the regulator in the 2009 EIA Update have been reviewed in light of changes to project execution and more current thinking regarding workforce requirements for oil sands mines. Based on this review, the workforce estimates provided in 2009 are still considered reasonable estimates, recognizing that estimates are open to considerable uncertainty (e.g., workforce availability, worker productivity, future technological advances).

Given that the underlying project workforce estimates remain the same, the EIA Application Case population projections provided to the regulator in 2009 also remain the same.

Community Effects

Population growth is the primary driver of community effects in the region. As such, Section 3.5.2.4, along with Attachment B, discusses the effect of the 2013 PDC population estimates on the community in the region.

Along with updated population estimates, this update of community effects is informed by:

- key respondent interviews and analysis of historical performance to gauge the capacity of education, health and other systems to respond to anticipated future demands;
- Shell's ongoing consultation in the region;
- analysis of recent Socio-Economic Impact Assessments (SEIAs) for other oil sands projects; and

- responses by the Alberta Energy Resources Conservation Board (now the Alberta Energy Regulator [AER]), other stakeholders, and interveners, to recent oil sands SEIAs in the course of the regulatory review process, including public hearings.

3.5.2.3 Population Effects

2013 Base Case and 2013 Planned Development Case Population Projections

The 2013 Base Case and 2013 PDC population projections for Fort McMurray are shown in Table 3.5-13. These projections are derived from the RMWB MDP forecast, the most recent forecast available from the RMWB Population and Employment Projection Model (Section 3.5.2.2).

Table 3.5-13 Urban Population Projection Comparisons (2013 Base Case and 2013 Planned Development Case)

Assessment Case	2012	2015	2018	2021	2024	2027	2030
2013 Base Case	76,009[(a)]	81,800	84,895	86,670	89,745	97,425	105,515
2013 Planned Development Case	76,009[(a)]	88,155	94,635	98,350	104,805	120,905	137,870

(a) RMWB 2012 Municipal Census number for Fort McMurray (RMWB 2012a).

Under 2013 PDC assumptions, the population of Fort McMurray is expected to reach nearly 137,870 in 2030, approximately 32,355 above the 2013 Base Case. The population under 2013 PDC assumptions is anticipated to vary by period in response to oil sands project activity. Specifically, the population of Fort McMurray is expected to:

- grow at an average annual rate of 5.1% between 2012 and 2015;
- slow to an annual average growth rate of 1.8% between 2016 and 2024; and
- accelerate to an annual average growth rate of 4.7% between 2024 and 2030.

Population projections are open to considerable uncertainty and, therefore, should be treated as estimates only and not as certain outcomes. Variables that could alter regional population growth include:

- changes in the timing and size of individual oil sands projects considered in the assessment;
- additional projects being brought forward that are currently not included in the assessment, especially in later years of the forecast period;
- future technological advances in oil sands construction and operation that affect a project's employment-related needs and, therefore, its population effect;
- the speed with which residential and infrastructure development occurs in the region;
- possible environmental thresholds that might serve to limit future oil sands development; and
- the impact of planning initiatives, such as the AOSA CRISP or Lower Athabasca Regional Plan (LARP), on future development (Government of Alberta 2011, 2012).

2013 PRM Application Case Population Projections

The PRM is expected to lead to an urban service area population that is about 4.5% higher than the 2013 Base Case in 2021 and 2024. After 2024, when construction is complete and PRM has reached full operations hiring, the long-term population impact of PRM is expected to be about 1% above the 2013 Base Case. Much of PRM's population impact will be mitigated by the following:

- PRM`s remote location;
- use of a camp-based model for housing workers during both construction and operations; and
- use of a fly-in/fly-out strategy of transporting workers in and out of the region.

3.5.2.4 Community Effects

Community effects will largely follow population effects. The 2013 PDC population projections provided in Section 3.5.2.3 are lower than those provided in the EIA. As such, community effects under 2013 PDC assumptions, in comparison to community effects provided in the EIA, will also be lower during the 2013 to 2021 period, providing the regulator with a more conservative forecast in the EIA.[1] With respect to the longer-term forecast (beyond 2021), infrastructure and service providers have additional time and resources to plan and act in addressing growth and associated socio-economic effects on the community.

Infrastructure and service providers in the region are in a better position to deal with increased growth than outlined in the filed SEIA, largely as a result of the following:

- **Additional funding that has been provided:** Resourcing challenges faced by regional service providers has been well documented over the years through several government and industry-sponsored reports (Nichols 2006; Radke 2006; RIWG 2005). In response, government funding has increased in recent years to address growth pressures in the region. For example, since 2007 the Government of Alberta has committed $2.25 billion to infrastructure and services in the Wood Buffalo region. According to RMWB representatives, about half of those funds have been spent as of late 2012 (CEAA 2012). For its part, the RMWB has also invested in major infrastructure developments, including RCMP detachment buildings and regional fire halls.
- **New agencies and structures that have been put in place, and new planning initiatives that have been carried out:** In response to the challenges posed by growth in the region, several short- and long-term planning initiatives have been carried out by the provincial and municipal governments. Specifically, in 2007 the provincial government established the Oil Sands Sustainable Development Secretariat to coordinate and improve planning, communications and service delivery to Alberta's oil sands regions, including the Wood Buffalo region. Among the Secretariat's initiatives are *Responsible Actions: A Plan for Alberta's Oil Sands* (Government of Alberta 2009) and the Athabasca Oil Sands Area Comprehensive Regional Infrastructure Sustainability Plan (CRISP) process (Government of Alberta 2011). Municipal representatives have raised some concerns about the content of and planned process for implementing CRISP (e.g., funding, ownership) (CEAA 2012). For its part, the municipality has also been

[1] Population projections beyond 2021 were not provided in the EIA filed in 2007.

carrying out planning initiatives to accommodate future demands for infrastructure and services, including the 2011 MDP.

- **Service providers being afforded additional time to plan and act:** The global financial crisis of 2008/2009 led to a period of relatively moderate growth in the region, giving service providers additional time to plan and act. As of 2012, service delivery outcomes have improved in several social infrastructure areas, including health and emergency services (e.g., reduced emergency department wait times, targeted emergency response times being met). The municipality's Chief Financial Officer has also noted that the 2008/09 recession and resultant slowdown in population growth provided the municipality with an opportunity to "aggressively rebuild and realign functions, processes and infrastructure to respond to future demands" (RMWB 2012b).

Although infrastructure and service providers in the region are in a better position to address growth than in 2007, they continue to face several issues, including:

- the demands of non-permanent residents, which have grown over the past decade;
- social stressors in the region, including social isolation, reduced community cohesion, increased homelessness and traffic;
- difficulty in attracting and retaining appropriately skilled workers as a result of relatively high housing costs and the region's remote location;
- the need for additional infrastructure (e.g., schools, health facilities); and
- the need for stable, predictable funding that also recognizes the particular challenges of service delivery in the region (e.g., rural, remote location).

Along with these challenges that are faced by the majority of infrastructure and service providers in the region, the municipality has highlighted a number of specific, priority concerns regarding their ability to plan for and accommodate future growth. Specifically:

- **The availability of developable land:** Development of land in the municipality has been complicated by topography (i.e., land suitable for development) and the fact that much of the region is comprised of Crown land/green zone which is held by the Government of Alberta. In the urban service area, new development is underway in both the Parsons Creek and Saline Creek communities, although somewhat hampered by transportation challenges (i.e., adequate road networks linking these new areas to the rest of Fort McMurray). Outside the urban service area, the provincial government announced in July 2013 the creation of the Urban Development Sub-region (UDSR), approximately 22,386 hectares (ha) of provincial land surrounding Fort McMurray where future urban development is the primary intended land use. The intention of the UDSR is to facilitate land use planning, timely release of land for urban development and efficient infrastructure planning and construction to accommodate population growth and urban expansion. (Government of Alberta 2013a,b).
- **The need for an improved transportation network:** Sizeable investments have been made in recent years to improve the regional transportation network, including: development of the Thickwood and Confederation Way interchanges; the five-lane Athabasca bridge; and various other twinning projects and upgrades to Highway 63. However, concerns remain as to whether planning and investment in the

transportation network can keep pace with growth in the urban service area (e.g., new transportation networks to access residential communities) and growth in industry-related traffic (e.g., development of an eastern by-pass route). Regional residents continue to also have serious concerns about traffic safety along Highway 63 and past delays in highway twinning.

The RMWB has initiated the Regional Structure Action Strategy (RSAS) process to facilitate and coordinate the implementation of various planning initiatives at both the provincial and municipal levels. The RSAS includes a task force that includes municipal, provincial and industry representatives and is expected to develop its action strategy by the end of 2013.

An overview of current socio-economic issues, along with responses from both government and industry to these issues, can be found in Appendix 2, Attachment B.

3.5.2.5 Summary

The socio-economic assessment in the SEIA offers the Joint Review Panel a more conservative forecast of population and subsequent community effects in the 2013 to 2021 period. Over the longer term (beyond 2021), strong growth is forecasted under 2013 PDC assumptions, but below that forecasted in the RMWB's MDP.

Responsible authorities are in a better position to deal with this potential future growth than in previous years as a result of increased revenue from property taxes (as a result of industrial growth), new funding initiatives, and policy and planning mechanisms put in place by government and industry. These initiatives have helped alleviate some socio-economic pressures and enhance the quality of life for local residents. An overview of current socio-economic issues, along with responses from both government and industry to these issues, can be found in Appendix 2, Attachment B.

The outcome of ongoing or contemplated planning exercises may also substantially alter effects in the region. However, concerns have been raised about the pace of implementation for some of these initiatives. Avoiding future socio-economic pressures will depend upon current planning initiatives being properly resourced, carried out in a timely manner, and flexible enough to respond and adapt to the dynamic socio-economic environment in the Wood Buffalo region.

3.6 2013 Planned Development Case Summary

Appendix 2, Section 3 presents the updated PDC assessment requested in JRP SIR 8. The revised assessment, referred to as the 2013 PDC, concluded that environmental effects for Air Quality, Environmental Health and Aquatic Resources are generally the same as the EIA PDC while effects on Terrestrial Resources and the Human Environment components have generally increased under the 2013 PDC.

The following sections provide conclusions by component for the 2013 PDC.

Air Quality

For the 2013 PDC, NO_2, $PM_{2.5}$, H_2S, benzene and acrolein were assessed because other air quality parameters were predicted to be negligible in the 2013 PRM Application Case. The regional annual NO_2 predictions were above the AAAQO outside developed areas; however, the predicted annual NO_2 concentrations in the communities were below the AAAQO. The H_2S predictions at the regional communities remain below the AAAQOs. The 24-hour $PM_{2.5}$ predictions were above the AAAQO at some communities. The 2013 PDC predicted 1-hour and annual benzene exceedances at Fort McMurray, and annual acrolein exceedances at Fort

McMurray and the Oil Sands Lodge. The benzene and acrolein predictions at all other communities were within applicable AAAQOs and other applicable criteria. The exceedances at Fort McMurray are primarily due to the estimated increase in emissions from future population growth in Fort McMurray. Of the 10 ambient air quality parameters assessed for the 2013 PDC, four are rated as having a low environmental consequence, two are rated as moderate, and four are rated as having a high environmental consequence.

Environmental Health

Overall, the changes between the 2013 Base Case and 2013 PDC risks are generally small. Cumulative environmental risks associated with the additional projects and activities planned for the region are not expected to result in adverse health effects. Based on the re-analysis, the 2013 PDC does not alter the assessment results or the conclusions originally presented in the HHRA of the EIA.

The results of the 2013 WHRA indicate that the overall risks posed to wildlife health will be low. Therefore, no impacts to wildlife populations are expected based on estimated wildlife exposures to predicted maximum acute and chronic air concentrations or predicted soil and surface water concentrations. These conclusions are consistent with those presented in the EIA WHRA.

Since the 2013 PRM Application Case assessment of air emissions effects on ecological receptors resulted in negligible environmental consequences, a classification of 2013 PDC effects was not completed.

Hydrogeology

The results of the 2013 PDC show that the effects of dewatering and depressurization from the portion of the proposed Teck Frontier Mine that is immediately adjacent to PRM will overlap with the effects from PRM. This dewatering and depressurization will lead to a 17% reduction in surface water outflows within the LSA as compared to the 2007 PDC. Minimal additional effects on groundwater discharge rates (5% reduction) are expected for the Athabasca River reaches between Nodes A1 and A3 from planned developments. This result is consistent with the limited additional drawdown predicted in the Basal Aquifer in the immediate vicinity of the Athabasca River.

Hydrology

The planned development activities within the LSA will result in decreased flows to Athabasca River from tributary creeks. The decreases in flows are due to closed-circuit operations during mine operation and due to increased evaporation from pit lakes in the Far Future.

The total annual net water requirement from the Athabasca River for the regional developments excluding the oil sands projects is 188.7 million m^3 (5.98 m^3/s). The total projected annual net water allocations to existing, approved and planned oil sands mining projects are about 611 million m^3. This represents about 76% of the total annual net water allocation of 799 million m^3 (25.4 m^3/s) in the Athabasca River basin.

Effects of the 2013 PDC on the Athabasca River flows and water levels were quantified for Reach 4 and Node S24, respectively. The total peak water withdrawal for the 2013 PDC is about 34.6 m^3/s, compared to 27.1 m^3/s for the 2013 PRM Application Case.

The predicted reduction in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions due to planned developments in the Athabasca River are less than 2 cm of the mean seasonal flow depths.

Water Quality

Water quality was assessed for the LSA and the Athabasca River under the 2013 PDC. Increases in constituent concentrations in LSA watercourses were predicted due to the Teck Frontier Mine, which is the only other planned project in the LSA. Negligible changes were predicted to pit lakes or to the Athabasca River under the 2013 PDC.

Terrestrial Resources

Soils and Terrain

The 2013 PDC assessment shows an increase in planned development disturbances. After reclamation, there will be a net increase of mineral soils (172,805 ha or 17% of Resource) at Closure, compared to the 2013 Base Case. A net loss of 28,080 ha (3% of the resource) of organic soils is predicted after reclamation based on the conceptualized landscape. The environmental consequence rating for permanent loss of organic soils for the 2013 PDC in the RSA is increased from low to moderate compared to the EIA.

Terrestrial Vegetation, Wetlands and Forest Resources

The 2013 PDC assessed effects to the following KIRs that were assessed to have negative and greater than negligible environmental consequences predicted in the LSA for the 2013 PRM Application Case at Closure: wetlands (including peatlands and patterned fens), old growth forests and high rare plant potential.

During construction and operations in the 2013 PDC, negative and low environmental consequence were predicted for wetlands (including peatlands and patterned fens) and old growth forests. A negative and moderate environmental consequence is predicted for high rare plant potential due to the loss of non-treed wetlands.

The results of the 2013 PDC assessment indicate that there has been no change to environmental consequence rankings from the EIA PDC at Far Future for wetlands (including peatlands and patterned fens) and old growth forest. The environmental consequence ranking at Far Future for wetlands (including peatlands and patterned fens) and old growth forest remained negative and low as in the EIA PDC (Volume 5, Section 7.6). The high rare plant potential environmental consequence ranking at Far Future is positive and low, and is the same as the EIA (Volume 5, Section 7.6).

Wildlife and Wildlife Habitat

The effects of PRM and other planned developments on wildlife abundance, habitat and movement were previously assessed in the EIA and the Species at Risk Assessment (*May 2011, Submission of Information to the Joint Review Panel,* Appendix 2).

Impacts affecting the abundance of Eskimo curlew and northern leopard frog are not predicted because these species have not been recorded in the RSA. Woodland caribou are declining to extirpation in the RSA with or without additional industrial developments and the combined effects of displaced alternate prey populations during construction and increased forage for moose and deer in vegetated clearings as well as in young reclaimed habitats are likely to result in increased alternate prey and wolf population densities in the absence of management intervention. Therefore, the cumulative effects of development in the RSA due to the 2013 PDC on woodland caribou may result in a high magnitude effect on abundance.

Where sufficient information is not available to assess the effects of landscape change on wildlife abundance, the results of habitat modelling (Appendix 3.7, Section 1) predictions regarding effects to high suitability habitat are used as a proxy, under the conservative assumption that abundance is directly related to the availability of habitat. However, as many wildlife KIRs are not likely to be directly limited by habitat in the RSA, this conservative assumption is likely to result in overestimations of actual effects to abundance. Of the wildlife KIRs that may be sensitive to the availability of habitat in the RSA (Section 4.2.3.1.1), habitat suitability modelling results suggest declines in abundance from the 2013 Base Case to the 2013 PDC that are high in environmental consequence for Canada warbler, rusty blackbird and yellow rail; moderate for Canada lynx, fisher, black-throated green warbler; and low for barred owl, beaver, black bear, Canadian toad, moose, common nighthawk, horned grebe, olive-sided flycatcher, short-eared owl and wolverine (Appendix 3.7, Section 1).

The combined effects of interactions with infrastructure and vehicle collisions are likely to have a negligible magnitude effect on the abundance of peregrine falcon, red knot and whooping crane, which seasonally migrate through the RSA.

Little brown myotis and northern myotis abundance is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, these species are opportunistic in their selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across their range. Effects to abundance may be assessed qualitatively by taking into consideration the small risks of mortality due to development in the RSA, which are predicted to be of negligible environmental consequence in the 2013 PDC.

The abundance of wood bison may be limited by disease, and potentially unregulated hunting. The combined effects of incidental sources of mortality associated with changes in the RSA between the 2013 Base Case and the 2013 PDC are predicted to result in a low magnitude effect on wood bison abundance.

Although western toad population declines in the RSA appear to be due to disease rather than habitat loss, soil disturbance in the RSA in the 2013 PDC may result in a negligible magnitude effect on western toad abundance.

Biodiversity

The 2013 PDC assessment predicted an overall negative low environmental consequence in the RSA for all levels of biodiversity during construction and operations and in the Far Future. This result is the same as what was predicted in the EIA PDC assessment (EIA, Volume 5, Section 7.6, Table 7.6-11).

Traditional Knowledge and Land Use

Under the 2013 PDC, disturbances to the combined moderate and intense use portions of the Fort McKay CSEs will represent 16% of the Large Game Harvesting CSE, 24% of the Bird Harvesting CSE, 12% of the Furbearer Harvesting CSE, 24% of the Fish Harvesting CSE and 40% of the Traditional Plant (Berry) Harvesting CSE. Under the 2013 PDC, disturbances are calculated to represent 24% of the area of MCFN's traditional territory within the RSA, 10% of the area of ACFN's Homeland Zone within the RSA, 35% of the area of ACFN's Proximate Zone within the RSA and 24% of the area of FM468's traditional territory within the RSA.

The results of the assessment indicate that the 2013 PDC has significant effects on traditional harvesting in the RSA for the Community of Fort McKay, MCFN, ACFN, FM468 and Fort McMurray Métis. The effects of the 2013 PDC are assessed as not significant for Fort Chipewyan Métis Local #125.

4.0 2013 PRM APPLICATION CASE TO PRE-INDUSTRIAL CASE ASSESSMENT

This section responds to JRP SIR 8, parts a(ii) and a(iii) specifically as they relate to the comparison of the 2013 PRM Application Case to the PIC.

The 2013 PRM Application Case includes the effects of PRM in combination with the effects from existing and approved industrial projects and activities associated with land use and infrastructure as of June 2012 when the JRP TOR were issued. A comparison of the 2013 PRM Application Case to the PIC includes an assessment of all existing and approved developments in the RSA, along with municipal developments and forest harvesting. The list of projects considered in the 2013 PRM Application Case is shown in Appendix 3.1, Section 2.4 of this submission. Forest fire and harvest information in the 2013 PRM Application Case was simulated with the ALCES® model, as described in Appendix 3.1, Section 2.8.

The following components were assessed based on availability of PIC and 2013 PRM Application Case data:

- air quality;
- surface water quality and aquatic health;
- soils and terrain;
- terrestrial vegetation, wetlands and forest resources;
- wildlife and wildlife habitat;
- biodiversity; and
- traditional land use.

4.1 Air Quality Assessment

4.1.1 Assessment Results

The air quality assessment for the PIC focused on SO_2, NO_2 and $PM_{2.5}$. The estimated PIC concentrations for these compounds at Fort McKay as well as the estimated natural background concentrations are provided in Section 2.2. Due to the lack of air quality information for the PIC, it was assumed that other compounds including CO, TRS compounds, VOCs, PAHs and trace metals were quite low, near zero concentrations, in the PIC. This is a conservative assumption as some of these compounds occur naturally in the region.

The model predictions for the 2013 Base Case, the 2013 PRM Application Case and the 2013 PDC are provided in Appendix 3.2. In general, the model predictions for CO, TRS, VOCs, PAHs and trace metals were below the applicable criteria in the 2013 Base Case and the 2013 PRM Application Case. The 24-hour $PM_{2.5}$ concentrations at several communities were predicted to be above the AAAQO of 30 µg/m³.

A summary of the PIC, 2013 Base Case and 2013 PRM Application Case regional SO_2 and NO_2 predictions are provided in Table 4.1-1. The maximum annual NO_2 predictions are above the AAAQO (ESRD 2013) in the RSA in the 2013 Base Case and the 2013 PRM Application Case. The change in the annual average NO_2 prediction in the RSA due to PRM is less than 1 µg/m³. The NO_2 predictions are considered conservative because, for modelling purposes, it was assumed that all developments were operating at their maximum capacity at the same time; however, the operational life of each development will actually be staggered over time. The model evaluation (EIA Volume 3, Appendix 3-8) also indicates that NO_2 predictions near open pit mine sites are over-predicted. The SO_2 and NO_2 predictions in the communities were predicted to be below the applicable AAAQOs.

Table 4.1-1 Summary of Regional SO_2 and NO_2 Predictions

Parameter[a]	AAAQO[b]	Pre-Industrial Case[c]	2013 Base Case	2013 PRM Application Case
Local Study Area				
maximum 1-hour SO_2 concentration [µg/m³]	450	3.2	82.2	82.2
maximum 24-hour SO_2 concentration [µg/m³]	125	3.1	39.5	39.5
maximum 30-day SO_2 concentration [µg/m³]	30	3.1	11.2	11.2
maximum annual SO_2 concentration [µg/m³]	20	0.9	4.6	4.6
maximum 1-hour NO_2 concentration [µg/m³]	300	23.3	150.9	150.9
maximum annual NO_2 concentration [µg/m³]	45	5.5	26.2	43.3
Regional Study Area				
maximum 1-hour SO_2 concentration [µg/m³]	450	3.2	276.4	276.4
maximum 24-hour SO_2 concentration [µg/m³]	125	3.1	70.6	70.6
maximum 30-day SO_2 concentration [µg/m³]	30	3.1	15.5	15.5
maximum annual SO_2 concentration [µg/m³]	20	0.9	10.4	10.4
maximum 1-hour NO_2 concentration [µg/m³]	300	23.3	214.2	214.2
maximum annual NO_2 concentration [µg/m³]	45	5.5	**51.6**	**52.4**

(a) All predictions are outside developed areas.

(b) ESRD 2013.

(c) The Pre-industrial Case includes natural background and anthropogenic sources. The 30-day SO_2 predictions were assumed to be the same as the 24-hour SO_2 predictions.

Note: **Bold** number indicates an exceedance above the Alberta Ambient Air Quality Objective (AAAQO).

4.1.2 Residual Impact Classification

The residual impact classifications associated with changes in ambient air quality between the 2013 PRM Application Case and the PIC are presented in Table 4.1-2 (criteria compounds), Table 4.1-3 (TRS compounds), Table 4.1-4 (VOC compounds), Table 4.1-5 (PAH compounds) and Table 4.1-6 (metals). The impacts associated with changes in ambient air quality between the 2013 Base Case and the PIC have also been included for context.

The impact classifications are based on comparison with available AAAQOs (ESRD 2013) and TCEQ ESLs (TCEQ 2013). The impact classification is for ambient air quality only and does not necessarily reflect impacts to environmental health. The air quality model predictions were provided as input into the HHRA (Appendix 3.3).

By consolidating the impact measurements listed in Tables 4.1-2 to 4.1-6, it is possible to determine an overall rating of the “environmental consequence” for each of the ambient air quality parameters that were evaluated. Of the 130 ambient air quality parameters assessed for the 2013 PRM Application Case, 82 are rated as having a negligible environmental consequence and 45 are rated as having a “low” environmental consequence when compared to the PIC.

One ambient air quality parameter (regional annual NO_2) was rated as having a moderate environmental consequence because the maximum prediction outside disturbed areas is above the AAAQO of 45 µg/m³ but below the desirable National Air Quality Objective of 60 µg/m³ (Health Canada 2006). As discussed in EIA

Volume 3, Section 3.4.3.2, elevated NO_2 concentrations are near approved projects in the region and a model performance evaluation completed as part of the air quality assessment (EIA, Appendix 3-8, Section 2.5) indicates that NO_2 predictions near open pit mine sites are over-predicted. This conservatism is likely due to the emission estimates used for mine fleet vehicles. The Air Working Group of the Cumulative Environmental Management Association (CEMA) is continuing efforts to develop new approaches to provide more realistic NO2 predictions.

Two parameters (community 24-hour $PM_{2.5}$ and annual acrolein) were rated with a high environmental consequence. The 24-hour PM2.5 predictions at Fort McKay, Fort McMurray, Cabin J, Cabin K and the Oil Sands Lodge are above the AAAQO of 30 µg/m³. These exceedances are due to existing and approved projects in the 2013 Base Case and there is no increase in predicted concentrations from 2013 Base Case to the 2013 PRM Application Case. For Fort McMurray, the background PM2.5 concentration, which accounts for the community emissions, was estimated to be above 30 µg/m³. The maximum annual acrolein prediction at Oil Sands Lodge is slightly above the TCEQ ESL of 0.15 µg/m³, and the change due to PRM is less than 1%.

The effects of $PM_{2.5}$ and acrolein on environmental health are assessed in Appendix 3.3. The HHRA concluded that emissions from PRM in combination with emissions from other sources (i.e., the 2013 PRM Application Case) are not expected to result in adverse health effects in the area. Moreover, the changes between the 2013 Base Case and the 2013 PRM Application Case are generally small, suggesting that the PRM is not expected to contribute appreciably to health risks in the region.

4.1.3 Environmental Significance Determination

Part iii) of the JRP request requires consideration of environmental significance after reclamation. After reclamation, there will be few sources of air emissions compared to operations and air quality levels are expected to return to near-PIC levels in the region. Therefore, the potential effects from the PIC to the 2013 PRM Application Case on air quality after reclamation are not considered a likely significant adverse environmental effect.

Table 4.1-2 Residual Impact Classification for Changes to the Ambient Air Quality (Criteria Compounds) Relative to the Pre-Industrial Case

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(a)]
local 1-hour SO_2	negative	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+5)	negligible (+5)
local 24-hour SO_2	negative	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+5)	negligible (+5)
local 30-day SO_2	negative	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+5)	negligible (+5)
local annual SO_2	negative	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)
local 1-hour NO_2	negative	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+5)	negligible (+5)
local annual NO_2	negative	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)
regional 1-hour SO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
regional 24-hour SO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
regional 30-day SO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
regional annual SO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
regional 1-hour NO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
regional annual NO_2	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
community 1-hour SO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 24-hour SO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 30-day SO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual SO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour NO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)

Table 4.1-2 Residual Impact Classification for Changes to the Ambient Air Quality (Criteria Compounds) Relative to the Pre-Industrial Case (continued)

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(a)]
community annual NO_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour CO	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	low (0)	negligible (+5)	negligible (+5)
community 8-hour CO	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	low (0)	negligible (+5)	negligible (+5)
community 24-hour $PM_{2.5}$	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	high (+16)	high (+16)

(a) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 4.1-3 Residual Impact Classification for Changes to the Ambient Air Quality (Total Reduced Sulphur Compounds) Relative to the Pre-Industrial Case

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(a)]
community 1-hour H_2S	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 24-hour H_2S	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 1-hour COS	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual COS	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour CS_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual CS_2	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)

(a) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 4.1-4 Residual Impact Classification for Changes to the Ambient Air Quality (Volatile Organic Compounds) Relative to the Pre-Industrial Case

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[a]
community 1-hour 1,1,1-trichloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual 1,1,1-trichloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour 1,1,2,2-tetrachloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual 1,1,2,2-tetrachloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour 1,1,2-trichloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual 1,1,2-trichloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour 1,1-dichloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual 1,1-dichloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour 1,2-dichloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual 1,2-dichloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour 1,2-dichloropropane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual 1,2-dichloropropane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour 1,3-butadiene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual 1,3-butadiene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour 1,3-dichloropropene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual 1,3-dichloropropene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)

Table 4.1-4 Residual Impact Classification for Changes to the Ambient Air Quality (Volatile Organic Compounds) Relative to the Pre-Industrial Case (continued)

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[a]
community 1-hour acetaldehyde	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 1-hour acetone	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community 1-hour acrolein	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual acrolein	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
community 1-hour benzene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
annual benzene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour carbon tetrachloride	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual carbon tetrachloride	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour chlorobenzene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual chlorobenzene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour chloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual chloroethane	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour chloroform	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual chloroform	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour cumene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 1-hour cyclohexane	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual cyclohexane	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)

Table 4.1-4 Residual Impact Classification for Changes to the Ambient Air Quality (Volatile Organic Compounds) Relative to the Pre-Industrial Case (continued)

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[a]
community 1-hour ethylbenzene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 1-hour ethylene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual ethylene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour ethylene dibromide	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual ethylene dibromide	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour formaldehyde	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 1-hour hexane group	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual hexane group	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour methanol	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community 1-hour methyl ethyl ketone group	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual methyl ethyl ketone group	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour methylene chloride	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual methylene chloride	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour phenol	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community 1-hour propylene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community 1-hour propylene oxide	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual propylene oxide	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)

Table 4.1-4 Residual Impact Classification for Changes to the Ambient Air Quality (Volatile Organic Compounds) Relative to the Pre-Industrial Case (continued)

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[a]
community 1-hour styrene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community 1-hour toluene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 1-hour trimethylbenzene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual trimethylbenzene	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour vinyl chloride	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual vinyl chloride	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour xylenes	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)

[a] Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 4.1-5 Residual Impact Classification for Changes to the Ambient Air Quality (Polycyclic Aromatic Hydrocarbons Compounds) Relative to the Pre-Industrial Case

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(a)]
community 1-hour pyrene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual pyrene	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour fluorenes/fluoranthenes and substitutes	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual fluorenes/fluoranthenes and substitutes	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour acenaphthenes/ acenaphthylenes	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual acenaphthenes/ acenaphthylenes	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour anthracenes/ phenanthrenes and substitutes	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual anthracenes/ phenanthrenes and substitutes	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour naphthalene and substitutes	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual naphthalene and substitutes	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour biphenyls	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual biphenyls	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)

[(a)] Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 4.1-6 Residual Impact Classification for Changes to the Ambient Air Quality (Metals) Relative to the Pre-Industrial Case

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[a]
community 1-hour aluminum	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual aluminum	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour antimony	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual antimony	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour arsenic	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual arsenic	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour barium	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual barium	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour beryllium	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual beryllium	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour cadmium	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual cadmium	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour chromium	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community 1-hour chromium VI	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual chromium VI	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour cobalt	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual cobalt	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour copper	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)

Table 4.1-6 Residual Impact Classification for Changes to the Ambient Air Quality (Metals) Relative to the Pre-Industrial Case (continued)

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(a)]
community annual copper	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour lead	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community 1-hour manganese	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual manganese	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour mercury	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual mercury	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour molybdenum	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual molybdenum	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour nickel	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual nickel	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour selenium	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual selenium	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
community 1-hour silver	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)
community annual silver	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
community 1-hour tin	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+1)	negligible (+1)
community annual tin	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)

(a) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.2 Aquatic Resources

4.2.1 Surface Water Quality and Aquatic Health Assessment

4.2.1.1 Assessment Results

The water quality assessment considered the PIC as part of the analyses in the EIA and in the 2013 PRM Application Case assessment (Volume 1, Section 3.3). The assessment considered both observed ranges of concentrations at each assessment node (labelled “Observed Natural Variation”) as well as the modelled PIC (labelled “Pre-development”). For waterbodies and watercourses within the LSA and the Athabasca River, water quality model predictions were provided along with PIC in all data tables in the EIA. Summary tables for the EIA Application Case were provided in the EIA, Section 6.5.6.3, Tables 6.5-16 to 6.5-18 for waterbodies and watercourses within the LSA, and Section 6.5.7.3, Table 6.5-22 for the Athabasca River. Full results for the EIA Application Case at all assessment nodes were provided along with PIC results in Appendix 4-7 of the EIA.

As described in the EIA, Volume 4A, Section 6.5.5.3, the water quality assessment focused on key constituents, which are substances that exceed the PIC and EIA Base Case concentrations and water quality guidelines. In addition, total dissolved solids, chronic and acute toxicity, naphthenic acids and tainting potential were automatically assessed as key constituents. Comparing the 2013 PRM Application Case to the PIC without considering the EIA Base Case would yield a similar analysis to what was presented in the EIA, Volume 4A, Section 6.5.5.3, because most constituents that were noted as having high concentrations in the EIA Base Case (EIA, Volume 4A, Section 6.5.5.1) continued to increase in the 2013 PRM Application Case and were assessed as key constituents. The results of pit lakes modelling were also presented along with and compared to the PIC. Because pit lakes do not exist in the PIC, natural lakes in the region were used as analogs for this comparison. A reference condition was compiled for the 2013 PRM Application Case consisting of water chemistry of natural lakes in the Oil Sands Region, as well as PIC conditions in LSA watercourses and in the Athabasca River (Volume 1, Section 3.4.2.3, Table 3.4-5). Because Base Case concentrations are not considered a benchmark in the pit lakes assessment, the results and conclusions listed in Volume 1, Section 3.4.2.3 for pit lakes are exactly the same if the 2013 PRM Application Case is compared directly to PIC.

Several time periods of the PRM were examined during major phases of the construction, operations, Closure and Far Future. The LSA waterbody and watercourse and Athabasca River results were presented as five discrete snapshots representing these phases, as described in the EIA, Volume 1, Section 3.3.1. The 2018, 2034 and 2042 snapshots, as amended, represent operational scenarios. The 2052 snapshot represents initial pit lakes release, which is a key milestone for site reclamation, and 2152, or Far Future, represents the time when the reclaimed landscape is at steady state. Pit lakes results were presented for both 2052 and 2152. In general, 2052 represents worst-case concentrations because that is when most of the process-affected water will report to pit lakes and ultimately discharge to the receiving environment, on a project-specific basis and regionally.

Predicted water concentrations in the tables referred to above were carried forward to the aquatic health assessment.

4.2.1.2 Residual Impact Classification

The aquatic health component compared predicted water concentrations to relevant guidelines and benchmarks, independent of PIC or 2013 Base Case concentrations. It is the absolute concentration, and not the change from the PIC or 2013 Base Case, that determined the environmental consequence. Therefore, the concentrations and environmental consequences presented for aquatic health in Appendix 1, Sections 3.4.2 are cumulative to the 2013 PRM Application Case. These results show that the environmental consequences for the 2013 PRM Application Case are negligible or low for all aquatic health parameters.

4.2.1.3 Environmental Significance Determination

The 2013 PRM Application Case environmental consequence rankings for aquatic health parameters are negligible or low. Therefore, they are not likely significant adverse environmental effects.

4.3 Terrestrial Resources

This section primarily addresses cumulative environmental changes from PIC to the 2013 PRM Application Case for terrestrial resources, with a focus on changes in the RSA. A primary objective of these analyses is to help understand the significance of cumulative effects at scales most relevant to the conservation and management of terrestrial resources. However, the Joint Review Panel for JME stated that significance should be assessed at both LSA and RSA scales. Consequently, significance has also been determined for the incremental effects of PRM, using a resource management criteria approach. The Joint Review Panel assessed significance at the LSA scale during construction and operations only, and the LSA scale assessment presented here similarly focuses on construction and operations.

Significance determinations at the RSA scale are made for terrestrial resources using the two approaches outlined in Appendix 3.1 (Section 2.11.2), which includes determining significance using ecological thresholds and resource management criteria. Significance determinations are presented at the LSA scale in Section 4.3.1. Significance determinations at the RSA scale are presented for: soils and terrain (Section 4.3.2), terrestrial vegetation, wetlands, and forest resources (Section 4.3.3), wildlife and wildlife habitat (Section 4.3.4), and biodiversity (Section 4.3.5).

4.3.1 Environmental Significance Determination for Incremental Effects of PRM at the Local Study Area Scale

As noted in Appendix 3.1, the terrestrial LSA was designed to capture the immediate effects of PRM and therefore did not cover an area large enough for the assessment of ecological thresholds for terrestrial KIRs. This is because most vegetation, wildlife and biodiversity resources in northeastern Alberta function at ecological scales much larger than the LSA (e.g., the range of a caribou herd). Therefore, at the LSA scale, only resource management criteria could be applied to an assessment of significance. Environmental consequences for the incremental effects of PRM on terrestrial resources at the LSA scale (i.e., 2013 Base Case to 2013 PRM Application Case) are presented in Appendix 1.

Resource management criteria include losses of more than 20% of a resource or any adverse effect to a federally-listed species at risk. Because PRM is an open pit mine and because the LSA was defined immediately around PRM, a significant adverse effect using the 20% criterion is likely for most KIRs during construction and operations. As noted in Appendix 3.1, a significant result using the 20% criterion indicates a high percent loss in the LSA, but does not necessarily translate directly into the potential for unsustainable plant and wildlife populations or loss of ecological function at broader scales. In other words, a significant result identified using resource management criteria based on a percent of the LSA may or may not be important at regional scales. The importance of the contribution of PRM to the cumulative effects to terrestrial resources in the broader region is discussed in Sections 4.3.2 to 4.3.6.

4.3.1.1 Vegetation

Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). High magnitude adverse and likely effects in the LSA during construction and operations are predicted for all terrestrial vegetation, wetlands and forest resources KIRs, with the exception of the effects of dust (Appendix 1). Therefore, effects are Significant according to resource management criteria for:

- terrestrial vegetation (uplands);
- lichen jack pine communities;
- riparian communities;
- old growth forests;
- wetlands (including peatlands and patterned fens);
- high rare plant potential;
- productive forests; and
- high traditional use plants potential.

4.3.1.2 Wildlife

Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. At the LSA scale during construction and operations, high magnitude losses occur to wildlife habitat for all KIRs, including species at risk (Appendix 1). Therefore, effects are Significant according to resource management criteria for:

- barred owl;
- beaver;
- black bear;
- black-throated green warbler;
- Canada lynx;
- Canadian toad;
- fisher;
- moose;
- Canada warbler;
- common nighthawk;
- horned grebe;
- little brown myotis;
- northern myotis;

- olive-sided flycatcher;
- peregrine falcon;
- red knot;
- rusty blackbird;
- short-eared owl;
- western toad;
- whooping crane;
- wolverine;
- wood bison;
- woodland caribou; and
- yellow rail.

4.3.1.3 Biodiversity

Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). High magnitude adverse and likely effects in the LSA are predicted during construction and operations for species-level, ecosystem-level and landscape-level biodiversity (Appendix 1). Therefore, the effects of PRM on biodiversity at the LSA scale are Significant according to resource management criteria for all three levels of biodiversity.

4.3.2 Soils and Terrain

4.3.2.1 Assessment Results

Changes to soil types in the RSA from the PIC to the 2013 PRM Application Case are summarized in Tables 4.3-1 and 4.3-2.

The two sources of permanent soil loss in the RSA in the 2013 PRM Application Case compared to the PIC are the conversion of soil units due to the construction of the South Redclay Lake (an increase in 490 ha), and permanent developments such as municipal growth and roads. Additionally, permanent losses of organic soils will occur as portions of these landscapes are converted to upland landforms after reclamation (i.e., 142,269 ha of reconstructed landforms). These results are carried forward to the Terrestrial Vegetation, Wetlands, and Forest Resources assessment for inclusion in the evaluation of environmental consequences to wetlands.

A predicted 118,579 ha (10% of the resource) of undisturbed mineral soils will be lost or altered from PIC to the 2013 PRM Application Case, of which 109,772 ha occurs between the PIC and the 2013 Base Case (Table 4.3-1). Mineral soils and some areas of organic soils will be reclaimed as mineral soils. A disturbance or alteration of 73,082 ha (7% of the resource) of organic soils between the PIC to the 2013 PRM Application Case is predicted, of which 70,676 ha occurs between the PIC and the 2013 Base Case.

Changes to land capability for forestry in the RSA from the PIC to the 2013 PRM Application Case are summarized in Table 4.3-3. The total changes between the PIC and the 2013 PRM Application Case account for 9% of the RSA, and represent a 6% decline in areas classified as high and moderate for forest capability.

Table 4.3-1 Changes to Soil Types in the Regional Study Area – 2013 PRM Application Case Compared to Pre-Industrial Case: Before Reclamation

Soil Series, Reclaimed Soils and Non-Soils	Pre-Industrial Case		2013 Base Case	Loss/Alteration Due to the 2013 Base Case[a]		Loss/Alteration Due to 2013 PRM Application Case		Closure		Net Change to Pre-Industrial Case due to 2013 PRM Application Case [c]	
	Area [ha]	% of RSA	Area [ha]	Area [ha]	% of Resource[b]	Area [ha]	% of Resource[b]	Area [ha]	% of RSA	Area [ha]	% of Resource[b]
Mineral Soils											
Algar Lake	47,983	2	42,044	-5,939	-12	-5,939	-12	42,043	2	-5,939	-12
Bitumount	50,132	2	37,996	-12,136	-24	-12,898	-26	37,234	2	-12,898	-26
Buckton	31,789	1	31,739	-50	-<1	-50	-<1	31,739	1	-50	-<1
Dover	59,194	3	50,801	-8,393	-14	-8,393	-14	50,801	2	-8,393	-14
Firebag	74,053	3	60,364	-13,689	-18	-13,689	-18	60,364	3	-13,689	-18
Fort	2,821	<1	1,821	-1,000	-35	-1,000	-35	1,821	<1	-1,000	-35
Gipsy	6,292	<1	6,291	-1	-<1	-1	-<1	6,291	<1	-1	-<1
Horse River	24,046	1	23,544	-502	-2	-502	-2	23,544	1	-502	-2
Joslyn	86,192	4	66,208	-19,984	-23	-19,986	-23	66,206	3	-19,986	-23
Kearl	3,940	<1	3,870	-70	-2	-70	-2	3,870	<1	-70	-2
Kinosis	54,204	2	49,429	-4,775	-9	-4,775	-9	49,429	2	-4,775	-9
Legend	127,074	6	126,228	-846	-1	-846	-1	126,228	6	-846	-1
Livock	37,106	2	36,431	-675	-2	-675	-2	36,431	2	-675	-2
Marguerite	76,769	3	69,996	-6,773	-9	-6,776	-9	69,993	3	-6,776	-9
McMurray	56,877	2	53,535	-3,342	-6	-4,118	-7	52,759	2	-4,118	-7
Mildred	186,704	8	171,159	-15,545	-8	-19,627	-11	167,077	7	-19,627	-11
Namur	61,299	3	60,640	-659	-1	-3,284	-5	58,015	3	-3,284	-5
Ruth Lake	16,294	1	12,286	-4,008	-25	-4,478	-27	11,816	1	-4,478	-27
Steepbank	130,837	6	120,129	-10,708	-8	-10,794	-8	120,043	5	-10,794	-8
Surmont	11,857	1	11,180	-677	-6	-677	-6	11,180	<1	-677	-6
subtotal (mineral soils)	*1,145,463*	*50*	*1,035,692*	*-109,772*	*-10*	*-118,579*	*-10*	*1,026,885*	*45*	*-118,579*	*-10*
Organic Soils											
Bayard	14,662	1	14,616	-46	-<1	-46	-<1	14,616	1	-46	-<1
Conklin	61,760	3	57,922	-3,838	-6	-3,852	-6	57,907	3	-3,852	-6
Gregoire	20,863	1	19,342	-1,521	-7	-1,521	-7	19,342	1	-1,521	-7
Hartley	174,524	8	152,844	-21,680	-12	-22,221	-13	152,303	7	-22,221	-13
McLelland	152,559	7	145,313	-7,246	-5	-7,363	-5	145,196	6	-7,363	-5
Mikkwa	126,054	6	125,183	-871	-1	-871	-1	125,183	5	-871	-1
Mariana	156,011	7	138,616	-17,395	-11	-18,477	-12	137,533	6	-18,477	-12
Muskeg	240,944	11	227,947	-12,997	-5	-13,460	-6	227,484	10	-13,460	-6
Wabasca	36,774	2	31,692	-5,082	-14	-5,271	-14	31,502	1	-5,271	-14
subtotal (organic soils)	*984,149*	*43*	*913,474*	*-70,676*	*-7*	*-73,082*	*-7*	*911,067*	*40*	*-73,082*	*-7*
Reconstructed Landforms	0	0	0	0	0	0	0	11,252	<1	11,252	n/a
South Redclay Lake	0	0	0	0	0	0	0	490	<1	490	n/a
Rough broken/rock	86,070	4	82415	-3,655	-4	-3,868	-4	82,202	4	-3,868	-4
Disturbed	1,557	<1	186,349	184,792	>100	196,299	>100	186,113	8	184,555	11,853
Water	53,958	2	53,309	-649	-1	-728	-1	53,230	2	-728	-1
Indian Reserves[a]	6,179	<1	6,137	-42	-1	-42	-1	6,137	<1	-42	-1
subtotal (other)	*147,764*	*6*	*328,211*	*180,446*	*>100*	*191,661*	*>100*	*339,424*	*15*	*191,660*	*130*
Total	**2,277,376**	**100**	**2,277,376**	**0**	**0**	**0**	**0**	**2,277,376**	**100**	0	0

(a) Loss/alteration due to 2013 Base Case is provided for comparative purposes.

(b) % Resource is calculated as a percentage of PIC area; the areas if this column are not additive.

(c) Net change is calculated as the difference between the Pre-Industrial Case and Closure, a value upon which the environmental consequence after reclamation is assessed.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

n/a = Not applicable.

Table 4.3-2 Summary of Changes to Soil Types in the Regional Study Area – 2013 PRM Application Case to Pre-Industrial Case: Before Reclamation

Soil Series, Reclaimed Soils and Non-Soils	Pre-Industrial Case		2013 Base Case	Loss/Alteration Due to the 2013 Base Case[a]		Loss/Alteration Due to 2013 PRM Application Case		Closure		Net Change to Pre-Industrial Case due to 2013 PRM Application Case[c]	
	Area [ha]	% of RSA	Area [ha]	Area [ha]	% of Resource [b]	Area [ha]	% of Resource[b]	Area [ha]	% of RSA	Area [ha]	% of Resource[b]
Mineral Soils	1,145,463	50	1,035,692	-109,772	-10	-118,579	-10	1,026,886	45	-118,579	-10
Organic soils	984,149	43	913,474	-70,676	-7	-73,082	-7	911,067	40	-73,082	-7
Rough Broken/Rock, Disturbed, Reconstructed, Indian Reserves	93,806	4	274,902	181,095	193	192,389	205	285,704	13	191,898	205
Water	53,958	2	53,309	-649	-1	-728	-1	53,720	2	-238	-<1
Total	**2,277,376**	**100**	**2,277,376**	**0**	**0**	**0**	**0**	**2,277,376**	**100**	**0**	**0**

(a) Loss/alteration due to 2013 Base Case is provided for comparative purposes.

(b) % Resource is calculated as a percentage of PIC area; the areas in this column are not additive.

(c) Net change is calculated as the difference between the Pre-Industrial Case and Closure, a value upon which the environmental consequence after reclamation is assessed.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

n/a = Not applicable.

Table 4.3-3 Predicted Forest Capability Changes in the Regional Study Area – 2013 PRM Application Case to Pre-Industrial Case: Before Reclamation

Forest Land Capability Class	Pre-Industrial Case		2013 Base Case	Loss/Alteration Due to 2013 Base Case		Loss/Alteration Due to 2013 PRM Application Case		Closure[a]		Net Change to Pre-Industrial Case due to 2013 PRM Application Case[c]	
	Area [ha]	% of RSA	Area [ha]	Area [ha]	% Resource[b]	Area [ha]	% Resource[b]	Area [ha]	% of RSA	Area [ha]	% Resource[b]
1 (high)	56,877	2	53,535	-3,342	-6	-3,344	-6	58,016	3	1,139	2
2 (moderate)	267,638	12	252,583	-15,055	-6	-16,594	-6	264,525	12	-3,113	-1
3 (low)	161,987	7	155,386	-6,601	-4	-7,908	-5	169,284	7	7,297	5
4 (conditionally	658,962	29	574,188	-84,774	-13	-89,911	-14	466,117	20	-192,845	-29
5 (non-productive)	1,070,220	47	995,889	-74,331	-7	-77,792	-7	1,073,659	47	3,439	<1
subtotal	*2,215,682*	*97*	*2,031,581*	*-184,101*	*-8*	*-195,549*	*-9*	2,031,601	*89*	*-184,083*	*-8*
Water[a]	53,958	1	53,309	-649	-1	-705	-1	53,286	2	-672	-1
Disturbed	1,557	2	186,349	184,792	>100	196,296	>100	192,489	8	190,932	12,263
Indian Reserve	6,179	1	6,137	-42	-1	-42	-1	0	0	-6,179	-100
subtotal	*61,694*	*2*	*245,795*	*184,101*	>100	*195,549*	*317*	245,775	*11*	*184,081*	*298*
Total	**2,277,376**	**100**	**2,277,376**	**0**	**0**	**0**	**0**	**2,277,378**	**100**	**0**	0

(a) Includes South Redclay Lake.

(b) % of Resource is calculated as a percentage of PIC area; the areas of this column are not additive.

(c) Net change is calculated as the difference between the Pre-Industrial Case and Closure, a value upon which the environmental consequence after reclamation is assessed.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

4.3.2.2 Residual Impact Classification Before and After Reclamation

The 2013 PRM Application Case will result in changes to soil in the RSA compared to PIC with the majority of changes in the RSA occurring between the PIC and the 2013 Base Case.

Before reclamation, the residual forestry capability impact is rated as a negative, moderate environmental consequence. Disturbances and constructed landforms in the Closure landscape will be reclaimed to a variety of land capability classifications; however, the distribution of the five land capability classes from 2013 Base Case in the RSA is not assessed here.

Changes in soil areas and function have a direct effect on vegetation communities, influencing which plant species will establish successfully at different positions in the reclaimed landscape. For both the 2013 Base Case and the 2013 PRM Application Case, this permanent loss of mineral and organic soils is predicted to have a negative high and moderate environmental consequence, respectively, at the RSA scale before and after reclamation (Tables 4.3-4 and 4.3-5). After reclamation, organic soils will be lost and mineral soils will increase due to the conversion of organic soils to upland conditions. There will be permanent loss of soil area between the PIC and the 2013 PRM Application Case due to the creation of South Redclay Lake and municipal disturbances that will not be reclaimed. Because the direction of effects to mineral soils after reclamation is positive, the impact classification is not applicable and thus not included in Table 4.3-5.

Table 4.3-4 Residual Impact Classification for Soil in the Regional Study Area Relative to Pre-Industrial Case: Before Reclamation

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (RSA)	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(a)]
Soils									
Permanent Loss of Mineral Soil	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+18)	high (+18)
Permanent Loss of Organic Soil	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	moderate (+13)	moderate (+13)
Land Capability for Forestry									
Equivalent Capability for Forestry	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	moderate (+13)	moderate (+13)

(a) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 4.3-5 Residual Impact Classification for Soil in the Regional Study Area Relative to Pre-Industrial Case: After Reclamation

Parameter	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (RSA)	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(a)]
Soils									
Permanent Loss of Organic soil	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	moderate (+13)	moderate (+13)
Land Capability for Forestry									
Equivalent Capability for Forestry	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	moderate (+13)	moderate (+13)

(a) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.2.3 Environmental Significance Determination After Reclamation

The assessment methods applied for the determination of significance are discussed in Appendix 3.1, Section 2.11.2. The determination of significance is applied after mitigations have been implemented. In the case of soils and terrain, this includes remediation of contaminated soils to applicable guideline values and reclamation.

4.3.2.3.1 Ecological Thresholds

The ecological threshold for a Significant effect on soils is a permanent loss of the soils' ability to support and sustain a boreal ecosystem. The soils in the RSA comprise an assemblage of soil moisture and nutrient conditions, with land capability classes for forestry ranging from non-productive to highly productive. Although the relative proportions of these classes will change, each of these classes is still capable of supporting boreal ecosystem vegetation. Changes to land capability are reflected in the assessment of the loss of soil area (i.e., the increase in residual disturbance and area of water). The permanent loss of soil area and changes to land capability for forestry are directly reflected in changes to terrestrial vegetation, wetlands and forest resources. As such, the significance of these effects is assessed in Section 4.3.2 Terrestrial Vegetation, Wetlands and Forest Resources.

4.3.2.3.2 Resource Management Criteria

A predicted 73,082 ha (7% of the resource) of undisturbed organic soils will be permanently lost or altered from PIC to the 2013 PRM Application Case in the RSA after reclamation, of which 97% (70,676 ha, 7% of the resource) is lost between the PIC and the 2013 Base Case (Table 4.3 1). As the loss of organic soils in the RSA is less than 20% of that present in the PIC, the effect is Not Significant according to resource management criteria.

4.3.3 Terrestrial Vegetation, Wetlands and Forest Resources

The basis on which each KIR was assessed is described in the EIA, Volume 3, Sections 1.3.6.1 and 1.3.6.2. The development of the PIC data are described in Appendix 2, Section 2.4.2.1 of this submission. Environmental consequence has been assigned to the loss/alteration between the PIC and the 2013 Base Case and between the PIC and the 2013 PRM Application Case, to illustrate the amount of change between these two assessment cases.

For the assessment of changes between the PIC to the 2013 PRM Application Case after reclamation, Closure is defined as 80 years after the decommissioning and final reclamation phase of PRM (i.e., when infrastructure is dismantled and final reclamation of the PRM surface footprint is completed). The Closure scenario includes only reclamation of PRM; therefore, disturbances present in the 2013 Base Case remain as disturbances in the 2013 PRM Application Case Closure landscape.

4.3.3.1 Assessment Results

4.3.3.1.1 Direct and Indirect Losses/Alterations From Vegetation Clearing in the Regional Study Area

The total area and percent cover of RLCC within the RSA from the PIC to the 2013 PRM Application Case are shown in Table 4.3-6. Relative to PIC, 21% of regional terrestrial land cover classes, 13% of wetlands, and 5% of miscellaneous land cover classes will be cleared in the RSA due to the 2013 PRM Application Case. These losses result from an increase in disturbance (i.e., cutblocks and other urban, industrial or other disturbances) relative to the PIC.

Table 4.3-6 Regional Land Cover Class Changes in the Regional Study Area – Pre-Industrial Case

Regional Land Cover Class	Pre-Industrial Case[(a)]		Loss/Alteration Due to the 2013 Base Case[(b)]		Loss/Alteration Due to 2013 PRM[(c)] Application Case		Closure[(d)]		Net Change Due to 2013 PRM [(e)] Application Case	
	Area [ha]	% of RSA[(f)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]
Terrestrial Vegetation										
coniferous jack pine	191,070	8	-24,738	-13	-25,086	-13	166,251	87	-24,819	-13
coniferous jack pine-black spruce	44,624	2	-4,570	-10	-4,570	-10	44,228	99	-397	-<1
coniferous white spruce	69,421	3	-17,035	-25	-17,657	-25	52,302	75	-17,119	-25
deciduous aspen-balsam poplar	233,520	10	-55,454	-24	-55,960	-24	179,418	77	-54,102	-23
mixedwood aspen-jack pine	49,528	2	-10,496	-21	-10,496	-21	39,147	79	-10,381	-21
mixedwood aspen-white spruce	197,394	9	-52,635	-27	-54,278	-27	144,411	73	-52,982	-27
terrestrial vegetation subtotal	*785,557*	*34*	*-164,927*	*-21*	*-168,047*	*-21*	*625,757*	*80*	*-159,801*	*-20*
Wetlands (Peatlands)										
non-treed wetlands	275,397	12	-34,288	-12	-36,800	-13	240,492	87	-34,905	-13
treed bog/poor fen	471,749	21	-47,894	-10	-50,274	-11	421,900	89	-49,849	-11
treed fen	268,124	12	-37,755	-14	-42,769	-16	226,151	84	-41,973	-16
wetlands subtotal	*1,015,270*	*45*	*-119,936*	*-12*	*-129,849*	*-13*	*888,543*	*88*	*-126,728*	*-12*
Miscellaneous										
burn	420,169	18	-24,044	-6	-24,470	-6	395,993	94	-24,176	-6
water[(h)]	54,040	2	-1,514	-3	-1,565	-3	54,743	101	704	1
miscellaneous subtotal	*474,209*	*21*	*-25,558*	*-5*	*-26,029*	*-5*	*450,736*	*95*	*-23,472*	*-5*
Disturbances										
cutblock	65	<1	100,095	154,890	100,095	154,890	100,160	154,990	100,095	154,890
disturbance (urban/industrial/other)	1,557	<1	-1,249	-80	-1,249	-80	212,181	13,631	210,624	13,531
disturbances subtotal	*1,621*	*<1*	*98,846*	*6,097*	*98,846*	*6,097*	*312,341*	*19,265*	*310,719*	*19,165*

Table 4.3-6 Regional Land Cover Class Changes in the Regional Study Area – Pre-Industrial Case (continued)

Regional Land Cover Class	Pre-Industrial Case[a]		Loss/Alteration Due to the 2013 Base Case[b]		Loss/Alteration Due to 2013 PRM[c] Application Case		Closure[d]		Net Change Due to 2013 PRM [e] Application Case	
	Area [ha]	% of RSA[f]	Area [ha]	% of Resource[g]	Area [ha]	% of Resource[g]	Area [ha]	% of Resource[g]	Area [ha]	% of Resource[g]
Unclassified										
unclassified (cloud/cloud shadow)[i]	719	<1	-719	-100	-719	-100	0	0	-719	-100
unclassified subtotal	*719*	*<1*	*-719*	*-100*	*-719*	*-100*	*0*	*0*	*-719*	*-100*
Total	**2,277,376**	**100**	**-212,293**	**-9**	**-225,797**	**-10**	**2,277,376**	**100**	**n/a**	**n/a**

(a) Includes burns as modelled by ALCES®.

(b) Includes burns and cutblocks as modelled by ALCES®.

(c) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect effects due to surficial aquifer drawdown from PRM within the RSA, and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed during construction and operations. Excluding indirect effects due to surficial aquifer drawdown from PRM there is a total loss/alteration of -223,615 ha, within the RSA.

(d) Closure scenario includes reclamation of the PRM development areas. Values presented in this table do not include indirect effects due to surficial aquifer drawdown, as drawdown will occur primarily during the life of PRM. Drawdown effects on wetlands types surrounding pit lakes may extend to Closure. At Closure combined direct and indirect effects are predicted to cause an additional loss of 2,182 ha (<1% of Resource) to wetlands.

(e) Net change is calculated as the difference between the PIC and Closure, a value upon which the environmental consequence at Closure is assessed.

(f) For the purposes of this assessment, each RLCC is assumed to be 100% of Resource at Pre-Industrial Case.

(g) % of Resource is calculated as a percentage of PIC area; the areas of this column are not additive.

(h) Closure values include South Redclay Lake as described in the EIA, Appendix 4-4, Section 1.4.1and planned littoral zones bordering pit lakes and South Redclay Lake.

(i) Describes those areas where the imagery of the earth's surface had been blocked by clouds or cloud shadows during the image capture period.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The Closure, Conservation and Reclamation (CC&R) Plan (EIA, Appendix 5-2) describes the land cover types that will be reclaimed after PRM completion using the LSA scale of mapping. These land cover types were correlated with RLCCs for the RSA (Golder 2007b) to determine the area of each RLCC following reclamation. At Closure, the RSA landscape will have an increase in cutblocks and industrial/urban disturbances, and a net decrease in terrestrial RLCCs (159,801 ha or 20% of the resource) between the PIC and the 2013 PRM Application Case. There will be a net decrease in wetlands by 126,728 ha (12% of the resource).

4.3.3.1.2 Overview of Indirect Effects due to Changes in Hydrogeology and Hydrology

The LSA and RSA were assessed for effects due to changes in hydrogeology and surface water hydrology in the EIA, Volume 4A, Sections 6.1 and 6.3, and Volume 5, Section 7.5. A full description of the indirect effects of surface water drawdown and the vegetation KIRs affected are detailed in Appendix 1, Section 4.3.1.3.

4.3.3.1.3 Key Indicator Resources and Vegetation Resources

Terrestrial Vegetation (Uplands)

In the PIC, terrestrial vegetation represented by the upland RLCCs, occupied 34% of the RSA (Table 4.3-6). During construction and operations, between the PIC and the 2013 PRM Application Case, there is predicted to be a loss to terrestrial vegetation (i.e., uplands) of 168,047 ha (21% of Resource) with the majority of the change occurring between the PIC and the 2013 Base Case (164,927 ha, or 21% of Resource). Regional land cover classification for terrestrial vegetation (i.e., uplands) is estimated to have a classification error of 18%. The majority of this error was due to the misclassification of terrestrial vegetation as wetlands. Depending on the spatial distribution of land cover classification errors, the amount of terrestrial vegetation may be underestimated by about 8%. Therefore, there may be more terrestrial vegetation present in the RSA than predicted based on the regional land cover classification. The environmental consequence to terrestrial vegetation (i.e., uplands) from the PIC to the 2013 PRM Application Case is the same as from the PIC to the 2013 Base Case. The environmental consequence for the 2013 PRM Application Case compared to the PIC for uplands is negative and high during construction and operations in the RSA (Section 4.3.3.2).

At Closure, terrestrial vegetation (i.e., uplands) is predicted to cover 625,757 ha (80% of Resource), representing a net decrease of 159,801 ha (20% of Resource) from PIC (Table 4.3-6). The majority of the net decrease occurs between the PIC and the 2013 Base Case (164,927 ha, or 21% of the resource). As a result, the environmental consequence to terrestrial vegetation (i.e., uplands) from the PIC to Closure is the same as from the PIC to the 2013 Base Case. This results in a negative and high environmental consequence within the RSA between the PIC and the 2013 PRM Application Case (Section 4.3.3.4).

Lichen Jack Pine Communities

The lichen jack pine ecosite phase (LSA) correlates to the coniferous jack pine RLCC at the RSA scale. The coniferous jack pine RLCC occupied 191,070 ha (8% of the RSA) of the RSA in the PIC (Table 4.3-6). Relative to PIC, coniferous jack pine communities are predicted to decrease by 25,086 ha (13% of the resource) during construction and operations with most of this decrease occurring between the PIC and the 2013 Base Case (24,738 ha, or 13% of Resource). Regional land cover classification for the coniferous jack pine RLCC is estimated to have a classification error of 82%. The majority of this error was due to the misclassification of coniferous jack pine-black spruce, treed fen and treed bog/poor fen as coniferous jack pine. Depending on the spatial distribution of land cover classification errors, the amount of coniferous jack pine may be overestimated by about 413%. The 13 regional land cover classes are evenly distributed within the RSA (Terrestrial Vegetation, Wetlands and Forest Resources Environmental Setting Report, Section 3.4.2.1). Therefore, although there may be less coniferous jack pine present in the RSA than predicted based on the regional land cover classification, a similar proportion is predicted to be lost during construction and operations. The environmental consequence to coniferous jack pine communities from the PIC to the 2013 PRM Application Case is the same as from the PIC to the 2013 Base Case. The 2013 PRM Application Case is predicted to have a negative, moderate environmental consequence on lichen jack pine communities in the RSA during construction and operations compared to the PIC (Section 4.3.3.2).

At Closure, coniferous jack pine communities are predicted to occupy 87% of the resource present in the PIC (Table 4.3-6), a net decrease of 24,819 ha (13% of Resource) between the 2013 PRM Application Case and the PIC. Most of this decrease occurs from PIC to the 2013 Base Case (24,738 ha, or 13% of the RSA). As a result, the environmental consequence to coniferous jack pine communities from the PIC to the 2013 PRM Application Case at Closure is the same as from the PIC to the 2013 Base Case. This results in a negative, moderate environmental consequence within the RSA between the PIC and the 2013 PRM Application Case at Closure (Section 4.3.3.4).

Old Growth Forest

The age of old growth forest was assessed differently depending on the stand type; black spruce, white spruce, tamarack and balsam fir stands were considered old growth at 140 years, jack pine stands at 120 years, and deciduous and mixedwood stands at 100 years (EIA, Volume 5, Section 7.5.2.2).

Following Andison (2003), the amount of old growth forest in the RSA was determined based on the mid-point values for age class variability within forested RLCCs. Based on this method, the estimated amount of old growth forest potential area in the RSA is 356,582 ha in the PIC (16% of the RSA; Table 4.3-7). The amount of old growth forest potential area is estimated to decrease by 63,120 ha (18% of Resource) between the PIC and the 2013 PRM Application Case with most of the change occurring between the PIC and the 2013 Base Case (61,070 ha, or 17% of Resource). Error in the estimate of old growth forest potential area may come from two sources: variation in the mid-point values for a given RLCC and error in the regional land cover classification. Mid-point values for old growth RLCCs fell within a narrow range (i.e., 20% to 28%; Table 4.3-7). Error associated with mid-point values cannot be quantified but is expected to be minimal due to the small amount of variation. Because estimates of old growth forest pool all RLCCs except water and non-treed wetlands, error associated with individual RLCCs is also expected to be minimal. Water was mapped with virtually 100% accuracy. In contrast, non-treed wetlands were overestimated by 300%. Coniferous jack pine-black spruce and treed fens were most often misclassified as non-treed wetland, both of which have old growth forest potential. Therefore, error due to regional land cover misclassification likely resulted in an overall underestimation of old growth forest potential area in the RSA. While Shell expects re-establishment of old growth forest in the reclaimed PRM area, for the purposes of the assessment, reclamation and closure measures for terrestrial resources consider conditions 80 years following the end of operations and reclamation. Development of old growth forest is expected to take 100 or more years, depending on the tree species (Andison 2003; Schneider 2001), such that effects after Closure and reclamation are conservatively estimated to be the same as effects before closure and reclamation.

Table 4.3-7 Old Growth Forests in the Regional Study Area – Pre-Industrial Case

Regional Land Cover Class	Forest Type (Old Growth Range)[(a)]	Estimated Occurrence of Old Growth in the RSA [%][(b)]	Pre-Industrial Case: Total Class Area in the RSA[(c)] [ha]	Loss/Alteration due to the 2013 Base Case Total Class Area in the RSA[(d)] [ha]	Loss/Alteration due to the 2013 PRM Application Case: Total Class Area in the RSA[(d)] [ha]	Estimated Pre-Industrial Case Old Growth in the RSA[(c)]		Estimated Loss/Alteration to Old Growth due to the 2013 Base Case[(d)]		Estimated Loss/Alteration to Old Growth due to the 2013 PRM[(d)(e)] Application Case	
						[ha]	% of RSA[(f)]	[ha]	% of Resource[(g)]	[ha]	% of Resource[(g)]
Forested Cover Type											
coniferous jack pine	pine dominant (16% to 36%)	26	191,070	-24,738	-25,086	49,678	2	-6,432	-13	-6,522	-13
coniferous jack pine–black spruce	pine dominant (16% to 36%)	26	44,624	-4,570	-4,570	11,602	<1	-1,188	-10	-1,188	-10
coniferous white spruce	white spruce dominant (10% to 34%)	22	69,421	-17,035	-17,657	15,273	<1	-3,748	-25	-3,885	-25
deciduous aspen–balsam poplar	hardwood dominant (14% to 42%)	28	233,520	-55,454	-55,960	65,386	3	-15,527	-24	-15,669	-24
mixedwood aspen–jack pine	mixedwood dominant (16% to 38%)	27	49,528	-10,496	-10,496	13,373	<1	-2,834	-21	-2,834	-21
mixedwood aspen–white spruce	mixedwood dominant (16% to 38%)	27	197,394	-52,635	-54,278	53,296	2	-14,211	-27	-14,655	-27
treed bog/poor fen	black spruce dominant (12% to 28%)	20	471,749	-47,894	-49,861	94,350	4	-9,579	-10	-9,972	-11
treed fen	black spruce dominant (12% to 28%)	20	268,124	-37,755	-41,973	53,625	2	-7,551	-14	-8,395	-16
Total		**n/a**	**1,525,430**	**-250,576**	**-259,880**	**356,582**	**16**	**-61,070**	**-17**	**-63,120**	**-18**

(a) Based on percent cover ranges of overmature dominant tree species derived from computer modelling of historic patterns in seral stage variation over time (Andison 2003).

(b) Based on mid-point of the overmature age class range values in Andison (2003).

(c) Burns and cutblocks as modelled by ALCES® are accounted for within each Regional Land Cover Class (RLCC).

(d) Includes burns and cutblocks as modelled by ALCES®.

(e) These values are used to assess environmental consequence during construction and operations and at Closure.

(f) For the purposes of this assessment, each RLCC is assumed to be 100% of Resource at Pre-Industrial Case.

(g) % of Resource is calculated as a percentage of PIC old growth area, the areas of this column are not additive.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

During construction and operations and at Closure, there is expected to be a negative and moderate environmental consequence for old growth forests in the RSA (Sections 4.3.3.2 and 4.3.3.4) between the PIC and the 2013 PRM Application Case. The environmental consequence to old growth forests from the PIC to the 2013 PRM Application Case is the same as from the PIC to the 2013 Base Case.

Wetlands (Including Peatlands and Patterned Fens)

Wetlands within the RSA are represented by the following RLCCs: non-treed wetlands, treed bog/poor fen and treed fen. At the RSA scale, area and percentages for peatlands and patterned fens are not assessed individually using Geographic Information System (GIS) analysis, because wetlands classification at the RSA scale is too coarse to differentiate peatlands and patterned fens separately from other wetlands. The finer scale of Alberta Vegetation Inventory (AVI) data that allows for peatlands and patterned fens to be mapped separately at the LSA scale is not available for the entire area of the RSA. Regional land cover classification for wetlands is estimated to have a classification error of 27%. The majority of this error was due to the misclassification of wetlands as terrestrial vegetation. Depending on the spatial distribution of land cover classification errors, the amount of wetlands may be overestimated by about 10%. Therefore, there may be fewer wetlands present in the RSA than predicted based on the regional land cover classification. Error within the regional land cover classification was qualitatively considered in the assessment of effects on wetlands in the RSA.

Wetlands account for 1,015,270 ha (45% of the RSA) at PIC (Table 4.3-6). Combined direct and indirect effects in the 2013 PRM Application Case during construction and operations, are predicted to result in a loss of 129,849 ha (13% of Resource) of wetlands (including peatlands and patterned fens) in the RSA. A large portion of this change occurs between the PIC and the 2013 Base Case, with a loss of 119,936 ha (12% of the resource). As a result, the environmental consequence to wetlands from the PIC to the 2013 PRM Application Case is the same as from the PIC to the 2013 Base Case. During construction and operations, a negative and moderate environmental consequence is expected for wetlands in the RSA (Section 4.3.3.2) between the PIC and the 2013 PRM Application Case.

At Closure, a net decrease of 126,728 ha (12% of Resource) of wetlands (including peatlands and patterned fens) in the RSA from PIC to 2013 PRM Application Case, due to direct effects, is predicted. A large portion of this change occurs from the PIC to the 2013 Base Case, with a loss of 119,936 ha (12% of the RSA). As a result, the environmental consequence to wetlands from the PIC to Closure is the same as from the PIC to the 2013 Base Case. At Closure, the effects on wetlands (including peatlands and patterned fens) are expected to have a negative and moderate environmental consequence at the RSA scale (Section 4.3.3.4).

Productive Forests

Regional land cover classes at the RSA level were classified as either ‘productive’ (i.e., economic) or ‘unproductive’ (i.e., non-economic). Black spruce and tamarack dominated stands are generally not harvested for timber and were considered to be non-productive. Burned areas at the RSA level were excluded from the productive forest land base even though portions of it may be productive because there is a lack of information on what types of vegetation occur within the burned areas. As a result, the burn land cover class was assigned an “unknown” productivity class.

Productive forests in the RSA include the following classes:

- coniferous jack pine;
- coniferous jack pine−black spruce;

- coniferous white spruce;
- deciduous aspen−balsam poplar;
- mixedwood aspen−jack pine;
- mixedwood aspen−white spruce; and
- cutblock.

Relative to PIC, the 2013 PRM Application Case will affect 67,952 ha (9% of Resource) of productive forests in the RSA during construction and operations (Table 4.3-8) with most of this change occurring from the PIC to the 2013 Base Case (64,832 ha, or 8% of Resource). Regional land cover classification for productive forest, excluding cutblocks, is estimated to have a classification error of 18%. Land classification error can not be calculated for cutblocks. The majority of this error was due to the misclassification of productive forest as wetlands. Depending on the spatial distribution of land cover classification errors, the amount of productive forest may be underestimated by about 8%. Therefore, there may be more productive forest present in the RSA than predicted based on the regional land cover classification. Error within the regional land cover classification likely results in a conservative assessment of effects on productive forest in the RSA. The environmental consequence to productive forests from the PIC to the 2013 PRM Application Case is the same as from the PIC to the 2013 Base Case. Environmental consequences are negative and low in the RSA during PRM construction and operations (Section 4.3.3.2).

At Closure, RSA productive forests are predicted to decrease by 59,706 ha (8% of the resource) between the PIC and the 2013 PRM Application Case. Environmental consequences are negative and low in the RSA at Closure (Section 4.3.3.4).

Rare Plant Potential

Rare plant potential areas are estimated based on the non-treed wetland and treed fen RLCCs. A total of 543,521 ha (24% of the RSA) of high rare plant potential areas were mapped within the RSA at PIC (Table 4.3-9). Combined direct and indirect effects from the PIC to the 2013 PRM Application Case will cause a net decrease of 79,568 ha (15% of the resource) of high rare plant potential areas during construction and operations (Table 4.3-9), with most of this change occurring from the PIC to 2013 Base Case (72,042 ha, or 13% of the RSA). At Closure, high rare plant potential areas are predicted to occupy 466,643 ha (86% of Resource), (Table 4.3-9). Regional land cover classification for rare plant potential areas is estimated to have an error of 40%. The majority of this error was due to the misclassification of rare plant potential areas as coniferous jack pine-black spruce or treed bog/poor fen. Depending on the spatial distribution of land cover classification errors, the amount of rare plant potential areas may be underestimated by about 30%. Therefore, there may be more rare plant potential areas present in the RSA than predicted based on the regional land cover classification. The environmental consequence to high rare plant potential from the PIC to the 2013 PRM Application Case is the same as from the PIC to the 2013 Base Case. Due to indirect and direct effects combined, environmental consequences are negative and moderate in the RSA during construction and operations (Section 4.3.3.2).

At Closure, combined direct and indirect effects are predicted to cause a net decrease in high rare plant potential areas of 76,878 ha (14% of the resource) with most of this change occurring from the PIC to the 2013 Base Case (72,042 ha, or 13% of the resource) (Table 4.3-9). Environmental consequences are negative and moderate in the RSA at Closure (Section 4.3.3.4).

Traditional Use Plant Potential

Traditional use plant potential areas are estimated based on the coniferous white spruce, deciduous aspen-balsam poplar, mixedwood aspen-jack pine and mixedwood aspen-white spruce RLCCs. A total of 549,863 ha (24% of the RSA) of high traditional use plant potential areas was mapped within the RSA at PIC (Table 4.3-10). In the RSA, 138,390 ha (25% of Resource) of the high traditional use plant potential are predicted to be altered from PIC to 2013 PRM Application Case (Table 4.3-10). Most of this change occurs from the PIC to the 2013 Base Case with a loss of 135,619 ha (25% of Resource) of high traditional use plant potential areas within the RSA. Regional land cover classification for traditional use plant potential areas is estimated to have an error of 8%. This error was due to the misclassification of traditional use plant potential areas as coniferous jack pine, coniferous jack pine-black spruce or treed fen. Depending on the spatial distribution of land cover classification errors, the amount of traditional use plant potential areas may be overestimated by about 1%. Therefore, there may be slightly less traditional use plant potential areas present in the RSA than predicted based on the regional land cover classification, but this small amount of error is not expected to affect the assessment of effects on traditional use plant potential in the RSA. The environmental consequence to high traditional use plant potential from the PIC to the 2013 PRM Application Case is the same as from the PIC to the 2013 Base Case. In the RSA, the environmental consequence rating for high traditional plant potential is negative and high (Section 4.3.3.2).

At Closure, high traditional use plant potential areas are predicted to have a net decrease of 134,585 ha (24% of the resource), relative to PIC. Most of this change occurs from the PIC to 2013 Base Case with a loss of 135,619 ha (25% of the RSA) of high traditional use plant potential within the RSA (Table 4.3-10). As a result, the environmental consequence to traditional use plant potential from the PIC to the 2013 PRM Application Case at Closure is the same as from the PIC to the 2013 Base Case (Section 4.3.3.2). At Closure, environmental consequences rankings are negative and high for high traditional plant potential (Section 4.3.3.4).

Table 4.3-8 Productive Forests Within the Regional Study Area – Pre-Industrial Case

Timber Productivity	Pre-Industrial Case [a]		Loss/Alteration due to the 2013 Base Case [b]		Loss/Alteration due to the 2013 PRM[b][c] Application Case		Closure[b][d]		Net Change [e]	
	[ha]	% of RSA[f]	[ha]	% of Resource[g]	[ha]	% of Resource[g]	[ha]	% of Resource[g]	[ha]	% of Resource[g]
potentially productive	785,622	34	-64,832	-8	-67,952	-9	725,916	92	-59,706	-8
unproductive land and water	1,070,867	47	-122,698	-11	-130,769	-12	1,155,467	108	84,600	8
unknown (burns)	420,169	18	-24,044	-6	-24,176	-6	395,993	94	-24,176	-6
unclassified (cloud/cloud shadow)[h]	719	<1	-719	-100	-719	-100	0	0	-719	-100
Total	**2,277,376**	**100**	**-212,293**	**-9**	**-223,615**	**-10**	**2,277,376**	**100**	**n/a**	**n/a**

(a) Includes burns as modelled by ALCES®.

(b) Includes burns and cutblocks as modelled by ALCES®.

(c) The values upon which the environmental consequence is assessed during construction and operations.

(d) Closure scenario includes reclamation of the PRM development areas.

(e) Net change is calculated as the difference between the PIC and Closure, a value upon which the environmental consequence at Closure is assessed.

(f) For the purposes of this assessment, each category is assumed to be 100% of Resource at Pre-Industrial Case.

(g) % of Resource is calculated as a percentage of PIC area; the areas of this column are not additive.

(h) Describes those areas where the imagery of the earth's surface had been blocked during the image capture period.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 4.3-9 Rare Plant Potential in the Regional Study Area – Pre-Industrial Case

RSA Rare Plant Potential	Pre-Industrial Case [a]		Loss/Alteration due to the 2013 Base Case[b]		Loss/Alteration due to the 2013 PRM[b][c] Application Case		Closure[b][d]		Net Change[e]	
	[ha]	% of RSA[f]	[ha]	% of Resource[g]	[ha]	% of Resource[g]	[ha]	% of Resource[g]	[ha]	% of Resource[g]
high	543,521	24	-72,042	-13	-79,568	-15	466,643	86	-76,878	-14
moderate	1,177,205	52	-11,647	-<1	-14,801	-1	1,167,678	99	-9,527	-<1
low	555,931	24	-127,886	-23	-130,708	-24	643,056	116	87,124	16
unclassified (unknown rare plant potential)[h]	719	<1	-719	-100	-719	-100	0	0	-719	-100
Total	**2,277,376**	**100**	**-212,293**	**-9**	**-225,797**	**-10**	**2,277,376**	**100**	**n/a**	**n/a**

(a) Includes burns as modelled by ALCES®.

(b) Includes burns and cutblocks as modelled by ALCES®.

(c) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect effects due to surficial aquifer drawdown from PRM within the Regional Study Area (RSA), and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed during construction and operations. Excluding indirect effects due to surficial aquifer drawdown from PRM there is a total loss/alteration of -223,615 ha, within the RSA.

(d) Closure scenario includes reclamation of the PRM development areas. Values presented in this table do not include indirect effects due to surficial aquifer drawdown, as drawdown will occur primarily during the life of PRM. Drawdown effects on wetlands types surrounding pit lakes may extend to Closure. At Closure combined direct and indirect effects are predicted to cause an additional loss of 2, 182 ha (<1% of Resource) to wetlands.

(e) Net change is calculated as the difference between the PIC and Closure, a value upon which the environmental consequence after reclamation is assessed.

(f) For the purposes of this assessment, each category is assumed to be 100% of Resource at Pre-Industrial Case.

(g) % of Resource is calculated as a percentage of PIC area; the areas of this column are not additive.

(h) Describes those areas where the imagery of the earth's surface had been blocked during the image capture period.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 4.3-10 Traditional Use Plant Potential Within the Regional Study Area – Pre-Industrial Case

RSA Traditional Plant Potential	Pre-Industrial Case[a]		Loss/Alteration due to the 2013 Base Case[b]		Loss/Alteration due to the 2013 PRM[b][c] Application Case		Closure[a][d]		Net Change[e]	
	[ha]	% of RSA[f]	[ha]	% of Resource[g]	[ha]	% of Resource[g]	[ha]	% of Resource[g]	[ha]	% of Resource[g]
high	549,863	24	-135,619	-25	-138,390	-25	415,278	76	-134,585	-24
moderate	1,204,666	53	-114,263	-9	-122,083	-10	1,088,271	90	-116,395	-10
low	522,128	23	38,307	7	35,395	7	773,827	148	251,698	48
unclassified (unknown rare plant potential)[h]	719	<1	-719	-100	-719	-100	0	0	-719	-100
Total	**2,277,376**	**100**	**-212,293**	**-9**	**-225,797**	**-10**	**2,277,376**	**100**	**n/a**	**n/a**

(a) Includes burns as modelled by ALCES®.

(b) Includes burns and cutblocks as modelled by ALCES®.

(c) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect effects due to surficial aquifer drawdown from PRM within the Regional Study Area (RSA), and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed during construction and operations. Excluding indirect effects due to surficial aquifer drawdown from PRM there is a total loss/alteration of -223,615 ha, within the RSA.

(d) Closure scenario includes reclamation of the PRM development areas. Values presented in this table do not include indirect effects due to surficial aquifer drawdown, as drawdown will occur primarily during the life of PRM. Drawdown effects on wetlands types surrounding pit lakes may extend to Closure. At Closure combined direct and indirect effects are predicted to cause an additional loss of 2, 182 ha (<1% of Resource) to wetlands.

(e) Net change is calculated as the difference between the PIC and Closure, a value upon which the environmental consequence after reclamation is assessed.

(f) For the purposes of this assessment, each category is assumed to be 100% of Resource at Pre-Industrial Case.

(g) % of Resource is calculated as a percentage of PIC area; the areas of this column are not additive.

(h) Describes those areas where the imagery of the earth's surface had been blocked during the image capture period.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

4.3.3.2 Residual Impact Classification During Construction and Operations

The environmental consequences on terrestrial vegetation, wetlands and forest resources in the RSA are assessed during construction and operations from the PIC to the 2013 PRM Application Case and are provided in Table 4.3-11. Of the seven KIRs and vegetation resources assessed, based on either the PRM's direct effects (i.e., footprint), or direct and indirect effects (i.e., footprint and drawdown), all seven KIRs and vegetation resources are predicted to have negative effects during construction and operations. However, the majority of effects to terrestrial vegetation, wetlands and forest resources from the PIC to the 2013 PRM Application Case are due to disturbances prior to the construction and operation of PRM (i.e., PIC to 2013 Base Case). As a result, the environmental consequences of effects from the PIC to the 2013 PRM Application Case are the same as those from the PIC to the 2013 Base Case for all KIRs and vegetation resources (Table 4.3-11).

Table 4.3-11 Residual Impact Classification for the Effects on Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Component Criteria	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (RSA)[a]	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[b]
terrestrial vegetation (uplands)[c]	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
lichen jack pine communities[c]	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
old growth forests[c]	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)	moderate (+15)
wetlands (including peatlands and patterned fens)[d]	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)	moderate (+15)
high rare plant potential[d]	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)	moderate (+15)
productive forests[c]	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
high traditional use plant potential[c]	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)

(a) RSA Environmental Consequence magnitude is based on percent of resource in the RSA at PIC.

(b) Application Case includes all existing and approved projects plus PRM.

(c) Assessed based on direct effects.

(d) Assessed based on direct and indirect effects.

Note: Numerical scores for ranking of environmental consequence are explained in EIA, Volume 3, Section 1.3.6.

4.3.3.3 Environmental Significance Determination During Construction and Operations

This section presents the environmental significance determination for Terrestrial Vegetation, Wetlands and Forest Resources at construction and operations. The CEAA (2012, internet site) states that significance should be determined only after taking into account any appropriate mitigation measures. Assessment methods for the determination of significance are discussed in Appendix 3.1, Section 2.8.3.

4.3.3.3.1 Ecological Thresholds

Ecological thresholds were used to assess all vegetation KIRs except productive forests and high traditional use plant areas because these vegetation KIRs are defined by human use rather than ecological function. Therefore ecological thresholds cannot be meaningfully applied to these KIRs. Environmental significance from PIC to 2013 PRM Application Case during construction and operations was determined as follows:

- Losses to terrestrial vegetation (uplands), lichen jack pine communities, old growth forests, wetlands (including peatlands and patterned fens) and high rare plant potential resulting from the PIC to 2013 PRM Application Case during construction and operations are considered Adverse effects.
- The losses to the aforementioned vegetation KIRs are considered Likely effects.
- Adverse effects to terrestrial vegetation (uplands) are predicted to be high magnitude and high environmental consequence (Table 4.3-11). Estimates of terrestrial vegetation (uplands) indicate a large amount of this resource exists in the RSA at 2013 Base Case (i.e., 620,630 ha) suggesting that ecological function will be maintained in the RSA despite a 21% loss during construction and operations. Error within the regional land cover classification likely resulted in an underestimation of terrestrial vegetation indicating that more is present in the RSA than predicted (Section 4.3.3.1.3). Therefore, effects on terrestrial vegetation (uplands) are considered Not Significant.
- Adverse effects to lichen jack pine communities are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-11). Error due to the regional land cover classification resulted in a four-fold overestimation of the extent of coniferous jack pine stands in the RSA (Section 4.3.3.1.3). Therefore, this RLCC is rarer in the RSA than predicted. Information is not available to evaluate the amount of lichen jack pine habitat required to maintain the ecological function of this vegetation community; therefore, ecological thresholds could not be assessed for the lichen jack pine KIR. Significance for this KIR was assessed using the resource management criteria (Section 4.3.3.5.2).
- Adverse effects to old growth forests are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-11). Error due to regional land cover misclassification likely resulted in an overall underestimation of old growth forest suggesting that this resource is more abundant in the RSA than predicted (Section 4.3.3.1.3). Based on the large amount of terrestrial vegetation present in the RSA (i.e., 620,630 ha at 2013 Base Case), it is likely that there is sufficient mature forest present to maintain the ecological function of remaining old growth forests because undisturbed patches of mature forest will become old growth forest. Therefore, effects on old growth forest are considered Not Significant.
- Adverse effects to wetlands (including peatlands and patterned fens) are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-11). Error due to regional land cover classification resulted in a 10% overestimation of wetlands in the RSA. Although, there may be fewer

wetlands in the RSA than predicted, they are abundant in the RSA (*Terrestrial Vegetation, Wetlands and Forest Resources Environmental Setting Report*, Golder 2007b, Section 3.4.2.1) and a 13% loss at construction and operations is not predicted to compromise the ecological function of remaining wetlands in the RSA. Therefore, effects on wetlands (including peatlands and patterned fens) are considered Not Significant.

- Adverse effects to high rare plant potential areas are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-11). Error due to the regional land cover classification resulted in a 30% underestimate of rare plant potential areas in the RSA suggesting that this resource is more abundant in the RSA than predicted (Section 4.3.3.1.3). Because there are no native, endemic rare plants in the Oil Sands Region, and because high rare plant potential is largely associated with wetlands, which are abundant in the RSA, the loss of 15% of this resource is not predicted to compromise the ecological function of the remaining communities with high rare plant potential. Therefore, effects on high rare plant potential areas are considered Not Significant.

4.3.3.3.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). High magnitude, Adverse and Likely effects are predicted for terrestrial vegetation (uplands) and high traditional use plant potential. Adverse effects to those KIRs during construction and operations are therefore determined to be Significant according to resource management criteria.

Additional consideration was given to lichen jack pine communities because there was a large amount of error associated with the classification of this community (i.e., coniferous jack pine; Section 4.3.3.1.3). Therefore, the predicted 13% loss of this resource may underestimate the amount lichen jack pine habitat that will be lost in the RSA. Because the coniferous jack pine RLCC is relatively evenly distributed in the RSA (*Terrestrial Vegetation, Wetlands and Forest Resources Environmental Setting Report*, Golder 2007b, Section 3.4.2.1), it is unlikely that 40% more lichen jack pine habitat will be disturbed than predicted. However, using a precautionary approach, error in the RLCC model could result in a high magnitude effect for lichen jack pine communities. Therefore, effects to lichen jack pine communities are determined to be Likely, Adverse and Significant.

Additional consideration was also given to old growth forests because of the error associated with the regional land cover classification and the magnitude of the effect on old growth forest was 18%, which is close to the 20% resource management threshold. Error due to regional land cover classification was difficult to quantify for old growth forests but was likely minimal and expected to result an overall underestimation of old growth forest potential area in the RSA (Section 4.3.3.1.3). The assessment of old growth is conservative because it does not account for existing mature forest that will become old growth if it is not disturbed. Therefore, error associated with the regional land cover classification was not predicted to result in a high magnitude effect for old growth forests.

Accounting for error associated with the RLCC model, effects to old growth forests, wetlands (including peatlands and patterned fens), productive forests and high rare plant potential are determined to be Likely, Adverse and Not Significant.

4.3.3.4 Residual Impact Classification at Closure

The residual impacts and environmental consequences of effects from the 2013 PRM Application Case at Closure compared to the PIC are shown in Table 4.3-12. All the effects on the KIRs and vegetation resources assessed are negative with low to high environmental consequences. A large portion of effects to terrestrial vegetation, wetlands and forest resources between the PIC and the 2013 PRM Application Case at Closure are due to changes between the PIC and the 2013 Base Case. As a result, the environmental consequences of effects for the 2013 PRM Application Case at Closure are the same as those from the PIC to the 2013 Base Case at Closure for vegetation KIRs and vegetation resources.

Table 4.3-12 Residual Impact Classification for Effects on Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: Closure

Component Criteria	Direction	Magnitude[(a)]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (RSA)[(b)]
terrestrial vegetation (uplands)	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
lichen jack pine communities	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
old growth forests	negative	moderate (+10)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)
wetlands (including peatlands and patterned fens)	negative	moderate (+10)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)
high rare plant potential	negative	moderate (+10)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)
productive forests	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
high traditional use plants potential	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)

(a) Assessed based on direct effects.

(b) Application Case includes all existing and approved projects plus PRM.

n/a = Not applicable.

Note: Numerical scores for ranking of environmental consequence are explained in EIA, Volume 3, Section 1.3.6.

4.3.3.5 Environmental Significance Determination at Closure

This section presents the environmental significance determination for Terrestrial Vegetation, Wetlands and Forest Resources at Closure. The CEAA (2012, internet site) states that significance should be determined only after taking into account any appropriate mitigation measures. Assessment methods for the determination of significance are discussed in Appendix 3.1, Section 2.8.3.

4.3.3.5.1 Ecological Thresholds

Ecological thresholds were used to assess all vegetation KIRs except productive forests and high traditional use plant areas because these vegetation KIRs are defined by human use rather than ecological function. Therefore ecological thresholds cannot be meaningfully applied to these KIRs. Environmental significance from PIC to 2013 PRM Application Case at Closure was determined as follows:

- Losses to terrestrial vegetation (uplands), lichen jack pine communities, old growth forests, wetlands (including peatlands and patterned fens) and high rare plant potential resulting from the PIC to 2013 PRM Application Case at Closure are considered Adverse effects.
- The losses to the aforementioned vegetation KIRs are considered Likely effects.
- Adverse effects to terrestrial vegetation (uplands) are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-12). Effects to terrestrial vegetation are reversible at Closure and are therefore considered Not Significant.
- Adverse effects to lichen jack pine communities are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-12). Error due to the regional land cover classification resulted in a four-fold overestimation of the extent of coniferous jack pine stands in the RSA (Section 4.3.3.1.3). Therefore, this RLCC is more rare in the RSA than predicted. Information is not available to evaluate the amount of lichen jack pine habitat required to maintain the ecological function of this vegetation community; therefore, ecological thresholds could not be assessed for the lichen jack pine KIR. Significance for this KIR was assessed using the resource management criteria (Section 4.3.3.5.2).
- Adverse effects to old growth forests are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-12). Error due to regional land cover misclassification likely resulted in an overall underestimation of old growth forest suggesting that this resource is more abundant in the RSA than predicted (Section 4.3.3.1.3). Old growth forests are not expected to be re-established within the 80-year period defined for the Closure scenario. However, the proportion of old growth forests in the RSA is predicted to return to its pre-disturbance proportions in 100 years or more, depending on the tree species (Andison 2003; Schneider 2001). Thus at Closure, the moderate magnitude loss of old growth forests is considered Not Significant (Table 4.3-7).
- Adverse effects to wetlands (including peatlands and patterned fens) are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-12). Non-treed wetlands at Far Future are predicted to increase based on the assumptions that linear disturbance in wetlands will naturally regenerate to non-treed wetlands, and that non-treed wetlands such as marsh (MONG), shrubland (Sh) or shrubby swamp (SONS) are a consistent component of reclamation plans. Accounting for error in the RLCC model, wetlands are abundant in the RSA (i.e., 119,936 ha in the RSA at the 2013 Base Case; Section 4.3.3.1.1, Table 4.3-6) and a 12% loss at Closure is not predicted to change the ecological function of this vegetation community. Therefore, effects on wetlands (including peatlands and patterned fens) are considered Not Significant.
- Adverse effects to high rare plant potential areas are predicted to be moderate magnitude and moderate environmental consequence (Table 4.3-12). Error due to the regional land cover classification resulted in a 30% underestimate of rare plant potential areas in the RSA suggesting that this resource is more abundant in the RSA than predicted (Section 4.3.3.1.3). Because there are no native, endemic rare plants in the Oil

Sands Region, and because high rare plant potential is largely associated with wetlands, which are abundant in the RSA, the loss of 14% of this resource is not predicted to compromise the ecological function of remaining communities with high rare plant potential. Therefore, effects on high rare plant potential areas are considered Not Significant.

4.3.3.5.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). High magnitude, Adverse and Likely effects are predicted for high traditional use plant potential in the RSA at Closure. Therefore, effects to high traditional use plant potential at Closure are determined to be Significant.

Additional consideration was given to the terrestrial vegetation (upland) community because of the error associated with the regional land cover classification and the magnitude of the effect on terrestrial vegetation was 20%. Although close, it did not exceed the resource management criteria. Error within the regional land cover classification likely resulted in an underestimation of terrestrial vegetation indicating that more is present in the RSA than predicted (Section 4.3.3.1.3). It is unlikely that a higher proportion of terrestrial vegetation will be disturbed than predicted. However, using a precautionary approach, error in the RLCC model could result in a high magnitude effect for terrestrial vegetation. Therefore, effects to terrestrial vegetation communities are determined to be Likely, Adverse and Significant.

Accounting for error associated with the RLCC model, effects to old growth forests, wetlands (including peatlands and patterned fens), productive forests and high rare plant potential are determined to be Likely, Adverse and Not Significant.

4.3.4 Wildlife and Wildlife Habitat

The effects of PRM and JME in combination with existing and approved developments on wildlife and wildlife habitat were assessed in the EIA and the Species at Rick Assessment in the *May 2011, Submission of Information to the Joint Review Panel*.

The environmental consequences and significance of the effects of changes in the RSA from the PIC to the 2013 Base Case and 2013 PRM Application Case for wildlife are quantitatively assessed prior to reclamation and assume that all disturbances occur simultaneously. Therefore, assessed environmental consequences and determinations of significance represent worst-case scenarios. The actual loss of habitat at any point in time will be less than predicted due to the phased nature and reclamation of the PRM and other existing and approved developments. There is a regulatory requirement to reclaim wildlife habitats disturbed by the PRM footprint at completion. The assessment is conservative because predicted environmental consequences are likely more adverse than what may actually take place. There will be a reduction in environmental consequence as wildlife habitat redevelops and wildlife populations return to the reclaimed landscape from neighbouring source populations.

Federally listed SAR were included as KIRs. Effects to little brown myotis and northern myotis were not previously assessed because they were not listed by COSEWIC until February of 2012 (COSEWIC 2012a, 2012b), but they are assessed here. Development in the RSA is not predicted to affect the abundance of Eskimo curlew and northern leopard frog, which do not breed in northeastern Alberta. Historical data on these species within the Oil Sands Region are not available. These two species are not assessed.

The effects of landscape changes on the abundance of wildlife from the PIC to the 2013 Base Case and 2013 PRM Application Case are assessed by considering available information on historical population trends and the factors that are known or suspected to limit populations of KIRs in the RSA. Quantitative modelling (i.e., a Population Viability Analysis [PVA]; Appendix 3.7, Section 3) is used for estimating the effects of landscape change on moose and black bear populations, for which sufficient data on demographic rates exist to conduct such an analysis. Where sufficient information is not available to assess the effects of landscape change on wildlife abundance, the results of habitat modelling (Appendix 3.7, Section 1) are used as a proxy, under the conservative assumption that abundance is directly related to the availability of habitat. Habitat effects were only considered as a proxy for predicting effects to abundance if development in the RSA was a causative factor in the decline of the KIR. Details regarding population trends, factors limiting populations, and relevant information from quantitative modelling are summarized for each KIR below.

The environmental consequences of changes to wildlife abundance, habitat and movement are assessed during operations from the PIC to the 2013 Base Case and 2013 PRM Application Case. The majority of effects to wildlife abundance, habitat and movement from the PIC to the 2013 PRM Application Case have occurred from the PIC to the 2013 Base Case. The environmental consequences of changes to high suitability wildlife habitat are assessed prior to reclamation from the PIC to the 2013 Base Case and to the 2013 PRM Application Case using output from habitat suitability models and ecological context based on available data and peer-reviewed literature to help determine effect magnitudes (Appendix 3.7, Section 1.3). On average, about 98% of habitat effects from the PIC to the 2013 PRM Application Case are due to disturbances that are present in the 2013 Base Case. For context, 2013 Base Case disturbances comprise 14% of the RSA, while construction of PRM will result in an additional disturbance of less than 1% of the RSA (Table 2.4-3).

Effects to wildlife movement are assessed in part through a linkage zone analysis of the RSA, which shows a high magnitude increase from the PIC to the 2013 Base Case and 2013 PRM Application Case for moose (Appendix 3.7, Section 4.0). Other wide-ranging terrestrial wildlife species are expected to experience similar effects to movement, while less vagile species (e.g., Canadian toad and western toad), avian species and myotis species (i.e., volant species) will be affected to a lesser degree.

4.3.4.1 Environmental Significance Determination During Construction and Operations

Ecological thresholds and resource management criteria were applied to determine significance of adverse effects for wildlife KIRs. The two approaches were conducted in parallel for each KIR and do not always provide identical results. Methods are presented in full in Appendix 3.1 (Section 2.8.3), along with a discussion of the advantages and disadvantages of each approach. The approaches as they apply to wildlife KIRs are summarized below in Sections 4.3.4.1.1 and 4.3.4.1.2.

4.3.4.1.1 Ecological Thresholds

The concept of ecological context is considered explicitly in the determination of significance through the consideration of adaptability and resilience. Adaptability refers to the ability of an ecological system, and in this case a wildlife species' population, to accommodate disturbance and remain more or less unchanged. Resilience is the ability of an ecological system to recover from a disturbance (Holling 1973; Levin et al. 1998). Highly resilient wildlife KIRs have the potential to recover quickly after disturbance and reclamation, whereas KIRs with low resilience will recover more slowly or may not recover. The ability to absorb or accommodate disturbance is a property of the KIR within the RSA and is not necessarily related to its provincial or federal status. For example, a wildlife species that is highly threatened provincially or federally may also have low adaptability and resilience at the RSA scale, or it may have a robust population within the RSA that is both adaptable and resilient. Ecological thresholds are used to identify boundaries that can be applied to the conservation and management of species and ecosystems.

Cumulative effects are considered to be significant if they exceed ecological thresholds and compromise resilience and adaptability such that wildlife populations are likely to no longer be self-sustaining and ecologically effective. However, a wildlife species' population that is not self-sustaining or ecologically effective does not represent a significant effect if cumulative effects within the RSA are not likely to be causal or contributing factors to the compromised resilience of that population. For example, if a species is declining in Alberta or across its North American range, but the cause of the decline is not associated with PRM or cumulative effects within the RSA, then the effects of cumulative effects within the RSA would be not significant. Little brown myotis (Section 4.3.4.2.12), northern myotis (Section 4.3.4.2.13) and western toad (Section 4.3.4.2.19) are primarily limited by disease unrelated to the effects of development in the RSA, and therefore the cumulative effects of development in the RSA are likely not significant for these species according to the ecological thresholds approach to determining significance.

To be conservative in the assessment of effects and the treatment of uncertainty, an effect is determined to be significant unless scientific evidence is compelling that a threshold is not likely to be exceeded, or that cumulative effects in the RSA are not causative or contributing factors in the exceedance of an ecological threshold.

4.3.4.1.2 Resource Management Criteria

Recent JRP decision reports for oil sands mines (Joint Review Panel for the Joslyn North Mine Project 2011, Joint Review Panel for the Shell Canada Energy Jackpine Mine Expansion Project 2013) have identified the following criteria, which are applied to the determination of significance for effects to terrestrial resources:

- an adverse effect that exceeds 20% of a resource at the RSA scale is determined to be significant.
- any adverse effect to federally listed species at risk is determined to be significant.

Each of these criteria was applied to adverse effects to each wildlife KIR to determine whether a significant cumulative effect was present. In cases where habitat was used as a surrogate for populations when evaluating the 20% loss criterion, only high and, occasionally, moderate-high quality habitats were considered. In this assessment, effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1).

4.3.4.2 Assessment Results

Assessment results are provided for the cumulative effects of changes from the PIC to the 2013 PRM Application Case to wildlife and wildlife habitat for each of the wildlife KIRs below.

4.3.4.2.1 Barred Owl

The barred owl is provincially listed as "Sensitive" and is not listed federally (ASRD 2010b, internet site). Information on barred owl population trends in Alberta is limited because no long-term surveys for this species have been established. In a review of historical records, Priestley (2004) showed that barred owls have been and continue to be distributed throughout much of the Boreal Forest, Parkland, Foothill and Rocky Mountain

Natural Regions of Alberta. The update to the Alberta Breeding Bird Atlas (2001 to 2005) found the barred owl was fairly stable throughout its range since the first atlas (1987 to 1991) and is increasing in the Boreal Forest Natural Region, although this may have been an artefact of increased survey effort in that region (Penner 2007). An analysis of Breeding Bird Survey (BBS) data by Environment Canada (2013, internet site) shows the barred owl population increasing at an average rate of 6% per year across Canada from 1972 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that barred owl populations in Alberta have increased by 4.7% per year from 1968 to 2011. However, breeding bird survey data are not designed for surveying for owls, and the accuracy of trends estimated from those data are therefore unknown.

Barred owls inhabit old growth mixedwood forests upon which they are dependent for nesting and brood-rearing (ASRD 2005; Olsen et al. 2006, internet site; Priestley 2004). As such, the clearing of old growth forest is believed to be the primary threat to barred owl populations in Alberta (ASRD 2005). In addition to the effects of direct habitat loss, barred owls also may be sensitive to indirect habitat loss due to the likely predation risk presented by great horned owls near large clearings (Russell 2008).

4.3.4.2.1.1 Environmental Consequences (Barred Owl)

Due to the sensitivity of barred owl populations to the clearing of old growth forest, it is likely that the effects of landscape change in the RSA have resulted in a population decline. Habitat suitability modelling estimates a 36% decline in high suitability habitat from the PIC to the 2013 Base Case, and a 37% decline from the PIC to the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a potential high magnitude decline in barred owl abundance and habitat in the RSA from the PIC to the 2013 Base Case and 2013 PRM Application Case (Table 4.3-13).

The effects of development on the movement of barred owl in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on barred owl in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-13 Residual Impact Classification for Effects on Barred Owl in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[b]
Abundance	negative	high (+15)	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)
Habitat	negative	high (+15)	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)
Movement	negative	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)
Net Effects	negative	high (+15)	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.1.2 Environmental Significance Determination During Construction and Operations (Barred Owl)

4.3.4.2.1.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on barred owl is high. Losses of high suitability habitat are predicted to be 36% from the PIC to the 2013 Base Case and 37% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for barred owl in the RSA (i.e., mixedwood aspen-jack pine and mixedwood aspen-white spruce) are estimated to have a classification error of 30%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Where high suitability habitat was misclassified because of errors in the regional land cover classification, the majority of the error was due to a misclassification of mixedwood forest as deciduous, which is considered to be moderate suitability habitat for barred owl. Classification error has also lead to an overall 24% underestimation of high suitability habitat for barred owls in the RSA, indicating that more high quality barred owl habitat is present in the RSA than was predicted by the habitat model. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds. Given the predicted areal extent of remaining high suitability habitat in the RSA (140,477 ha in the 2013 PRM Application Case; Appendix 3.7, Table 1.3-1) and data suggesting that the barred owl population in boreal Alberta is relatively stable or at worst slowly declining, it is unlikely that the barred owl population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to barred owl in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the barred owl population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the barred owl population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effect is considered Likely.

Therefore, the effects on barred owl between the 2013 PRM Application Case and PIC are considered Likely, Adverse, but Not Significant.

4.3.4.2.1.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects which exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on barred owl abundance are likely adverse and high in magnitude, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for barred owl according to resource management criteria.

4.3.4.2.2 Beaver

Beavers are provincially listed as "Secure" and not listed federally (ASRD 2010b, internet site). Beavers are considered keystone species because by building dams to modify and create their habitat, they exert a strong influence on aquatic and riparian communities (Baker and Hill 2003; Boyle and Owens 2007). Unregulated fur trade harvest coupled with habitat destruction led to severe declines in the North American population of beavers by 1900 (Boyle and Owens 2007). However, due to harvest regulations, protection of wetlands, translocation efforts and natural dispersal, the beaver population has been restored and is now stable throughout much of its range, including Alberta (ASRD 2010b, internet site; Boyle and Owens 2007) and beaver is considered a nuisance species in many locales.

Currently, the principal threats to beaver populations are anthropogenic habitat destruction and degradation (Boyle and Owens 2007). Water storage, diversion and channelization affect beaver habitat by changing seasonal flow regimes and stream morphology, and causing loss or degradation of riparian vegetation used as forage (Boyle and Owens 2007). For example, unseasonably low water levels can cause decreased accessibility to food and leave beavers vulnerable to predation, while unseasonably high water levels can wash away food caches or cause dams to burst (Boyle and Owens 2007). The trapping and shooting of beavers to reduce beaver damage is considered a localized threat (Boyle and Owens 2007).

4.3.4.2.2.1 Environmental Consequences (Beaver)

Reliable data are not available for historical population trends of beaver in the RSA. Due to the sensitivity of beavers to habitat alterations, to be conservative, regional population trends for beaver may be inferred from changes to habitat. Landscape changes in the RSA from the PIC to the 2013 Base Case and from the PIC to the 2013 PRM Application Case prior to reclamation have resulted in declines in high suitability beaver habitat of 13% (Appendix 3.7, Section 1). This suggests a potential decline in beaver abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case (Table 4.3-14).

The effects of development on the movement of beaver in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on beaver in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-14 Residual Impact Classification for Effects on Beaver in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[(a)]		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(b)]
Abundance	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.2.2 Environmental Significance Determination During Construction and Operations (Beaver)

4.3.4.2.2.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on beaver is moderate. Losses of high suitability habitat are predicted to be 13% from the PIC to the 2013 Base Case and 13% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for beaver in the RSA (i.e., water, upland and treed fen) are estimated to have a classification error of 8%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Where high suitability habitat was misclassified because of errors in the regional land cover classification, the majority of the error was due to a misclassification of upland as wetland, which is considered to be moderate suitability habitat. Classification error has also lead to an overall 30% underestimation of high suitability habitat for beaver in the RSA, indicating that more high quality beaver habitat is present in the RSA than was predicted by the habitat model. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, indicating that the model would overpredict the potential for landscape changes to exceed ecological thresholds based on the amount of high suitability habitat remaining.

Given the predicted areal extent of remaining high suitability habitat in the RSA (509,023 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1), it is unlikely that the beaver population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to beaver in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the beaver population in the RSA are considered Adverse effects.

- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the beaver population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on beaver between the 2013 PRM Application Case and PIC are considered Likely, Adverse, but Not Significant.

4.3.4.2.2.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on beaver abundance are likely adverse and moderate in magnitude and beaver is not a federally listed species, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Not Significant for beaver according to resource management criteria.

4.3.4.2.3 Black Bear

The black bear is considered "Not at Risk" federally and is not listed by SARA (Government of Canada 2013, internet site). Provincially, the black bear is listed as "Secure" (ASRD 2010, internet site), and is permitted to be hunted using bait in the Oil Sands Region (Alberta Government 2013, internet site).

Black bears are widely distributed and occupy all major forested habitats in the province (Gunson 1993). The black bear population in Alberta has increased in recent years due to improvements in habitat associated with the partial clearing of forests for roads, trails and other developments (ASRD 2010a, internet site). In addition, recent sightings in the City of Edmonton and other areas of central Alberta suggest the species may be extending its range into former habitats (ASRD 2011).

Black bears can be highly tolerant of oil developments, including roads (Tietje and Ruff 1983). The greatest threat to black bear populations is mortality by man, either due to hunting, the destruction of animals that become nuisances due to attraction to garbage, or accidental collisions with vehicles.

4.3.4.2.3.1 Environmental Consequences (Black Bear)

Reliable data are not available for historical population trends of black bear in the RSA. The effects of landscape change on the black bear population in the RSA were estimated using a PVA. The carrying capacity of the RSA for black bear is estimated to have declined by 12% from the PIC to the 2013 Base Case and the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 3). This suggests a decline in black bear abundance in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case (Table 4.3-15).

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decline in high suitability black bear habitat that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case (Table 4.3-15).

The effects of development on the movement of black bear in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on black bear in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-15 Residual Impact Classification for Effects on Black Bear in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[b]
Abundance	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.3.2 Environmental Significance Determination During Construction and Operations (Black Bear)

4.3.4.2.3.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on black bear is moderate. Losses of high suitability habitat are predicted to be 11% from the PIC to the 2013 Base Case and 12% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for black bear in the RSA (i.e., upland excluding coniferous jackpine-black spruce forest) are estimated to have a classification error of 22%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Classification error has also lead to an overall 22% overestimation of high suitability habitat for black bear in the RSA. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds. Given the predicted areal extent of remaining high suitability habitat in the RSA (1,023,705 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1), it is unlikely that the black bear population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to black bear in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the black bear population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the black bear population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.

- The predicted effects are considered Likely.

Therefore, the effects on black bear between the 2013 PRM Application Case and PIC are Likely, Adverse, but Not Significant.

4.3.4.2.3.2.2 Resource Management

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on black bear abundance are likely adverse and moderate in magnitude and black bear is not a federally listed species, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Not Significant for black bear according to resource management criteria.

4.3.4.2.4 Black-Throated Green Warbler

The black-throated green warbler is not listed federally but is listed as "Special Concern" in Alberta due to suspected population declines and reliance on intact old growth stands (ASRD 2010b, internet site). An analysis of BBS data by Environment Canada (2013, internet site) shows the black-throated green warbler population decreasing at an average rate of 7.4% per year across Canada from 1970 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that black-throated green warbler populations in Alberta have declined by 7.4% per year from 1968 to 2011. ABMI (2012) reported that black-throated green warbler abundance was slightly lower than in undisturbed reference sites (i.e., 81% intactness) in the Boreal Plains Ecozone in Alberta, of which the Oil Sands Region is a part.

The decline in black-throated green warbler populations appears to be due to the direct and indirect effects of habitat loss. In Alberta, black-throated green warblers are associated with continuous white spruce and mixedwood old growth stands, and appear to avoid fragmented landscapes (Hobson and Bayne 2000a,b). An increase in disturbance and fragmentation of breeding habitat is likely the greatest cause of population declines and remains the greatest threat to persistence of the species (Morse and Poole 2005, internet site). Abundance tends to decrease in response to forest harvest (Hanowski et al. 2003). Disturbance may also increase the susceptibility of black-throated green warblers to nest predation by small mammals and brood parasitism by brown-headed cowbirds (Norton 1999). The loss of habitat on the wintering grounds likely compounds the rate of decline (ASRD 2010b, internet site).

4.3.4.2.4.1 Environmental Consequences (Black-Throated Green Warbler)

Due to the sensitivity of black-throated green warbler populations to the clearing of old growth forest, it is likely that the effects of landscape change in the RSA have resulted in a population decline. Assuming a 7.4% decline per year from 1968 to 2011 (Sauer et al. 2012, internet site) would result in an approximately 96% decline. Habitat suitability modelling estimates a 36% decline in high suitability habitat from the PIC to the 2013 Base Case, and a 37% decline from the PIC to the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a potential decline in black-throated green warbler abundance and habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case (Table 4.3-16).

The effects of development on the movement of black-throated green warbler in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on black-throated green warbler in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-16 Residual Impact Classification for Effects on Black-Throated Green Warbler in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[(a)]		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(b)]
Abundance	negative	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)
Habitat	negative	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.4.2 Environmental Significance Determination During Construction and Operations (Black-Throated Green Warbler)

4.3.4.2.4.2.1 Ecological Thresholds

The decline of the black-throated green warbler in Alberta has been estimated to be 7% per year between 1968 and 2011, which suggests a decline of 96% over that period (Sauer et al. 2012, internet site). The population trend estimated for black-throated green warbler is for Alberta, and is not specific to the RSA. However, if the black-throated green warbler population in the RSA has declined by as much as 96% from the PIC to the 2013 Base Case, it may be declining to extirpation and would therefore not be self-sustaining or ecologically effective. Given the known adverse effects of increased disturbance and fragmentation on the species and its affinity for old growth forest, increased development since the PIC in the RSA could be considered to be incrementally contributing to the decline of the black-throated green warbler population in the RSA. As has been the case throughout this assessment of effects of the 2013 PRM Application Case relative to the PIC, the majority of the effects have occurred between the PIC and the 2013 Base Case. For example, 98% of the high suitability black-throated green warbler habitat that is predicted to be lost from the PIC to the 2013 PRM Application Case was already lost from the PIC to the 2013 Base Case (Appendix 3.7, Section 1.3).

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on black-throated green warbler is high. Losses of high suitability habitat are predicted to be 36% from the PIC to the 2013 Base Case and 37% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for black-throated green warbler in the RSA (i.e., coniferous white spruce and mixedwood aspen-white spruce forest) are estimated to have a classification error of 31%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated.

Classification error has lead to an overall 54% underestimation of high suitability habitat for black-throated green warbler in the RSA, indicating that more high quality black-throated green warbler habitat is present in the RSA than was predicted by the habitat model. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds.

The following discusses the effects of changes in the RSA to black-throated green warbler in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the black-throated green warbler population in the RSA are considered Adverse effects.
- Available data suggest that black-throated green warbler populations in Alberta may be declining to extirpation. Given the known negative effects of increased disturbance and fragmentation on the species and its affinity for old growth forest, increased development in the RSA could be considered to be incrementally contributing to the decline of the black-throated green warbler population in the RSA. Therefore, cumulative effects of development in the RSA may have exceeded ecological thresholds for the black-throated green warbler population and the population may no longer be self-sustaining and ecologically effective. To be precautionary, these are considered Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on black-throated green warbler from the PIC to the 2013 PRM Application Case are Likely, Adverse and Significant.

4.3.4.2.4.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on black-throated green warbler abundance are high in magnitude, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for black-throated green warbler according to resource management criteria.

4.3.4.2.5 Canada Lynx

Canada lynx are not listed federally, but are listed as “Sensitive” in Alberta (ASRD 2010b, internet site). Lynx populations naturally cycle according to the abundance of their main prey, snowshoe hare (Krebs et al. 2001). Trapping of Canada lynx occurs in the Oil Sands Region. Reliable data are not available for historical population trends of Canada lynx in the RSA.

Concerns over the effect of habitat loss and fragmentation on lynx, along with the small population size during low cycle phases, resulted in lynx being listed as “Sensitive” in Alberta (ASRD 2010b, internet site) and trapping take is currently limited by a quota system. Although regenerating forest stands provide habitat for snowshoe hare and thus food sources for lynx, the loss of denning sites, reductions in the number and size of forest patches, and opening of habitat that facilitates access of generalist species (e.g., coyotes), suggest that lynx may be sensitive to human development (Buskirk et al. 2000; Squires et al. 2010).

4.3.4.2.5.1 Environmental Consequences (Canada Lynx)

Due to the sensitivity of Canada lynx populations to habitat loss and fragmentation, it is likely that the effects of landscape change in the RSA have resulted in a population decline. To be conservative, population trends for Canada lynx in the RSA may be inferred from changes to habitat. Landscape changes in the RSA from the PIC to the 2013 Base Case and from the PIC to the 2013 PRM Application Case prior to reclamation have resulted in declines in high and moderate-high suitability Canada lynx habitat of 18% and 19%, respectively (Appendix 3.7, Section 1). This suggests a potential decline in Canada lynx abundance and habitat that is moderate in magnitude and environmental consequence in the RSA from the PIC to the 2013 Base Case and the 2013 PRM Application Case (4.3-17).

The effects of development on the movement of Canada lynx in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on Canada lynx in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-17 Residual Impact Classification for Effects on Canada Lynx in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.5.2 Environmental Significance Determination During Construction and Operations (Canada Lynx)

4.3.4.2.5.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on Canada lynx is moderate. Losses of high and moderate-high suitability habitat are predicted to be 18% from the PIC to the 2013 Base Case and 19% from the PIC to the 2013 PRM Application Case. The cumulative effects of development in the RSA on Canada lynx habitat were predicted using an empirically derived RSF, for which model error was estimated through validation and the model was determined to perform moderately well (EIA, Volume 5, Appendix 5-4, Section 1.2.2). Nonetheless, the amount of high and moderate-high suitability habitat lost may be underestimated, and may exceed 20% to become a high magnitude effect. Therefore, classification error may increase the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (732,417 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1) and that lynx harvest is governed by quotas, it is unlikely that the Canada lynx population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to Canada lynx in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the Canada lynx population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the Canada lynx population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on Canada lynx between the 2013 PRM Application Case and PIC are considered Likely, Adverse, but Not Significant.

4.3.4.2.5.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Habitat loss is predicted to be less than 20% (i.e., 19% from the PIC to the 2013 PRM Application Case), but may exceed 20% after considering uncertainty due to model error. Therefore, to be conservative, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for Canada lynx according to resource management criteria.

4.3.4.2.6 Canadian Toad

The Canadian toad is listed as "May Be At Risk" provincially and is not listed federally (ASRD 2010b, internet site). Although there is little information on population trends of this species in Alberta, suspected population declines were documented in the southern part of province (Hamilton et al. 1998), while population increases have been estimated in the boreal forest (Brown 2009).

The main limiting factor affecting Canadian toad distribution in the boreal forest is likely the availability of suitable overwintering habitat (Hamilton et al. 1998; Roberts 2003, pers. comm.). Canadian toads hibernate below the frost line in burrows in upland habitats (Brown 2009). Poor burrowing ability restricts the availability of suitable overwintering habitat by restricting the types of substrate toads can utilize (Hamilton et al. 1998).

4.3.4.2.6.1 Environmental Consequences (Canadian Toad)

Reliable data are not available for historical population trends of Canadian toad in the RSA. However, due to the sensitivity of Canadian toad populations to the availability of overwintering habitat, it is likely that the effects of landscape change in the RSA may have resulted in a population decline. To be conservative, regional population trends for Canadian toad may be inferred from changes to habitat. Landscape changes in the RSA from the PIC to the 2013 Base Case and from the PIC to the 2013 PRM Application Case prior to reclamation have resulted in declines in high suitability Canadian toad habitat of 11% and 12%, respectively (Appendix 3.7, Section 1). This suggests a potential decline in Canadian toad abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case (Table 4.3-18).

The effects of development on the movement of Canadian toad in the RSA are predicted to result in a moderate environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on Canadian toad in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-18 Residual Impact Classification for Effects on Canadian Toad in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[(a)]		Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(c)]
Abundance	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Movement	negative	moderate (+10)	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)
Net Effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.6.2 Environmental Significance Determination During Construction and Operations (Canadian Toad)

4.3.4.2.6.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on Canadian toad is moderate. Losses of high suitability habitat are predicted to be 11% from the PIC to the 2013 Base Case and 12% from the PIC to the 2013 PRM Application Case. Model validation was conducted for the Canadian toad HSI model, and the model was determined to effectively distinguish between high, moderate and low suitability habitat (EIA, Volume 5, Appendix 5-4, Section 1.2.4). Although the amount of high suitability habitat lost may be underestimated, based on model validation results it is unlikely that habitat loss would exceed 20% and therefore become a high magnitude effect. Further, classification error has lead to no change in estimation of high suitability habitat for Canadian toad in the RSA. Therefore, model error due to regional land cover misclassification results in no change in the estimation of the potential of high suitability habitat in the RSA to support Canadian toads.

Given the predicted areal extent of remaining high suitability habitat in the RSA (169,707 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1), it is unlikely that the Canadian toad population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to Canadian toad in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the Canadian toad population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the Canadian toad population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on Canadian toad between the 2013 PRM Application Case and PIC are considered Likely, Adverse, but Not Significant.

4.3.4.2.6.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on Canadian toad abundance are predicted to be likely adverse and moderate in magnitude and Canadian toad is not a federally listed species, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Not Significant for Canadian toad according to resource management criteria.

4.3.4.2.7 Fisher

The fisher is provincially listed as “Sensitive” but has not been listed federally (ASRD 2010b, internet site). Reliable data are not available for historical population trends of fisher in the RSA. The primary threats to fisher populations are mortality due to trapping, and habitat loss and fragmentation due to forest clearing (Lofroth et al. 2010; Ruggiero et al. 1994; Weir 2003). Harvest in Alberta is limited by a quota system. Although fishers forage over large areas and within a mosaic of habitat types, they require forests with late successional attributes (i.e., closed canopy, large woody debris, large snags, tree cavities, and a well-developed understorey) to support a robust prey base (Lofroth et al. 2010; Weir and Lara Almuedo 2010).

4.3.4.2.7.1 Environmental Consequences (Fisher)

Although historical population trends of fisher in the RSA have not been documented, due to the sensitivity of fisher populations to the availability of suitable habitat, it is likely that the effects of landscape change in the RSA have resulted in a population decline. To be conservative, regional population trends for fisher may be inferred from changes to habitat. Landscape changes in the RSA have resulted in declines in high and moderate-high suitability fisher habitat of 15% from the PIC to the 2013 Base Case, and 16% from the PIC to the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a potential decline in fisher abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case (Table 4.3-19).

The effects of development on the movement of fisher in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on fisher in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-19 Residual Impact Classification for Effects on Fisher in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.7.2 Environmental Significance Determination During Construction and Operations (Fisher)

4.3.4.2.7.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on fisher is moderate. Losses of high and moderate-high suitability habitat are predicted to be 15% from the PIC to the 2013 Base Case and 16% from the PIC to the 2013 PRM Application Case. The cumulative effects of development in the RSA on fisher habitat were predicted using an empirically derived RSF, for which model error was estimated through validation and the model accuracy was determined to be low (EIA, Volume 5, Appendix 5-4, Section 1.2.2). Therefore, the amount of high and moderate-high suitability habitat lost may be underestimated, and may exceed 20% to become a high magnitude effect. However, given the predicted areal extent of remaining high and moderate-high suitability habitat in the RSA (846,962 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1) and that harvest is limited by a quota system, it is unlikely that the fisher population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to fisher in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the fisher population in the RSA are considered Adverse effects.

- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the fisher population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on fisher between the 2013 PRM Application Case and PIC are considered Likely, Adverse, but Not Significant.

4.3.4.2.7.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Habitat loss is predicted to be less than 20% (i.e., 16% from the PIC to the 2013 PRM Application Case), but may exceed 20% after considering uncertainty due to model error. Therefore, to be conservative, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for fisher according to resource management criteria.

4.3.4.2.8 Moose

Moose are listed as “Secure” in Alberta, and are not listed federally (ASRD 2010b, internet site). Moose populations naturally fluctuate due to climate variability (Saether 1997), predation (Post and Stenseth 1998), resource availability (Ferguson et al. 2000), and density dependent processes (Ferguson et al. 2000). Ungulate aerial surveys provide a means to track population changes; however, estimates have large error margins and survey costs limit the number of Wildlife Management Units (WMUs) surveyed each year. Of the WMUs in the RSA (i.e., WMUs 518, 519, 529, 530 and 531), only WMU 518 and the southern half of WMU 530 have been surveyed multiple times using the random stratified block method to allow for an accurate estimation of population trends (Skilnick 2013, pers. comm.). Survey results to do not appear to show a decline, although the error inherent in population density estimates may be obscuring a decline, if one exists. As a result, ESRD considers the moose populations of WMUs 518 and 530 to be “potentially stable” (Skilnick 2013, pers. comm.). Surveys were conducted in WMU 531 in 1994, 2001 and 2009, and although a direct comparison between years is difficult due to varying survey methods, moose abundance in WMU 531 does appear to have declined (Morgan and Powell 2009; Skilnick 2013, pers. comm.). The WMU immediately south of the RSA, WMU 516, was surveyed in 1994, 1998, 2003 and 2011. Estimates from these surveys indicate the population has remained relatively stable, as the upper and lower estimates overlap between years, and the 1994 and 2011 population size estimates were 919 and 933, respectively (Nordstrom and Ranger 2011).

Percent hunter success resulting from harvesting tends to be strongly and linearly related to population size, and is therefore another means to monitor population trends (Roseberry and Woolf 1991). Hunter success for WMUs in the RSA has ranged from 12.1% to 100% between 2007 and 2012; however no statistically significant linear trend was detected over that period. Hunter success was higher for WMU 519 through the early 2000s, suggesting that the population increased at that time; however, success rate has remained lower in recent years. Harvest by First Nations continues to remain undocumented. While there is uncertainty around population size and trends, these available data do not indicate major changes are occurring in moose population size in the RSA.

Factors that can lead to moose population declines include disease, malnutrition due to habitat loss or increased competition, heat stress, over harvest, and/or predation (Murray et al. 2006). ALCES (2013) speculated that reduced moose populations in northeastern Alberta are most likely the result of increased mortality rates associated with higher human populations, increased access, and more trucks and off-highway vehicles. Moose are susceptible to heat stress and southern populations are expected to recede while northern populations increase as winters become less severe due to climate change (Dussault et al. 2004; Rempel 2011). Concurrent expansion of white-tailed deer populations are expected to increase contact with pathogens, while warmer climates may further facilitate pathogen transmission (Lankester 2010; Murray et al. 2006; Rempel 2011). In Alberta, winters are becoming less severe and white-tailed deer are expanding (Dawe 2011). Although the increased overlap between moose and white-tailed deer has not led to increased disease spread to date; the spread of white-tailed deer may lead to changes in boreal predator – prey dynamics and/or direct competition for resources (Latham et al. 2011; Murray et al. 2006). Increases in early seral forest across a landscape, as a result of regeneration after land use development, can increase abundance of moose as a result of higher quality and quantity of food resources (Boan et al. 2011).

4.3.4.2.8.1 Environmental Consequences (Moose)

Reliable data are only partially available for historical population trends of moose in the RSA. The effects of landscape change on the moose population in the RSA were estimated using a PVA. The carrying capacity of the RSA for moose is estimated to have declined by 12% from the PIC to the 2013 Base Case and the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 3). This is a reasonable and conservative estimate based on the available data, and suggests a decline in abundance in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case (Table 4.3-20).

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decline in high and moderate-high moose habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case (Table 4.3-20).

Table 4.3-20 Residual Impact Classification for Effects on Moose in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[(a)]		Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(c)]
Abundance	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

The effects of development on the movement of moose in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on moose in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

4.3.4.2.8.2 Environmental Significance Determination During Construction and Operations (Moose)

4.3.4.2.8.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on moose is moderate. Losses of high suitability habitat are predicted to be 12% from the PIC to the 2013 Base Case and 13% from the PIC to the 2013 PRM Application Case. The cumulative effects of development in the RSA on moose habitat were predicted using an empirically derived RSF, for which model error was estimated through validation and the model accuracy was determined to be low (EIA, Volume 5, Appendix 5-4, Section 1.2.2). Therefore, the amount of high suitability habitat lost may be underestimated, and may exceed 20% to become a high magnitude effect. However, given the predicted areal extent of remaining high suitability habitat in the RSA (809,111 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1) and data suggesting that the moose population may be slowly declining, it is unlikely that the moose population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to moose in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the moose population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the moose population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on moose between the 2013 PRM Application Case and PIC are considered Likely, Adverse, but Not Significant.

4.3.4.2.8.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Habitat loss is predicted to be less than 20% (i.e., 13% from the PIC to the 2013 PRM Application Case), but may exceed 20% after considering uncertainty due to model error. Therefore, to be conservative, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for moose according to resource management criteria.

4.3.4.2.9 Canada Warbler

The Canada warbler is federally listed as "Threatened" by COSEWIC (2008) and "Schedule 1: Threatened" by SARA (Government of Canada 2013, internet site). In Alberta, the Canada warbler is listed as "Sensitive" (ASRD 2010b, internet site). Alberta represents the western-most extension of the Canada warbler's range in North America (Semenchuk 1992). Canada supports approximately 80% of the Canada warbler's breeding range. According to Breeding Bird Survey (BBS) data, the Canadian population of Canada warblers has declined by 5.4% per year between 1997 and 2007, amounting to a population loss of 85% (COSEWIC 2008). An analysis of BBS data by Environment Canada (2013, internet site) estimates a 3.5% decline per year in the Alberta population from 1970 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that Canada warbler populations in Alberta appear to have decreased by 3.4% per year from 1968 to 2011, which would have resulted in a 77% decline in the population during that period. However, ABMI reported that Canada warbler abundance was similar to undisturbed reference conditions in the Boreal Plains Ecozone (i.e., 100% intactness) under existing conditions (ABMI 2012).

Habitat loss and degradation in the wintering and breeding range for Canada warbler could be responsible for their decline (COSEWIC 2008; Reitsma et al. 2010, internet site). On their breeding range, Canada warblers have lost habitat due to the draining of wetlands for agriculture and urban development in the northeastern part of their range and the clearing of boreal mixedwood forests for agriculture and industrial development associated with the pulp and paper and oil and gas sectors in the northwestern part of their range (COSEWIC 2008; Reitsma et al. 2010, internet site). In addition, the occurrence of breeding Canada warblers appears to be negatively affected by the proximity and length of paved roads in forested landscapes (COSEWIC 2008).

4.3.4.2.9.1 Environmental Consequences (Canada Warbler)

Canada warbler populations are likely sensitive to habitat alteration in the boreal forest. Therefore, landscape change in the RSA may have resulted in a population decline. An assumed 3.4% population decline per year from 1968 to 2011 (Sauer et al. 2012, internet site) would result in an approximately 77% total population decline. Habitat suitability modelling estimates a 52% decline in high suitability habitat from the PIC to both the 2013 Base Case and the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). Collectively, this suggests a potential decline in Canada warbler abundance and habitat that is high in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case in the RSA (Table 4.3-21).

The effects of development on the movement of Canada warbler in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on Canada warbler in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-21 Residual Impact Classification for Effects on Canada Warbler in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[(a)]		Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(c)]
Abundance	negative	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)
Habitat	negative	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.9.2 Environmental Significance Determination During Construction and Operations (Canada Warbler)

4.3.4.2.9.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on Canada warbler is high. Losses of high suitability habitat are predicted to be 52% from the PIC to both the 2013 Base Case and the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for Canada warbler in the RSA (i.e., deciduous aspen-balsam poplar) are estimated to have a classification error of 47%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. The majority of classification error for habitat predicted to be high suitability for Canada warbler was due to a misclassification of deciduous forest as mixedwood, which is considered to be moderate suitability habitat for Canada warbler. In addition, classification error may have lead to an overestimation of the amount of high suitability habitat that may be present in the RSA. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds.

In Alberta, the Canada warbler population may have declined by 77% from 1968 and 2011 (Sauer et al. 2012, internet site). Although the population trend estimated for Canada warbler for Alberta is not specific to the RSA, Canada warbler may be declining to extirpation. The decline of Canada warbler has been linked to both the loss of southern wintering habitat as well as the clearing of boreal mixedwood forests (COSEWIC 2008). However, the similarity of Canada warbler abundance in the Boreal Plains Ecozone under existing conditions relative to reference conditions (i.e., 100% intactness; ABMI 2012) suggests that this population decline is not due to habitat loss in the boreal forest. Nonetheless, to be conservative given uncertainty regarding the cause of the population decline in Alberta, it is assumed that development in the RSA has incrementally contributed to the decline of this species. There is a predicted 52% loss in high suitability habitat from the PIC to 89,021 ha of high suitability habitat remaining in the RSA in the 2013 PRM Application Case. Combined, the apparent population decline, high percentage habitat loss and relatively little high suitability habitat available, the Canada warbler population in the RSA may not be self-sustaining or ecologically effective. Canada warblers are infrequently recorded in the RSA during breeding bird point counts.

The following discusses the effects of changes in the RSA to Canada warbler in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the Canada warbler population in the RSA are considered Adverse effects.
- Available data on population trends and estimates of habitat loss and availability suggest that the Canada warbler population in the RSA may be declining to extirpation. To be conservative given uncertainty regarding the cause of the population decline in Alberta, it is assumed that development in the RSA has incrementally contributed to the decline of this species. Therefore, cumulative effects of development in the RSA may have exceeded ecological thresholds for Canada warbler such that its population would no longer be self-sustaining and ecologically effective. To be precautionary, these are considered Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on Canada warbler from the PIC to the 2013 PRM Application Case are considered Likely, Adverse and Significant.

4.3.4.2.9.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, due to the likely adverse and high magnitude effects on the abundance of this federally listed species, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for Canada warbler according to resource management criteria.

4.3.4.2.10 Common Nighthawk

The common nighthawk is listed as “Sensitive” in Alberta (ASRD 2010b, internet site), and is federally listed as “Threatened” by COSEWIC (2007a) and “Schedule 1: Threatened” by SARA (Government of Canada 2013, internet site) due to both short- and long-term population declines (COSEWIC 2007a). The population status of the common nighthawk is relatively unknown due to strong variations in local abundance (FAN 2007) and the difficulty of observing the species (MELP 1998). However, long-term data collected in Canada from 1968 to 2005 suggests a population decline (COSEWIC 2007a). An analysis of BBS data by Environment Canada (2013, internet site) shows the common nighthawk population declining at an average rate of 3% per year in Alberta from 1970 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that common nighthawk populations in Alberta have declined by 3.3% per year from 1968 to 2011. However, breeding bird survey data are not designed for surveying for common nighthawks, and the accuracy of trends estimated from those data are therefore unknown.

Reasons for the apparent decline of common nighthawk populations are not well understood, but may be due in part to diminishing populations of insect prey due to pesticide use (COSEWIC 2007a; Brigham et al. 2011, internet site). The main threat to common nighthawk populations in North America is suggested to be the loss and alteration of suitable breeding habitat (COSEWIC 2007a). For example, fire suppression and changes in harvesting practices have reduced the number of open areas in forested regions, and the loss of native prairie to intensive agriculture has reduced common nighthawk nesting habitat (COSEWIC 2007a).

4.3.4.2.10.1 Environmental Consequences (Common Nighthawk)

Common nighthawk populations are likely sensitive to habitat alteration in the boreal forest. Therefore, it is likely that the effects of landscape change in the RSA have resulted in a population decline. Habitat suitability modelling estimates a 9% decline in high suitability habitat from the PIC to both the 2013 Base Case and the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in common nighthawk abundance and habitat in the RSA that is low in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case (Table 4.3-22).

The effects of development on the movement of common nighthawk in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on common nighthawk in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-22 Residual Impact Classification for Effects on Common Nighthawk in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	low (+5)	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)
Habitat	negative	low (+5)	low +5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	low (+5)	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.10.2 Environmental Significance Determination During Construction and Operations (Common Nighthawk)

4.3.4.2.10.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on common nighthawk is low. Losses of high suitability habitat are predicted to be 9% from the PIC to the 2013 Base Case and 9% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for common nighthawk in the RSA (i.e., burns, coniferous jack pine) are estimated to have a classification error of 82% for jack pine habitat. The accuracy of burns in the RSA is difficult to estimate, as their spatial distribution is based on a stochastic simulation by ALCES of the expected average area burned over time (Appendix 3.1, Section 2.8.2). Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Classification error may have also lead to an overestimation of high suitability habitat for common nighthawk in the RSA. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (321,933 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1), and data suggesting a slow population decline over time, even after taking into consideration an underestimation of habitat loss and an overestimation of habitat availability due to model error, it is unlikely that the common nighthawk population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective. Common nighthawks are frequently recorded in the RSA and frequent disturbed areas.

The following discusses the effects of changes in the RSA to common nighthawk in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the common nighthawk population in the RSA are considered Adverse effects.
- Because common nighthawks are frequently recorded in the RSA and frequent disturbed areas, and due to the likely extent of remaining high suitability habitat, the cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the common nighthawk population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effect is considered Likely.

Therefore, the effects on common nighthawk between the 2013 PRM Application Case and PIC are considered Likely, Adverse, but Not Significant.

4.3.4.2.10.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because common nighthawk is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for common nighthawk according to resource management criteria.

4.3.4.2.11 Horned Grebe

The horned grebe is migratory, with over 90% of its breeding range occurring in Canada, and with a majority of the western population occurring in Alberta and Saskatchewan (COSEWIC 2009b). The horned grebe is federally listed as "Special Concern" by COSEWIC (2009c) but it is not listed by SARA (Government of Canada 2013, internet site). An analysis of BBS data by Environment Canada (2013, internet site) suggests that the horned grebe population in Alberta has been declining by 1.3% per year on average from 1970 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that the horned grebe population in Alberta has declined by 1.7% per year from 1968 to 2011, which would result in an approximately 52% decline over that period. The breeding range of horned grebes appears to be experiencing a northwestward contraction (COSEWIC 2009b).

The mechanisms responsible for the population decline of the horned grebe are unknown but several potential threats have been identified. Perhaps most importantly, habitat loss and degradation has occurred on their breeding range throughout the prairies where wetlands have been lost due to agricultural activity and degraded through eutrophication from the accumulation of fertilizers and other contaminants (COSEWIC 2009b). The bioaccumulation of toxins, as well as increased predation pressure may also be playing a role in the decline.

4.3.4.2.11.1 Environmental Consequences (Horned Grebe)

The decline in horned grebes has been largely attributed to the loss of wetlands on the prairies. As such, the Alberta-wide decline that has been reported is not likely compounded by habitat change in the boreal forest, where the availability of wetlands is not likely to be limiting. However, to be conservative, population trends for horned grebe in the RSA may be inferred from changes to habitat. Habitat suitability modelling estimates a decline in high suitability habitat of 19% from the PIC to the 2013 Base Case, and 20% from the PIC to the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in horned grebe abundance and habitat that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case in the RSA (Table 4.3-23).

The effects of development on the movement of horned grebe in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on horned grebe in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-23 Residual Impact Classification for Effects on Horned Grebe in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)
Habitat	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.11.2 Environmental Significance Determination During Construction and Operations (Horned Grebe)

4.3.4.2.11.2.1 Ecological Thresholds

Development in the RSA was assessed as having a moderate environmental consequence for effects on the abundance of horned grebe based on changes to habitat. However, it is unlikely that development in the RSA has contributed to declines of this species. Declines appear to be due to wetland loss in the prairies for horned grebe (COSEWIC 2009b). Losses of high suitability habitat are predicted to be 19% from the PIC to the 2013 Base Case and 20% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for horned grebe in the RSA (i.e., non-treed wetlands and areas of lakes within 25 m of shoreline) are estimated to have a classification error of 67%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated, and may exceed 20% to become a high magnitude effect. In addition, the amount of high suitability habitat in the RSA may have been overestimated. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted amount of remaining high quality habitat available in the RSA (229,596 ha in the 2013 PRM Application Case, Appendix 3.7, Section 1.3), the apparent slow population decline in Alberta and the likelihood that declines are due to wetland loss in the prairies rather than development in the boreal forest, it is unlikely that the horned grebe population in the RSA has been compromised by development to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to horned grebe in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on horned grebe are considered Adverse effects.

- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the horned grebe population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on horned grebe from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.11.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Habitat loss is not predicted to exceed 20% from the PIC to the 2013 PRM Application Case, but may exceed 20% after considering uncertainty due to model error. Therefore, to be conservative, and also because horned grebe is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for horned grebe according to resource management criteria.

4.3.4.2.12 Little Brown Myotis

The little brown myotis is provincially listed as “Secure” (ASRD 2010b, internet site) and federally listed as “Endangered” by COSEWIC (2012a, 2012b) due to the rapidly spreading WNS, which is a fungal disease that interferes with hibernation. This disease is spreading from the east and is not yet present in Alberta, but has been detected as far west as Manitoba. Once considered common and widely distributed, little brown myotis populations are now in sharp decline due to WNS, which has resulted in several local extirpations in the eastern portion of its range, and is ultimately expected to cause regional and possibly range-wide extinction in a very short ecological time frame (Frick et al. 2010). If WNS continues spreading at the current rate, the entire Canadian population would likely be impacted within 11 to 22 years (COSEWIC 2012a).

White-noise syndrome is the most important factor affecting the population trajectory of this species. Other factors that may affect populations of these species include access to winter hibernacula and summer roosting and foraging habitat. Winter hibernacula in the Alberta Oil Sands Region are only known from outside the RSA in Cadomin Cave and Wood Buffalo National Park (ASRD and ACA 2009; Barclay 2012, pers. comm.), and will not be affected by the PRM or development in the RSA. Hibernacula appear to be selected by bats for their high humidity and relatively stable, cool temperatures that are above freezing (Fenton 1970 in Kunz and Reichard 2010). Little brown myotis are considered to be habitat generalists with respect to their summer roosting and foraging habitat (Kunz and Reichard 2010). They form reproductive colonies in barns, attics, tree cavities and other places that remain dark throughout the day (Crampton and Barclay 1998).

4.3.4.2.12.1 Environmental Consequences (Little Brown Myotis)

Little brown myotis are primarily limited by WNS across their range. Prior to the arrival of WNS in Alberta, the availability of hibernacula may be limiting regional abundance of this species. When the number of hibernacula, typically caves, is low, bat populations are clumped and the risk of effects such as predation and disease is increased (ASRD and ACA 2009; Caceres and Pybus 1997). However, no hibernacula are likely to occur within the RSA. Summer roosting and foraging requirements are general and therefore not likely to be limiting to regional abundance of little brown myotis given that 80% of the RSA remains undisturbed in the 2013 PDC. Therefore, effects to abundance may be assessed qualitatively by taking into consideration the small risks of mortality due to development in the RSA, which are predicted to be limited to the effects of sensory disturbance on population abundance. Interactions with infrastructure and direct mortality due to site clearing and vehicle collisions are unlikely to affect the abundance of little brown myotis. Development in the RSA is predicted to result in a negligible magnitude decline in little brown myotis abundance from the PIC to the 2013 Base Case and 2013 PRM Application Case.

Little brown myotis abundance is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, the species is opportunistic in its selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across its range. Therefore, effects to abundance for little brown myotis may be assessed qualitatively by taking into consideration the negligible environmental consequence of mortality due to development in the RSA. The effects of development on little brown myotis abundance are predicted to be negligible from the PIC to the 2013 Base Case and 2013 PRM Application Case in the RSA (Table 4.3-24).

Table 4.3-24 Residual Impact Classification for Effects on Little Brown Myotis in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Habitat	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Little brown myotis use mixedwood and coniferous forests for foraging and roosting habitat (ASRD and ACA 2009, Crampton and Barclay 1998). Mixedwood and coniferous forests show a less than 20% decline from the PIC to the 2013 Base Case and from the PIC to the 2013 PRM Application Case prior to reclamation (Table 4.3-6), resulting in a decline in little brown myotis habitat that is moderate is magnitude and environmental consequence in the RSA (Table 4.3-24).

The effects of development on the movement of little brown myotis in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application

Case. The net effects of development on little brown myotis in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

4.3.4.2.12.2 Environmental Significance Determination During Construction and Operations (Little Brown Myotis)

4.3.4.2.12.2.1 Ecological Thresholds

Net environmental consequences of the effects of change in the RSA from the PIC to the 2013 PRM Application Case are negligible for little brown myotis. The abundance of little brown myotis is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, this species is opportunistic in its selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across the range of little brown myotis. As such, it is unlikely that changes in the RSA from the PIC have contributed to a decline of this species. The following discusses the effects of changes in the RSA to little brown myotis in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the little brown myotis population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the little brown myotis population would no longer be self-sustaining and ecologically effective. Therefore, these are considered a Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on little brown myotis from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.12.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because little brown myotis is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for little brown myotis according to resource management criteria.

4.3.4.2.13 Northern Myotis

The northern myotis is listed as “May Be at Risk” in Alberta (ASRD 2010b, internet site) and is federally listed as “Endangered” by COSEWIC (2012a, 2012b) due to the westerly spread of WNS. This disease is spreading from the east and is not yet present in Alberta, but has been detected as far west as Manitoba. If WNS continues spreading at the current rate, the entire Canadian population would likely be impacted within 11 to 22 years (COSEWIC 2012b). Prior to 2000, there were few data on the northern myotis distribution in northern Alberta. One historical record of the northern myotis was documented in the Fort McKay area in the summer of 1983 (Caceres and Pybus 1997). However, results from long-term capture and echolocation data in the Oil Sands Region suggest that this species may be more common than previously thought, particularly north of Fort McMurray (Grindal et al. 2011).

White-noise syndrome is the most important factor affecting the population trajectory of this species. Other factors that may affect populations of these species include access to winter hibernacula and summer roosting and foraging habitat. Winter hibernacula in the Alberta Oil Sands Region are only known from outside the RSA in Cadomin Cave and Wood Buffalo National Park (ASRD and ACA 2009; Barclay 2012, pers. comm.), and will not be affected by the PRM or development in the RSA. Hibernacula appear to be selected by bats for their high humidity and relatively stable, cool temperatures that are above freezing (Fenton 1970 in Kunz and Reichard 2010). Northern myotis are considered to be habitat generalists with respect to their summer roosting and foraging habitat (Kunz and Reichard 2010). They form reproductive colonies in barns, attics, tree cavities and other places that remain dark throughout the day (Crampton and Barclay 1998).

4.3.4.2.13.1 Environmental Consequences (Northern Myotis)

Northern myotis are primarily limited by WNS across their range. Prior to the arrival of WNS in Alberta, the availability of hibernacula may be limiting regional abundance of this species. However, no hibernacula are likely to occur within the RSA. Summer roosting and foraging requirements are general and therefore not likely to be limiting to the regional abundance of this species given that 80% of the RSA remains undisturbed in the 2013 PDC. Therefore, effects to abundance may be assessed qualitatively by taking into consideration the small risks of mortality due to development in the RSA, which are predicted to be limited to the effects of sensory disturbance on population abundance. Interactions with infrastructure, direct mortality due to site clearing and vehicle collisions are unlikely to affect the abundance of northern myotis. Development in the RSA is predicted to result in a decline in northern myotis abundance that is negligible in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case (Table 4.3-25).

Northern myotis use mixedwood and coniferous forests for foraging and roosting habitat (ASRD and ACA 2009; Crampton and Barclay 1998). Mixedwood and coniferous forests show a less than 20% decline from the PIC to the 2013 Base Case and from the PIC to the 2013 PRM Application Case prior to reclamation (Table 4.3-6), resulting in a decline in northern myotis habitat that is moderate in magnitude and environmental consequence in the RSA (Table 4.3-25).

The effects of development on the movement of northern myotis in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on northern myotis in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-25 Residual Impact Classification for Effects on Northern Myotis in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Habitat	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.13.2 Environmental Significance Determination During Construction and Operations (Northern Myotis)

4.3.4.2.13.2.1 Ecological Thresholds

Environmental consequences of the effects of change in the RSA from the PIC to the 2013 PRM Application Case are negligible for northern myotis abundance. The abundance of northern myotis is unlikely to be affected because loss in the RSA, as hibernacula are likely to occur in the RSA, the species is opportunistic in its selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across the range of northern myotis. As such, it is unlikely that changes in the RSA from the PIC have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to northern myotis in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on northern myotis populations in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the northern myotis population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on northern myotis from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.13.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because northern myotis is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for northern myotis according to resource management criteria.

4.3.4.2.14 Olive-Sided Flycatcher

The olive-sided flycatcher is considered “May Be At Risk” in Alberta (ASRD 2010b, internet site) and is federally listed as “Threatened” by COSEWIC (2007b) and “Schedule 1: Threatened” by SARA (Government of Canada 2013, internet site). The federal listing is a result of a widespread, consistent and continuing population decline since 1968, and up to a 79% decline was estimated for the Canadian population by 2006 (COSEWIC 2007b). An analysis of BBS data by Environment Canada (2013, internet site) suggests an average decline of 1.8% per year in Alberta between 1970 and 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that olive-sided flycatcher populations in Alberta have declined by 2% per year from 1968 to 2011, which would result in an approximately 58% decline over that period. The ABMI (2012) reported that olive-sided flycatcher abundance was close to undisturbed reference conditions in the Boreal Plains Ecozone (i.e., 91% intactness) under existing conditions. In a more detailed analysis of habitat associations and the effects of human footprint on the species, ABMI (2012) determined that abundance of olive-sided flycatcher peaked in landscapes with approximately 40% human footprint.

The causes of widespread decline in olive-sided flycatcher populations throughout their broad North American breeding range are uncertain, although some hypotheses have been proposed. Managed forests in breeding ranges may be producing population sinks (Robertson and Hutto 2007). However, the consistent population decline across the breeding range suggests that habitat loss and alteration on their wintering range or migratory fly-way, where olive-sided flycatchers are more concentrated and vulnerable, may be responsible for these trends (COSEWIC 2007b). The widespread use of pesticides may also have contributed to the decline.

4.3.4.2.14.1 Environmental Consequences (Olive-Sided Flycatcher)

The decline in olive-sided flycatchers has been largely attributed to habitat loss and alteration on their wintering range or migratory fly-way, although habitat alteration within their breeding range may be a contributing factor. Therefore, to be conservative, population trends for olive-sided flycatcher in the RSA may be inferred from changes to habitat. Habitat suitability modelling estimates a decline in high suitability habitat of 11% from the PIC to both the 2013 Base Case and the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a potential decline in olive-sided flycatcher abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case (Table 4.3-26).

The effects of development on the movement of olive-sided flycatcher in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on olive-sided flycatcher in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-26 Residual Impact Classification for Effects on Olive-Sided Flycatcher in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[(a)]		Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(c)]
Abundance	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)
Habitat	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.14.2 Environmental Significance Determination During Construction and Operations (Olive-Sided Flycatcher)

4.3.4.2.14.2.1 Ecological Thresholds

To be conservative, development in the RSA was assessed as having a moderate environmental consequence for effects on the abundance of olive-sided flycatcher based on changes to habitat. However, it is unlikely that development in the RSA has contributed to a decline of this species. Declines appear to be due to habitat loss and alteration within the wintering range of olive-sided flycatcher (COSEWIC 2007b). Losses of high suitability habitat (i.e., burns) are predicted to be 11% from the PIC to the 2013 Base Case and 11% from the PIC to the 2013 PRM Application Case. The accuracy of burns in the RSA is difficult to estimate because their spatial distribution is based on a stochastic simulation by ALCES of the expected average area burned over time (Appendix 3.1, Section 2.8.2). Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Therefore, classification error may increase the likelihood that landscape changes will exceed ecological thresholds; however, given the predicted areal extent of remaining high suitability habitat in the RSA (393,154 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1) the apparent slow population decline in Alberta, and the likelihood that declines are due to habitat loss in wintering ranges rather than development in the boreal forest, it is unlikely that the olive-sided flycatcher population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to olive-sided flycatcher in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on olive-sided flycatcher are considered Adverse effects.
- Because a large amount of intact habitat remains available in the RSA, cumulative effects of development are not likely to exceed ecological thresholds such that the olive-sided flycatcher population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on olive-sided flycatcher from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.14.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because olive-sided flycatcher is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for olive-sided flycatcher according to resource management criteria.

4.3.4.2.15 Peregrine Falcon

The peregrine falcon (*anatum/tundrius* subspecies) is federally listed as “Special Concern” by COSEWIC (2009a) and is not listed by SARA (Government of Canada 2013, internet site). Provincially, the peregrine falcon is listed as “At Risk” (ASRD 2010b, internet site).

Peregrine falcons are likely migratory in the Oil Sands Region as nesting eyries have not been documented to date. Peregrine falcons were not observed during field surveys conducted for PRM and historical habitat association data from the Oil Sands Region are not available.

4.3.4.2.15.1 Environmental Consequences (Peregrine Falcon)

Peregrine falcons are likely only migratory in the RSA. Therefore, effects to abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure and vehicle collisions on population abundance, to which exposure is very limited. Combined, these factors are likely to result in a decline in peregrine falcon abundance in the RSA from the PIC to the 2013 Base Case and the 2013 PRM Application Case that is negligible in magnitude and environmental consequence (Table 4.3-27).

Peregrine falcons are unlikely to be sensitive to the availability of migratory (i.e., staging) habitat within the RSA, and peregrine falcon movement is unlikely to be affected by development in the RSA. Therefore, affects to peregrine falcon habitat and movement are not assessed (Table 4.3-27). The net effects of development on peregrine falcon in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-27 Residual Impact Classification for Effects on Peregrine Falcon in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

n/a = not applicable.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.15.2 Environmental Significance Determination During Construction and Operations (Peregrine Falcon)

4.3.4.2.15.2.1 Ecological Thresholds

Environmental consequences of the effects of change in the RSA from the PIC to the 2013 PRM Application Case are negligible for peregrine falcon because the species seasonally migrates through the RSA. As such, it is unlikely that changes in the RSA from the PIC have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to peregrine falcon in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the peregrine falcon population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the peregrine falcon population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on peregrine falcon from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.15.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because peregrine falcon is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for peregrine falcon according to resource management criteria.

4.3.4.2.16 Red Knot

The red knot does not breed in Alberta; the species nests in tundra habitats near coastlines in the central Canadian Arctic (Harrington 2001, internet site). However, red knots do migrate through eastern Alberta during the last three weeks of May, typically stopping over for about a week before continuing to their northern breeding grounds. The red knot is federally listed as “Endangered” by COSEWIC (2007c) and is not listed under SARA (Government of Canada 2013, internet site). Red knots are threatened primarily by overfishing of horseshoe crabs in southern wintering grounds (COSEWIC 2007c). Provincially, the red knot is listed as “May Be At Risk” (ASRD 2010b, internet site).

4.3.4.2.16.1 Environmental Consequences (Red Knot)

No red knots were observed during surveys conducted in the LSA and there are no historical data for this species in the Oil Sands Region. However, red knot may migrate through the Oil Sands Region and the RSA. As such, effects to abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure and vehicle collisions on population abundance, to which exposure is very limited. Combined, these factors are likely to result in a decline in red knot abundance from the PIC to the 2013 Base Case and the 2013 PRM Application Case that is negligible in magnitude and environmental consequence in the RSA (Table 4.3-28).

Red knot is unlikely to be sensitive to the availability of migratory (i.e., staging) habitat within the RSA, and red knot movement is unlikely to be affected by development in the RSA. Therefore, affects to red knot habitat and movement are not assessed (Table 4.3-28). The net effects of development on red knot in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-28 Residual Impact Classification for Effects on Red Knot in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

n/a = not applicable.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.16.2 Environmental Significance Determination During Construction and Operations (Red Knot)

4.3.4.2.16.2.1 Ecological Thresholds

Environmental consequences of the effects of change in the RSA from the PIC to the 2013 PRM Application Case are negligible for red knot abundance because the RSA falls within its migratory range. As such, it is unlikely that changes in the RSA from the PIC have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to red knot in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the red knot population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible because the species seasonally migrates through the RSA. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the red knot population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on red knot from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.16.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because red knot is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for red knot according to resource management criteria.

4.3.4.2.17 Rusty Blackbird

Rusty blackbirds are considered “Sensitive” provincially (ASRD 2010b, internet site). They are listed federally as “Special Concern” by COSEWIC (2006) and “Schedule 1: Special Concern” by SARA (Government of Canada 2013, internet site). Rusty blackbirds have been declining throughout their range over the last century (COSEWIC 2006; Greenberg and Droege 1999). An analysis of BBS data by Environment Canada (2013, internet site) suggests that the Canadian population has declined by an average of 6.6% per year from 1970 to 2011, and the Alberta population has declined by 2.3% over the same period (Environment Canada 2010, internet site). Sauer et al. (2012, internet site) analyzed BBS data and estimated that rusty blackbird populations in Alberta have declined by 3.3% per year from 1968 to 2011, suggesting a 76% decline during that period.

The primary cause of this decline has been attributed to habitat loss, in particular the conversion of the Mississippi Valley flood plain forests to agricultural and urban areas (Greenberg and Droege 1999). In addition, 100,000 rusty blackbirds were exterminated in the southern United States between 1974 and 1992 during bird control programs implemented to reduce populations of nuisance birds that damage crops (Avery 1995; COSEWIC 2006).

4.3.4.2.17.1 Environmental Consequences (Rusty Blackbird)

The decline in rusty blackbirds has been largely attributed to the loss of habitat within their wintering range. As such, the Alberta-wide decline that has been reported is not likely compounded by habitat change in the boreal forest, where the availability of wetlands is not likely to be limiting. However, to be conservative, population trends for rusty blackbird in the RSA may be inferred from changes to habitat. Habitat suitability modelling estimates a decline in high suitability habitat of 20% from the PIC to the 2013 Base Case and 22% from the PIC to the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in rusty blackbird abundance and habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 Base Case and high from the PIC to the 2013 PRM Application Case (Table 4.3-29).

The effects of development on the movement of rusty blackbird in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on rusty blackbird in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-29 Residual Impact Classification for Effects on Rusty Blackbird in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)
Habitat	negative	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.17.2 Environmental Significance Determination During Construction and Operations (Rusty Blackbird)

4.3.4.2.17.2.1 Ecological Thresholds

To be conservative, development in the RSA was assessed as having a high environmental consequence for effects on the abundance of rusty blackbird based on changes to habitat. However, it is unlikely that development in the RSA has contributed to a decline of this species. Declines appear to be due to habitat loss and alteration within the wintering range of rusty blackbird (Greenberg and Droege 1999). Losses of high suitability habitat are predicted to be 20% from the PIC to the 2013 Base Case and 22% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for rusty blackbird in the RSA (i.e., non-treed wetlands and treed fens) are estimated to have a classification error of 40%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. In addition, classification error may have also lead to a 30% underestimation of high suitability habitat for rusty blackbird in the RSA. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds.

Given the predicted areal extent of remaining high suitability habitat in the RSA (460,892 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1), the apparent slow population decline in Alberta, and the likelihood that declines are due to habitat loss within the wintering range rather than development in the boreal forest, it is unlikely that the rusty blackbird population in the RSA has been compromised by the cumulative effects of development to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to rusty blackbird in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on rusty blackbird are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the rusty blackbird population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on rusty blackbird from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.17.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because rusty blackbird is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for rusty blackbird according to resource management criteria.

4.3.4.2.18 Short-Eared Owl

The short-eared owl is federally listed as “Special Concern” by COSEWIC (2009a) and “Schedule 3: Special Concern” by SARA (Government of Canada 2013, internet site). In Alberta, the short-eared owl is listed as “May Be At Risk” (ASRD 2010b, internet site). An analysis of BBS data by Environment Canada (2013, internet site) suggests that the short-eared owl population in Alberta has increased at an average rate of 2.8% per year between 1970 and 2011. Sauer et al. (2012, internet site) analyzed BBS data using a hierarchical analysis (Link and Sauer 2002) and estimated that short-eared owl populations in Alberta have increased by 1% per year from 1968 to 2012. However, in both cases the confidence limits of trend estimates are wide and populations may in fact be declining. Breeding bird survey data are not designed for surveying for short-eared owls, and the accuracy of trends estimated from those data are therefore unknown.

Habitat loss due to the degradation of coastal marshes and grasslands are most likely the major threat to this species (COSEWIC 2009a). Habitat loss in central and northern Canada is believed to be negligible (COSEWIC 2009a).

4.3.4.2.18.1 Environmental Consequences (Short-Eared Owl)

As habitat loss due to the degradation of coastal marshes and grasslands are most likely the major threat to this species, and habitat loss in central and northern Canada is believed to be negligible, it is unlikely that the short-eared owl population is affected by habitat change in the RSA. Habitat suitability modelling estimates an increase in high suitability habitat of 2% from the PIC to both the 2013 Base Case and the 2013 PRM Application Case prior to reclamation due to the increase in cutblocks in the RSA (Appendix 3.7, Section 1). Therefore, to be conservative, effects to abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure, vehicle collisions and sensory disturbance on population abundance. Combined, these factors are likely to result in a decline in short-eared owl abundance in the RSA from the PIC to the 2013 Base Case and 2013 PRM Application Case that is negligible in magnitude and environmental consequence (Table 4.3-30).

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts an increase in short-eared owl habitat that is low in magnitude and environmental consequence in the RSA from the PIC to the 2013 Base Case and the 2013 PRM Application Case due to the increase in high suitability cutblocks (Table 4.3-30).

The effects of development on the movement of short-eared owl in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on short-eared owl in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-30 Residual Impact Classification for Effects on Short-Eared Owl in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Habitat	positive	low (+5)	low +5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.18.2 Environmental Significance Determination During Construction and Operations (Short-Eared Owl)

4.3.4.2.18.2.1 Ecological Thresholds

Environmental consequences of the effects of change in the RSA from the PIC to the 2013 PRM Application Case are negligible for short-eared owl abundance because this species benefits from the availability of open habitat, which results in a low magnitude environmental consequence of increased habitat availability in the RSA. Gains of high suitability habitat are predicted to be 2% from both the PIC to the 2013 Base Case and the PIC to the 2013 PRM Application Case. Error in regional land cover classification for habitat classified as high suitability for short-eared owl in the RSA (i.e., cut blocks, burns and non-treed wetlands) is difficult to estimate. The accuracy of burns and cutblocks in the RSA is difficult to estimate because their spatial distribution is based on a stochastic simulation by ALCES of the expected average area burned and cut over time (Appendix 3.1, Section 2.8.2). Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat may be overestimated. Therefore, classification error may increase the likelihood that landscape changes will exceed ecological thresholds.

To be conservative, effects on short-eared owl abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure, vehicle collisions and sensory disturbance. Combined, these factors are likely to result in a negligible environmental consequence on short-eared owl abundance in the RSA from the PIC to the 2013 PRM Application Case. Given the predicted areal extent of high suitability habitat in the RSA (398,868 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1) and the fact that the decline of this species is likely due to the degradation of coastal marshes and grasslands (COSEWIC 2009a), it is unlikely that the short-eared owl population in the RSA has been compromised by the cumulative effects of development to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to short-eared owl in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the short-eared owl population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the short-eared owl population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on short-eared owl from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.18.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because short-eared owl is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the

2013 PRM Application Case are determined to be Significant for short-eared owl according to resource management criteria.

4.3.4.2.19 Western Toad

The western toad is listed as "Sensitive" in Alberta (ASRD 2010b, internet site). Federally, the western toad is listed as "Special Concern" by COSEWIC (2002b) and "Schedule 1: Special Concern" by SARA (Government of Canada 2013, internet site).

The population of western toads appears to be stable in Alberta, while declines may be occurring in southwest British Columbia (COSEWIC 2002b). The federal listing of this species is because it is the only International Union for the Conservation of Nature (IUCN) red-listed species occurring in Canada. This red-listed status exists because many populations in the United States have either declined or been extirpated, even in relatively pristine habitats, for unknown reasons (COSEWIC 2002b). Although the cause of western toad decline is not entirely clear, it appears to be related to disease rather than habitat loss (COSEWIC 2002b). Direct mortality during the stripping of overburden for mining has the potential to affect overwintering toads. Therefore, direct mortality due to soil disturbance in the RSA may result in a low magnitude reduction in the abundance of western toads.

4.3.4.2.19.1 Environmental Consequences (Western Toad)

The cause of western toad decline appears to be related to disease unrelated to development in the RSA, and not habitat loss. However, direct mortality during the stripping of overburden for mining has the potential to result in the mortality of overwintering toads. Therefore, direct mortality due to soil disturbance in the RSA may result in a reduction in the abundance of western toads that is low in magnitude and environmental consequence from the PIC to the 2013 Base Case and the 2013 PDC (Table 4.3-31).

Table 4.3-31 Residual Impact Classification for Effects on Western Toad in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)
Habitat	negative	high (+15)	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)
Movement	negative	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)
Net Effects	negative	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decline in high suitability western toad breeding habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case (Table 4.3-31).

The effects of development on the movement of western toad in the RSA are predicted to result in a moderate environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on western toad in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

4.3.4.2.19.2 Environmental Significance Determination During Construction and Operations (Western Toad)

4.3.4.2.19.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on western toad is low. Losses of high suitability habitat are predicted to be 21% from the PIC to the 2013 Base Case and 22% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for western toad in the RSA (i.e., water, non-treed wetlands) are estimated to have a classification error of 67%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. In addition, the amount of high suitability habitat in the RSA may have been overestimated. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, the decline of western toads appears to be due to disease rather than habitat loss, and therefore it is unlikely that habitat changes in the RSA have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to western toad in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the western toad population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are low. Because the western toad population appears to be limited by disease and not habitat, the cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the western toad population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on western toad from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.19.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because western toad is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the

2013 PRM Application Case are determined to be Significant for western toad according to resource management criteria.

4.3.4.2.20 Whooping Crane

Three distinct wild populations of whooping crane occur in North America (ASRD 2003); two reintroduced populations occur in Florida (one population migrating to Wisconsin to breed), and a third, natural population, breeds in Wood Buffalo National Park and winters on the Gulf Coast in Texas (ASRD 2003). The whooping crane is federally listed as “Endangered” by COSEWIC (2000) and “Schedule 1: Endangered” by SARA (Government of Canada 2013, internet site). In Alberta, the whooping crane is listed as “At Risk” (ASRD 2010b, internet site). No whooping cranes were observed incidentally in the LSA and records of whooping cranes in the Oil Sands Region generally are few. However, based on radio telemetry data, their migratory flyway between southern wintering grounds and nesting habitat in Wood Buffalo National Park traverses the Oil Sands Region in northeastern Alberta (Environment Canada 2012b, Appendix 2).

4.3.4.2.20.1 Environmental Consequences (Whooping Crane)

Whooping cranes are migratory in the RSA, and therefore effects to abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure and vehicle collisions on population abundance, to which exposure is very limited. Combined, these factors are likely to result in a decline in whooping crane abundance from the PIC to the 2013 Base Case and the 2013 PRM Application Case that is negligible in magnitude and environmental consequence in the RSA (Table 4.3-32).

Whooping cranes in the Oil Sands Region breed exclusively in the northern portion of Wood Buffalo National Park in the Northwest Territories. The majority of the RSA’s wetlands remain undisturbed and therefore whooping cranes are unlikely to be affected by the availability of migratory (i.e., staging) habitat within the RSA. In addition, whooping crane movement is unlikely to be affected by development in the RSA. Therefore, effects to whooping crane habitat and movement are not assessed (Table 4.3-32).

The net effects of development on whooping crane in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-32 Residual Impact Classification for Effects on Whooping Crane in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

n/a = not applicable.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.20.2 Environmental Significance Determination During Construction and Operations (Whooping Crane)

4.3.4.2.20.2.1 Ecological Thresholds

Environmental consequences of the effects of change in the RSA from the PIC to the 2013 PRM Application Case are negligible for whooping crane abundance because the species seasonally migrates through the RSA. As such, it is unlikely that changes in the RSA from the PIC have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to whooping crane in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the whooping crane population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible because the species seasonally migrates through the RSA. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the whooping crane population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effect is considered Likely.

Therefore, the effects on whooping crane from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.20.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because whooping crane is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for whooping crane according to resource management criteria.

4.3.4.2.21 Wolverine

Wolverines are year-round residents of the boreal forest in northeastern Alberta. The wolverine is federally listed as “Special Concern” (COSEWIC 2003) and is not listed by SARA (Government of Canada 2013, internet site). Provincially, the wolverine is listed as “May Be At Risk” (ASRD 2010b, internet site). Trapping of wolverine occurs in Alberta and harvest is limited by a quota system.

The range of wolverine in Alberta has declined (Peterson 1997), with an expected associated decline in population abundance. This decline may be due to loss of habitat far from human disturbance, reduction in the availability of large carrion, and trapping pressure (Peterson 1997). Trapping harvest is currently limited by a quota system in Alberta. The population of wolverines in Alberta appears to be declining, although very few studies have been conducted and population estimates have been based mainly on historical trapping information, which is generally not a reliable method of population estimation (Petersen 1997). In Alberta, this species has been reduced to the northern portion of the province and areas along the mountains and foothills (Petersen 1997). Wolverines are uncommon carnivores in the Oil Sands Region with large home ranges (1,450 km^2 and 525 km^2 for males and females, respectively [Magoun et al. 2005]). Movement corridors and habitat connectivity in the regional landscape are likely important to the species.

4.3.4.2.21.1 Environmental Consequences (Wolverine)

Reliable data are not available for historical population trends of wolverine in the RSA. However, due to the sensitivity of wolverine populations to the availability of suitable habitat and the effects of increased access on trapper harvest, it is likely that the effects of landscape change in the RSA have resulted in a population decline. To be conservative, regional population trends for wolverine may be inferred from changes to habitat. Landscape changes in the RSA have resulted in declines in high suitability wolverine habitat of 21% from the PIC to the 2013 Base Case, and 22% from the PIC to the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in wolverine abundance and habitat that is high in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case in the RSA (Table 4.3-33).

The effects of development on the movement of wolverine in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on wolverine in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-33 Residual Impact Classification for Effects on Wolverine in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
Habitat	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
Movement	negative	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)
Net Effects	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.21.2 Environmental Significance Determination During Construction and Operations (Wolverine)

4.3.4.2.21.2.1 Ecological Thresholds

Due to the sensitivity of wolverine populations to the availability of suitable habitat and the effects of increased access on trapper harvest, it is likely that the effects of landscape change in the RSA may have contributed incrementally to a population decline. The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on wolverine is high. Losses of high suitability habitat are predicted to be 21% from the PIC to the 2013 Base Case and 22% from the PIC to the 2013 PRM Application Case. Regional land cover classification error does not affect predictions of high suitability wolverine habitat in the RSA because wolverines readily use all available habitats. The wolverine habitat suitability model is a core security model and is based on distance to disturbance (*May 2011, Submission of Information to the Joint Review Panel*, Appendix B). Nonetheless, error is inherent in all models, and effects to high suitability wolverine habitat may have been underestimated.

Given the predicted areal extent of remaining high suitability habitat in the RSA (1,782,764 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1) and that wolverine harvest is governed by quotas, it is unlikely that the wolverine population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to wolverine in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the wolverine population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the wolverine population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.

- The predicted effects are considered Likely.

Therefore, the effects on wolverine from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.21.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, due to the high magnitude effects to the abundance of this federally listed species, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant for wolverine according to resource management criteria.

4.3.4.2.22 Wood Bison

The wood bison is listed federally as "Threatened" by COSEWIC and "Schedule 1: Threatened" by SARA (Government of Canada 2013, internet site). Wood bison are listed as "At Risk" in Alberta (ASRD 2010b, internet site).

Wood bison are protected in Wood Buffalo National Park located in northeast Alberta and within a special wildlife management area in northwest Alberta. Otherwise, wood bison occurring on provincial lands outside of the designated management area, including wood bison in the RSA, are not protected by legislation unless they are owned as livestock. Wood bison in and around Wood Buffalo National Park are infected by the cattle diseases bovine tuberculosis and bovine brucellosis, as well as anthrax (Mitchell and Gates 2002). These diseases are believed to be the primary limitation on the range of wood bison (Mitchell and Gates 2002). The Ronald Lake wood bison herd is the only herd that occurs in the RSA, and it is currently presumed to be infected (Government of Alberta 2013). An examination of telemetry collar data shows that the home range of the Ronald Lake herd overlaps with Wood Buffalo National Park (Government of Alberta 2013), and therefore bison of the Ronald Lake herd may interact with diseased bison that occur in and around the park. However, as a result of tissue and blood tests in 2012 and 2013, the rate of disease in the Ronald Lake herd is predicted to be between 0% and 12% for tuberculosis and brucellosis (Government of Alberta 2013). Therefore, the herd appears to be infected at a rate that is lower than the sampling strategy was capable of detecting, and lower than the 30% to 50% rate of disease present in herds in and around Wood Buffalo National Park (Government of Alberta 2013).

Bison hunting is allowed outside of the protected areas to reduce the transmission of the diseases to the uninfected Hay-Zama herd within the special wildlife management area in northwestern Alberta. The LSA falls outside the boundaries of the protected areas mentioned above. As such, the Ronald Lake Herd is subject to unregulated hunting. Harvest pressure is associated with winter access across the Athabasca River by ice bridge (Powell and Morgan 2010). However, even with unregulated hunting associated with increased access developed for timber harvest and winter drilling programs that have occurred over the last six years and the potential for disease, there is no evidence that the Ronald Lake bison herd is decreasing, and it may be increasing (Government of Alberta 2013).

Historical wood bison range occurs throughout the regional study area (Roe 1951). Bison require early seral vegetation and strongly select for meadow and willow grassland habitats for foraging (Lartner and Gates 1991). The Richardson fire and vegetation clearing for oil and gas exploration, pipeline and transmission line rights-of-way, and forest harvest are likely to increase suitable foraging habitat for bison through the creation of early seral vegetation. In the 2013 PRM Application Case, soil disturbances due to industrial development take up only 14% of the RSA. Based on habitat suitability modelling in the regional study area, 66% (180,069 ha) of high suitability habitat for bison present in the PIC is still present in the 2013 PRM Application Case. Much of this habitat is currently not utilized by the Ronald Lake herd.

4.3.4.2.22.1 Environmental Consequences (Wood Bison)

The wood bison population in the RSA is unlikely to be limited by the availability of habitat, but rather by the effects of unregulated hunting, predation and disease (e.g., bovine tuberculosis, bovine brucellosis, anthrax). As a result of the PRM, bison are likely to be displaced to alternate suitable habitat outside of the PRM footprint, where road access outside of the LSA but associated with the PRM, combined with unregulated hunting, could have a detrimental effect on the herd. Although risks of interactions with infrastructure, mortality due to clearing, vehicle collisions and sensory disturbance are unlikely to have a greater than negligible effect on the population, increased access could potentially result in a decline in wood bison abundance. However, increases in existing access due to the presence of an ice bridge across the Athabasca River in winter and Teck Resources Limited's Frontier Oil Sands Mine winter drilling programs do not seem to have resulted in a decline in the Ronald Lake herd (Government of Alberta 2013). As a result of the potential effects of increased access to the PRM area after construction of the Athabasca River bridge, the access road to PRM will have access restrictions limiting traffic to project personnel. When implemented properly, restricting access has been proven to be an effective way to dramatically reduce incidents of hunting mortality (e.g., Crichton et al. 2004). Restricting access to project personnel along with a prohibition of firearms should effectively reduce the potential for increased hunting mortality on the Ronald Lake herd. After mitigation, the magnitude and environmental consequence of development in the RSA on wood bison abundance are predicted to be negligible from the PIC to the 2013 Base Case (Table 4.3-34). From the PIC to the 2013 PRM Application case, the magnitude and environmental consequence of development in the RSA on wood bison abundance are predicted to be low because increased access due to PRM could potentially result in a decline in wood bison abundance due to unregulated hunting.

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decline in high suitability wood bison habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 Base Case and the 2013 PDC (Table 4.3-34).

The effects of development on the movement of wood bison in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on wood bison in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-34 Residual Impact Classification for Effects on Wood Bison in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	negligible (0)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	low (+7)
Habitat	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
Movement	negative	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)
Net Effects	negative	negligible (0)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	low (+7)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.22.2 Environmental Significance Determination During Construction and Operations (Wood Bison)

4.3.4.2.22.2.1 Ecological Thresholds

Wood bison in the RSA are not protected from unregulated harvest. Increased access outside the PRM footprint but constructed for PRM could result in increases to the unregulated hunting to which the Ronald Lake herd is currently subjected. However, recent increases in access do not appear to have resulted in a decline in the size of the herd and access control will minimize the potential adverse effects of increased hunting due to increased access in the 2013 PRM Application Case. Wood bison are likely limited by disease, predation and unregulated hunting rather than habitat loss, and therefore it is unlikely that habitat loss in the RSA from the PIC have contributed to the decline of this species.

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on wood bison is low. Losses of high suitability habitat are predicted to be 34% from the PIC to the 2013 Base Case and 35% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for wood bison in the RSA (i.e., non-treed wetland) are estimated to have a classification error of 75%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Classification error has lead to an overestimation of high suitability habitat for wood bison in the RSA, indicating that less high quality wood bison habitat is present in the RSA than was predicted by the habitat model. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (180,069 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1) and the fact that there is no evidence that the Ronald Lake bison herd is decreasing, it is unlikely that the wood bison population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to wood bison in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on wood bison populations in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are low. The wood bison population in the RSA are likely limited by disease, predation and unregulated hunting, rather than habitat loss, and there is no evidence that the Ronald Lake bison herd is decreasing, despite winter access to the herd by hunters. Therefore, the cumulative effects of development in the RSA after mitigation are not likely to exceed ecological thresholds such that the wood bison population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on wood bison from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.22.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because wood bison is federally listed and adversely affected by the cumulative effects of industrial development, effects from the PIC to the 2013 PRM Application Case are determined to be Significant for wood bison according to resource management criteria.

4.3.4.2.23 Woodland Caribou

Woodland caribou are listed federally as “Threatened” by COSEWIC and “Schedule 1: Threatened” by SARA (Government of Canada 2013, internet site). In Alberta, woodland caribou are listed as “At Risk” (ASRD 2010b, internet site). Woodland caribou are one of Canada’s most widely distributed large mammals (Government of Canada 2013, internet site).

Woodland caribou are virtually absent from the LSA, which is located outside designated caribou areas. However, the Red Earth, Richardson and West Side of the Athabasca River (WSAR) woodland caribou ranges occur partially within the RSA. The annual population growth rate (i.e., lambda) for adult female caribou in the Red Earth and WSAR populations was last estimated in the winter of 2008 to 2009 to be 0.84 and 0.78, respectively, while the population trend in the Richardson range is unknown (ASRD and ACA 2010). Lambda values of less than one indicate that the woodland caribou populations in the RSA are in a state of decline. The Alberta populations have been estimated to be 170 to 206 for the Red Earth range, 204 to 272 for the WSAR range, and 150 for the Richardson range (Environment Canada 2012a). It was recently estimated that the Red Earth population was likely to decline to less than 10 animals in about 25 years, the Richardson population in about 60 years, and the WSAR population in about 70 years given the current population size and rate of decline (Schneider et al. 2010). This outcome is predicted whether or not further development occurs in the RSA. This decline appears to be due to predation by wolves, which have increased in abundance due to increases in populations of white-tailed deer (Latham et al. 2011). White tailed deer appear to have increased in abundance due to the creation of early seral habitat as a result of large-scale deforestation (Latham et al. 2011).

4.3.4.2.23.1 Environmental Consequences (Woodland Caribou)

Woodland caribou populations appear to be declining to extirpation in the RSA due to the indirect effects of industrial development. This suggests a decline in woodland caribou abundance in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 Base Case and 2013 PRM Application Case.

The environmental consequences of changes to high suitability woodland caribou habitat are assessed prior to reclamation from the PIC to the 2013 Base Case and to the 2013 PRM Application Case using output from habitat suitability models and ecological context based on available data and peer-reviewed literature to help determine effect magnitudes (Appendix 3.7, Section 1.3). The environmental consequences of effects to woodland caribou habitat from the PIC to the 2013 PRM Application Case are negative and high (Table 4.3-35). The majority (i.e., 99%) of effects to woodland caribou habitat from the PIC to the 2013 PRM Application Case are due to disturbances that are present in the 2013 Base Case. As a result, the environmental consequences of effects to high suitability woodland caribou habitat from the PIC to the 2013 PRM Application Case are the same as those from the PIC to the 2013 Base Case.

The effects to wildlife movement are assessed in part through a linkage zone analysis of the RSA, which shows a high magnitude increase from the PIC to the 2013 Base Case and 2013 PRM Application Case for moose (Appendix 3.7, Section 4.0). Other wide-ranging terrestrial wildlife species like woodland caribou are expected to experience similar effects to movement. The environmental consequence of effects to woodland caribou movement from the PIC to the 2013 PRM Application Case are high (Table 35). The majority of effects to habitat from the PIC to the 2013 PRM Application Case and the 2013 PDC are due to disturbances that are present in the 2013 Base Case. As a result, the environmental consequences of effects to movement from the PIC to the 2013 PRM Application Case are the same as those from the PIC to the 2013 Base Case.

The net effects to the woodland caribou population in the RSA from the PIC to the 2013 PRM Application Case are equivalent to the overall effects of development on abundance. The apparent decline of woodland caribou to extirpation in the RSA due to the indirect effects of industrial development suggests a high magnitude net effect to woodland caribou in the RSA from the PIC to the 2013 Base Case and 2013 PRM Application Case (Table 4.3-35).

Table 4.3-35 Residual Impact Classification for Effects on Woodland Caribou in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[a]		Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[c]
Abundance	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+23)	high (+23)
Habitat	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+20)	high (+20)
Movement	negative	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)
Net Effects	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+23)	high (+23)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.23.2 Environmental Significance Determination During Construction and Operations (Woodland Caribou)

4.3.4.2.23.2.1 Ecological Thresholds

Woodland caribou are virtually absent from the LSA, which is located outside designated caribou areas. However, the Red Earth, Richardson and West Side of the Athabasca River (WSAR) woodland caribou ranges occur in the RSA, and appear to be declining to extirpation. This decline appears to be due to the indirect effects of industrial development on predator-prey dynamics. The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PRM Application Case on woodland caribou is high. The majority of these effects occur between the PIC and the 2013 Base Case. Losses of high suitability habitat are predicted to be 49% from both the PIC to the 2013 Base Case and the PIC to the 2013 PRM Application Case. Model validation was conducted for the woodland caribou HSI model, and the model was determined to effectively distinguish between high, moderate and low suitability habitat (EIA, Volume 5, Appendix 5-4, Section 1.2.4). Nonetheless, the amount of high suitability habitat lost may be underestimated, although the magnitude of effects is already classified as high.

The following discusses the effects of changes in the RSA to woodland caribou in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on the woodland caribou populations in the RSA are considered Adverse effects.
- Available data suggest that woodland caribou herds that occur in the RSA are declining to extirpation due to the indirect effects of industrial development in the 2013 Base Case. Therefore, cumulative effects of development in the RSA appear to have exceeded ecological thresholds such that the woodland caribou population is no longer self-sustaining and ecologically effective. Therefore these are considered Significant effects.

- The predicted effects are considered Likely.

Therefore, the effects on woodland caribou from the PIC to the 2013 PRM Application Case are considered Likely, Adverse and Significant.

4.3.4.2.23.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because woodland caribou is federally listed and effects are high in magnitude, the cumulative effects of industrial development from the PIC to the 2013 PRM Application Case are determined to be Significant according to resource management criteria for woodland caribou.

4.3.4.2.24 Yellow Rail

Yellow rails are listed federally as a species of 'Special Concern' by COSEWIC (2009c) and are listed on Schedule 1 of SARA as 'Special Concern' (Government of Canada 2013, internet site). In Alberta, this bird has "Undetermined" status because information on population size and trends is lacking (ASRD 2010b, internet site).

Yellow rail population size and trends are relatively unknown because standardized bird survey methods are not effective at sampling for this species (COSEWIC 2009c). However, a compilation of available information suggests that this species may have declined in the last 10 years (COSEWIC 2009c). The loss and degradation of habitat, especially on southern wintering grounds, is believed to be the primary threat to yellow rails (COSEWIC 2009c).

4.3.4.2.24.1 Environmental Consequences (Yellow Rail)

The decline in yellow rails has been largely attributed to the loss of habitat within their wintering range. As such, yellow rail abundance is unlikely to be affected by habitat change in the RSA, where the availability of wetlands is not likely to be limiting. However, to be conservative, population trends for yellow rail in the RSA may be inferred from changes to habitat. Habitat suitability modelling estimates a decline in high suitability habitat of less than 20% from the PIC to the 2013 Base Case, and 21% from the PIC to the 2013 PRM Application Case prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in yellow rail abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 Base Case and high from the PIC to the 2013 PRM Application Case (Table 4.3-36).

The effects of development on the movement of yellow rail in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 Base Case and the 2013 PRM Application Case. The net effects of development on yellow rail in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 4.3-36 Residual Impact Classification for Effects on Yellow Rail in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case: During Construction and Operations

Potential Effects	Direction	Magnitude[(a)]		Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(c)]
Abundance	negative	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)
Habitat	negative	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)
Movement	negative	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

4.3.4.2.24.2 Environmental Significance Determination During Construction and Operations (Yellow Rail)

4.3.4.2.24.2.1 Ecological Thresholds

To be conservative, development in the RSA was assessed as having a high environmental consequence for effects on the abundance of yellow rail based on changes to habitat from the PIC to the 2013 PRM Application Case. However, it is unlikely that development in the RSA has contributed to a decline of this species. Declines appear to be due to habitat loss and alteration within the wintering range of yellow rail (COSEWIC 2009c). Losses of high suitability habitat are predicted to be 20% from the PIC to the 2013 Base Case and 21% from the PIC to the 2013 PRM Application Case. Regional land cover classification data for habitat classified as high suitability for yellow rail in the RSA (i.e., non-treed wetlands) are estimated to have a classification error of 75%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Classification error has lead to an overestimation of high suitability habitat for yellow rail in the RSA, indicating that more high quality yellow rail habitat is present in the RSA than was predicted by the habitat model. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (217,737 ha in the 2013 PRM Application Case, Appendix 3.7, Table 1.3-1), and that apparent population declines appear to be due to habitat loss and alteration within the wintering range, it is unlikely that the yellow rail population in the RSA has been compromised by the cumulative effects of development to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to yellow rail in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case:

- Effects on yellow rail are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the yellow rail population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on yellow rail from the PIC to the 2013 PRM Application Case are considered Likely, Adverse, but Not Significant.

4.3.4.2.24.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because yellow rail is federally listed and adversely affected by the cumulative effects of industrial development, effects from the PIC to the 2013 PRM Application Case are determined to be Significant for yellow rail according to resource management criteria.

4.3.4.2.24.3 Effects After Reclamation

The environmental consequences associated with development on wildlife and their significance for the 2013 PRM Application Case after reclamation in the RSA are difficult to identify because reclamation plans for all developments in the 2013 PRM Application Case are not available in appropriate, consistent geospatial formats and therefore the composition of the RSA landscape after reclamation is not known in any definitive manner. However, an approximation of what the 2013 PRM Application Case landscape in the RSA might look like after reclamation and the resulting effects on KIRs can be estimated by extrapolating from the LSA closure plan to a regional scale, assuming that the generalized changes in the LSA are representative of what will also occur across the RSA.

At Closure, there will be a shift from peatland habitats to upland terrestrial habitats and a shift from early successional habitats to mid-successional habitats within the 80-year time frame used to assess effects at Closure. The benefits of late successional habitats will not be realized at 80 years post-reclamation. However, old growth forest is expected to re-establish on reclaimed land after 100 years or more. There will also be a net decrease in human disturbance and associated sensory disturbance within the RSA due to the reclamation of disturbances present at the 2013 PRM Application Case before Closure. As a result, species that are strongly tied to terrestrial habitat are predicted to increase in their occurrence due to the increase in habitat availability after reclamation. Conversely, although wetland species are predicted to be present in the post-reclamation landscape, their populations are not likely to recover to pre-industrial conditions because wetland habitats will generally be less prevalent and fens and bogs (i.e., peatlands) that were a part of the PIC but were subsequently disturbed will no longer be present.

The influx of wildlife into the reclaimed landscape will be determined by the proximity of potential immigrants in neighboring landscapes, the presence of wildlife movement corridors into reclaimed landscapes, and the age and developmental stage of the reclaimed land. Small mammals, including microtines (i.e., small rodents) and snowshoe hares, are often the first wildlife to occupy newly reclaimed areas. These species create an essential prey base that allows colonization by raptors and small to mid-sized carnivores such as weasels. Small mesocarnivores such as weasels will exploit the small mammal prey base when cover areas on the reclaimed site provide the security and stalking cover preferred by these species. Invasive and opportunistic species that are more tolerant of humans, such as deer, fox and coyote, are expected to be some of the first of the larger wildlife species on the reclaimed site. Other tolerant species, including many bird species, will also make use of the reclaimed site early in its development. Over time, as vegetation matures to provide adequate food (i.e., browse) and cover, moose and wolves will begin using the reclaimed area. Finally, the more elusive, wide-ranging wildlife species (e.g., wolf) and species requiring mature and old growth forests (e.g., black-throated green warbler) will colonize the area. The following paragraphs discuss the predicted habitat conditions for KIRs and SAR in the reclaimed landscape relative to the conditions prior to reclamation as well as to the PIC, and the period when each species is likely to become established after reclamation.

After reclamation, increases in high suitability habitat are predicted for barred owl, black-throated green warbler, Canada warbler and olive-sided flycatcher relative to conditions prior to reclamation as well as to the PIC because these species are associated with mature forest stands. These species are also predicted to immigrate into the post-reclamation landscape once mature forest becomes established 80 years or more after initial reclamation.

Barred owls prefer mature mixedwood forests over 80 years of age, particularly for nesting. Young stands, coniferous stands, treed muskegs and open areas appear to be avoided. Therefore habitat suitability will increase in the reclaimed landscape over 80 years as the reclaimed forest continues to mature. One hundred or more years after Closure, barred owl habitat in the reclaimed landscape will increase relative to conditions prior to reclamation and to the PIC as a result of the shift to terrestrial uplands. Barred owls will not likely be present in the reclaimed landscape until after the development of mature and old growth forest.

The black-throated green warbler is generally associated with mature coniferous forests, but also breeds in mixedwood forests, and less commonly in deciduous stands. Recent evaluation of Breeding Bird Survey (BBS) data in Alberta indicates that the black-throated green warbler has declined at an annual rate of 7% from 1966 to 2011 (Sauer et al. 2012, internet site). If this trend continues, this species could become extirpated in the time frame of PRM. The black-throated green warbler population in the RSA immediately after reclamation will likely be smaller than existed in PIC. However, over time the black-throated green warbler population in the RSA is predicted to recover because although the species has declined in Alberta, its population has been generally stable when considering its entire range (Sauer et al. 2012). Canada warblers have been recorded breeding primarily in mature stands of mixed deciduous forests and less commonly in mixedwood stands. Canada warblers can occur in younger stands, but mature and old forests are preferred. Prime nesting habitat for olive-sided flycatchers occurs in mature conifer forests associated with forest openings (i.e., open canopy and edge habitat) for foraging. As the area of upland forests are predicted to increase after reclamation, habitat for Canada warbler and olive-sided flycatcher is also predicted to increase after reclamation.

Black bear, Canada lynx and fisher will see increases in the availability of quality habitat in a reclaimed landscape relative to the landscape prior to reclamation and in the PIC because of a higher proportion of terrestrial uplands in the RSA. Black bears are well adapted to forest environments; dense shrub cover, adequate mature trees and canopy cover provide optimal habitat for resting, travelling and escape. Burns, riparian areas and forest openings provide conditions for the production of berries, which are a major food source for black bears in summer and early fall. Canada lynx habitat preference, in general and particularly in winter, reflects that of its primary prey, the snowshoe hare. The primary determinant of habitat preference for snowshoe hares appears to be the density of understorey vegetation. High-quality lynx habitat often contains mature aspen, white spruce and black spruce stands with substantial browse and horizontal cover, as well as a persistent, modest number of hares. Fishers utilize coniferous and mixedwood forests of a variety of age classes, so long as a high density of small mammals are available for prey, which requires abundant coarse woody debris. Provided security cover is available nearby, black bears are likely the first of these three species to take advantage of a reclaimed landscape because of the increased prevalence of berry foraging opportunities in forests with lower canopy cover. Canada lynx will appear once their prey, snowshoe hare and sufficient cover for successful hunting are present. Fisher will likely establish after a mature forest with sufficient coarse woody debris are present, likely 50 or more years after reclamation, or earlier if coarse woody debris is artificially introduced to the reclaimed landscape.

Moose are associated with early seral landscapes. In winter, moose tend to prefer herb/shrub communities and young forest stands provided that snow depth is not limiting. Lower levels of canopy cover provide the increased quality and quantity of forage that moose prefer. As such, moose are likely to be among the first large mammals to immigrate into a reclaimed landscape when forage and security cover become established. The post-reclamation landscape is predicted to provide more high-quality moose habitat relative to habitat availability for the species prior to reclamation and in the PIC as a result of the increases to terrestrial uplands.

Beavers are more associated with terrestrial upland habitat and associated wetlands than peatlands and, as such, will experience an increase in available high quality habitat in the reclamation landscape relative to both the landscape before reclamation and the PIC. Ideal beaver habitat includes ponds, small lakes with muddy bottoms and meandering streams. Beavers will likely be relatively early immigrants into the reclamation landscape, arriving within the first 20 to 30 years, once sufficient forage (e.g., aspen saplings) and trees for lodge and dam building are available.

Both Canadian and western toads require water sources such as ponds, marshes and slow-moving watercourses for breeding. However, their overwintering habitat requirements are distinct. Hibernation sites for Canadian toads are communal and involve burrowing below the frostline in loose, coarse-textured soil. There are predicted increases in habitat for Canadian toad in the reclaimed landscape relative to both the landscape prior to reclamation and the PIC as a result of increases in overwintering habitat. Conversely, western toad hibernacula are found in peat hummocks, cavities beneath spruce trees and decayed root channels, as well as squirrel middens and abandoned beaver lodges. Breeding habitat for western toads includes fens and bogs. Because much of this breeding habitat cannot be reclaimed currently, there may be a small decrease in quality habitat for western toads relative to the landscape before reclamation and there are predicted decreases in quality habitat for western toads in the reclaimed landscape relative to the PIC. Although the cause of western toad decline in Alberta is not entirely clear, it appears to be related to disease rather than habitat availability. Therefore, changes to habitat in the RSA are unlikely to affect the western toad population. The timing of toad immigration into the reclaimed landscape is not known.

Common nighthawks are associated with a variety of open habitats, including forest clearings, burned areas, grassy meadows, rocky outcrops, sandy areas, grasslands, pastures, peat bogs, marshes, lake shores, quarries and mines. Forested areas with low canopy closure may also provide habitat for the common nighthawk. Habitat availability after reclamation will increase relative to habitat availability prior to reclamation. The prevalence of burns on the landscape will fluctuate over time but burns are expected to re-occur naturally in a post-reclamation landscape. Therefore, common nighthawk habitat after reclamation will likely be similar to that which was present prior to development. The timing of common nighthawk immigration into the reclaimed landscape is unknown, although it could occur relatively early after reclamation because of their affinity for open or semi-open habitats.

Although habitat availability after reclamation will increase relative to habitat availability prior to reclamation, decreases in high suitability habitat are predicted from the PIC to the 2013 PRM Application Case for horned grebe, rusty blackbird, short-eared owl, and yellow rail. Horned grebes mainly select semi-permanent and permanent freshwater ponds and shallow bays or marshes containing open water and rich with emergent vegetation such as sedges, rushes and cattails. Rusty blackbirds inhabit isolated, low-elevation wetlands in coniferous and mixed forest habitats across the boreal region, including bogs, fens, muskegs, swamps, wet meadows, wet forest openings and floodplain forests. Short-eared owls prefer open habitats, including grassy or brushy meadows and marshland. Yellow rails occupy sedge meadow wetlands and marshlands with little or no standing water; this most closely describes graminoid fen or marsh wetlands types in the RSA, which are wetlands dominated by sedge and reed grasses and less than 10% willow cover. The predicted declines are due to a net decrease in wetlands types that are preferred by these species. However, for short-eared owls, the continuation of forest harvesting in the future may maintain levels of high suitability habitat above that present in the PIC.

Populations of horned grebe, rusty blackbird, short-eared owl and yellow rail may be affected by habitat changes that are generally predicted to be adverse due to a decline in the extent of wetlands types after Closure relative to the PIC. Horned grebes are predicted to benefit from the reclamation of PRM due to the creation of the South Redclay Lake as well as the creation of a large graminoid marsh (MONG) in the northwest of the LSA. However, in general horned grebes and other wetlands dependent species are likely to lose high quality habitat due to the conversion of wetlands present under baseline conditions to uplands after reclamation. Given that the abundance of these species is not likely to be limited by habitat in northeastern Alberta and the extent of remaining habitat for these species in the RSA, regional populations in the reclaimed landscape are predicted to be similar to populations currently present in the region (i.e., relatively rare). The immigration of these species will depend on the development of suitable habitats in the reclamation landscape. Short-eared owls may be early arrivals due to their preference for hunting and breeding in open habitats once a small mammal prey base is established.

Wolverine habitat availability in the reclaimed landscape will increase relative to habitat availability prior to reclamation and will likely be fairly similar to what existed in the PIC. Wolverines use a wide range of habitat types within their large home ranges, but appear to show a preference for undisturbed areas. Wolverine population density may be more closely linked to food accessibility and sensitivity to human proximity than to specific habitat attributes. Once disturbance is removed from the landscape and prey is available, wolverines are predicted to return. However, wolverines are relatively rare and are likely to be rare after reclamation as well.

Little brown myotis and northern myotis are primarily limited by WNS, a fungal disease, across their range. This disease has not yet been identified in Alberta (ASRD 2011, internet site). Prior to the arrival of WNS in Alberta, the availability of hibernacula may be limiting regional abundance. However, no hibernacula are likely to occur within the RSA, and therefore are not likely to be affected by development. Little brown myotis and northern myotis are considered to be habitat generalists with respect to their summer roosting and foraging habitat, utilizing a range of mixedwood and coniferous forests (ASRD and ACA 2009; Crampton and Barclay 1998; Kunz and Reichard 2010). Due to the general increase in upland habitats after reclamation, summer roosting and foraging habitat availability after reclamation will increase relative to habitat availability prior to reclamation. Due to the limitations likely to be imposed by WNS, little brown myotis and northern myotis populations are not likely to be affected by habitat changes in the RSA.

Although there will be increases in habitat after reclamation relative to conditions prior to reclamation, decreases in high suitability habitat are predicted for wood bison in the RSA after reclamation relative to the PIC. Wood bison are obligate grazers, subsisting on grasses and sedges and so tend to be strongly associated with graminoid-dominated plant communities. Bison strongly select meadow and willow grassland habitats and tend to avoid habitats dominated by coniferous forests. The predicted decline in habitat availability is due to a net decrease in wetlands types that are preferred by bison. However, wood bison populations are not predicted to be affected. Wood bison abundance is likely limited by unregulated hunting, predation and disease (e.g., bovine tuberculosis, bovine brucellosis, anthrax), and habitat availability is likely not limiting the population in the RSA. Historical bison range occurs throughout the RSA, although much of this habitat is currently not utilized despite its continued availability. Bison could be early migrants into a reclaimed landscape because of their preference for graminoid-dominated plant communities that will develop soon after reclamation is initiated.

Woodland caribou habitat availability after reclamation will not substantially change relative to habitat availability prior to reclamation but the species will experience a decrease in the amount of high suitability habitat after reclamation relative to the PIC. Regional-level habitat selection by woodland caribou involves selection of areas with a high coverage of peatlands. The most important winter food source for woodland caribou are terrestrial lichens which are mostly found in peatlands, in particular treed fens and bogs. Because peatlands currently cannot be reclaimed, the reclaimed landscape will have less woodland caribou habitat than existed in the past. Although woodland caribou are virtually absent from the LSA, which is located outside designated caribou areas, there are three caribou ranges in the RSA: the Red Earth, Richardson and West Side of the Athabasca River woodland caribou ranges. The three herds that occupy these ranges appear to be declining to extirpation. This decline appears to be due to predation by wolves, which have increased in abundance due to increases in populations of white-tailed deer. White tailed deer appear to have increased in abundance due to the creation of early seral habitat as a result of large-scale deforestation. Extirpation is predicted whether or not further development occurs in the RSA. Caribou populations and the extent of caribou habitat in the RSA after reclamation will be smaller than existed in the PIC.

4.3.5 Biodiversity

The effects of PRM and other existing and approved developments on biodiversity were assessed relative to the EIA Base Case in the EIA, Volume 5, Section 7.5.6. This section presents the effects to biodiversity in the RSA related to changes from the PIC to the 2013 PRM Application Case. A biodiversity assessment is provided to explicitly tie together the interacting effects of PRM and other existing developments on fish, vegetation and wildlife at the species, ecosystem, and landscape levels of biodiversity. This assessment places an emphasis on the ecosystem- and landscape-levels and uses the same assessment methods as described in the EIA, Volume 5, Section 7.5.6, where appropriate. Any notable deviations from the EIA assessment methods are described in Appendix 3.1, Section 2.8.

4.3.5.1 Assessment Results

4.3.5.1.1 Species-Level Biodiversity Impact Analysis

The species-level biodiversity effects of the 2013 PRM Application Case relative to the PIC are addressed in Sections 4.3.2 and 4.3.3 of this submission for vegetation and wildlife, respectively. Suitable PIC data for fish population sizes are not available and the sampling techniques from historic studies are not comparable to current studies. Therefore, a fish and fish habitat assessment was not possible for the PIC (Section 2.3.4). As such, fish and fish habitat is not considered in the species-level biodiversity impact analysis. Potential species-level effects to vegetation and wildlife resources are summarized below.

4.3.5.1.1.1 Terrestrial Vegetation, Wetlands and Forest Resources

From the PIC to the 2013 PRM Application Case for species-level KIRs assessed at the RSA scale, a negative residual impact with a moderate and high environmental consequence is predicted for high rare plant potential and high traditional use plant potential, respectively (Table 4.3-12). The majority of these effects from the PIC to the 2013 PRM Application Case are due to disturbances that occurred between the PIC and the 2013 Base Case, prior to the construction and operation of PRM (Section 4.3.3.4).

4.3.5.1.1.2 Wildlife and Wildlife Habitat

From the PIC to the 2013 PRM Application Case, industrial development in the RSA results in negative residual impacts with high environmental consequences to barred owl, black-throated green warbler, Canada warbler, rusty blackbird, wolverine, woodland caribou and yellow rail abundance (Section 4.3.4.2). Environmental consequences are negligible for the residual impacts to little brown myotis, northern myotis, peregrine falcon, red knot, short-eared owl and whooping crane abundance, and low to moderate for the abundance of the remaining wildlife KIRs (Section 4.3.4.2).

The environmental consequences of residual impacts to habitat from the PIC to the 2013 PRM Application Case are low for common nighthawk and short-eared owls, moderate for beaver, black bear, Canada lynx, Canadian toad, fisher, horned grebe, little brown myotis, northern myotis, moose and olive-sided flycatcher, and high for all remaining wildlife KIRs (Section 4.3.4.2). The majority of impacts to habitat from the PIC to the 2013 PRM Application Case are due to disturbances that are present in the 2013 Base Case (Section 4.3.4.2).

The environmental consequences of residual impacts to wildlife movement from the PIC to the 2013 PRM Application Case are negligible for all volant KIRs (i.e., avian and myotis species), moderate for amphibian KIRs, and high for the more vagile terrestrial KIRs (e.g., black bear, wolverine) (Section 4.3.4.2).

4.3.5.1.2 Ecosystem-Level Biodiversity Impact Analysis

At the ecosystem-level of biodiversity, effects of the 2013 PRM Application Case are evaluated by considering changes in the areal extent of RLCCs in the RSA ranked high, moderate or low for biodiversity potential. Biodiversity potential represents the relative contribution of a RLCC to the overall biological diversity of an area. Both direct (i.e., PRM footprint) and indirect (i.e., groundwater drawdown) effects are assessed in this subsection.

Biodiversity Potential

Effects of changes from the PIC to the 2013 PRM Application Case on RLCCs in the RSA are presented according to biodiversity potential in Figure 4.3-1 and Table 4.3-37, and are summarized according to rank as follows:

- During construction and operations of the 2013 PRM Application Case, high biodiversity potential areas will decrease by 79,575 ha (15%) compared to the PIC. The majority (54%) of this loss will occur to the treed fen RLCC. Of the losses to high biodiversity potential areas, 72,042 ha (13%) occurs between the PIC and the 2013 Base Case. At Closure, an overall decrease in high biodiversity potential areas of 76,878 ha (14%) will result from losses in both the non-treed wetlands and treed fen RLCCs relative to the PIC (Figure 4.3-1).
- Moderate biodiversity potential areas will decrease by 134,263 ha (16%) relative to the PIC during construction and operations of the 2013 PRM Application Case. With the exception of water, each RLCC is affected by greater than 10% of its total area compared to PIC conditions. Of the losses to moderate biodiversity potential areas, 129,573 ha (15%) occurs between the PIC and the 2013 Base Case. At Closure, moderate biodiversity potential areas will decrease by 129,628 ha (15%) (Figure 4.3-1). Water is the only moderate-ranked RLCC that will increase at Closure relative to the PIC. The increase in the water RLCC is due to the addition of pit lakes and South Redclay Lake to the Closure landscape.
- During construction and operations of the 2013 PRM Application Case, low biodiversity potential areas will decrease by 11,240 ha (1%). Only cutblock areas will increase compared to the PIC. The majority of the negatively affected low-ranked areas consists of a 55,960 ha reduction in the deciduous aspen−balsam poplar RLCC. In comparison, 9,959 ha (1% relative to the PIC) of areas ranked low for biodiversity potential were lost due to the 2013 Base Case. At Closure, low-ranked areas increase by 207,225 ha (23%) relative to the PIC (Figure 4.3-1). Cutblock and disturbance areas comprise the entirety of this gain in low biodiversity potential areas. The remaining low-ranked RLCCs decrease at Closure relative to PIC conditions.

Figure 4.3-1 Change in Biodiversity Potential in the Regional Study Area – Pre-Industrial Case to the 2013 PRM Application Case: Closure

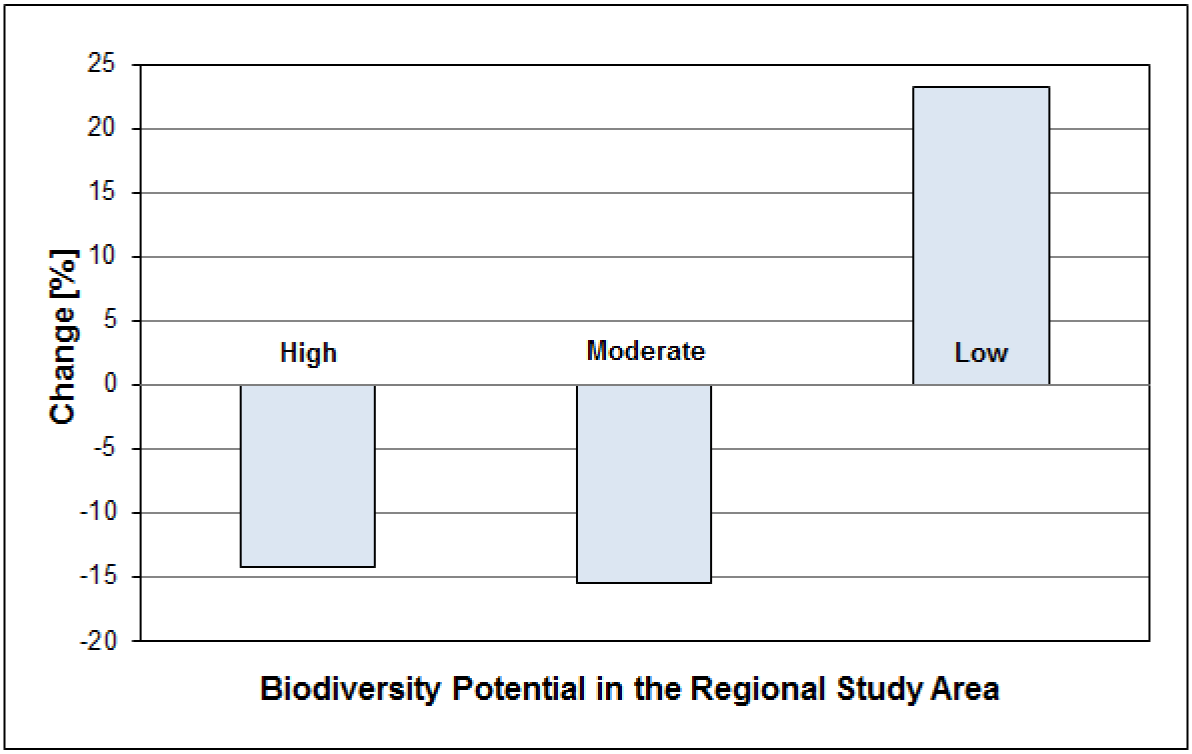

Table 4.3-37 Change in Biodiversity Potential in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case

Regional Land Cover Class	Pre-Industrial Case	Loss/Alteration Due to 2013 Base Case[(a)]		Loss/Alteration Due to 2013 PRM Application Case		Closure	Net Change due to the 2013 PRM Application Case[(b)]	
	Area [ha]	Area [ha]	% of Resource[(c)]	Area [ha]	% of Resource[(c)]	Area [ha]	Area [ha]	% of Resource[(c)]
High Biodiversity Potential								
non-treed wetlands	275,397	-34,288	-12	-36,806	-13	240,492	-34,905	-13
treed fen	268,124	-37,755	-14	-42,769	-16	226,151	-41,973	-16
subtotal	*543,521*	*-72,042*	*-13*	*-79,575*	*-15*	*466,643*	*-76,878*	*-14*
Moderate Biodiversity Potential								
coniferous white spruce	69,421	-17,035	-25	-17,657	-25	52,302	-17,119	-25
mixedwood aspen−jack pine	49,528	-10,496	-21	-10,496	-21	39,147	-10,381	-21
mixedwood aspen-white spruce	197,394	-52,635	-27	-54,278	-27	144,411	-52,982	-27
treed bog/poor fen	471,749	-47,894	-10	-50,274	-11	421,900	-49,849	-11
water	54,040	-1,514	-3	-1,559	-3	54,743	704	1
subtotal	*842,132*	*-129,573*	*-15*	*-134,263*	*-16*	*712,504*	*-129,628*	*-15*
Low Biodiversity Potential								
burn	420,169	-24,044	-6	-24,470	-6	395,993	-24,176	-6
coniferous jack pine	191,070	-24,738	-13	-25,086	-13	166,251	-24,819	-13
coniferous jack pine-black spruce	44,624	-4,570	-10	-4,570	-10	44,228	-397	-<1
cutblock	65	100,095	154,890	100,095	154,890	100,160	100,095	154,890
deciduous aspen−balsam poplar	233,520	-55,454	-24	-55,960	-24	179,418	-54,102	-23
disturbance[(d)]	1,557	-1,249[(e)]	-80	-1,249	-80	212,181	210,624	13,531
subtotal	*891,004*	*-9,959*	*-1*	*-11,240*	*-1*	*1,098,230*	*207,225*	*23*
Not Ranked								
cloud[(f)]	719	-719	-100	-719	-100	0	-719	-100
Total[(g)]	**2,277,376**	**-212,293**	**-9**	**-225,797**	**-10**	**2,277,376**	**n/a**	**n/a**

(a) Loss/alteration due to the 2013 Base Case is provided for comparative purposes.

(b) Net change due to the 2013 PRM Application Case is calculated as the difference between the Pre-Industrial Case and Closure, combining direct effects due to site clearing (PRM footprint) and indirect effects due to groundwater drawdown from PRM. Net change is the value upon which the environmental consequence after reclamation is assessed.

(c) This column is calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

(d) Includes urban, industrial and other human disturbances in the RSA.

(e) This is the total amount of previously disturbed areas that fall within the footprints of projects and activities considered under 2013 Base Case conditions in the RSA.

(f) Clouds on the Landsat image prevent interpretation of regional land cover class in some areas for Pre-Industrial Case; therefore, 1% of the RSA could not be ranked according to biodiversity potential.

(g) Total RSA or footprint and groundwater drawdown.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

4.3.5.1.3 Landscape-Level Biodiversity Impact Analysis

At the landscape-level of biodiversity, effects of the PRM and other existing and approved developments are assessed by considering changes in heterogeneity and degree of fragmentation within the RSA. Landscape heterogeneity is a measure of landscape composition, similarity and arrangement based on patch type (i.e., RLCCs). Fragmentation relates to how categories (e.g., natural, non-forested and forested) are partitioned on the landscape.

Heterogeneity

The effects on landscape heterogeneity in the RSA were measured by changes in area of land cover categories (e.g., terrestrial, wetlands and water). These changes illustrate the effects of the PRM and other projects and activities on general landscape patterns in the RSA. The results are presented in Table 4.3-38 and are summarized as follows:

- Terrestrial RLCCs will decrease by 168,047 ha (21%) due to construction and operations of the 2013 PRM Application Case. Of the losses to terrestrial RLCCs, 164,927 ha (21%) occurs between the PIC and the 2013 Base Case. At Closure, terrestrial RLCCs decrease by 159,801 ha (20%) in the RSA relative to PIC conditions (Table 4.3-38). All terrestrial RLCCs decrease in the Closure landscape (Table 4.3-37).
- Construction and operations of the 2013 PRM Application Case will result in a decrease of 129,849 ha (13%) of wetland RLCCs. Of these losses to wetland RLCCs, 119,936 ha (12%) occurs between the PIC and the 2013 Base Case. Wetlands in the RSA will decrease by 126,728 ha (12%) overall from the PIC to Closure (Table 4.3-38). The largest decrease will occur to treed bog/poor fen, followed by treed fen (Table 4.3-37). These two RLCCs are mainly composed of peatland land cover types, which cannot be reclaimed with current technologies.
- The water land cover category comprises the smallest proportion (1,559 ha) of the overall change, relative to the PIC, due to construction and operations of the 2013 PRM Application Case. Of this loss to the water land cover category, 1,514 ha (3% relative to the PIC) occurs as a result of the 2013 Base Case. Relative to the proportion present in the PIC, this land cover category increases slightly (1%) at Closure (Table 4.3-38).
- The burn land cover category is affected by 6% of its areal extent relative to PIC conditions due to the 2013 Base Case, the 2013 PRM Application Case and at Closure (Table 4.3-38).
- The 2013 Base Case will result in an increase of 311,139 ha (19,191%) to the disturbed land cover category relative to the PIC (Table 4.3-38). The 2013 PRM Application Case will result in an additional 13,504 ha of disturbance compared to the 2013 Base Case. The net change in disturbance due to the 2013 PRM Application Case, relative to the PIC, will be an increase of 310,719 ha (19,165%) (Table 4.3-38).

Table 4.3-38 Change in Area of Cover Categories in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case

Cover Category	Pre-Industrial Case	Loss/Alteration Due to 2013 Base Case[a]		Loss/Alteration Due to 2013 PRM Application Case		Closure	Net Change due to the 2013 PRM Application Case[b]	
	Area [ha]	Area [ha]	% of Resource[c]	Area [ha]	% of Resource[c]	Area [ha]	Area [ha]	% of Resource[c]
burn	420,169	-24,044	-6	-24,470	-6	395,993	-24,176	-6
disturbed[d]	1,621	311,139	19,191	324,643	20,027	312,341	310,719	19,165
terrestrial	785,557	-164,927	-21	-168,047	-21	625,757	-159,801	-20
water	54,040	-1,514	-3	-1,559	-3	54,743	704	1
wetlands	1,015,270	-119,936	-12	-129,849	-13	888,543	-126,728	-12
other (cloud)	719	-719	-100	-719	-100	0	-719	-100
Total	**2,277,376**	**n/a**	**n/a**	**n/a**	**n/a**	**2,277,376**	**n/a**	**n/a**

(a) Loss/alteration due to the 2013 Base Case is provided for comparative purposes.

(b) Net change due to the 2013 PRM Application Case is calculated as the difference between the Pre-Industrial Case and Closure, combining direct effects due to site clearing (PRM footprint) and indirect effects due to groundwater drawdown from PRM. Net change is a value upon which the environmental consequence after reclamation is assessed.

(c) This column is calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

(d) Includes cutblocks, urban, industrial and other human disturbances in the RSA.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Fragmentation

The RSA fragmentation analysis identified changes in natural, disturbed, forested and non-forested areas. The results are presented in Table 4.3-39 and are summarized as follows:

- Natural areas will decrease by 323,925 ha (14%) relative to the PIC due to construction and operations of the 2013 PRM Application Case (Table 4.3-39). Of this loss in natural areas, 310,421 ha (14%) occurs between the PIC and the 2013 Base Case. At Closure, natural areas will experience a net decrease of 310,001 ha (14%) compared to the PIC.
- Construction and operations of the 2013 PRM Application Case will result in a 261,089 ha (17%) decrease in forested areas relative to the PIC. Of this loss in forested areas, 250,576 ha (16%) occurs between the PIC and the 2013 Base Case. At Closure, there will be a net decrease of 251,623 ha (16%) relative to the PIC (Table 4.3-39). A smaller net decrease (8%) in non-forested areas from the PIC to Closure results primarily from the reclamation of areas disturbed by the PRM footprint to water.

Table 4.3-39 Change in Natural, Disturbed, Forested and Non-Forested Areas in the Regional Study Area – Pre-Industrial Case to 2013 PRM Application Case

Cover Category	Pre-Industrial Case	Loss/Alteration Due to 2013 Base Case[a]		Loss/Alteration Due to 2013 PRM Application Case		Closure	Net Change due to Pierre River Mine[b]	
	Area [ha]	Area [ha]	% of Resource[c]	Area [ha]	% of Resource[c]	Area [ha]	Area [ha]	% of Resource[c]
natural	2,275,036	-310,421	-14	-323,925	-14	1,965,036	-310,001	-14
disturbed[d]	1,621	98,846	6,097	98,846	6,097	312,341	310,719	19,165
forested	1,525,430	-250,576	-16	-261,089	-17	1,273,807	-251,623	-16
non-forested	749,606	-59,845	-8	-62,835	-8	691,228	-58,378	-8

(a) Loss/alteration due to the 2013 Base Case is provided for comparative purposes.

(b) Net change due to the 2013 PRM Application Case is calculated as the difference between the Pre-Industrial Case and Closure, combining direct effects due to site clearing (PRM footprint) and indirect effects due to groundwater drawdown from PRM. Net change is a value upon which the environmental consequence after reclamation is assessed.

(c) This column is calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

(d) Includes cutblocks, urban, industrial and other human disturbances in the RSA.

4.3.5.2 Residual Impact Classification During Construction and Operations

The residual impacts to biodiversity in the RSA during construction and operations, from the PIC to the 2013 PRM Application Case, are presented in Table 4.3-40. The biodiversity species-level residual impact classification draws directly upon the Terrestrial Vegetation, Wetlands and Forest Resources and Wildlife and Wildlife Habitat residual impacts (Sections 4.3.2.4 and 4.3.3.3, respectively). The ecosystem- and landscape-level residual impact classifications are based on the changes discussed in Sections 4.3.4.1.2 and 4.3.4.1.3 of the Biodiversity Assessment. For comparative purposes, environmental consequences of residual impacts to biodiversity from the PIC to the 2013 Base Case are also shown in Table 4.3-40.

Table 4.3-40 Residual Impact Classification for Biodiversity in the Regional Study Area – Pre-Industrial Case: During Construction and Operations

Biodiversity Criteria	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[a]
species-level effects	negative	moderate (+10)	moderate (+10)	regional to beyond regional (+1 to +2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12 to +13)	moderate (+12 to +13)
ecosystem-level effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)	moderate (+15)
landscape-level effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)

(a) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

The residual impacts of the changes from the PIC to the 2013 PRM Application Case on vegetation and wildlife KIRs are negative, with the exception of a positive residual impact on short-eared owl habitat. The overall magnitude of the residual impact at the species-level of biodiversity is considered moderate because most of the negative residual impacts to KIRs fell into the moderate category. Residual impacts to vegetation KIRs are considered regional in geographic extent; however, the criterion varies for wildlife KIRs. Residual impacts to wildlife KIRs are either regional or beyond regional, with some local impacts. All effects were considered to be long-term for vegetation and wildlife KIRs. In addition, the majority of residual impacts to vegetation and wildlife KIRs were considered reversible and predicted to occur with high frequency.

From the PIC to the 2013 Base Case and the 2013 PRM Application Case during construction and operations, the overall magnitude of the residual impact on ecosystem-level biodiversity is considered moderate because the negative net change to both high and moderate biodiversity potential areas will be between 10% and 20% (Table 4.3-37). The residual impact is considered to be regional in geographic extent due the regional scale of the assessment. The peatlands (i.e., fens, bogs) that make up nearly half of the high biodiversity potential category in the RSA cannot be reclaimed with current technologies if the soil has been disturbed. However, the RLCC that comprises the remainder of the high biodiversity potential category (i.e., non-treed wetlands) can be reclaimed. Non-treed wetlands include wetlands types such as marsh (MONG), shrubland (Sh) and shrubby swamp (SONS), which are a consistent component of reclamation plans. In addition, the largest losses are to RLCCs that can also be reclaimed, such as mixedwood aspen-white spruce, coniferous white spruce, deciduous aspen−balsam poplar, and mixedwood aspen−jack pine (Table 4.3-37). For these reasons, the overall residual impact was scored as partially irreversible. The residual impact is also considered to be long-term in duration and high in frequency.

At the landscape level, the negative changes in heterogeneity and fragmentation metrics are variable, but most fall in the moderate magnitude range (i.e., between 10% and 20%), both due to construction and operations of the 2013 PRM Application Case and the 2013 Base Case. The residual impact is considered to be regional in geographic extent and long-term in duration.

Overall, negative moderate environmental consequences due to construction and operations of the 2013 PRM Application Case are predicted for the species-, ecosystem- and landscape-levels of biodiversity. These results apply to effects from both the construction and operations of the 2013 PRM Application Case, as well as the 2013 Base Case. The majority of the effects to biodiversity from the PIC to the 2013 PRM Application Case are due to changes from the PIC to the 2013 Base Case, as indicated by the identical environmental consequence ratings.

4.3.5.3 Environmental Significance Determination During Construction and Operations

From the PIC to construction and operations of the 2013 PRM Application Case, species-, ecosystem- and landscape-level effects are ranked as having a negative, moderate environmental consequence. Assessment methods for the determination of significance are discussed in Appendix 3.1, Section 2.8.3.

4.3.5.3.1 Ecological Thresholds

The following summarizes the change to species-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PRM Application Case:

- The cumulative effects to species-level biodiversity are considered Adverse due to losses of vegetation and wildlife resources.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds and compromise resilience and adaptability of most plant and wildlife populations in the RSA such that their

populations would no longer be self-sustaining and ecologically effective. However, development in the RSA is likely to have exceeded ecological thresholds for three wildlife species (i.e., black-throated green warbler, Canada warbler, and woodland caribou; Section 4.3.4.2).

- The predicted effects are considered Likely.

Therefore, cumulative effects to biodiversity at the species level from the PIC to the 2013 PRM Application Case are not predicted to have exceeded ecological thresholds for the majority of species, but Likely, Significant, and Adverse environmental effects have been identified for some species.

At the ecosystem level, disturbances can push ecosystems into an alternate stable state from which they might not recover (Krebs 2009; Mayer and Rietkerk 2004). Given the increased level of disturbance in the 2013 PRM Application Case since PIC, the potential for permanent change in ecosystem function as a consequence of regional development exists. A biodiversity management framework for the Lower Athabasca Region that defines ecological effect thresholds is currently not available. Of the high biodiversity potential areas present in the PIC, 85% (463,946 ha; Table 4.3-37, Section 4.3.5.1.2) is estimated to remain intact during construction and operations of the 2013 PRM Application Case. This level of change is not expected to cause the ecosystem as a whole to enter an alternate stable state. Some components of the ecosystem, such as the large mammal predator-prey community, clearly have changed and the significance of these changes for individual species such as caribou is addressed at the species level (Section 4.3.4.25).

The conclusions about the significance of effects to biodiversity at the ecosystem level are associated with some uncertainty. Although some components of the ecosystem such as the large mammal community have been well studied, many ecological interactions at the ecosystem level have not been extensively studied in northeastern Alberta. Moreover, model error contributes to uncertainty. High biodiversity potential areas identified in the RSA (i.e., non-treed wetlands and treed fen RLCCs) have a classification accuracy estimated to be 40%. Because of the uncertainty in the spatial distribution of high biodiversity potential areas, losses may have been underestimated if developments more frequently affected these areas than was predicted by the model. However, the amount of high biodiversity areas in the RSA may have been underestimated because the direction of the error meant that many areas classified as low or moderate biodiversity potential actually consisted of high biodiversity potential. Therefore, although classification error may have led to an underestimation of the loss of high biodiversity potential areas in some places, there is likely more high biodiversity potential area in the RSA than predicted. This means the model was conservative and more likely to predict that ecological thresholds were exceeded based on areal extent of high biodiversity potential areas remaining after disturbance.

The following discusses the change to ecosystem-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PRM Application Case:

- The cumulative effects to ecosystem-level biodiversity are considered an Adverse effect because high and moderate biodiversity potential categories experience losses in areal extent.
- An ecological threshold has not likely been exceeded for biodiversity potential in the RSA given the areal extent of the resource remaining and the general intactness of ecological communities in the RSA. Therefore, this is considered to be a Not Significant effect.
- The predicted effect is considered Likely.

Consequently, the cumulative effects to ecosystem-level biodiversity from the PIC to the 2013 PRM Application Case is considered a Likely, Not Significant, and Adverse environmental effect.

At the landscape level, the variety and abundance of patch types (i.e., composition), how they are arranged within the matrix (configuration), and the degree of connectivity, or inversely, fragmentation, of a landscape can affect species and the ecological processes that influence them (McGarigal and Marks 1995). Landscape features, such as patch size and shape, proximity of similar patches and presence of functional corridors, have implications for species interactions, distribution and population persistence (Debinski and Holt 2000; Fahrig 2003; Fahrig et al. 2011; Noss and Harris 1986). As for ecosystem-level biodiversity, the potential for permanent change in landscape function as a consequence of regional development exists given the increased level of disturbance since the PIC. The following discusses the change to landscape-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PRM Application Case:

- The cumulative effects to landscape-level biodiversity are considered Adverse effects due to the alteration of composition, configuration, and connectivity of the landscape.
- Although thresholds are unknown, it is unlikely that an unacceptable threshold has been reached for landscape-level biodiversity in the RSA given the areal extent of the RSA that remains undisturbed in the 2013 PRM Application Case (i.e., 86%). Therefore, this is considered a Not Significant effect.
- The predicted impact is considered Likely.

Therefore, the cumulative effects to landscape-level biodiversity from the PIC to the 2013 PRM Application Case are determined to be Likely, Not Significant, and Adverse environmental effects.

4.3.5.3.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). High magnitude adverse and likely effects were predicted for a number of species in the species level assessments and a large number of significant effects were identified using resource management criteria (Sections 4.3.2 and 4.3.3). High magnitude adverse and likely effects were not predicted for either ecosystem or landscape levels of biodiversity. Even given model uncertainty with respect to biodiversity potential, an increase from a 15% loss to a 20% loss of high biodiversity potential area is unlikely. Therefore, no significant effect was identified using resource management criteria.

4.3.5.4 Residual Impact Classification at Closure

The residual impacts to biodiversity in the RSA at Closure, from the PIC to the 2013 PRM Application Case, are presented in Table 4.3-41. The biodiversity species-level residual impact classification draws directly upon the Terrestrial Vegetation, Wetlands and Forest Resources, and Wildlife and Wildlife Habitat residual impacts (Sections 4.3.2.4 and 4.3.3.3, respectively). The environmental consequences of the residual impacts to wildlife KIRs are quantitatively assessed prior to Closure only and assume that all disturbances occur simultaneously. Therefore, the predicted effects of the 2013 PRM Application Case represent worst-case scenarios (Section 4.4.3). The ecosystem- and landscape-level residual impact classifications are based on the changes discussed in Sections 4.3.5.1.2 and 4.3.5.1.3 of the Biodiversity Assessment. For comparative purposes, environmental consequences of residual impacts to biodiversity from the PIC to the 2013 Base Case are also shown in Table 4.3-41.

Table 4.3-41 Residual Impact Classification for Biodiversity in the Regional Study Area – Pre-Industrial Case: Closure

Biodiversity Criteria	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case[(a)]
species-level effects	negative	moderate (+10)	moderate (+10)	regional to beyond regional (+1 to +2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12 to +13)	moderate (+12 to +13)
ecosystem-level effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)	moderate (+15)
landscape-level effects	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)

(a) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

The residual impacts of the changes from the PIC to the 2013 PRM Application Case on vegetation and wildlife KIRs are all negative, with the exception of a positive residual impact on short-eared owl habitat. The overall magnitude of the residual impact at the species-level of biodiversity is considered moderate because most of the negative residual impacts to KIRs fell into either the negligible or high categories. Residual impacts to vegetation KIRs are considered regional in geographic extent. However, the criterion varies for wildlife KIRs. Most residual impacts are either regional or beyond regional for wildlife KIRs, with some local impacts. All effects were considered to be long-term for vegetation and wildlife KIRs. In addition, the majority of residual impacts to vegetation and wildlife KIRs were considered reversible and predicted to occur with high frequency.

At Closure, the overall magnitude of the residual impact on ecosystem-level biodiversity is considered moderate because the negative net change to both high and moderate biodiversity potential areas will be between 10% and 20% (Table 4.3-37). The residual impact is also considered to be regional, long-term and partially irreversible.

At the landscape level, the negative changes in heterogeneity and fragmentation metrics are variable, but most fall in the moderate magnitude range (i.e., between 10% and 20%) at Closure of the 2013 PRM Application Case. The residual impact is considered to be regional in geographic extent and long-term in duration.

Overall, negative moderate environmental consequences due to the 2013 PRM Application Case are predicted for the species-, ecosystem- and landscape-levels of biodiversity. These results apply to effects from both the 2013 PRM Application Case at Closure, as well as from PIC to the 2013 Base Case. The majority of the effects to biodiversity from the PIC to the 2013 PRM Application Case are due to changes from the PIC to the 2013 Base Case, as indicated by the identical environmental consequence ratings.

4.3.5.5 Environmental Significance Determination at Closure

From the PIC to the 2013 PRM Application Case at Closure, species-, ecosystem- and landscape-level effects are ranked as having a negative, moderate environmental consequence. Assessment methods for the determination of significance are discussed in Appendix 3.1, Section 2.8.3.

4.3.5.5.1 Ecological Thresholds

The following summarizes the change to species-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PRM Application Case:

- The cumulative effects to species-level biodiversity are considered Adverse due to losses of vegetation and wildlife resources.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds and compromise resilience and adaptability of most plant and wildlife populations in the RSA such that their populations would no longer be self-sustaining and ecologically effective. However, development in the RSA is likely to have exceeded ecological thresholds for three wildlife species (i.e., black-throated green warbler, Canada warbler, and woodland caribou; Section 4.3.4.2).
- The predicted effects are considered Likely.

Therefore, cumulative effects to biodiversity at the species level from the PIC to the 2013 PRM Application Case are not predicted to have exceeded ecological thresholds for the majority of species, but Likely, Significant and Adverse environmental effects have been identified for some species.

As previously stated in Section 4.3.5.3, disturbances can push ecosystems into an alternate stable state from which they might not recover (Krebs 2009; Mayer and Rietkerk 2004). Given the increased level of disturbance in the 2013 PRM Application Case since PIC, the potential for permanent change in ecosystem function as a consequence of regional development exists. A biodiversity management framework for the Lower Athabasca Region that defines ecological effect thresholds is currently not available. Of the high biodiversity potential areas present in the PIC, 86% (466,643 ha; Table 4.3-37, Section 4.3.5.1.2) is estimated to remain intact at Closure in the 2013 PRM Application Case. This level of change is not expected to cause the ecosystem as a whole to enter an alternate stable state. Some components of the ecosystem, such as the large mammal predator-prey community, clearly have changed and the significance of these changes for individual species such as caribou is addressed at the species level (Section 4.3.4.25).

The conclusions about the significance of effects to biodiversity at the ecosystem level are associated with some uncertainty. Although some components of the ecosystem such as the large mammal community have been well studied, many ecological interactions at the ecosystem level have not been extensively studied in northeastern Alberta. Moreover, model error contributes to uncertainty. High biodiversity potential areas identified in the RSA (i.e., non-treed wetlands and treed fen RLCCs) have a classification accuracy estimated to be 40%. Because of the uncertainty in the spatial distribution of high biodiversity potential areas, losses may have been underestimated if developments more frequently affected these areas than was predicted by the model. However, the amount of high biodiversity areas in the RSA may have been underestimated because the direction of the error meant that many areas classified as low or moderate biodiversity potential actually consisted of high biodiversity potential. Therefore, although classification error may have led to an underestimation of the loss of high biodiversity potential areas in some places, there is likely more high biodiversity potential area in the RSA than predicted, which means the model was conservative and more likely to predict that ecological thresholds were exceeded based on aerial extent of high biodiversity potential areas remaining after disturbance.

The following discusses the change to ecosystem-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PRM Application Case:

- The cumulative effects to ecosystem-level biodiversity are considered an Adverse effect because high and moderate biodiversity potential categories experience losses in areal extent.
- An ecological threshold has not likely been exceeded for biodiversity potential in the RSA given the areal extent of the resource remaining and the general intactness of ecological communities in the RSA. Therefore, this is considered to be a Not Significant effect.
- The predicted effect is considered Likely.

Therefore, the cumulative effects to ecosystem-level biodiversity from the PIC to the 2013 PRM Application Case is considered a Likely, Not Significant, and Adverse environmental effect.

At the landscape level, the composition, configuration, and the degree of connectivity of a landscape can affect species and the ecological processes that influence them (McGarigal and Marks 1995). As for ecosystem-level biodiversity, the potential for permanent change in landscape function as a consequence of regional development exists given the increased level of disturbance since the PIC. The following discusses the change to landscape-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PRM Application Case:

- The cumulative effects to landscape-level biodiversity are considered Adverse effects due to the alteration of composition, configuration, and connectivity of the landscape.
- Although thresholds are unknown, it is unlikely that an unacceptable threshold has been reached for landscape-level biodiversity in the RSA given the areal extent of the RSA that remains undisturbed in the 2013 PRM Application Case (i.e., 86%). Therefore, this is considered a Not Significant effect.
- The predicted impact is considered Likely.

Therefore, the cumulative effects to landscape-level biodiversity from the PIC to the 2013 PRM Application Case are determined to be Likely, Not Significant, and Adverse environmental effects.

4.3.5.5.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). High magnitude adverse and likely effects were predicted for a number of species in the species level assessments and a large number of significant effects were identified using resource management criteria (Sections 4.3.2 and 4.3.3). High magnitude adverse and likely effects were not predicted for either ecosystem or landscape levels of biodiversity. Even given model uncertainty with respect to biodiversity potential, an increase from a 14% loss to a 20% loss of high biodiversity potential area is unlikely. Therefore, no significant effect was identified using resource management criteria.

4.3.6 Summary

Overall, the assessment of cumulative effects to terrestrial resources indicates substantial changes in the RSA from PIC to the 2013 PRM Application Case. Most of these changes are negative and result primarily from the cumulative effects of existing and approved developments (i.e., the 2013 Base Case). For example, on average about 98% of wildlife habitat effects from the PIC to the 2013 PRM Application Case are due to disturbances that are present in the 2013 Base Case. The PRM makes an incremental contribution to the large existing cumulative effects identified at 2013 Base Case.

An assessment to determine whether these changes constituted significant adverse effects was conducted for each terrestrial KIR and for biodiversity at the species, ecosystem, and landscape levels. Prior to reclamation, the ecological threshold approach identified significant effects for three KIRs, whereas resource management criteria identified significant effects for 24 KIRs, or 69% of all KIRs (Table 4.3-42). The PRM contribution to significant adverse cumulative effects is small relative to the effect already present at 2013 Base Case. Using both ecological thresholds and resource management criteria, most Significant effects identified for terrestrial resources were already present in the 2013 Base Case.

The distinction between significance approaches is important when evaluating the results presented in Table 4.3-42. As noted in Appendix 3.1, ecological thresholds produce a more appropriate and meaningful assessment of significance for conservation of terrestrial resources because they indicate whether or not populations or ecosystems have lost, or are expected to lose, the ability to sustain themselves or maintain ecological function. A significant result identified using ecological thresholds represents a critical conservation concern. Significant adverse effects identified using ecological thresholds should be addressed to avoid contributing to the loss of healthy plant or animal populations or ecological function within the RSA.

The resource management criteria approach used for this assessment, in contrast, is ecologically arbitrary for many KIRs. There is no evidence that the loss of 20% of a resource is an appropriate ecological threshold for most species, and many studies identify much higher losses (i.e., between 40% and 90%) before abrupt and non-linear, negative changes in ecological or population function occur (Andren 1994; Monkkonen and Reunanen 1999; Rompre et al. 2010; Swift and Hannon 2010). Similarly, it is generally not reasonable to assume that any adverse effect to a species at risk, no matter how small, will meaningfully alter the sustainability of the population in the RSA. However, resource management criteria do identify limits identified by resource managers or regulators beyond which losses are considered unacceptable. Significant effects identified using resource management criteria therefore represent adverse effects, but not effects that necessarily require immediate management action to achieve long-term conservation of the resource.

After reclamation, the number of Significant adverse cumulative effects decrease for vegetation KIRs. Effects to soils and ecosystem and landscape level biodiversity are Not Significant before and after reclamation. Adverse cumulative effects would also likely decline for most wildlife KIRs after reclamation, and this would likely result in a reduction of the number of Significant adverse effects, especially those detected using the 20% resource management criterion. However, spatially explicit reclamation data to evaluate the amount of high quality habitat reclaimed at the RSA scale are unavailable and significance after reclamation was not determined for wildlife KIRs, resulting in an overall conservative assessment of predicted impacts based on effects during construction and operations.

Table 4.3-42 Summary of Key Indicator Resource Significance Determinations for Cumulative Effects to Terrestrial Resources from the Pre-Industrial Case to the 2013 PRM Application Case.

KIR	Before Reclamation		After Reclamation	
	RSA – Ecological Thresholds	RSA – Resource Management Criteria	RSA – Ecological Thresholds	RSA – Resource Management Criteria
Soils				
soil	-	-	n/a	Not Significant
Vegetation				
terrestrial vegetation	Not Significant	Significant	Not Significant	Significant
lichen jack pine community	-	Significant	-	Significant
wetlands	Not Significant	Not Significant	Not Significant	Not Significant
old growth forests	Not Significant	Not Significant	Not Significant	Not Significant
productive forests	-	Not Significant	Not Significant	Not Significant
high rare plant potential areas	Not Significant	Not Significant	Not Significant	Not Significant
high traditional use plant potential areas	-	Significant	-	Significant
Wildlife				
barred owl	Not Significant	Significant	-	-
beaver	Not Significant	Not Significant	-	-
black bear	Not Significant	Not Significant	-	-
black-throated green warbler	Significant	Significant	-	-
Canada lynx	Not Significant	Significant	-	-
Canadian toad	Not Significant	Not Significant	-	-
fisher	Not Significant	Significant	-	-
moose	Not Significant	Significant	-	-
Canada warbler	Significant	Significant	-	-
common nighthawk	Not Significant	Significant	-	-
horned grebe	Not Significant	Significant	-	-
little brown myotis	Not Significant	Significant	-	-
northern myotis	Not Significant	Significant	-	-
olive-sided flycatcher	Not Significant	Significant	-	-
peregrine falcon	Not Significant	Significant	-	-
red knot	Not Significant	Significant	-	-
rusty blackbird	Not Significant	Significant	-	-
short-eared owl	Not Significant	Significant	-	-
western toad	Not Significant	Significant	-	-
whooping crane	Not Significant	Significant	-	-
wolverine	Not Significant	Significant	-	-
wood bison	Not Significant	Significant	-	-
woodland caribou	Significant	Significant	-	-
yellow rail	Not Significant	Significant	-	-
Biodiversity				
species-level	Significant	Not Significant	Significant	Not Significant
ecosystem-level	Not Significant	Not Significant	Not Significant	Not Significant
landscape-level	Not Significant	Not Significant	Not Significant	Not Significant

n/a = Not applicable; - = Significance not assessed because of linkages with other components (i.e., soils indicators are directly reflected in changes to terrestrial vegetation, wetlands and forest resources), limited data (i.e., lichen jack pine community) or lack of meaningful ecological application of the indicator (i.e., productive forest and areas of high traditional use plant potential). To be conservative, and due to uncertainty in future population trends, significance for wildlife is assessed during construction and operations only.
Note: Cumulative effects from the PIC to the 2013 PRM Application Case include and are predominantly due to existing and approved developments in the 2013 Base Case.

4.3.7 Additional Mitigation – Biodiversity Offsets

The CEAA's (2013) Operational Policy Statement under CEAA 2012 states that where mitigation of significant adverse cumulative effects is not possible, restitution (i.e., replacement, restoration, or compensation) for damage caused by residual environmental effects should be considered by regulators.

In July 2013, the JRP Decision Report for Shell's Jackpine Mine Expansion Project recognized that there are few options available for avoiding or minimizing the adverse effects of large surface mines beyond those mitigations already put forward by Shell and as such recommended to the Federal and Provincial governments that conservation offsets should be considered.

Shell is committed to working cooperatively with the Governments of Alberta and Canada to assist in developing policy to mitigate the significant adverse effects associated with the development of oil sands resources in the region.

Mitigation could take several forms, for example, options may include setting aside of lands that may otherwise be developed, or to provide capacity funding to secure lands that may already be protected from a regulatory standpoint but their protection is non-existent due to insufficient funding. Offsets can also include the restoration of previously disturbed lands. An important aspect of the development of offset policy should be that it needs to recognize that there is unlikely to be a "one size fits all" solution and that flexibility will likely be required on a case by case basis.

Options Shell could consider to offset the significant adverse effects of the PRM include, but are not limited to, the following:

- land conservation;
- reclamation of historical footprints (oil sands, conventional oil and gas development);
- fund or partner with others on conservation;
- conservation initiatives (e.g., offset policy development); and
- research initiatives that will directly benefit conservation (e.g., reclamation).

Using these options or others, Shell will work cooperatively with the Governments of Alberta and Canada and other interested parties to develop appropriate mitigations to reduce the effects of PRM on the terrestrial environment.

4.4 Traditional Land Use

The following sections summarize the significance of cumulative effects on Traditional Land Use (TLU) during Construction and Operations prior to Closure for the 2013 PRM Application Case.

4.4.1 Fort McKay Community

The cumulative effects to traditional hunting, trapping, fishing and traditional plant and berry harvesting were each assessed as high magnitude in the RSA under the 2013 PRM Application Case. Due to the location of land and access disturbances in relation to the community of Fort McKay, the impacts are likely to be experienced by the community as a whole and have resulted in substantial effects to the community of Fort McKay's ability to undertake TLU activities. The cumulative effect to Fort McKay's traditional land use at the

2013 PRM Application Case, including existing and approved developments, is therefore considered significant prior to reclamation.

Although the cumulative effects of the 2013 PRM Application Case on the traditional hunting, fishing and traditional plant and berry harvesting activities are considered significant, the disturbances to the Fort McKay Community preferred harvesting areas have mostly occurred as a result of existing and approved developments (i.e., 2013 Base Case). The PRM will disturb no more than 1% of any of Fort McKay Community's preferred harvesting areas and given the location of the Project, the footprint is expected to have a small effect on traditional trails used to access preferred harvesting areas. Therefore, on its own, the PRM's effects on the traditional land use activities are considered not significant.

4.4.2 Mikisew Cree First Nation

The cumulative effects to traditional hunting, fishing and traditional plant and berry harvesting were each assessed as high magnitude in the RSA under the 2013 PRM Application Case. The effects on MCFN traditional trapping in the RSA were assessed as adverse and moderate in magnitude for the individual(s) trapping on RFMA #2892. As a result of the high magnitude impacts on traditional hunting, fishing and plant harvesting, the cumulative effects of the 2013 PRM Application Case are considered significant for MCFN traditional land use within the RSA prior to reclamation.

While the cumulative effects of the 2013 PRM Application Case on MCFN traditional hunting, fishing and traditional plant and berry harvesting within the RSA were considered significant, the effects of the PRM on its own are considered not significant. The Project disturbance to the portion of the MCFN traditional territory that overlaps the RSA is only 1%. The MCFN trapping areas within the RSA, represented by RFMA #2892, are located close to the northern boundary of the RSA and will not be disturbed by the PRM. On its own, the PRM is not expected to substantially disturb access to other MCFN preferred harvesting areas in the RSA. Therefore, on its own, the PRM's effects on the traditional land use activities are considered not significant.

4.4.3 Athabasca Chipewyan First Nation

When the effects to the TLU resource base, preferred harvesting areas, access to preferred areas, and the effects to air, noise, human health and social factors are considered, the 2013 PRM Application Case is considered to have high magnitude effects for ACFN traditional harvesting within the RSA. As a result of the high magnitude impacts to traditional harvesting the effects of the 2013 PRM Application Case, including existing and approved developments, are considered to have a substantial effect on ACFN harvesting in the RSA, and are considered significant.

While the effects of the 2013 PRM Application Case on ACFN traditional harvesting activities within the RSA have been assessed as significant, the effects of the PRM, on its own, are considered not significant. Most of the 2013 PRM Application Case disturbances have been caused by existing and approved developments (i.e., 2013 Base Case). On its own, the PRM represents 1% of the area of the RSA portion of the Homeland Zone and 1% of the RSA portion of the Fort McKay and Fort McMurray proximate zones. The PRM is not expected to have a substantial effect on ACFN access to preferred areas for harvesting within the RSA.

4.4.4 Fort McMurray #468 First Nation

The assessment determined that the 2013 PRM Application Case cumulative effects to FM468 traditional hunting and plant and berry harvesting within the RSA are adverse and high in magnitude, while effects to

FM468 traditional trapping and fishing are adverse and moderate in magnitude. As a result of the high magnitude effects to FM468 traditional harvesting within the RSA, the cumulative effects of the 2013 PRM Application Case, including existing and approved developments, are considered significant.

While the cumulative effects of the 2013 PRM Application Case on traditional harvesting within the RSA are considered significant, most of the disturbances occur as a result of existing and approved developments (i.e., 2013 Base Case). The PRM is close to the northern boundary of FM468's traditional territory, and most of the traditional harvesting activities are located south of Fort McMurray (outside the RSA) and on the east side of the Athabasca River. As a result, the effects of the PRM, on its own, are considered not significant for FM468 TLU within the RSA.

4.4.5 Fort Chipewyan Métis Local #125

The cumulative effects classification determined that the effects to traditional hunting, fishing and traditional plant and berry harvesting by members of Fort Chipewyan Métis Local #125 within the RSA were adverse and high in magnitude. The cumulative effects to traditional fishing were assessed as low. The high impacts are mostly the result of impacts to the use of RFMA #1275 by the Métis RFMA holders. The available information further indicated that the large majority of traditional land use by members of Fort Chipewyan Métis Local #125 occurs north of the RSA in the larger area around Fort Chipewyan. Because the impacts within the RSA are limited to a few individuals the cumulative impacts of the 2013 PRM Application Case are not expected to substantially alter the ability of Fort Chipewyan Métis Local #125 members to practice traditional activities. As a result, the cumulative effects of the 2013 PRM Application Case on traditional harvesting by Fort Chipewyan Métis within the RSA are considered not significant.

For the reasons identified above, the effects of PRM on its own are also considered not significant in relation to Fort Chipewyan Métis Local #125 TLU.

4.4.6 Fort McMurray Métis Local #1935

The cumulative effects in the 2013 PRM Application Case are considered to have high magnitude effects on Fort McMurray Métis Local #1935 traditional hunting, fishing and traditional plant and berry harvesting within the RSA. There is not enough information to assess the cumulative effects of the 2013 PRM Application Case on trapping by Fort McMurray Métis Local #1935. As a result of the high magnitude and long duration effects to traditional hunting, fishing and traditional plant and berry harvesting, the cumulative effects of the 2013 PRM Application Case, including existing and approved developments, on Fort McMurray Métis Local #1935 harvesting in the RSA are considered significant.

Because of the small size of the PRM footprint in relation to the RSA and that most of the disturbance to traditional access within the RSA has been caused by existing and approved developments (i.e., the 2013 Base Case), the effects of the PRM on its own are not considered significant to the traditional harvesting activities of Fort McMurray Métis Local #135 members.

4.4.7 Significance of Effects at Closure

The wildlife assessment (Section 4.3.4.2.24.3) has indicated that at Closure, there will be increased quality habitat for black bear, moose, Canada lynx, fisher and beaver, compared to the Pre-Industrial Case. At Closure there is expected to be an overall decrease in high quality habitat for wood bison and woodland caribou. Wood bison are also expected to be early migrants into reclaimed areas. At Closure, the combined high and moderate traditional plant potential is expected to be 14% lower than that found at Pre-Industrial Case. While it is not possible to determine the RSA closure landscape in detail because detailed reclamation plans are not available for all projects in the 2013 PRM Application Case, the assessment assumes that project-related disturbances will generally be reclaimed to allow wildlife re-population in preferred harvesting areas throughout RSA, and access to resources and preferred harvesting areas by traditional harvesters. Although the 2013 PRM Application Case was not expected to have a significant effect on fish abundance, the closure landscape is expected to facilitate access to preferred fishing areas. As a result, the opportunities for traditional wildlife harvesting (trapping, hunting and fishing) are expected to increase as a result of the closure landscape.

The effects to traditional plant harvesting opportunities within the RSA are also generally expected to increase. While the combined high and moderate traditional plant potential is expected to remain much the same at Closure as under the 2013 PRM Application Case, the decrease in land disturbance is expected to provide easier access to preferred harvesting areas. As a result of the closure landscape, the effects of the 2013 PRM Application Case post-reclamation on traditional harvesting opportunities are assessed as not significant.

Socio-economic factors can also influence the undertaking of traditional harvesting. These include a variety of socio-economic factors, such as desire to continue with traditional land use activities, engagement in wage employment, and perceptions of contamination relating to water, wildlife, or vegetation. While these factors have been identified as present for Aboriginal groups assessed in the 2013 PRM Application Case, it is not possible to determine the degree to which they will affect Aboriginal populations at the time of reclamation or closure.

4.5 2013 PRM Application Case to Pre-Industrial Case Summary

4.5.1 Air Quality

Of the 130 ambient air quality parameters assessed for the 2013 PRM Application Case, 82 are rated as having a negligible environmental consequence and 45 are rated as having a low environmental consequence when compared to the PIC. The annual NO_2 predicted concentration in the RSA was rated as having a moderate environmental consequence because the maximum prediction outside disturbed areas is above the AAAQO. Elevated NO_2 concentrations are near approved projects in the region and a model performance evaluation completed as part of the air quality assessment (EIA Volume 3, Appendix 3-8) indicates that NO_2 predictions near open pit mine sites are over-predicted.

Two parameters (community 24-hour $PM_{2.5}$ and annual acrolein) were rated with a high environmental consequence. The 24-hour $PM_{2.5}$ predictions at several communities are above the AAAQO due to existing and approved projects in the 2013 Base Case. There is no increase in predicted concentrations from 2013 Base Case to the 2013 PRM Application Case. The maximum annual acrolein prediction at Oil Sands Lodge is slightly above the TCEQ ESL; however, the change due to PRM is less than 1%.

After reclamation, there will be few sources of air emissions compared to operations and air quality levels are expected to return to near-PIC levels in the region. Therefore, the potential effects from the PIC to the 2013 PRM Application Case on air quality after reclamation are not considered a likely significant adverse environmental effect.

4.5.2 Surface Water Quality and Aquatic Health

The 2013 PRM Application Case environmental consequence rankings for aquatic health parameters are negligible or low. Therefore, they are not likely significant adverse environmental effects.

4.5.3 Terrestrial Resources

Overall, the assessment of cumulative effects to terrestrial resources indicates substantial changes in the RSA from PIC to the 2013 PRM Application Case. Most of these changes are negative and result primarily from the cumulative effects of existing and approved developments (i.e., the 2013 Base Case). For example, on average about 98% of wildlife habitat effects from the PIC to the 2013 PRM Application Case are due to disturbances that are present in the 2013 Base Case. The PRM makes an incremental contribution to the large existing cumulative effects identified at 2013 Base Case.

An assessment to determine whether these changes constituted significant adverse effects was conducted using both ecological threshold and resource management criteria approaches for each terrestrial KIR, including biodiversity overall, for which PRM effects were assessed to be greater than negligible at the LSA scale. A detailed explanation for the both ecological threshold and resource management criteria is presented in Appendix 3.1. Prior to reclamation, the ecological threshold approach identified significant effects for three KIRs, whereas resource management criteria identified significant effects for 24 KIRs, or 69% of all KIRs (Table 4.5-1). The PRM contribution to significant adverse cumulative effects is small relative to the effect already present at 2013 Base Case. Using both ecological thresholds and resource management criteria, most Significant effects identified for terrestrial resources were already present in the 2013 Base Case.

The distinction between significance approaches is important when evaluating the results presented in Table 4.5-1. As noted in Appendix 3.1, ecological thresholds produce a more appropriate and meaningful assessment of significance for conservation of terrestrial resources because they indicate whether or not populations or ecosystems have lost, or are expected to lose, the ability to sustain themselves or maintain ecological function. A significant result identified using ecological thresholds represents a critical conservation concern. Significant adverse effects identified using ecological thresholds should be addressed to avoid contributing to the loss of healthy plant or animal populations or ecological function within the RSA.

The resource management criteria approach used for this assessment, in contrast, is ecologically arbitrary for many KIRs. There is no evidence that the loss of 20% of a resource is an appropriate ecological threshold for most species, and many studies identify much higher losses (i.e., between 40% and 90%) before abrupt and non-linear, negative changes in ecological or population function occur (Andren 1994; Monkkonen and Reunanen 1999; Rompre et al. 2010; Swift and Hannon 2010). Similarly, it is generally not reasonable to assume that any adverse effect to a species at risk, no matter how small, will meaningfully alter the sustainability of the population in the RSA. However, resource management criteria do identify limits identified by resource managers or regulators beyond which losses are considered unacceptable. Significant effects identified using resource management criteria therefore represent adverse effects, but not effects that necessarily require immediate management action to achieve long-term conservation of the resource.

After reclamation, the number of Significant adverse cumulative effects decrease for vegetation KIRs. Effects to soils and ecosystem and landscape level biodiversity are Not Significant before and after reclamation. Adverse cumulative effects would also likely decline for most wildlife KIRs after reclamation, and this would likely result in a reduction of the number of Significant adverse effects, especially those detected using the 20% resource management criterion. However, spatially explicit reclamation data to evaluate the amount of high quality habitat reclaimed at the RSA scale are unavailable and significance after reclamation was not determined for wildlife KIRs, resulting in an overall conservative assessment of predicted impacts based on effects during construction and operations.

Table 4.5-1 Summary of Key Indicator Resource Significance Determinations for Cumulative Effects to Terrestrial Resources from the Pre-Industrial Case to the 2013 PRM Application Case

KIR	Before Reclamation		After Reclamation	
	RSA – Ecological Thresholds	RSA – Resource Management Criteria	RSA – Ecological Thresholds	RSA – Resource Management Criteria
Soils				
soil	-	-	n/a	Not Significant
Vegetation				
terrestrial vegetation	Not Significant	Significant	Not Significant	Significant
lichen jack pine community	-	Significant	-	Significant
wetlands	Not Significant	Not Significant	Not Significant	Not Significant
old growth forests	Not Significant	Not Significant	Not Significant	Not Significant
productive forests	-	Not Significant	Not Significant	Not Significant
high rare plant potential areas	Not Significant	Not Significant	Not Significant	Not Significant
high traditional use plant potential areas	-	Significant	-	Significant
Wildlife				
barred owl	Not Significant	Significant	-	-
beaver	Not Significant	Not Significant	-	-
black bear	Not Significant	Not Significant	-	-
black-throated green warbler	Significant	Significant	-	-
Canada lynx	Not Significant	Significant	-	-
Canadian toad	Not Significant	Not Significant	-	-
fisher	Not Significant	Significant	-	-
moose	Not Significant	Significant	-	-
Canada warbler	Significant	Significant	-	-
common nighthawk	Not Significant	Significant	-	-
horned grebe	Not Significant	Significant	-	-
little brown myotis	Not Significant	Significant	-	-
northern myotis	Not Significant	Significant	-	-
olive-sided flycatcher	Not Significant	Significant	-	-
peregrine falcon	Not Significant	Significant	-	-
red knot	Not Significant	Significant	-	-
rusty blackbird	Not Significant	Significant	-	-
short-eared owl	Not Significant	Significant	-	-
western toad	Not Significant	Significant	-	-
whooping crane	Not Significant	Significant	-	-
wolverine	Not Significant	Significant	-	-
wood bison	Not Significant	Significant	-	-
woodland caribou	Significant	Significant	-	-
yellow rail	Not Significant	Significant	-	-
Biodiversity				
species-level	Significant	Not Significant	Significant	Not Significant
ecosystem-level	Not Significant	Not Significant	Not Significant	Not Significant
landscape-level	Not Significant	Not Significant	Not Significant	Not Significant

n/a = Not applicable; - = Significance not assessed because of linkages with other components (i.e., soils indicators are directly reflected in changes to terrestrial vegetation, wetlands and forest resources), limited data (i.e., lichen jack pine community) or lack of meaningful ecological application of the indicator (i.e., productive forest and areas of high traditional use plant potential). To be conservative, and due to uncertainty in future population trends, significance for wildlife is assessed during construction and operations only.

Note: Cumulative effects from the PIC to the 2013 PRM Application Case include and are predominantly due to existing and approved developments in the 2013 Base Case.

4.5.4 Traditional Land Use

The effects to traditional land use under the 2013 Application Case were determined for each of the potentially affected Aboriginal groups. The effects of the 2013 Application Case were determined for hunting, trapping, fishing, and plant and berry harvesting opportunities. Harvesting opportunities were considered to be a combination of the availability of each underlying resource (e.g., wildlife, fish) and access to the resource. The assessment also considered the effects on traditional harvesting activities from odour, noise, visual effects, human health effects and socio-economic effects. A summary of the effects classification for each of the potentially affected Aboriginal groups is found in Table 4.5-2, below.

Table 4.5-2 Effects Classification and Significance for Traditional Land Use Under the 2013 PRM Application Case

Aboriginal Group	Effects Classification for Traditional Land Use	Significance Prior to Reclamation
Community of Fort McKay	High	Significant
Mikisew Cree First Nation	Moderate to High	Significant
Athabasca Chipewyan First Nation	High	Significant
Fort McMurray #468 First Nation	Moderate to High	Significant
Fort Chipewyan Métis Local #125	Low to High (Effects mostly limited to use of RFMA #1275)	Not Significant
Fort McMurray Métis Local #1935	High (Trapping not assessed)	Significant

Note: All effects classifications were assessed as negative in direction, regional in extent, long term in duration and irreversible, therefore only the magnitude has been provided within the table.

4.5.5 Significance Post-Reclamation

While it is not possible to determine the RSA closure landscape in detail because detailed reclamation plans are not available for all projects in the 2013 PRM Application Case, the assessment assumes that project-related disturbances will generally be reclaimed to allow wildlife re-population in preferred harvesting areas throughout RSA, and access to resources and preferred harvesting areas by traditional harvesters. Although the 2013 PRM Application Case was not expected to have a significant effect on fish abundance, the closure landscape is expected to facilitate access to preferred fishing areas. As a result, the opportunities for traditional wildlife harvesting (trapping, hunting and fishing) are expected to increase as a result of the closure landscape.

The effects to traditional plant harvesting opportunities within the RSA are also generally expected to increase. While the combined high and moderate traditional plant potential is expected to remain much the same at Closure as under the 2013 PRM Application Case, the decrease in land disturbance is expected to provide easier access to preferred harvesting areas. As a result of the closure landscape, the effects of the 2013 PRM Application Case post-reclamation on traditional harvesting opportunities are assessed as not significant.

Socio-economic factors can also influence the undertaking of traditional harvesting. These include a variety of socio-economic factors, such as desire to continue with traditional land use activities, engagement in wage employment, and perceptions of contamination relating to water, wildlife, or vegetation. While these factors have been identified as present for Aboriginal groups assessed in the 2013 PRM Application Case, it is not possible to determine the degree to which they will affect Aboriginal populations at the time of reclamation or closure.

5.0 2013 PLANNED DEVELOPMENT CASE TO PRE-INDUSTRIAL CASE ASSESSMENT

This section responds to JRP SIR 8, parts a(ii) and a(iii), specifically as they relate to the comparison of the 2013 PDC to the PIC.

The 2013 PDC includes the effects of PRM plus the effects from existing, approved and publicly disclosed industrial projects and activities associated with land use and infrastructure as of June 2012 when the JRP Terms of Reference, were issued. A comparison of the 2013 PDC to the PIC includes an assessment of all existing, approved and publicly disclosed developments in the RSA, along with municipal developments and forest harvesting. The list of projects considered in the 2013 PDC is provided in Appendix 3.1, Section 2.4. Forest fire and harvest information in the 2013 PDC was simulated with the ALCES® model, as described in Appendix 3.1, Section 2.8.

The following components were assessed based on the availability of PIC and 2013 PDC Data:

- air quality;
- surface water quality and aquatic health;
- soils and terrain;
- terrestrial vegetation, wetlands and forest resources;
- wildlife and wildlife habitat;
- biodiversity; and
- traditional land use.

5.1 Air Quality

5.1.1 Assessment Results

The model predictions for the 2013 PDC are provided in Appendix 3.2. A summary of the PIC, 2013 Base Case, 2013 PRM Application Case and 2013 PDC regional SO_2 and NO_2 predictions used for the impact assessment is provided in Table 5.1-1. The maximum annual NO_2 predictions in the LSA and RSA are above the AAAQO for the 2013 PDC. The NO_2 predictions are considered conservative because, for modelling purposes, it was assumed that all developments were operating at their maximum capacity at the same time; however, the operational life of each development will actually be staggered over time. The model evaluation (EIA Volume 3, Appendix 3-8) also indicates that NO_2 predictions near open pit mine sites are over-predicted. The remaining SO_2 and NO_2 predictions in the communities were predicted to be below the applicable AAAQOs for the 2013 Base Case, 2013 PRM Application Case and 2013 PDC. The 24-hour $PM_{2.5}$ concentrations at several communities were predicted to be above the AAAQO of 30 µg/m³ for the 2013 Base Case, 2013 PRM Application Case and 2013 PDC. The CO, TRS, VOCs, PAHs and trace metals predictions were below the applicable criteria with the exception of benzene and acrolein which were above the AAAQO or TCEQ ESL at Fort McMurray in the 2013 PDC.

Table 5.1-1 Summary of Regional SO_2 and NO_2 Predictions

Parameter[(a)]	AAAQO[(b)]	Pre-Industrial Case[(c)]	2013 Base Case	2013 PRM Application Case	2013 PDC
Local Study Area					
maximum 1-hour SO_2 concentration [µg/m³]	450	3.2	82.2	82.2	86.1
maximum 24-hour SO_2 concentration [µg/m³]	125	3.1	39.5	39.5	26.7
maximum 30-day SO_2 concentration [µg/m³]	30	3.1	11.2	11.2	8.3
maximum annual SO_2 concentration [µg/m³]	20	0.9	4.6	4.6	4.1
maximum 1-hour NO_2 concentration [µg/m³]	300	23.3	150.9	150.9	139.4
maximum annual NO_2 concentration [µg/m³]	45	5.5	26.2	43.3	**45.5**
Regional Study Area					
maximum 1-hour SO_2 concentration [µg/m³]	450	3.2	276.4	276.4	329.1
maximum 24-hour SO_2 concentration [µg/m³]	125	3.1	70.6	70.6	72.3
maximum 30-day SO_2 concentration [µg/m³]	30	3.1	15.5	15.5	24.5
maximum annual SO_2 concentration [µg/m³]	20	0.9	10.4	10.4	18.8
maximum 1-hour NO_2 concentration [µg/m³]	300	23.3	214.2	214.2	212.0
maximum annual NO_2 concentration [µg/m³]	45	5.5	**51.6**	**52.4**	**57.6**

(a) All predictions are outside developed areas.

(b) ESRD 2013.

(c) The Pre-industrial Case includes natural background and anthropogenic sources. The 30-day SO_2 predictions were assumed to be the same as the 24-hour SO_2 predictions.

Note: **Bold** number indicates an exceedance above the Alberta Ambient Air Quality Objective (AAAQO).

5.1.2 Residual Impact Classification

The approach to conducting cumulative effects assessments defined by the *Canadian Environmental Assessment Act,* 2012 (Government of Canada 2012) indicates that environmental effects should be considered when they accumulate or interact with those of other developments. Although modelling was conducted to predict concentrations of SO_2, NO_2, CO, $PM_{2.5}$, select TRS compounds, VOCs, PAHs and metals in the region and at selected regional communities, only those compounds that had a low, moderate or high environmental consequence in the 2013 PRM Application Case are included in this section. This is consistent with the assessment methods used in the EIA (Volume 3, Section 2.1.2) and Appendix 1. The predictions for the 2013 PDC are presented in Appendix 3.2.

The environmental consequences for the Air Quality Assessment based on a comparison of the 2013 PDC to the PIC are shown in Table 5.1-2. Of the 10 ambient air quality parameters assessed for the 2013 PDC, four are rated as having a low environmental consequence, two are rated as moderate, and four are rated as having a high environmental consequence.

The community 1-hour and annual benzene and annual acrolein are classified as having a high environmental consequence. This classification is primarily due to the estimated increase in emissions from future population growth in Fort McMurray. The PRM did not cause a change in the benzene and acrolein predictions in Fort McMurray. Further discussion of the effects of these predictions is discussed in the HHRA (Appendix 3.3).

The community 24-hour $PM_{2.5}$ concentrations were also classified as having a high environmental consequence due to the predicted exceedances of the AAAQO at Fort McKay, Fort McMurray, Cabin J, Cabin K and the Oil Sands Lodge. The exceedances are due to other regional projects and the PRM causes a minimal increase in the predicted concentrations at these communities.

Table 5.1-2 Residual Impact Classification for Changes to the Ambient Air Quality Relative to the Pre-Industrial Case

Parameter	Direction	Magnitude			Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 PDC					2013 Base Case	2013 PRM Application Case[(a)]	2013 PDC
local annual NO_2	negative	low (+5)	low (+5)	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)	moderate (+11)
regional annual NO_2	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
community annual NO_2	negative	low (+5)	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)	low (+7)
community 24-hour $PM_{2.5}$	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	high (+16)	high (+16)	high (+16)
community 1-hour H_2S	negative	low (+5)	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)	low (+6)
community 24-hour H_2S	negative	low (+5)	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)	low (+6)
community 1-hour acrolein	negative	low (+5)	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)	low (+6)
community annual acrolein	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
community 1-hour benzene	negative	low (+5)	low (+5)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low (+6)	high (+16)
community annual benzene	negative	low (+5)	low (+5)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)	high (+17)

(a) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

The regional and local annual NO_2 predictions were classified as having a moderate environmental consequence because the predictions outside developed areas were above the AAAQO but below the National Ambient Air Quality Objective (Health Canada 2006). The exceedances are due to other regional projects and the PRM causes a minimal increase in the predicted concentrations.

The effects of benzene and acrolein on environmental health are assessed in Section 3.2.1.2. The HHRA concluded that emissions from PRM in combination with emissions from other sources are not expected to result in adverse health effects in the RSA. Moreover, the changes between the 2013 Base Case and the 2013 PRM Application Case are generally small, suggesting that the PRM is not expected to contribute appreciably to health risks in the region. The 2013 PDC assessment also did not alter the assessment results or the conclusions presented in the HHRA of the EIA.

5.1.3 Environmental Significance Determination

Part iii) of the JRP SIR 8 requires consideration of environmental significance after reclamation. After reclamation, there will be few sources of air emissions compared to operations and air quality levels are expected to return to near-PIC levels in the region. Therefore, the potential effects from the PIC to the 2013 PDC on air quality after reclamation are not considered a likely significant adverse environmental effect.

5.2 Aquatic Resources

5.2.1 Water Quality and Aquatic Health Assessment

5.2.1.1 Assessment Results

The water quality assessment considered the PIC as part of the analyses in the EIA and in the 2013 PRM Application Case assessment in Appendix 1, Section 3.3 and the PDC assessment in Section 3.3. The assessments considered both observed ranges of concentrations at each assessment node (labelled “Observed Natural Variation”) as well as the modelled PIC (labelled “Pre-development”). For waterbodies and watercourses within the LSA and the Athabasca River, water quality model predictions were provided along with PIC in all data tables in the EIA and in this submission.

Predicted water concentrations in the assessments referred to above were carried forward to the aquatic health assessment. As described in the EIA, Volume 4A, Section 6.5.5.3, the water quality assessment focused on key constituents, which are substances that exceed the PIC and EIA Base Case concentrations and water quality guidelines. For the PDC assessment, the same criteria were used except Application Case concentrations were also considered in the screening. In all assessments, total dissolved solids, chronic and acute toxicity, naphthenic acids and tainting potential were automatically assessed as key constituents.

A comparison of PDC to PIC water quality and aquatic health results was summarized by compiling SOPC concentrations from both the Application Case and PDC. Where constituents appeared in both assessments, the maximum concentration from either assessment case was retained. This way, the maximum potential effects are represented in the PDC to PIC assessment. The list of SOPCs and their respective concentrations were assessed for potential effects to aquatic health for the Application Case in Volume 1, Section 3.4.2.2 and for the PDC in Section 3.3.4. The resulting residual impact classification derived by assuming the worst-case for each SOPC is provided in Section 5.2.1.2.

5.2.1.2 Residual Impact Classification

Activities associated with the 2013 PDC are predicted to cause changes in water quality compared to PIC conditions. Potential effects on aquatic health were evaluated in consideration of two potential effects pathways:

- direct effects occurring as a result of predicted changes to water quality; and
- indirect effects related to dietary consumption and possible accumulation of substances in fish tissue.

The residual impact classification for the 2013 PDC to PIC is shown in Table 5.2-1.

Table 5.2-1 Residual Impact Classification for Aquatic Health – 2013 Planned Development Case to Pre-Industrial Case

Parameter	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Consequence
Toxic Units	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Boron	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Lead	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Cadmium	negative	low (+5)	local (0)	long-term (+2)	high (+2)	reversible (-3)	low (+6)
Manganese	negative	low (+5)	local (0)	medium-term (+1)	medium (+1)	reversible (-3)	negligible (+4)
Cobalt	negative	low (+5)	local (0)	long-term (+2)	medium (+1)	reversible (-3)	negligible (+5)
Iron	negative	low (+5)	local (0)	long-term (+2)	high (+2)	reversible (-3)	low (+6)
Chloride	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Total dissolved solids	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Naphthenic acids	negative	negligible (0)	n/a	n/a	n/a	n/a	negligible (0)
Fish tissue (chromium)	negative	low (+5)	local (0)	long-term (+2)	high (+2)	reversible (-3)	low (+6)

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.
n/a = Not applicable.

Predicted median concentrations of boron and chloride met the CEBs for all watercourses and snapshots, and the frequency of exceedance of the CEBs was very low. Given that the peak value predictions corresponded to the 99.91 percentile, or a one-day in three-year frequency of occurrence, and given the degree of conservatism in water quality predictions due to overestimates of bioavailability in total concentrations, the magnitude of impact for these substances was considered to be negligible and additional residual impact classification was not warranted.

Peak cadmium and manganese concentrations were predicted to have a higher frequency of exceedance with the CEBs. These more frequent CEB exceedances were considered consistent with a potential low magnitude of effect. For cadmium the geographic extent was local (limited to 1 or 2 watercourses), short-term (limited to 1 or 2 snapshots), of relatively low frequency, and unlikely to result in permanent harm to aquatic health (i.e., reversible). For manganese, geographic extent was local (limited to 1 or 2 watercourses), medium-term (occurring during operations), of relatively low frequency, and reversible. These factors resulted in an overall environmental consequence classification of negligible for each metal.

Comparison of cobalt concentrations to the CEB and toxicity data resulted in a conclusion of potential low magnitude effect on aquatic health, moderate frequency, and long duration since the median concentrations exceed the CEB and highest peak values are predicted for the Far Future snapshot. However, these effects would be local in scale and reversible, and the overall environmental consequence classification was still negligible following the classification assessment method from the EIA.

Iron and lead were predicted to increase relative to the PIC, but considering the conservatism in the assessment described in Volume 1, Section 3.4.2.1, the increase in iron and lead concentrations was not considered large enough to result in a change to the effects classification.

Changes in naphthenic acid concentrations are expected to have a negligible effect on aquatic biota based on (1) labile and refractory naphthenic acids meeting their respective CEBs, and (2) the expectation that total naphthenic acids, being comprised primarily of the refractory fraction will meet the CEB for this fraction.

The concentration of chromium predicted in fish tissues for the 2013 PDC was the same as for the 2013 PRM Application Case, and therefore, the effects classification remains the same if the 2013 PDC is compared directly to PIC.

Based on the effects criteria, concentrations of individual substances received negligible to low ratings for environmental consequence (Table 3.3-18). Of the individual substances considered in the assessment, changes in the concentrations of cadmium, and iron in water, and chromium in fish tissue were deemed to be of low consequence to aquatic health, while the others were deemed to be negligible.

Potential effects resulting from elevated levels of these parameters may be over-estimated, because of the conservative assumptions used to complete the assessment. These substances are strongly influenced by site-specific factors that mediate bioavailability and toxicity. It was not possible to fully account for the factors that mediate speciation and aquatic toxicity of these substances using the screening water quality guidelines or CEBs. In many cases, the PIC concentrations at or above the CEBs, combined with the presence of a PIC healthy aquatic community, indicate that CEBs may overstate the potential for adverse effects. When the lines of evidence are considered together, including predicted acute and chronic toxicity levels, as well as predicted changes to sediment quality, water quality and fish tissue metal concentrations, potential changes to aquatic health resulting from the PRM and other existing and planned developments are expected to be negligible to be low for small streams in the LSA.

5.2.1.3 Environmental Significance Determination

The 2013 PDC to PIC environmental consequence rankings for aquatic health parameters are negligible or low. Therefore, they are not likely significant adverse environmental effects.

5.3 Terrestrial Resources

This section provides the results of the assessment of the 2013 PDC to the PIC for soils and terrain; terrestrial vegetation, wetlands and forest resources; wildlife and wildlife habitat; and biodiversity. Significance determinations are made for terrestrial resources using the two approaches outlined in Appendix 3.1 (Section 2.8.3) which includes determining significance using Ecological Thresholds and Resource Management Criteria.

5.3.1 Soils and Terrain

The effects of JME and PRM and planned developments on soils and terrain were assessed in the EIA, Volume 5, Section 7.3 through 7.6, and in the 2008 EIA Update, Section 2.7.2.

5.3.1.1 Residual Impact Classification Before Reclamation

The 2013 PDC indicates 188,948 ha (16% of the resource) of mineral soils and 124,766 ha (13% of the resource) of organic soils will be lost or disturbed from the PIC to the 2013 PDC (Table 5.3-1). Changes in PIC soil types due to the 2013 PDC are presented in Table 5.3-1. As each of Tables 5.3-1 and 5.3-2 describe the disturbance conditions before reclamation, closure pit lakes and South Redclay Lake are grouped with reconstructed landforms. The environmental consequence for these changes are high for each of the permanent loss of mineral soils and the permanent loss of organic soils before reclamation due to the 2013 PDC compared to the PIC (Table 5.3-3). The direction of the effects is negative, with a moderate magnitude, and the effects are regional, irreversible, and the frequency is high.

Table 5.3-1 Changes to Soil Types – 2013 Planned Development Case to Pre-Industrial Case

Soil Series, Reclaimed Soils and Non-Soils	Pre-Industrial Case		2013 Base Case	Loss/Alteration due to 2013 Base Case[a]		Loss/Alteration due to 2013 PRM Application Case		Loss/Alteration due to 2013 Planned Development Case		Closure	Net Change to Pre-Industrial Case due to 2013 Planned Development Case [c]	
	Area [ha]	% of RSA	Area [ha]	Area [ha]	% Resource[b]	Area [ha]	% Resource[b]	Area [ha]	% Resource[b]	Area [ha]	Area [ha]	% Resource[b]
Mineral Soils												
Algar Lake	47,983	2	42,044	-5,939	-12	-5,939	-12	-11,004	-23	36,979	-11,004	-23
Bitumount	50,132	2	37,996	-12,136	-24	-12,898	-26	-15,918	-32	34,214	-15,918	-32
Buckton	31,789	1	31,739	-50	-<1	-50	-<1	-66	-<1	31,723	-66	-<1
Dover	59,194	3	50,801	-8,393	-14	-8,393	-14	-14,042	-24	45,153	-14,041	-24
Firebag	74,053	3	60,364	-13,689	-18	-13,689	-18	-15,055	-20	58,998	-15,055	-20
Fort	2,821	<1	1,821	-1,000	-35	-1,000	-35	-1,035	-37	1,787	-1,034	-37
Gipsy	6,292	<1	6,291	-1	-<1	-1	-<1	-1	-<1	6,291	-1	-<1
Horse River	24,046	1	23,544	-502	-2	-502	-2	-2,975	-12	21,071	-2,975	-12
Joslyn	86,192	4	66,208	-19,984	-23	-19,986	-23	-28,257	-33	57,935	-28,257	-33
Kearl	3,940	<1	3,870	-70	-2	-70	-2	-279	-7	3,661	-279	-7
Kinosis	54,204	2	49,429	-4,775	-9	-4,775	-9	-7,247	-13	46,957	-7,247	-13
Legend	127,074	6	126,228	-846	-1	-846	-1	-5,763	-5	121,312	-5,762	-5
Livock	37,106	2	36,431	-675	-2	-675	-2	-2,603	-7	34,503	-2,603	-7
Marguerite	76,769	3	69,996	-6,773	-9	-6,776	-9	-7,864	-10	68,905	-7,864	-10
McMurray	56,877	2	53,535	-3,342	-6	-4,118	-7	-6,405	-11	50,472	-6,405	-11
Mildred	186,704	8	171,159	-15,545	-8	-19,627	-11	-25,226	-14	161,478	-25,226	-14
Namur	61,299	3	60,640	-659	-1	-3,284	-5	-21,304	-35	39,995	-21,304	-35
Ruth Lake	16,294	1	12,286	-4,008	-25	-4,478	-27	-6,940	-43	9,354	-6,940	-43
Steepbank	130,837	6	120,129	-10,708	-8	-10,794	-8	-15,520	-12	115,316	-15,521	-12
Surmont	11,857	1	11,180	-677	-6	-677	-6	-1,480	-12	10,377	-1,480	-12
subtotal (mineral soils)	*1,145,463*	*50*	*1,035,692*	*-109,771*	*-10*	*-118,579*	*-10*	*-188,984*	-16	*956,480*	*-188,983*	*-16*
Organic Soils												
Bayard	14,662	1	14,616	-46	-<1	-46	-<1	-248	-<1	14,414	-248	-2
Conklin	61,760	3	57,922	-3,838	-6	-3,852	-6	-8,575	-<1	53,185	-8,575	-14
Gregoire	20,863	1	19,342	-1,521	-7	-1,521	-7	-2,559	-<1	18,304	-2,559	-12
Hartley	174,524	8	152,844	-21,680	-12	-22,221	-13	-30,502	-<1	144,022	-30,502	-17
McLelland	152,559	7	145,313	-7,246	-5	-7,363	-5	-16,265	-<1	136,294	-16,265	-11
Mikkwa	126,054	6	125,183	-871	-1	-871	-1	-3,957	-<1	122,097	-3,957	-3
Mariana	156,011	7	138,616	-17,395	-11	-18,477	-12	-30,023	-<1	125,988	-30,023	-19
Muskeg	240,944	11	227,947	-12,997	-5	-13,460	-6	-25,307	-<1	215,637	-25,307	-11
Wabasca	36,774	2	31,692	-5,082	-14	-5,271	-14	-7,330	-<1	29,444	-7,330	-20
subtotal (organic soils)	*984,149*	*43*	*913,474*	*-70,675*	*-7*	*-73,082*	*-7*	*-124,766*	-<1	*859,384*	*-124,765*	*-13*
Reconstructed Landforms	0	0	0	0	0	0	0	0	n/a	142,269	142,269	n/a
Rough broken/rock	86,070	4	82,415	-3,655	-4	-3,868	-4	-5524	-6	80,547	-5,523	-6
Disturbed	1,557	<1	186,349	184,792	11,868	196,299	12,608	321,085	20,622	180,370	178,813	11,484
Water	53,958	2	53,309	-649	-1	-728	-1	-1739	-3	52,218	-1,740	-3
Indian Reserves[a]	6,179	<1	6,137	-42	-1	-42	-1	-72	-1	6,107	-72	-1
subtotal (other)	*147,764*	*6*	*328,211*	*180,447*	*122*	*191,661*	*130*	*313,750*	212	*461,512*	*313,748*	*212*
Total	**2,277,376**	**100**	**2,277,376**	**0**	**0**	**0**	**0**	**0**	**0**	**2,277,376**	**0**	**0**

[a] Loss/alteration due to 2013 Base Case is provided for comparative purposes.

[b] Calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

[c] Net change is calculated as the difference between the Pre-Industrial Case and Closure, a value upon which the environmental consequence after reclamation is assessed.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

n/a = Not applicable.

Table 5.3-2 Summary of Changes to Soil Types – 2013 Planned Development Case to Pre-Industrial Case: Before Reclamation

Soil Series, Reclaimed Soils and Non-Soils	Pre-Industrial Case		2013 Base Case	Loss/Alteration due to 2013 Base Case[(a)]		Loss/Alteration due to 2013 PRM Application Case		Loss/Alteration due to 2013 Planned Development Case		Closure	Net Change to Pre-Industrial Case due to 2013 Planned Development Case[(c)]	
	Area [ha]	% of RSA	Area [ha]	Area [ha]	% Resource[(b)]	Area [ha]	% Resource[(b)]	Area [ha]	% Resource[(b)]	Area [ha]	Area [ha]	% Resource[(b)]
Mineral soils	1,145,463	50	1,035,692	-109,771	-10	-118,579	-10	-188,984	-16	956,480	-188,983	-16
Organic soils	984,149	43	913,474	-70,675	-7	-73,082	-7	-124,766	-13	859,384	-124,765	-13
Water	53,958	2	53,309	-649	-1	-728	-1	-1,739	-3	52,218	-1,740	-3
Rough Broken/Rock, Disturbed, Reconstructed, Indian Reserves	93,806	4	274,902	181,096	193	192,389	205	315,489	336	409,294	315,488	336
Total	**2,277,376**	**100**	**2,277,376**	**0**	**0**	**0**	**0**	**0**	**0**	**2,277,376**	**0**	**0**

(a) Loss/alteration due to 2013 Base Case is provided for comparative purposes.

(b) Calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

(c) Net change is calculated as the difference between the Pre-Industrial Case and Closure, a value upon which the environmental consequence after reclamation is assessed.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

n/a = Not applicable.

Table 5.3-3 Residual Impact Classification for Soils in the Regional Study Area – Pre-Industrial Case: Before Reclamation

Parameter	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (RSA)
Soils							
Permanent Loss of Mineral Soil	negative	moderate (+10)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+18)
Permanent Loss of Organic Soil	negative	moderate (+10)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+18)

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.1.2 Residual Impact Classification After Reclamation

Organic and mineral soils will be lost or altered due to the 2013 PDC. There will be a net increase of 63,034 ha (6% of the resource) in mineral soils after reclamation due to the conversion of organic soils to upland reclaimed landscapes (Table 5.3-4). There is a 19,818 ha decrease in disturbed, rocks, and reconstructed areas (21% of the resource) and an increase in water of 55,540 ha (103% of the resource) from the PIC to 2013 PDC. There is a loss of organic soils of 98,756 ha (10% of the resource) from the PIC to the 2013 PDC after reclamation, because many disturbed areas are reclaimed to mineral soils.

After reclamation, the 2013 PDC will result in a permanent decrease of soil area due to construction of closure pit lakes and the South Redclay Lake, urban growth and infrastructure. Changes in soil areas and function have a direct effect on vegetation communities, influencing which plant species will establish successfully at different positions in the reclaimed landscape. The permanent reduction in soil area after reclamation is predicted to have a negative, moderate environmental consequence at the RSA level (Table 5.3-5).

Table 5.3-4 Summary of Changes to Soil Types – 2013 Planned Development Case to Pre-Industrial Case: After Reclamation

Soil Series, Reclaimed Soils and Non-Soils	Pre-Industrial Case		2013 Base Case	Loss/Alteration due to 2013 Base Case[a]		Loss/Alteration due to 2013 PRM Application Case		Loss/Alteration due to 2013 Planned Development Case		Closure	Net Change to Pre-Industrial Case due to 2013 Planned Development Case[c]	
	Area [ha]	% of RSA	Area [ha]	Area [ha]	% Resource[b]	Area [ha]	% Resource[b]	Area [ha]	% Resource[b]	Area [ha]	Area [ha]	% Resource[b]
Mineral soils	1,145,463	50	1,035,692	-109,771	-10	-118,579	-10	-188,984	-16	1,208,497	63,034	6
Organic soils	984,149	43	913,474	-70,675	-7	-73,082	-7	-124,766	-13	885,393	-98,756	-10
Water	53,958	2	53,309	-649	-1	-728	-1	-1,739	-3	109,498	55,540	103
Rough Broken/Rock, Disturbed, Reconstructed, Indian Reserves	93,806	4	274,902	181,096	193	192,389	205	315,489	336	73,988	-19,818	-21
Total	**2,277,376**	**100**	**2,277,376**	**0**	**0**	**0**	**0**	**0**	**0**	**2,277,376**	**0**	**0**

(a) Loss/alteration due to 2013 Base Case is provided for comparative purposes.

(b) Calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

(c) Net change is calculated as the difference between the Pre-Industrial Case and Closure, a value upon which the environmental consequence after reclamation is assessed.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

n/a = Not applicable.

Table 5.3-5 Residual Impact Classification for Soils in the Regional Study Area – Pre-Industrial Case: After Reclamation

Parameter	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (RSA)
Soils							
Permanent Loss of Organic Soil	negative	low (+5)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	moderate (+13)

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.1.3 Environmental Significance Determination After Reclamation

5.3.1.3.1 Ecological Thresholds

From the PIC to the 2013 PDC before reclamation, the permanent losses of mineral and organic soil are ranked as having negative, high environmental consequences and are considered to be Likely, Significant, and Adverse environmental effects.

After reclamation, the permanent loss of organic soil is ranked as having a negative, moderate environmental consequence and is considered to be a Likely, Significant, and Adverse environmental effect. The direction of effects to the permanent loss of mineral soils after reclamation is positive (Table 5.3-4; increase of 6% of Resource) and therefore this parameter is not included in the residual impact classification table.

Changes to land capability for forestry are reflected in the assessment of the loss of soil area. The permanent loss of total soil area in the RSA and changes to land capability for forestry are directly reflected in changes to Terrestrial Vegetation, Wetlands and Forest Resources. As such, significance of these effects will be assessed in Section 5.3.2 Terrestrial Vegetation, Wetlands and Forest Resources.

5.3.1.3.2 Resource Management Criteria

A predicted 98,756 ha (10% of the resource) of undisturbed organic soils will be permanently lost or altered from PIC to the 2013 PDC Case in the RSA after reclamation, of which 72% (70,676 ha, 7% of the resource) is lost between the PIC and the 2013 Base Case (Table 5.3-4). Because the loss of organic soils in the RSA is less than 20% of that present in the PIC, the effect is Not Significant according to resource management criteria.

5.3.2 Terrestrial Vegetation, Wetlands and Forest Resources

The effects of JME and PRM and planned developments on terrestrial vegetation, wetlands and forest resources were assessed in the EIA Volume 5, Section 7.3 through 7.6, and in Section 3.0 of this appendix.

For the assessment of change from PIC to the 2013 PDC after reclamation, PDC Far Future is defined as 80 years following final reclamation for PRM and other planned developments. The regional Far Future landscape scenario provides a conceptualized non-spatial reclaimed landscape of existing, approved and planned developments. It is based on predictions using knowledge of the area as well as a ratio for each regional land cover class that was developed in 2007 based on published reclamation plans.

5.3.2.1 Assessment Results

5.3.2.1.1 Change to Regional Land Cover Classes

The combined developments in the 2013 PDC will result in the direct and indirect loss or alteration to the PIC terrestrial and wetlands resources as summarized in Table 5.3-6. A total of 218,549 ha (28% of Resource) of the PIC terrestrial RLCCs will be disturbed in the 2013 PDC. A large portion of this loss is a result of the change between PIC and 2013 Base Case (164,927 ha or 21% of Resource). Error due to the RLCC model varied for each RLCC but generally resulted in an overestimation of wetlands and an underestimation of uplands (Section 4.3.3.1.3). Although terrestrial vegetation will be lost during construction and operations, there will be an overall increase in terrestrial vegetation by 3% of the resource between the PIC and 2013 PDC after reclamation. The largest portion of terrestrial vegetation gained will be in the coniferous white spruce RLCC.

During 2013 PDC construction and operations, there will be a loss of 190,658 ha (19% of Resource) of wetlands within the RSA. A large portion of this change occurs from PIC to 2013 Base Case, with a loss of 119,936 ha (12% of Resource) of wetlands within the RSA. Following reclamation, the net decrease is reduced to 129,877 ha of wetlands (13% of Resource) between the PIC and the 2013 PDC at Far Future. The largest wetlands area loss will be in the treed bog/poor fen and treed fen RLCCs. Wetlands are predicted to account for 885,393 ha or 87% of Resource following reclamation, a loss of 13% of Resource (Table 5.3-6).

5.3.2.1.2 Change to Old Growth Forest

The estimated effect that the 2013 PDC will have on old growth forests compared to PIC in the RSA is outlined in Table 5.3-7. Error due to regional land cover classification was difficult to quantify for old growth forests but was likely minimal and expected to result an overall underestimation of old growth forest potential area in the RSA (Section 4.3.3.1.3). Due to the combined effects of the 2013 PDC developments, up to 85,530 ha of estimated potential PIC old growth forest area may be cleared in the RSA (24% of Resource). Much of the predicted change occurs from the PIC to the 2013 Base Case with a loss of 61,070 ha (17%) of the resource. Old growth forests are not expected to be re-established within the 80-year period defined for the Far Future scenario. However, over time the proportion of old growth forests in the RSA will likely return to the pre-disturbance proportions.

5.3.2.1.3 Change to Rare Plant Potential

The predicted changes to high rare plant potential habitat from the PIC to the 2013 PDC are presented in Table 5.3-8. Error due to the regional land cover classification resulted in a 30% underestimate of rare plant potential areas in the RSA suggesting that this resource is more abundant in the RSA than predicted (Section 4.3.3.1.3). An estimated 118,011 ha of high rare plant potential will be lost from the PIC to the 2013 PDC (22% of Resource). Much of this change occurs from the PIC to the 2013 Base Case with a loss of 72,042 ha (13% of Resource) within the RSA (Table 5.3-8). After reclamation, high rare plant potential habitat is predicted to decrease by 57,644 ha (11% of Resource) from the PIC to the 2013 PDC.

Table 5.3-6 Regional Land Cover Classes in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case

Regional Land Cover Class	Pre-Industrial Case[a]		Loss/Alteration to Pre-Industrial Case Due to the 2013 Base Case[b]		Loss/Alteration to Pre-Industrial Case Due to the 2013 PRM[b][c] Application Case		Loss/Alteration to Pre-Industrial Case Due to 2013 Planned Development Case[b][d]		Far Future[b][e]		Net Change to Pre-Industrial Case Due to 2013 Planned Development Case[f]	
	Area [ha]	% of RSA[g]	Area [ha]	% of Resource[h]	Area [ha]	% of Resource[h]	Area [ha]	% of Resource[h]	Area [ha]	% of Resource[h]	Area [ha]	% of Resource[h]
Terrestrial Vegetation												
coniferous jack pine	191,070	8	-24,738	-13	-25,086	-13	-29,881	-16	178,719	94	-12,351	-6
coniferous jack pine-black spruce	44,624	2	-4,570	-10	-4,570	-10	-6,191	-14	63,928	143	19,303	43
coniferous white spruce	69,421	3	-17,035	-25	-17,657	-25	-22,189	-32	90,754	131	21,333	31
deciduous aspen-balsam poplar	233,520	10	-55,454	-24	-55,960	-24	-78,760	-34	229,061	98	-4,460	-2
mixedwood aspen-jack pine	49,528	2	-10,496	-21	-10,496	-21	-12,837	-26	59,217	120	9,689	20
mixedwood aspen-white spruce	197,394	9	-52,635	-27	-54,278	-27	-68,692	-35	187,176	95	-10,218	-5
terrestrial vegetation subtotal	*785,557*	*34*	*-164,927*	*-21*	*-168,047*	*-21*	*-218,549*	*-28*	*808,855*	*103*	*23,297*	*3*
Wetlands (Peatlands)												
non-treed wetlands	275,397	12	-34,288	-12	-36,800	-13	-53,429	-19	278,607	101	3,210	1
treed bog/poor fen	471,749	21	-47,894	-10	-50,274	-11	-72,647	-15	399,516	85	-72,234	-15
treed fen	268,124	12	-37,755	-14	-42,769	-16	-64,582	-24	207,270	77	-60,854	-23
wetlands subtotal	*1,015,270*	*45*	*-119,936*	*-12*	*-129,842*	*-13*	*-190,658*	*-19*	*885,393*	*87*	*-129,877*	*-13*
Miscellaneous												
burn	420,169	18	-24,044	-6	-24,470	-6	-33,279	-8	387,185	92	-32,984	-8
water	54,040	2	-1,514	-3	-1,565	-3	-2,652	-5	73,988	137	19,948	37
miscellaneous subtotal	*474,209*	*21*	*-25,558*	*-5*	*-26,036*	*-5*	*-35,931*	*-8*	*461,173*	*97*	*-13,036*	*-3*
Disturbances												
cutblock	65	<1	100,095	154,890	100,095	154,890	99,047	153,269	99,112	153,369	99,047	153,269
disturbance	1,557	<1	-1,249	-80	-1,249	-80	-1,349	-87	22,843	1,467	21,287	1,367
disturbances subtotal	*1,621*	*<1*	*98,846*	*6,097*	*98,846*	*6,097*	*97,698*	*6,026*	*121,956*	*7,522*	*120,334*	*7,422*
Unclassified												
unclassified (cloud/cloud shadow)[i]	719	<1	-719	-100	-719	-100	-719	-100	0	0	-719	-100
unclassified subtotal	*719*	*<1*	*-719*	*-100*	*-719*	*-100*	*-719*	*-100*	*0*	*0*	*-719*	*-100*
Total	**2,277,376**	**100**	**-212,293**	**-9**	**-225,797**	**-10**	**-348,159**	**-15**	**2,277,376**	**100**	**n/a**	**n/a**

(a) Includes burns as modelled by ALCES®.

(b) Includes burns and cutblocks as modelled by ALCES®.

(c) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect effects due to surficial aquifer drawdown from PRM within the RSA, and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed during construction and operations. Excluding indirect effects due to surficial aquifer drawdown from PRM there is a total loss/alteration of -223,615 ha, within the RSA.

(d) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect project effects due to surficial aquifer drawdown from PRM within the RSA, plus existing, approved and planned developments in the RSA. Excluding indirect effects due to surficial aquifer drawdown from PRM the total loss/alteration is -345,977 ha, within the RSA.

(e) Values presented in this table do not include indirect effects due to surficial aquifer drawdown, as drawdown will occur primarily during the life of PRM. Drawdown effects on wetlands types surrounding pit lakes may extend to Far Future. At Far Future combined direct and indirect effects are predicted to cause an additional loss of 2,182 ha of wetlands.

(f) Net change is calculated as the difference between the PIC and Far Future a value upon which the environmental consequence at Far Future is assessed.

(g) For the purposes of this assessment, each RLCC is assumed to be 100% of Resource at Pre-Industrial Case.

(h) % of Resource is calculated as a percentage of PIC area; the areas of this column are not additive.

(i) Describes those areas where the imagery of the earth's surface had been blocked by clouds or cloud shadows during the image capture period.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 5.3-7 Old Growth Forest in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case

Regional Land Cover Class	Forest Type (Old Growth Range)[a]	Mid-Point Estimated Occurrence of Old Growth in the RSA[b]	Pre-Industrial Case: Total Class Area in the RSA[c]	Loss/Alteration of Pre-Industrial Case Due to the 2013 Base Case: Total Class Area in the RSA[d]	Loss/Alteration of Pre-Industrial Case Due to the 2013 PRM Application Case: Total Class Area in the RSA[d]	Loss/Alteration of Pre-Industrial Case Due to 2013 Planned Development Case: Total Class Area in the RSA[d]	Estimated Pre-Industrial Case Old Growth in the RSA[e]		Estimated Loss/Alteration of Pre-Industrial Case Old Growth Due to the 2013 Base Case[e]		Estimated Loss/Alteration of Pre-Industrial Case Old Growth Due to the 2013 PRM[e] Application Case		Estimated Loss/Alteration of Pre-Industrial Case Old Growth Due to 2013 Planned Development Case[e]	
		[% of Land Cover Class]	Area [ha]	Area [ha]	Area [ha]	Area [ha]	Area [ha]	% of RSA[f]	Area [ha]	% of Resource[g]	Area [ha]	% of Resource[g]	Area [ha]	% of Resource[g]
Terrestrial Vegetation														
coniferous jack pine	pine dominant (16% to 36%)	26	191,070	-24,738	-25,086	-29,881	49,678	2	-6,432	-13	-6,522	-13	-7,769	-16
coniferous jack pine-black spruce	pine dominant (16% to 36%)	26	44,624	-4,570	-4,570	-6,191	11,602	<1	-1,188	-10	-1,188	-10	-1,610	-14
coniferous white spruce	white spruce dominant (10% to 34%)	22	69,421	-17,035	-17,657	-22,189	15,273	<1	-3,748	-25	-3,885	-25	-4,882	-32
deciduous aspen-balsam poplar	hardwood dominant (14% to 42%)	28	233,520	-55,454	-55,960	-78,760	65,386	3	-15,527	-24	-15,669	-24	-22,053	-34
mixedwood aspen-jack pine	mixedwood dominant (16% to 38%)	27	49,528	-10,496	-10,496	-12,837	13,373	<1	-2,834	-21	-2,834	-21	-3,466	-26
mixedwood aspen-white spruce	mixedwood dominant (16% to 38%)	27	197,394	-52,635	-54,278	-68,692	53,296	2	-14,211	-27	-14,655	-27	-18,547	-35
treed bog/poor fen	black spruce dominant (12% to 28%)	20	471,749	-47,894	-49,861	-72,234	94,350	4	-9,579	-10	-9,972	-11	-14,447	-15
treed fen	black spruce dominant (12% to 28%)	20	268,124	-37,755	-41,973	-63,787	53,625	2	-7,551	-14	-8,395	-16	-12,757	-24
Total		**n/a**	**1,525,430**	**-250,576**	**-259,880**	**-354,570**	**356,582**	**16**	**-61,070**	**-17**	**-63,120**	**-18**	**-85,530**	**-24**

(a) Based on percent cover ranges of overmature dominant tree species derived from computer modelling of historic patterns in seral stage variation over time (Andison 2003).

(b) Based on overmature age class range values in Andison (2003).

(c) Includes burns as modelled by ALCES®.

(d) Includes burns and cutblocks as modelled by ALCES®.

(e) Estimations are calculated by multiplying the total area of each land cover class by the mid-point estimated occurrence of old growth.

(f) For the purposes of this assessment, each RLCC is assumed to be 100% of Resource at Pre-Industrial Case.

(g) % of Resource is calculated as a percentage of PIC area; the areas of this column are not additive.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 5.3-8 Rare Plant Potential in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case

Rare Plant Potential	Pre-Industrial Case[(a)]		Loss/Alteration to Pre-Industrial Case Due to the 2013 Base Case[(b)]		Loss/Alteration to Pre-Industrial Case Due to the 2013 PRM[(a)(c)] Application Case		Loss/Alteration to Pre-Industrial Case Due to 2013 Planned Development Case[(b)(d)]		Far Future[(b)]		Net Change to Pre-Industrial Case Due to 2013 Planned Development Case[(e)]	
	Area [ha]	% of RSA[(f)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]
high	543,521	24	-72,042	-13	-79,568	-15	-118,011	-22	485,877	89	-57,644	-11
moderate	1,177,205	52	-11,647	-<1	-14,801	-1	-55,786	-5	1,187,677	101	10,472	<1
low	555,931	24	-127,886	-23	-130,708	-24	-173,643	-31	603,822	109	47,891	9
unclassified (unknown rare plant potential)(j)	719	<1	-719	-100	-719	-100	-719	-100	0	0	-719	-100
Total	**2,277,376**	**100**	**-212,293**	**-9**	**-225,797**	**-10**	**-348,159**	**-15**	**2,277,376**	**100**	**n/a**	**n/a**

(a) Includes burns as modelled by ALCES®.

(b) Includes burns and cutblocks as modelled by ALCES®.

(c) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect effects due to surficial aquifer drawdown from PRM within the RSA, and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed during construction and operations. Excluding indirect effects due to surficial aquifer drawdown from PRM there is a total loss/alteration of -223,615 ha, within the RSA.

(d) Loss/alteration combines direct effects due to site clearing (PRM footprint) and indirect PRM effects due to surficial aquifer drawdown from PRM within the RSA, plus existing, approved and planned developments in the RSA. Excluding indirect effects due to surficial aquifer drawdown from PRM the total loss/alteration is -345,977 ha, within the RSA.

(e) Net change is calculated as the difference between the PIC and Far Future a value upon which the environmental consequence at Far Future is assessed.

(f) For the purposes of this assessment, each category is assumed to be 100% of Resource at Pre-Industrial Case.

(g) % of Resource is calculated as a percentage of PIC area; the areas of this column are not additive.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

5.3.2.2 Residual Impact Classification Before and After Reclamation

The effects description and environmental consequences associated with the change from the PIC to the 2013 PDC during construction and operations and the 2013 PDC at Far Future are summarized in Tables 5.3-9 and 5.3-10.

Wetlands (including peatlands and patterned fens) have been assigned a negative and moderate environmental consequence ranking during construction and operations and at Far Future from the PIC to the 2013 PDC (Tables 5.3-9 and 5.3-10), which is the same ranking assigned for the PIC to the 2013 PRM Application Case (Table 4.3-11). The residual impact was designated reversible/irreversible because peatlands, i.e., fens and bogs, cannot be reclaimed with current technologies, but wetlands including swamps, marshes and open water can be reclaimed. Reclamation programs will be adaptively managed to incorporate the results and recommendations from ongoing research regarding establishment of bogs and fens on the Far Future landscape (EIA, Appendix 5-2, Section 4).

From the PIC to the 2013 PDC, the overall environmental consequence for old growth forests in the RSA is negative and high both during construction and operations and at Far Future (Tables 5.3-9 and 5.3-10), and differs from the negative and moderate environmental consequence ranking assigned for the changes between the PIC and the 2013 Base Case. However, the proportions of old growth forests in the RSA will likely return to the pre-disturbance proportions after 100 to 140 years.

During construction and operations, a negative and high environmental consequence has been assigned to high rare plant potential from the PIC to the 2013 PDC (Table 5.3-9), and at Far Future a negative and moderate environmental consequence has been assigned (Table 5.3-10). The environmental consequence to high rare plant potential from the PIC to 2013 PDC at construction and operations differs from the negative and moderate environmental consequence from the PIC to the 2013 Base Case.

Table 5.3-9 Residual Impact Classification for Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area – Pre-Industrial Case to the 2013 Planned Development Case: During Construction and Operations

Component Criteria	Direction	Magnitude[a]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
wetlands (including peatlands and patterned fens)	negative	moderate (+10)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)
old growth forests	negative	high (+15)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	high (+20)
high rare plant potential	negative	high (+15)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	high (+20)

(a) Residual impact magnitude is based on percent of resource.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 5.3-10 Residual Impact Classification for Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area – Pre-Industrial Case to the 2013 Planned Development Case: Far Future

Component Criteria	Direction	Magnitude[(a)]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
wetlands (including peatlands and patterned fens)	negative	moderate (+10)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)
old growth forests	negative	high (+15)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	high (+20)
high rare plant potential	negative	moderate (+10)	regional (+1)	long term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)

(a) Residual impact magnitude is based on percent of resource.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.2.3 Environmental Significance Determination Before Reclamation

This section presents the environmental significance determination for Terrestrial Vegetation, Wetlands and Forest Resources at construction and operations. The CEAA (2012, internet site) states that significance should be determined only after taking into account any appropriate mitigation measures. Assessment methods for the determination of significance are discussed in Appendix 3.1, Section 2.8.3.

5.3.2.3.1 Ecological Thresholds

Ecological thresholds were used to assess wetlands (including peatlands and patterned fens), old growth forests, and areas of high rare plant potential in terms of Adverse and Likely effects from the PIC to 2013 PDC during operations:

- The loss of wetlands (including peatlands and patterned fens), old growth and areas of high rare plant potential resulting from the PIC to 2013 PDC are considered Adverse effects.
- The loss of wetlands (including peatlands and patterned fens), old growth forests, and high rare plant potential areas are considered Likely effects.
- The environmental consequence ratings for effects on wetlands (including peatlands and patterned fens) are negative, moderate and irreversible/reversible on a regional scale during construction and operations for the 2013 PDC compared to PIC (Table 5.3-9). Error due to regional land cover classification resulted in a 10% overestimation of wetlands in the RSA (Section 4.3.3.1.3). Although, there may be fewer wetlands in the RSA than predicted and peatlands will be permanently lost, wetlands (including peatlands and patterned fens) are abundant in the RSA (Table 5.3-6) and a 19% loss at 2013 PDC during construction and operations is not predicted to compromise the ecological function of remaining wetlands in the RSA. Therefore, effects on wetlands (including peatlands and patterned fens) are considered Not Significant.
- The environmental consequence ratings for effects on old growth forests and high rare plant potential areas are negative, high and irreversible/reversible on a regional scale during construction and operations for the 2013 PDC compared to PIC (Table 5.3-9). The ratings were designated reversible/irreversible because some old growth RLCCs, i.e., fens and bogs, cannot be reclaimed with current technologies, but terrestrial RLCCs can be reclaimed. Error due to the RLCC model resulted in an underestimation of these KIRs in the RSA suggesting that these KIRs are more abundant than predicted (Section 4.3.3.1.3). Based on the

large amount of old growth forest and high rare plant potential areas remaining in the RSA (Tables 5.3-7 and 5.3-8), the cumulative effects of development are not likely to exceed ecological thresholds and compromise the ecological function of remaining old growth forest and high rare plant potential areas. Therefore, effects on old growth forest and high rare plant potential areas are considered Not Significant.

5.3.2.3.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). Accounting for error associated with the RLCC model, high magnitude Adverse and Likely effects are predicted for old growth forests and high rare plant potential. Adverse effects to those KIRs during construction and operations of the 2013 PDC as compared to the PIC are therefore determined to be Significant according to resource management criteria.

Accounting for error associated with the RLCC model, effects to wetlands (including peatlands and patterned fens) are determined to be Likely, Adverse and Not Significant.

5.3.2.4 Environmental Significance Determination After Reclamation

This section presents the environmental significance determination for Terrestrial Vegetation, Wetlands and Forest Resources at Far Future. The CEAA (2012, internet site) states that significance should be determined only after taking into account any appropriate mitigation measures. Assessment methods for the determination of significance are discussed in Appendix 3.1, Section 2.8.3.

5.3.2.4.1 Ecological Thresholds

Ecological thresholds were used to assess wetlands (including peatlands and patterned fens), old growth forests, and areas of high rare plant potential in terms of Adverse and Likely effects from the PIC to 2013 PDC at Far Future:

- The loss of wetlands (including peatlands and patterned fens), old growth and areas of high rare plant potential resulting from the PIC to 2013 PDC are considered Adverse effects.
- The loss of wetlands (including peatlands and patterned fens), old growth forests, and high rare plant potential areas are considered Likely effects.
- The environmental consequence ratings for effects on wetlands (including peatlands and patterned fens) and for effects to areas with high rare plant potential are negative, moderate and irreversible/reversible on a regional scale at Far Future for the 2013 PDC compared to PIC (Table 5.3-10). The ratings were designated reversible/irreversible because peatlands, i.e., fens and bogs, cannot be reclaimed with current technologies but non-peatland wetlands can be reclaimed. Accounting for error due to the RLCC model (Section 4.3.3.1.3), and the irreversible loss of peatlands, the loss of these KIRs at 2013 PDC after reclamation is not predicted to compromise the ecological function of remaining wetlands in the RSA because of the overall abundance of these KIRs in the RSA (Tables 5.3-6 and 5.3-8). Therefore, effects on wetlands and high rare plant potential areas are considered Not Significant.
- The environmental consequence ratings for effects on old growth forests is negative, high and irreversible/reversible on a regional scale at Far Future for the 2013 PDC compared to PIC (Table 5.3-10). The ratings were designated reversible/irreversible because some old growth RLCCs, i.e., fens and bogs, cannot be reclaimed with current technologies, but terrestrial RLCCs can be reclaimed. Old growth forests

are not expected to be re-established within the 80-year period defined for the Far Future scenario. However, the proportion of old growth forests in the RSA is predicted to return to its pre-disturbance proportions in 100 years or more, depending on the tree species (Andison 2003; Schneider 2001). Accounting for error due to the RLCC model (Section 4.3.3.1.3), the cumulative effects of development from PIC to the 2013 PDC are not likely to exceed ecological thresholds and compromise the ecological function of remaining old growth forest because of the large amount of old growth forest remaining in the RSA (Tables 5.3-7 and 5.3-8). Therefore, effects on old growth forest are considered Not Significant.

5.3.2.4.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). Accounting for error associated with the RLCC model, high magnitude adverse and likely effects are predicted for old growth forests in the RSA at Closure. Therefore, effects to old growth forests at Closure are determined to be Significant.

Accounting for error associated with the RLCC model, effects to wetlands (including peatlands and patterned fens) and high rare plant potential are determined to be Likely, Adverse and Not Significant.

5.3.3 Wildlife and Wildlife Habitat

The effects of JME and PRM and planned developments on Wildlife and Wildlife Habitat were previously assessed in the EIA (Volume 5, Section 7.3.4 through 7.6) and the Species at Risk Assessment in the *May 2011, Submission of Information to the Joint Review Panel.*

The environmental consequences and significance of the effects of changes in the RSA from the PIC to the 2013 Base Case, 2013 PRM Application Case, and the 2013 PDC for wildlife are assessed as described in Section 4.3.4.

The majority of effects to wildlife abundance, habitat and movement from the PIC to the 2013 PDC have occurred from the PIC to the 2013 Base Case. For context, 2013 Base Case disturbances take up 14% of the RSA, while the 2013 PDC will result in an additional disturbance of 6% of the RSA (Table 5.3-6).

5.3.3.1 Environmental Significance Determination During Construction and Operations

Assessment methods for the determination of significance are described in detail in Appendix 3.1 (Section 2.8.3) and include the concepts of ecological thresholds and resource management criteria.

5.3.3.2 Assessment Results

Assessment results are provided for the cumulative effects of changes from the PIC to the 2013 PDC to wildlife and wildlife habitat for each of the wildlife KIRs below.

5.3.3.2.1 Barred Owl

The barred owl is provincially listed as “Sensitive” and is not listed federally (ASRD 2010b, internet site). Information on barred owl population trends in Alberta is limited because no long-term surveys for this species have been established. In a review of historical records, Priestley (2004) showed that barred owls have been and continue to be distributed throughout much of the Boreal Forest, Parkland, Foothill and Rocky Mountain Natural Regions of Alberta. The update to the Alberta Breeding Bird Atlas (2001 to 2005) found the barred owl was fairly stable throughout its range since the first atlas (1987 to 1991) and is increasing in the Boreal Forest

Natural Region, although this may have been an artefact of increased survey effort in that region (Penner 2007). An analysis of Breeding Bird Survey (BBS) data by Environment Canada (2013, internet site) shows the barred owl population increasing at an average rate of 6% per year across Canada from 1972 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that barred owl populations in Alberta have increased by 4.7% per year from 1968 to 2011. However, breeding bird survey data are not designed for surveying for owls, and the accuracy of trends estimated from those data are therefore unknown.

Barred owls inhabit old growth mixedwood forests upon which they are dependent for nesting and brood-rearing (ASRD 2005; Olsen et al. 2006, internet site; Priestley 2004). As such, the clearing of old growth forest is believed to be the primary threat to barred owl populations in Alberta (ASRD 2005). In addition to the effects of direct habitat loss, barred owls also may be sensitive to indirect habitat loss due to the likely predation risk presented by great horned owls near large clearings (Russell 2008).

5.3.3.2.1.1 Environmental Consequences (Barred Owl)

Due to the sensitivity of barred owl populations to the clearing of old growth forest, it is likely that the effects of landscape change in the RSA have resulted in a population decline. Habitat suitability modelling estimates a high magnitude decline in high suitability habitat from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 1). This suggests a potential decline in barred owl abundance and habitat that is high in magnitude and environmental consequence in the RSA from the PIC to the 2013 PDC (Table 5.3-11).

The effects of development on the movement of barred owl in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on barred owl in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-11 Residual Impact Classification for Effects on Barred Owl in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	high (+15)	high (+15)	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)	high (+16)
Habitat	negative	high (+15)	high (+15)	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)	high (+16)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)	negligible (+2)
Net Effects	negative	high (+15)	high (+15)	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)	high (+16)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.1.2 Environmental Significance Determination During Construction and Operations (Barred Owl)

5.3.3.2.1.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PDC on barred owl is high. The majority of these effects occur between the PIC and the 2013 Base Case. Losses of high suitability habitat are predicted to be 43% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for barred owl in the RSA (i.e., mixedwood aspen-jack pine and mixedwood aspen-white spruce) are estimated to have a classification error of 30%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Where high suitability habitat was misclassified because of errors in the regional land cover classification, the majority of the error was due to a misclassification of mixedwood forest as deciduous, which is considered to be moderate suitability habitat for barred owl. Classification error has also lead to an overall 24% underestimation of high suitability habitat for barred owls in the RSA, indicating that more high quality barred owl habitat is present in the RSA than was predicted by the habitat model. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds. Given the predicted areal extent of remaining high suitability habitat in the RSA (126,033 ha in the 2013 PDC; Appendix 3.7, Table 1.3-1) and data suggesting that the barred owl population in the boreal forest of Alberta is relatively stable or at worst slowly declining, it is unlikely that the barred owl population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to barred owl in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the barred owl population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the barred owl population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on barred owl from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.1.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on barred owl abundance are likely adverse and high in magnitude, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for barred owl according to resource management criteria.

5.3.3.2.2 Beaver

Beavers are provincially listed as “Secure” and not listed federally (ASRD 2010b, internet site). Beavers are considered keystone species because through building dams to modify and create their habitat, they exert a strong influence on aquatic and riparian communities (Baker and Hill 2003; Boyle and Owens 2007). Unregulated fur trade harvest coupled with habitat destruction led to severe declines in the North American population of beavers by 1900 (Boyle and Owens 2007). However, due to harvest regulations, protection of wetlands, translocation efforts and natural dispersal, the beaver population has been restored and is now stable throughout much of its range, including Alberta (ASRD 2010b, internet site; Boyle and Owens 2007) and is considered a nuisance species in many locales.

Currently, the principal threats to beaver populations are anthropogenic habitat destruction and degradation (Boyle and Owens 2007). Water storage, diversion and channelization affect beaver habitat by changing seasonal flow regimes and stream morphology, and causing loss or degradation of riparian vegetation used as forage (Boyle and Owens 2007). For example, unseasonably low water levels can cause decreased accessibility to food and leave beavers vulnerable to predation, while unseasonably high water levels can wash away food caches or cause dams to burst (Boyle and Owens 2007). The trapping and shooting of beavers to reduce beaver damage is considered a localized threat (Boyle and Owens 2007).

5.3.3.2.2.1 Environmental Consequences (Beaver)

Reliable data are not available for historical population trends of beaver in the RSA. Due to the sensitivity of beavers to habitat alterations, to be conservative regional population trends for beaver may be inferred from changes to habitat. Landscape changes in the RSA from the PIC to the 2013 PDC prior to reclamation have resulted in moderate magnitude declines in high suitability beaver habitat (Appendix 3.7, Section 1). This suggests a potential decline in beaver abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-12).

The effects of development on the movement of beaver in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 PDC. The net effects of development on beaver in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-12 Residual Impact Classification for Effects on Beaver in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.2.2 Environmental Significance Determination During Construction and Operations (Beaver)

5.3.3.2.2.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA form the PIC to the 2013 PDC on beaver is moderate. Losses of high suitability habitat are predicted to be 19% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for beaver in the RSA (i.e., water, upland and treed fen) are estimated to have a classification error of 8%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Where high suitability habitat was misclassified because of errors in the regional land cover classification, the majority of the error was due to a misclassification of upland as wetland, which is considered to be moderate suitability habitat. Classification error has also lead to an overall 30% underestimation of high suitability habitat for beaver in the RSA, indicating that more high quality beaver habitat is present in the RSA than was predicted by the habitat model. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds.

Given the predicted areal extent of remaining high suitability habitat in the RSA (477,447 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1) and data suggesting that the beaver population is relatively stable, it is unlikely that beaver population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to beaver in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the beaver population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the beaver population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on beaver between the PIC and the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.2.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Habitat loss is predicted to be less than 20% (i.e., 19% from the PIC to the 2013 PDC), but may exceed 20% after considering uncertainty due to model error. Therefore, to be conservative, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for beaver according to resource management criteria.

5.3.3.2.3 Black Bear

The black bear (*Ursus americanus*) is considered "Not at Risk" federally and is not listed by SARA (Government of Canada 2013, internet site). Provincially, the black bear is listed as "Secure" (ASRD 2010b, internet site), and is permitted to be hunted using bait in the Oil Sands Region (Alberta Government 2013, internet site).

Black bears are widely distributed and occupy all major forested habitats in the province (Gunson 1993). The black bear population in Alberta has increased in recent years due to improvements in habitat associated with the partial clearing of forests for roads, trails and other developments (ASRD 2010a, internet site). In addition, recent sightings in the City of Edmonton and other areas of central Alberta suggest the species may be extending its range into former habitats (ASRD 2011).

Black bears can be highly tolerant of oil developments, including roads (Tietje and Ruff 1983). The greatest threat to black bear populations is mortality by man, either due to hunting, the destruction of animals that become nuisances due to attraction to garbage, or accidental collisions with vehicles.

5.3.3.2.3.1 Environmental Consequences (Black Bear)

Reliable data are not available for historical population trends of black bear in the RSA. The effects of landscape change on the black bear population in the RSA were estimated using a PVA. A moderate magnitude decline in the carrying capacity of the RSA for black bear is estimated from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 3). This suggests a decline in black bear abundance in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-13).

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decline in high suitability black bear habitat that is moderate in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-13).

The effects of development on the movement of black bear in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 PDC. The net effects of development on black bear in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-13 Residual Impact Classification for Effects on Black Bear in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.3.2 Environmental Significance Determination During Construction and Operations (Black Bear)

5.3.3.2.3.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA form the PIC to the 2013 PDC on black bear is moderate. Losses of high suitability habitat are predicted to be 18% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for black bear in the RSA (i.e., upland excluding coniferous jackpine-black spruce forest) are estimated to have a classification error of 22%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Classification error has also lead to an overall 22% overestimation of high suitability habitat for black bear in the RSA. Therefore, classification error may have lead to an underestimation of high suitability habitat loss, and less high suitability habitat is likely present than predicted, thereby increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (946,085 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1), it is unlikely that the black bear population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to black bear in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the black bear population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the black bear population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on black bear from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.3.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Habitat loss is predicted to be less than 20% (i.e., 18% from the PIC to the 2013 PDC), but may exceed 20% after considering uncertainty due to model error. Therefore, to be conservative, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for black bear according to resource management criteria.

5.3.3.2.4 Black-Throated Green Warbler

The black-throated green warbler is not listed federally but is listed as "Special Concern" in Alberta due to suspected population declines and reliance on intact old growth stands (ASRD 2010b, internet site). An analysis of BBS data by Environment Canada (2013, internet site) shows the black-throated green warbler population decreasing at an average rate of 7.4% per year across Canada from 1970 to 2011. Sauer et al. (2011, internet site) analyzed BBS data and estimated that black-throated green warbler populations in Alberta have declined by 7.4% per year from 1968 to 2011. The ABMI (2012) reported that black-throated green warbler abundance was slightly lower than in undisturbed reference sites (i.e., 81% intactness) in the Boreal Plains Ecozone in Alberta, of which the Oil Sands Region is a part.

The decline in black-throated green warbler populations appears to be due to the direct and indirect effects of habitat loss. In Alberta, black-throated green warblers are associated with continuous white spruce and mixedwood old growth stands, and appear to avoid fragmented landscapes (Hobson and Bayne 2000a,b). An increase in disturbance and fragmentation of breeding habitat is likely the greatest cause of population declines and remains the greatest threat to persistence of the species (Morse and Poole 2005, internet site). Abundance tends to decrease in response to forest harvest (Hanowski et al. 2003). Disturbance may also increase the susceptibility of black-throated green warblers to nest predation by small mammals and brood parasitism by brown-headed cowbirds (Norton 1999). The loss of habitat on the wintering grounds likely compounds the rate of decline (ASRD 2010b, internet site).

5.3.3.2.4.1 Environmental Consequences (Black-Throated Green Warbler)

Due to the sensitivity of black-throated green warbler populations to the clearing of old growth forest, it is likely that the effects of landscape change in the RSA have resulted in a population decline. Assuming a 7.4% decline per year from 1968 to 2011 (Sauer et al. 2012, internet site) would result in an approximately 96% decline. Habitat suitability modelling estimates a 44% decline in high suitability habitat from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 1). This suggests a potential decline in black-throated green warbler abundance and habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-14).

The effects of development on the movement of black-throated green warbler in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on black-throated green warbler in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-14 Residual Impact Classification for Effects on Black-Throated Green Warbler in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Habitat	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.4.2 Environmental Significance Determination During Construction and Operations (Black-Throated Green Warbler)

5.3.3.2.4.2.1 Ecological Thresholds

The decline of the black-throated green warbler in Alberta has been estimated to be as high as 7% per year between 1966 and 2011, which suggests a decline of 96% over that period (Sauer et al. 2012, internet site). The population trend estimated for black-throated green warbler is for Alberta, and is not specific to the RSA. However, if the black-throated green warbler population in the RSA has declined by as much as 96% from the PIC to the 2013 Base Case, it may be declining to extirpation and would therefore not be self-sustaining or ecologically effective. Given the known adverse effects of increased disturbance and fragmentation on the species and its affinity for old growth forest, increased development since the PIC in the RSA could be considered to be incrementally contributing to the decline of the black-throated green warbler population in the RSA. As has been the case throughout this assessment of effects of the 2013 PDC relative to the PIC, the majority of the effects have occurred between the PIC and the 2013 Base Case. For example, 82% of the high suitability black-throated green warbler habitat that is predicted to be lost from the PIC to the 2013 PDC was already lost from the PIC to the 2013 Base Case (Appendix 3.7, Section 1.3).

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PDC on black-throated green warbler is high. Losses of high suitability habitat are predicted to be 44% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for black-throated green warbler in the RSA (i.e., coniferous white spruce and mixedwood aspen-white spruce forest) are estimated to have a classification error of 31%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. However, classification error has lead to an overall 54% underestimation of high suitability habitat for black-throated green warbler in the RSA, indicating that more high quality black-throated green warbler habitat is present in the RSA than was predicted by the habitat model. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds.

The following discusses the effects of changes in the RSA to black-throated green warbler in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the black-throated green warbler population in the RSA are considered Adverse effects.
- Available data suggest that black-throated green warbler populations in Alberta may be declining to extirpation. Given the known negative effects of increased disturbance and fragmentation on the species and its affinity for old growth forest, increased development in the RSA could be considered to be incrementally contributing to the decline of the black-throated green warbler population in the RSA. Therefore, cumulative effects of development in the RSA may have exceeded ecological thresholds such that the black-throated green warbler population may no longer be self-sustaining and ecologically effective. To be precautionary, these are considered Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on black-throated green warbler from the PIC to the 2013 PDC are considered Likely, Adverse and Significant.

5.3.3.2.4.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on black-throated green warbler abundance are likely adverse and high in magnitude, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for black-throated green warbler according to resource management criteria.

5.3.3.2.5 Canada Lynx

Canada lynx are not listed federally, but are listed as “Sensitive” in Alberta (ASRD 2010b, internet site). Lynx populations naturally cycle according to the abundance of their main prey, snowshoe hare (Krebs et al. 2001). Trapping of Canada lynx occurs in the Oil Sands Region. Reliable data are not available for historical population trends of Canada lynx in the RSA.

Concerns over the effect of habitat loss and fragmentation on lynx, along with the small population size during low cycle phases, resulted in lynx being listed as “Sensitive” in Alberta (ASRD 2010b, internet site) and trapping take is currently limited by a quota system. Although regenerating forest stands provide habitat for snowshoe hare and thus food sources for lynx, the loss of denning sites, reductions in the number and size of forest patches, and opening of habitat that facilitates access of generalist species (e.g., coyotes), suggest that lynx may be sensitive to human development (Buskirk et al. 2000; Squires et al. 2010).

5.3.3.2.5.1 Environmental Consequences (Canada Lynx)

Due to the sensitivity of Canada lynx populations to habitat loss and fragmentation, it is likely that the effects of landscape change in the RSA have resulted in a population decline. To be conservative, population trends for Canada lynx in the RSA may be inferred from changes to habitat. Landscape changes in the RSA from the PIC to the 2013 PDC prior to reclamation have resulted in a high magnitude decline in high and moderate-high suitability Canada lynx habitat (Appendix 3.7, Section 1). This suggests a potential decline in Canada lynx abundance and habitat that is high in magnitude and environmental consequence in the RSA from the PIC to the 2013 PDC (Table 5.3-15).

The effects of development on the movement of Canada lynx in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 PDC. The net effects of development on Canada lynx in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-15 Residual Impact Classification for Effects on Canada Lynx in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.5.2 Environmental Significance Determination During Construction and Operations (Canada Lynx)

5.3.3.2.5.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PDC on Canada lynx is high. Losses of high and moderate-high suitability habitat are predicted to be 28% from the PIC to the 2013 PDC. The cumulative effects of development in the RSA on Canada lynx habitat were predicted using an empirically derived RSF, for which model error was estimated through validation and the model was determined to perform moderately well (EIA, Volume 5, Appendix 5-4, Section 1.2.2). Nonetheless, the amount of high and moderate-high suitability habitat lost may be underestimated and may exceed 20%. Therefore, classification error may increase the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (647,722 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1) and that lynx harvest is governed by quotas, it is unlikely that the Canada lynx population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective. The following discusses the effects of changes in the RSA to Canada lynx in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the Canada lynx population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the Canada lynx population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on Canada lynx from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.5.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Habitat loss is predicted to be greater than 20% (i.e., 28% from the PIC to the 2013 PDC). Therefore, to be conservative, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for Canada lynx according to resource management criteria.

5.3.3.2.6 Canadian Toad

The Canadian toad is listed as “May Be At Risk” provincially and is not listed federally (ASRD 2010b, internet site). Although there is little information on population trends of this species in Alberta, suspected population declines were documented in the southern part of province (Hamilton et al. 1998), while population increases have been estimated in the boreal forest (Brown 2009).

The main limiting factor affecting Canadian toad distribution in the boreal forest is likely the availability of suitable overwintering habitat (Hamilton et al. 1998; Roberts 2003, pers. comm.). Canadian toads hibernate below the frost line in burrows in upland habitats (Brown 2009). Poor burrowing ability restricts the availability of suitable overwintering habitat by restricting the types of substrate toads can utilize (Hamilton et al. 1998).

5.3.3.2.6.1 Environmental Consequences (Canadian Toad)

Reliable data are not available for historical population trends of Canadian toad in the RSA. However, due to the sensitivity of Canadian toad populations to the availability of overwintering habitat, it is likely that the effects of landscape change in the RSA may have resulted in a population decline. To be conservative, regional population trends for Canadian toad may be inferred from changes to habitat. Landscape changes in the RSA from the PIC to the 2013 PDC prior to reclamation have resulted in moderate magnitude declines in high suitability Canadian toad habitat (Appendix 3.7, Section 1). This suggests a potential decline in Canadian toad abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-16).

The effects of development on the movement of Canadian toad in the RSA are predicted to result in a moderate environmental consequence from the PIC to the 2013 PDC. The net effects of development on Canadian toad in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-16 Residual Impact Classification for Effects on Canadian Toad in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[(a)]			Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[(c)]	2013 Planned Development Case
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Habitat	negative	moderate (+10)	moderate (+10)	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Movement	negative	moderate (+10)	moderate (+10)	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.6.2 Environmental Significance Determination During Construction and Operations (Canadian Toad)

5.3.3.2.6.2.1 Ecological Thresholds

Losses of high suitability habitat for Canadian Toad are predicted to be 17% from the PIC to the 2013 PDC. Model validation was conducted for the Canadian toad HSI model, and the model was determined to effectively distinguish between high, moderate and low suitability habitat (EIA, Volume 5, Appendix 5-4, Section 1.2.4). Although the amount of high suitability habitat lost may be underestimated, based on model validation results it is unlikely that habitat loss would exceed 20% and therefore become a high magnitude effect. Further, classification error has lead to no change in estimation of high suitability habitat for Canadian toad in the RSA. Therefore, model error due to regional land cover misclassification results in no change in the estimation of the potential of high suitability habitat in the RSA to support Canadian toads.

Given the predicted areal extent of remaining high suitability habitat in the RSA (160,768 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1) and data suggesting that the Canadian toad population in the RSA may be stable, it is unlikely that the Canadian toad population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to Canadian toad in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the Canadian toad population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the Canadian toad population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on Canadian toad from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.6.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on Canadian toad abundance are predicted to be likely adverse and moderate in magnitude and Canadian toad is not a federally listed species, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Not Significant for Canadian toad according to resource management criteria.

5.3.3.2.7 Fisher

The fisher is provincially listed as "Sensitive" but has not been listed federally (ASRD 2010b, internet site). Reliable data are not available for historical population trends of fisher in the RSA. The primary threats to fisher populations are mortality due to trapping, and habitat loss and fragmentation due to forest clearing (Lofroth et al. 2010; Ruggiero et al. 1994; Weir 2003). Harvest in Alberta is limited by a quota system. Although fishers forage over large areas and within a mosaic of habitat types, they require forests with late successional attributes (i.e., closed canopy, large woody debris, large snags, tree cavities, and a well-developed understorey) to support a robust prey base (Lofroth et al. 2010; Weir and Lara Almuedo 2010).

5.3.3.2.7.1 Environmental Consequences (Fisher)

Although historical population trends of fisher in the RSA have not been documented, due to the sensitivity of fisher populations to the availability of suitable habitat, it is likely that the effects of landscape change in the RSA have resulted in a population decline. To be conservative, regional population trends for fisher may be inferred from changes to habitat. Landscape changes in the RSA have resulted in a high magnitude decline in high and moderate-high suitability fisher habitat from the PIC to the 2013 PDC during construction and operations (Appendix 3.7, Section 1). This suggests a potential decline in fisher abundance and habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-17).

The effects of development on the movement of fisher in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 PDC. The net effects of development on fisher in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

5.3.3.2.7.2 Environmental Significance Determination During Construction and Operations (Fisher)

5.3.3.2.7.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA form the PIC to the 2013 PDC on fisher is high. Losses of high and moderate high suitability habitat are predicted to be 25% from the PIC to the 2013 PDC. The cumulative effects of development in the RSA on fisher habitat were predicted using an empirically derived RSF, for which model error was estimated through validation and the model accuracy was determined to be low (EIA, Volume 5, Appendix 5-4, Section 1.2.2). Therefore, the amount of high suitability habitat lost may be underestimated and exceeds 20% to become a high magnitude effect. However, given the predicted areal extent of remaining high and moderate-high suitability habitat in the RSA (763.534 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1) and that harvest is limited by a quota system, it is unlikely that the fisher population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to fisher in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the fisher population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the fisher population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on fisher from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

Table 5.3-17 Residual Impact Classification for Effects on Fisher in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[(a)]			Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[(c)]	2013 Planned Development Case
Abundance	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.7.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on fisher abundance are likely adverse and high in magnitude, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for fisher according to resource management criteria.

5.3.3.2.8 Moose

Moose are listed as "Secure" in Alberta, and are not listed federally (ASRD 2010b, internet site). Moose populations naturally fluctuate due to climate variability (Saether 1997), predation (Post and Stenseth 1998), resource availability (Ferguson et al. 2000), and density dependent processes (Ferguson et al. 2000). Ungulate aerial surveys provide a means to track population changes; however, estimates have large error margins and survey costs limit the number of Wildlife Management Units (WMUs) surveyed each year. Of the WMUs in the RSA (i.e., WMUs 518, 519, 529, 530 and 531), only WMU 518 and the southern half of WMU 530 have been surveyed multiple times using the random stratified block method to allow for an accurate estimation of population trends (Skilnick 2013, pers. comm.). Survey results to do not appear to show a decline, although the error inherent in population density estimates may be obscuring a decline, if one exists. As a result, ESRD considers the moose populations of WMUs 518 and 530 to be "potentially stable" (Skilnick 2013, pers. comm.). Surveys were conducted in WMU 531 in 1994, 2001 and 2009, and although a direct comparison between years is difficult due to varying survey methods, moose abundance in WMU 531 does appear to have declined (Morgan and Powell 2009; Skilnick 2013, pers. comm.). The WMU immediately south of the RSA, WMU 516, was surveyed in 1994, 1998, 2003 and 2011. Estimates from these surveys indicate the population has remained relatively stable, as the upper and lower estimates overlap between years, and the 1994 and 2011 population size estimates were 919 and 933, respectively (Nordstrom and Ranger 2011).

Percent hunter success resulting from harvesting tends to be strongly and linearly related to population size, and is therefore another means to monitor population trends (Roseberry and Woolf 1991). Hunter success for WMUs in the RSA has ranged from 12.1% to 100% between 2007 and 2012; however no statistically significant linear trend was detected over that period. Hunter success was higher for WMU 519 through the early 2000s, suggesting that the population increased at that time; however, success rate has remained lower in recent years. Harvest by First Nations continues to remain undocumented. While there is uncertainty around population size and trends, these available data do not indicate major changes are occurring in moose population size in the RSA.

Factors that can lead to moose population declines include disease, malnutrition due to habitat loss or increased competition, heat stress, over harvest, and/or predation (Murray et al. 2006). According to ALCES (2013), reduced moose populations in northeastern Alberta are most likely the result of increased mortality rates associated with higher human populations, increased access, and more trucks and off-highway vehicles. Moose are susceptible to heat stress and southern populations are expected to recede while northern populations increase as winters become less severe due to climate change (Dussault et al. 2004; Rempel 2011). Concurrent expansion of white-tailed deer populations are expected to increase contact with pathogens, while warmer climates may further facilitate pathogen transmission (Lankester 2010; Murray et al. 2006; Rempel 2011). In Alberta, winters are becoming less severe and white-tailed deer are expanding (Dawe 2011). Although the increased overlap between moose and white-tailed deer has not led to increased disease spread to date; the spread of white-tailed deer may lead to changes in boreal predator – prey dynamics and/or direct competition for resources (Latham et al. 2011; Murray et al. 2006). Increases in early seral forest across a landscape, as a result of regeneration after land use development, can increase abundance of moose as a result of higher quality and quantity of food resources (Boan et al. 2011).

5.3.3.2.8.1 Environmental Consequences (Moose)

Reliable data are only partially available for historical population trends of moose in the RSA. The effects of landscape change on the moose population in the RSA were estimated using a PVA. A decline in carrying capacity and abundance of the RSA for moose of moderate magnitude and environmental consequence is estimated from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 3; Table 5.3-20). This is a reasonable and conservative estimate based on the available data.

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decline in high and moderate-high moose habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-18).

The effects of development on the movement of moose in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 PDC. The net effects of development on moose in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-18 Residual Impact Classification for Effects on Moose in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.8.2 Environmental Significance Determination During Construction and Operations (Moose)

5.3.3.2.8.2.1 Ecological Thresholds

Losses of high and moderate-high suitability habitat are predicted to be 21% from the PIC to the 2013 PDC. The cumulative effects of development in the RSA on moose habitat were predicted using an empirically derived RSF, for which model error was estimated through validation and the model accuracy was determined to be low (EIA, Volume 5, Appendix 5-4, Section 1.2.2). Therefore, the amount of high and moderate-high suitability habitat lost may be underestimated and may exceed 20%. However, given the predicted areal extent of remaining high and moderate-high suitability habitat in the RSA (736,851 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1) and data suggesting that the moose population may be slowly declining, it is unlikely that the moose population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to moose in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the moose population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the moose population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on moose from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.8.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Habitat loss is predicted to exceed 20% (i.e., 21% from the PIC to the 2013 PDC). Therefore, to be conservative, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for moose according to resource management criteria.

5.3.3.2.9 Canada Warbler

The Canada warbler is federally listed as "Threatened" by COSEWIC (2008) and "Schedule 1: Threatened" by SARA (Government of Canada 2013, internet site). In Alberta, the Canada warbler is listed as "Sensitive" (ASRD 2010b, internet site). Alberta represents the western-most extension of the Canada warbler's range in North America (Semenchuk 1992). Canada supports approximately 80% of the Canada warbler's breeding range. According to Breeding Bird Survey (BBS) data, the Canadian population of Canada warblers has declined by 5.4% per year between 1997 and 2007, amounting to a population loss of 85% (COSEWIC 2008). An analysis of BBS data by Environment Canada (2013, internet site) estimates a 3.5% decline per year in the Alberta population from 1970 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that Canada warbler populations in Alberta appear to have decreased by 3.4% per year from 1968 to 2011, which would have resulted in a 77% decline in the population during that period. However, ABMI reported that Canada warbler abundance was similar to undisturbed reference conditions in the Boreal Plains Ecozone (i.e., 100% intactness) under existing conditions (ABMI 2012).

Habitat loss and degradation in the wintering and breeding range for Canada warbler could be responsible for their decline (COSEWIC 2008; Reitsma et al. 2010, internet site). On their breeding range, Canada warblers have lost habitat due to the draining of wetlands for agriculture and urban development in the northeastern part of their range and the clearing of boreal mixedwood forests for agriculture and industrial development associated with the pulp and paper and oil and gas sectors in the northwestern part of their range (COSEWIC 2008; Reitsma et al. 2010, internet site). In addition, the occurrence of breeding Canada warblers appears to be negatively affected by the proximity and length of paved roads in forested landscapes (COSEWIC 2008).

5.3.3.2.9.1 Environmental Consequences (Canada Warbler)

Canada warbler populations are likely sensitive to habitat alteration in the boreal forest. Therefore, landscape change in the RSA may have resulted in a population decline. An assumed 3.4% population decline per year from 1968 to 2011 (Sauer et al. 2012, internet site) would result in an approximately 77% total population decline. Habitat suitability modelling estimates a 62% decline in high suitability habitat from the PIC to both the 2013 PDC prior to reclamation (Appendix 3.7, Section 1). Collectively, this suggests a potential decline in Canada warbler abundance and habitat that is high in magnitude and environmental consequence from the PIC to the 2013 PDC in the RSA (Table 5.3-19).

The effects of development on the movement of Canada warbler in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on Canada warbler in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-19 Residual Impact Classification for Effects on Canada Warbler in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Habitat	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.9.2 Environmental Significance Determination During Construction and Operations (Canada Warbler)

5.3.3.2.9.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PDC on Canada warbler is high. Losses of high suitability habitat are predicted to be 62% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for Canada warbler in the RSA (i.e., deciduous aspen-balsam poplar) are estimated to have a classification error of 47%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. The majority of classification error for habitat predicted to be high suitability for Canada warbler was due to a misclassification of deciduous forest as mixedwood, which is considered to be moderate suitability habitat for Canada warbler. In addition, classification error may have lead to an overestimation of the amount of high suitability habitat that may be present in the RSA. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds.

In Alberta, the Canada warbler population may have declined by 77% from 1968 and 2011 (Sauer et al. 2012, internet site). Although the population trend estimated for Canada warbler for Alberta is not specific to the RSA, Canada warbler may be declining to extirpation. The decline of Canada warbler has been linked to both the loss of southern wintering habitat as well as the clearing of boreal mixedwood forests (COSEWIC 2008). However, the similarity of Canada warbler abundance in the Boreal Plains Ecozone under existing conditions relative to reference conditions (i.e., 100% intactness; ABMI 2012) suggests that this population decline is not due to habitat loss in the boreal. Nonetheless, to be conservative given uncertainty regarding the cause of the population decline in Alberta, it is assumed that development in the RSA has incrementally contributed to the decline of this species. There is a predicted 62% loss in high suitability habitat from the PIC to 70,773 ha of high suitability habitat remaining in the RSA in the 2013 PDC. Combined, the apparent population decline, high percentage habitat loss and relatively little high suitability habitat available, the Canada warbler population in the RSA may not be self-sustaining or ecologically effective. Canada warblers are infrequently recorded in the RSA during breeding bird point counts.

The following discusses the effects of changes in the RSA to Canada warbler in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the Canada warbler population in the RSA are considered Adverse effects.
- Available data on population trends and estimates of habitat loss and availability suggest that the Canada warbler population in the RSA may be declining to extirpation. To be conservative given uncertainty regarding the cause of the population decline in Alberta, it is assumed that development in the RSA has incrementally contributed to the decline of this species. Therefore, cumulative effects of development in the RSA may have exceeded ecological thresholds for Canada warbler such that its population would no longer be self-sustaining and ecologically effective. To be precautionary, these are considered Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on Canada warbler from the PIC to the 2013 PDC are considered Likely, Adverse and Significant.

5.3.3.2.9.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on Canada warbler abundance are likely adverse and high in magnitude and Canada warbler is federally listed, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for Canada warbler according to resource management criteria.

5.3.3.2.10 Common Nighthawk

The common nighthawk is listed as "Sensitive" in Alberta (ASRD 2010b, internet site), and is federally listed as "Threatened" by COSEWIC (2007a) and "Schedule 1: Threatened" by SARA (Government of Canada 2013, internet site) due to both short- and long-term population declines (COSEWIC 2007a). The population status of the common nighthawk is relatively unknown due to strong variations in local abundance (FAN 2007) and the difficulty of observing the species (MELP 1998). However, long-term data collected in Canada from 1968 to 2005 suggests a population decline (COSEWIC 2007a). An analysis of BBS data by Environment Canada (2013, internet site) shows the common nighthawk population declining at an average rate of 3% per year in Alberta from 1970 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that common nighthawk populations in Alberta have declined by 3.3% per year from 1968 to 2011. However, breeding bird survey data are not designed for surveying for common nighthawks, and the accuracy of trends estimated from those data are therefore unknown.

Reasons for the apparent decline of common nighthawk populations are not well understood, but may be due in part to diminishing populations of insect prey due to pesticide use (COSEWIC 2007a; Brigham et al. 2011, internet site). The main threat to common nighthawk populations in North America is suggested to be the loss and alteration of suitable breeding habitat (COSEWIC 2007a). For example, fire suppression and changes in harvesting practices have reduced the number of open areas in forested regions, and the loss of native prairie to intensive agriculture has reduced common nighthawk nesting habitat (COSEWIC 2007a).

5.3.3.2.10.1 Environmental Consequences (Common Nighthawk)

Common nighthawk populations are likely sensitive to habitat alteration in the boreal forest. Therefore, it is likely that the effects of landscape change in the RSA have resulted in a population decline. Habitat suitability modelling estimates a moderate magnitude decline in high suitability habitat from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in common nighthawk abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-20).

The effects of development on the movement of common nighthawk in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on common nighthawk in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-20 Residual Impact Classification for Effects on Common Nighthawk in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	low (+5)	low (+5)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)	moderate (+13)
Habitat	negative	low (+5)	low +5)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)	moderate (+13)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	low (+5)	low (+5)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)	moderate (+13)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.10.2 Environmental Significance Determination During Construction and Operations (Common Nighthawk)

5.3.3.2.10.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA form the PIC to the 2013 PDC on common nighthawk is moderate. Losses of high suitability habitat are predicted to be 12% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for common nighthawk in the RSA (i.e., burns, coniferous jack pine) are estimated to have a classification error of 82% for jack pine habitat. The accuracy of burns in the RSA is difficult to estimate, as their spatial distribution is based on a stochastic simulation by ALCES of the average expected area burned over time (Appendix 3.1, Section 2.8.2). Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Classification error may have also lead to an overestimation of high suitability habitat for common nighthawk in the RSA. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (310,249 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1) and data suggesting a slow population decline over time, even after taking into consideration an underestimation of habitat loss and an overestimation of habitat availability due to model error it is unlikely that the common nighthawk population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective. Common nighthawks are frequently recorded in the RSA and frequent disturbed areas.

The following discusses the effects of changes in the RSA to common nighthawk in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the common nighthawk population in the RSA are considered Adverse effects.
- Because common nighthawks are frequently recorded in the RSA and frequent disturbed areas, and due to the likely extent of remaining high suitability habitat, the cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the common nighthawk population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on common nighthawk from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.10.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because common nighthawk is a federally listed species that is adversely affected, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for common nighthawk according to resource management criteria.

5.3.3.2.11 Horned Grebe

The horned grebe is migratory, with over 90% of its breeding range occurring in Canada, and with a majority of the western population occurring in Alberta and Saskatchewan (COSEWIC 2009b). The horned grebe is federally listed as "Special Concern" by COSEWIC (2009c) but it is not listed by SARA (Government of Canada 2013, internet site). An analysis of BBS data by Environment Canada (2013, internet site) suggests that the horned grebe population in Alberta has been declining by 1.3% per year on average from 1970 to 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that the horned grebe population in Alberta has declined by 1.7% per year from 1968 to 2011, which would result in an approximately 52% decline over that period. The breeding range of horned grebes appears to be experiencing a northwestward contraction (COSEWIC 2009b).

The mechanisms responsible for the population decline of the horned grebe are unknown but several potential threats have been identified. Perhaps most importantly, habitat loss and degradation has occurred on their breeding range throughout the prairies where wetlands have been lost due to agricultural activity and degraded through eutrophication from the accumulation of fertilizers and other contaminants (COSEWIC 2009b). The bioaccumulation of toxins, as well as increased predation pressure may also be playing a role in the decline.

5.3.3.2.11.1 Environmental Consequences (Horned Grebe)

The decline in horned grebes has been largely attributed to the loss of wetlands on the prairies. As such, the Alberta-wide decline that has been reported is not likely compounded by habitat change in the boreal forest, where the availability of wetlands is not likely to be limiting. However, to be conservative, population trends for horned grebe in the RSA may be inferred from changes to habitat. Habitat suitability modelling estimates a high magnitude decline in high suitability habitat from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in horned grebe abundance and habitat that is high in magnitude and environmental consequence from the PIC to the 2013 PDC in the RSA (Table 5.3-21).

The effects of development on the movement of horned grebe in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on horned grebe in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-21 Residual Impact Classification for Effects on Horned Grebe in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.11.2 Environmental Significance Determination During Construction and Operations (Horned Grebe)

5.3.3.2.11.2.1 Ecological Thresholds

Development in the RSA was assessed as having a high environmental consequence for effects on the abundance of horned grebe based on changes to habitat. However, it is unlikely that development in the RSA has contributed to declines of this species. Declines appear to be due to wetland loss in the prairies for horned grebe (COSEWIC 2009b). Losses of high suitability habitat are predicted to be 27% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for horned grebe in the RSA (i.e., non-treed wetlands and areas of lakes within 25 m of shoreline) are estimated to have a classification error of 67%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated and exceeds 20%. In addition, the amount of high suitability habitat in the RSA may have been overestimated. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted amount of remaining high quality habitat available in the RSA (208,459 ha in the 2013 PDC, Appendix 3.7, Section 1.3), the apparent slow population decline in Alberta and the likelihood that declines are due to wetland loss in the prairies rather than development in the boreal forest, it is unlikely that the horned grebe population in the RSA has been compromised by development to the point that it is no longer self-sustaining and ecologically effective. The following discusses the effects of changes in the RSA to horned grebe in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on horned grebe are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the horned grebe population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on horned grebe from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.11.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because effects on horned grebe abundance are likely adverse and high in magnitude and horned grebe is federally listed, cumulative effects from the PIC to the 2013 PDC are determined to be Significant for horned grebe according to resource management criteria.

5.3.3.2.12 Little Brown Myotis

The little brown myotis is provincially listed as "Secure" (ASRD 2010b, internet site) and federally listed as "Endangered" by COSEWIC (2012a, 2012b) due to the rapidly spreading WNS, which is a fungal disease that interferes with hibernation. This disease is spreading from the east and is not yet present in Alberta, but has been detected as far west as Manitoba. Once considered common and widely distributed, little brown myotis populations are now in sharp decline due to WNS, which has resulted in several local extirpations in the eastern portion of its range, and is ultimately expected to cause regional and possibly range-wide extinction in a very short ecological time frame (Frick et al. 2010). If WNS continues spreading at the current rate, the entire Canadian population would likely be impacted within 11 to 22 years (COSEWIC 2012a).

White-nose syndrome is the most important factor affecting the population trajectory of this species. Other factors that may affect populations of these species include access to winter hibernacula and summer roosting and foraging habitat. Winter hibernacula in the Alberta Oil Sands Region are only known from outside the RSA in Cadomin Cave and Wood Buffalo National Park (ASRD and ACA 2009; Barclay 2012, pers. comm.), and will not be affected by PRM or development in the RSA. Hibernacula appear to be selected by bats for their high humidity and relatively stable, cool temperatures that are above freezing (Fenton 1970 in Kunz and Reichard 2010). Little brown myotis are considered to be habitat generalists with respect to their summer roosting and foraging habitat (Kunz and Reichard 2010). They form reproductive colonies in barns, attics, tree cavities and other places that remain dark throughout the day (Crampton and Barclay 1998).

5.3.3.2.12.1 Environmental Consequences (Little Brown Myotis)

Little brown myotis are primarily limited by WNS across their range. Prior to the arrival of WNS in Alberta, the availability of hibernacula may be limiting regional abundance of this species. When the number of hibernacula, typically caves, is low, bat populations are clumped and the risk of effects such as predation and disease is increased (ASRD and ACA 2009; Caceres and Pybus 1997). However, no hibernacula are likely to occur within the RSA. Summer roosting and foraging requirements are general and therefore not likely to be limiting to regional abundance of little brown myotis given that 80% of the RSA remains undisturbed in the 2013 PDC. Therefore, effects to abundance may be assessed qualitatively by taking into consideration the small risks of mortality due to development in the RSA, which are predicted to be limited to the effects of sensory disturbance on population abundance. Interactions with infrastructure and direct mortality due to site clearing and vehicle collisions are unlikely to affect the abundance of little brown myotis. Development in the RSA is predicted to result in a negligible magnitude decline in little brown myotis abundance from the PIC to the 2013 PDC.

Little brown myotis abundance is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, the species is opportunistic in its selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across its range. Therefore, effects to abundance for little brown myotis may be assessed qualitatively by taking into consideration the negligible environmental consequence of mortality due to development in the RSA. The effects of development on little brown myotis abundance are predicted to be negligible from the PIC to the 2013 PDC in the RSA (Table 4.3-24).

Little brown myotis use mixedwood and coniferous forests for foraging and roosting habitat (ASRD and ACA 2009, Crampton and Barclay 1998). Mixedwood and coniferous forests show a 25% decline from the PIC to the 2013 PDC prior to reclamation (Table 5.3-5), resulting in a decline in little brown myotis habitat that is high in magnitude and environmental consequence in the RSA (Table 5.3-22).

The effects of development on the movement of little brown myotis in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on little brown myotis in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-22 Residual Impact Classification for Effects on Little Brown Myotis in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.12.2 Environmental Significance Determination During Construction and Operations (Little Brown Myotis)

5.3.3.2.12.2.1 Ecological Thresholds

Net environmental consequences of the effects of change in the RSA from the PIC to the 2013 PDC are negligible for little brown myotis. The abundance of little brown myotis is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, this species is opportunistic in its selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across the range of little brown myotis. As such, it is unlikely that changes in the RSA from the PIC have contributed to a decline of this species.

The following discusses the effects of changes in the RSA to little brown myotis in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the little brown myotis population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the little brown myotis population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on little brown myotis from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.12.2.2 Resource Management Criteria

Resource management criteria stipulate that likely adverse effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because little brown myotis is a federally listed species that is adversely affected, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for little brown myotis according to resource management criteria.

5.3.3.2.13 Northern Myotis

The northern myotis is listed as “May Be at Risk” in Alberta (ASRD 2010b, internet site) and is federally listed as “Endangered” by COSEWIC (2012a, 2012b) due to the westerly spread of WNS. This disease is spreading from the east and is not yet present in Alberta, but has been detected as far west as Manitoba. If WNS continues spreading at the current rate, the entire Canadian population would likely be impacted within 11 to 22 years (COSEWIC 2012b). Prior to 2000, there were few data on the northern myotis distribution in northern Alberta. One historical record of the northern myotis was documented in the Fort McKay area in the summer of 1983 (Caceres and Pybus 1997). However, results from long-term capture and echolocation data in the Oil Sands Region suggest that this species may be more common than previously thought, particularly north of Fort McMurray (Grindal et al. 2011).

White-nose syndrome is the most important factor affecting the population trajectory of this species. Other factors that may affect populations of these species include access to winter hibernacula and summer roosting and foraging habitat. Winter hibernacula in the Alberta Oil Sands Region are only known from outside the RSA in Cadomin Cave and Wood Buffalo National Park (ASRD and ACA 2009; Barclay 2012, pers. comm.), and will not be affected by the PRM or development in the RSA. Hibernacula appear to be selected by bats for their high humidity and relatively stable, cool temperatures that are above freezing (Fenton 1970 in Kunz and Reichard 2010). Northern myotis are considered to be habitat generalists with respect to their summer roosting and foraging habitat (Kunz and Reichard 2010). They form reproductive colonies in barns, attics, tree cavities and other places that remain dark throughout the day (Crampton and Barclay 1998).

5.3.3.2.13.1 Environmental Consequences (Northern Myotis)

Northern myotis are primarily limited by WNS across their range. Prior to the arrival of WNS in Alberta, the availability of hibernacula may be limiting regional abundance of this species. However, no hibernacula are likely to occur within the RSA. Summer roosting and foraging requirements are general and therefore not likely to be limiting to the regional abundance of this species given that 80% of the RSA remains undisturbed in the 2013 PDC. Therefore, effects to abundance may be assessed qualitatively by taking into consideration the small risks of mortality due to development in the RSA, which are predicted to be limited to the effects of sensory disturbance on population abundance. Interactions with infrastructure, direct mortality due to site clearing and vehicle collisions are unlikely to affect the abundance of northern myotis. Development in the RSA is predicted to result in a decline in northern myotis abundance that is negligible in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-23).

Northern myotis use mixedwood and coniferous forests for foraging and roosting habitat (ASRD and ACA 2009; Crampton and Barclay 1998). Mixedwood and coniferous forests show a 25% decline from the PIC to the 2013 Base Case and from the PIC to the 2013 PDC prior to reclamation (Table 4.3-6), resulting in a decline in northern myotis habitat that is high in magnitude and environmental consequence in the RSA (Table 5.3-23).

The effects of development on the movement of northern myotis in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on northern myotis in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-23 Residual Impact Classification for Effects on Northern Myotis in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.13.2 Environmental Significance Determination During Construction and Operations (Northern Myotis)

5.3.3.2.13.2.1 Ecological Thresholds

The net environmental consequences of the effects of change in the RSA from the PIC to the 2013 PDC are negligible for northern myotis abundance. The abundance of northern myotis is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, the species is opportunistic in its selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across the range of northern myotis. As such, it is unlikely that changes in the RSA from the PIC have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to northern myotis in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on northern myotis populations in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the northern myotis population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on northern myotis from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.13.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because northern myotis is a federally listed species that is adversely affected, the cumulative effects of industrial development from PIC to 2013 PDC are determined to be Significant for this species according to resource management criteria.

5.3.3.2.14 Olive-Sided Flycatcher

The olive-sided flycatcher is considered “May Be At Risk” in Alberta (ASRD 2010b, internet site) and is federally listed as “Threatened” by COSEWIC (2007b) and “Schedule 1: Threatened” by SARA (Government of Canada 2013, internet site). The federal listing is a result of a widespread, consistent and continuing population decline since 1968, and up to a 79% decline was estimated for the Canadian population by 2006 (COSEWIC 2007b). An analysis of BBS data by Environment Canada (2013, internet site) suggests an average decline of 1.8% per year in Alberta between 1970 and 2011. Sauer et al. (2012, internet site) analyzed BBS data and estimated that olive-sided flycatcher populations in Alberta have declined by 2% per year from 1968 to 2011, which would result in an approximately 58% decline over that period. The ABMI (2012) reported that olive-sided flycatcher abundance was close to undisturbed reference conditions in the Boreal Plains Ecozone (i.e., 91% intactness) under existing conditions. In a more detailed analysis of habitat associations and the effects of human footprint on the species, ABMI (2012) determined that abundance of olive-sided flycatcher peaked in landscapes with approximately 40% human footprint.

The causes of widespread decline in olive-sided flycatcher populations throughout their broad North American breeding range are uncertain, although some hypotheses have been proposed. Managed forests in breeding ranges may be producing population sinks (Robertson and Hutto 2007). However, the consistent population decline across the breeding range suggests that habitat loss and alteration on their wintering range or migratory fly-way, where olive-sided flycatchers are more concentrated and vulnerable, may be responsible for these trends (COSEWIC 2007b). The widespread use of pesticides may also have contributed to the decline.

5.3.3.2.14.1 Environmental Consequences (Olive-Sided Flycatcher)

The decline in olive-sided flycatchers has been largely attributed to habitat loss and alteration on their wintering range or migratory fly-way, although habitat alteration within their breeding range may be a contributing factor. Therefore, to be conservative, population trends for olive-sided flycatcher in the RSA may be inferred from changes to habitat. Habitat suitability modelling estimates a moderate magnitude decline in high suitability habitat from the PIC to 2013 PDC prior to reclamation (Appendix 3.7, Section 1). This suggests a potential decline in olive-sided flycatcher abundance and habitat in the RSA that is moderate in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-24).

The effects of development on the movement of olive-sided flycatcher in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on olive-sided flycatcher in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-24 Residual Impact Classification for Effects on Olive-Sided Flycatcher in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	moderate (+13)
Habitat	negative	moderate (+10)	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	moderate (+13)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	moderate (+13)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.14.2 Environmental Significance Determination During Construction and Operations (Olive-Sided Flycatcher)

5.3.3.2.14.2.1 Ecological Thresholds

To be conservative, development in the RSA was assessed as having a moderate environmental consequence for effects on the abundance of olive-sided flycatcher based on changes to habitat. However, it is unlikely that development in the RSA has contributed to a decline of this species. Declines appear to be due to habitat loss and alteration within the wintering range of olive-sided flycatcher (COSEWIC 2007b). Losses of high suitability habitat (i.e., burns) are predicted to be 15% from the PIC to the 2013 PDC. The accuracy of burns in the RSA is difficult to estimate because their spatial distribution is based on a stochastic simulation by ALCES of the expected average area burned over time (Appendix 3.1, Section 2.8.2). Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Therefore, classification error may increase the likelihood that landscape changes will exceed ecological thresholds; however, given the predicted areal extent of remaining high suitability habitat in the RSA (374,311 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1), the apparent slow population decline in Alberta, and the likelihood that declines are due to habitat loss in wintering ranges rather than development in the boreal forest, it is unlikely that the olive-sided flycatcher population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to olive-sided flycatcher in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on olive-sided flycatcher are considered Adverse effects.
- Because a large amount of intact habitat remains available in the RSA, cumulative effects of development are not likely to exceed ecological thresholds such that the olive-sided flycatcher population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on olive-sided flycatcher from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.14.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because olive-sided flycatcher is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for olive-sided flycatcher according to resource management criteria.

5.3.3.2.15 Peregrine Falcon

The peregrine falcon (*anatum/tundrius* subspecies) is federally listed as “Special Concern” by COSEWIC (2009a) and is not listed by SARA (Government of Canada 2013, internet site). Provincially, the peregrine falcon is listed as “At Risk” (ASRD 2010b, internet site).

Peregrine falcons are likely migratory in the Oil Sands Region as nesting eyries have not been documented to date. Peregrine falcons were not observed during field surveys conducted for PRM and historical habitat association data from the Oil Sands Region are not available.

5.3.3.2.15.1 Environmental Consequences (Peregrine Falcon)

Peregrine falcons are likely only migratory in the RSA. Therefore, effects to abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure and vehicle collisions on population abundance, to which exposure is very limited. Combined, these factors are likely to result in a decline in peregrine falcon abundance in the RSA from the PIC to the 2013 PDC that is negligible in magnitude and environmental consequence (Table 5.3-25).

Peregrine falcons are unlikely to be sensitive to the availability of migratory (i.e., staging) habitat within the RSA, and peregrine falcon movement is unlikely to be affected by development in the RSA. Therefore, affects to peregrine falcon habitat and movement are not assessed (Table 5.3-25). The net effects of development on peregrine falcon in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

5.3.3.2.15.2 Environmental Significance Determination During Construction and Operations (Peregrine Falcon)

5.3.3.2.15.2.1 Ecological Thresholds

Environmental consequences of the effects of change in the RSA from the PIC to the 2013 PDC are negligible for peregrine falcon because the species seasonally migrates through the RSA. As such, it is unlikely that changes in the RSA from the PIC have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to peregrine falcon in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the peregrine falcon population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible because the species seasonally migrates through the RSA. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the peregrine falcon population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on peregrine falcon from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.15.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because peregrine falcon is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for peregrine falcon according to resource management criteria.

Table 5.3-25 Residual Impact Classification for Effects on Peregrine Falcon in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

n/a = not applicable.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.16 Red Knot

The red knot does not breed in Alberta; the species nests in tundra habitats near coastlines in the central Canadian Arctic (Harrington 2001, internet site). However, red knots do migrate through eastern Alberta during the last three weeks of May, typically stopping over for about a week before continuing to their northern breeding grounds. The red knot is federally listed as "Endangered" by COSEWIC (2007c) and is not listed under SARA (Government of Canada 2013, internet site). Red knots are threatened primarily by overfishing of horseshoe crabs in southern wintering grounds (COSEWIC 2007c). Provincially, the red knot is listed as "May Be At Risk" (ASRD 2010b, internet site).

5.3.3.2.16.1 Environmental Consequences (Red Knot)

No red knots were recorded during surveys conducted in the LSA and there are no historical data for this species in the Oil Sands Region. However, red knot may migrate through the Oil Sands Region and the RSA. As such, effects to abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure and vehicle collisions on population abundance, to which exposure is very limited. Combined, these factors are likely to result in a decline in red knot abundance from the PIC to the 2013 PDC that is negligible in magnitude and environmental consequence in the RSA (Table 5.3-26).

Red knot is unlikely to be sensitive to the availability of migratory (i.e., staging) habitat within the RSA, and red knot movement is unlikely to be affected by development in the RSA. Therefore, affects to red knot habitat and movement are not assessed (Table 5.3-26). The net effects of development on red knot in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

5.3.3.2.16.2 Environmental Significance Determination During Construction and Operations (Red Knot)

5.3.3.2.16.2.1 Ecological Thresholds

Environmental consequences of the effects of change in the RSA from the PIC to the 2013 PDC are negligible for red knot abundance because the species seasonally migrates through the RSA. As such, it is unlikely that changes in the RSA from the PIC have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to red knot in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the red knot population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible because the species seasonally migrates through the RSA. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the red knot population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on red knot from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

Table 5.3-26 Residual Impact Classification for Effects on Red Knot in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[(a)]			Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[(c)]	2013 Planned Development Case
Abundance	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

n/a = not applicable.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.16.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because red knot is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for red knot according to resource management criteria.

5.3.3.2.17 Rusty Blackbird

Rusty blackbirds are considered “Sensitive” provincially (ASRD 2010b, internet site). They are listed federally as “Special Concern” by COSEWIC (2006) and “Schedule 1: Special Concern” by SARA (Government of Canada 2013, internet site). Rusty blackbirds have been declining throughout their range over the last century (COSEWIC 2006; Greenberg and Droege 1999). An analysis of BBS data by Environment Canada (2013, internet site) suggests that the Canadian population has declined by an average of 6.6% per year from 1970 to 2011, and the Alberta population has declined by 2.3% over the same period (Environment Canada 2010, internet site). Sauer et al. (2012, internet site) analyzed BBS data and estimated that rusty blackbird populations in Alberta have declined by 3.3% per year from 1968 to 2011, suggesting a 76% decline during that period.

The primary cause of this decline has been attributed to habitat loss, in particular the conversion of the Mississippi Valley flood plain forests to agricultural and urban areas (Greenberg and Droege 1999). In addition, 100,000 rusty blackbirds were exterminated in the southern United States between 1974 and 1992 during bird control programs implemented to reduce populations of nuisance birds that damage crops (Avery 1995; COSEWIC 2006).

5.3.3.2.17.1 Environmental Consequences (Rusty Blackbird)

The decline in rusty blackbirds has been largely attributed to the loss of habitat within their wintering range. As such, the Alberta-wide decline that has been reported is not likely compounded by habitat change in the boreal forest, where the availability of wetlands is not likely to be limiting. However, to be conservative, population trends for rusty blackbird in the RSA may be inferred from changes to habitat. Habitat suitability modelling estimates a high magnitude decline in high suitability habitat from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in rusty blackbird abundance and habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-27).

The effects of development on the movement of rusty blackbird in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on rusty blackbird in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-27 Residual Impact Classification for Effects on Rusty Blackbird in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[(a)]			Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[(c)]	2013 Planned Development Case
Abundance	negative	moderate (+10)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)	high (+21)
Habitat	negative	moderate (+10)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)	high (+21)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)	high (+21)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.17.2 Environmental Significance Determination During Construction and Operations (Rusty Blackbird)

5.3.3.2.17.2.1 Ecological Thresholds

To be conservative, development in the RSA was assessed as having a high environmental consequence for effects on the abundance of rusty blackbird based on changes to habitat. However, it is unlikely that development in the RSA has contributed to a decline of this species. Declines appear to be due to habitat loss and alteration within the wintering range of rusty blackbird (Greenberg and Droege 1999). Losses of high suitability habitat are predicted to be 30% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for rusty blackbird in the RSA (i.e., non-treed wetlands and treed fens) are estimated to have a classification error of 40%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. In addition, classification error may have also lead to a 30% underestimation of high suitability habitat for rusty blackbird in the RSA. Therefore, although classification error may have lead to an underestimation of high suitability habitat loss, more high suitability habitat is likely present than predicted, thereby reducing the likelihood that landscape changes will exceed ecological thresholds.

Given the predicted areal extent of remaining high suitability habitat in the RSA (413,208 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1), the apparent slow population decline in Alberta, and the likelihood that declines are due to habitat loss within the wintering range rather than development in the boreal forest, it is unlikely that the rusty blackbird population in the RSA has been compromised by the cumulative effects of development to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to rusty blackbird in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on rusty blackbird are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the rusty blackbird population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on rusty blackbird from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.17.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because rusty blackbird is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for rusty blackbird according to resource management criteria.

5.3.3.2.18 Short-Eared Owl

The short-eared owl is federally listed as “Special Concern” by COSEWIC (2009a) and “Schedule 3: Special Concern” by SARA (Government of Canada 2013, internet site). In Alberta, the short-eared owl is listed as “May Be At Risk” (ASRD 2010b, internet site). An analysis of BBS data by Environment Canada (2013, internet site) suggests that the short-eared owl population in Alberta has increased at an average rate of 2.8% per year between 1970 and 2011. Sauer et al. (2012, internet site) analyzed BBS data using a hierarchical analysis (Link and Sauer 2002) and estimated that short-eared owl populations in Alberta have increased by 1% per year from 1968 to 2012. However, in both cases the confidence limits of trend estimates are wide and populations may in fact be declining. Breeding bird survey data are not designed for surveying for short-eared owls, and the accuracy of trends estimated from those data are therefore unknown.

Habitat loss due to the degradation of coastal marshes and grasslands are most likely the major threat to this species (COSEWIC 2009a). Habitat loss in central and northern Canada is believed to be negligible (COSEWIC 2009a).

5.3.3.2.18.1 Environmental Consequences (Short-Eared Owl)

As habitat loss due to the degradation of coastal marshes and grasslands are most likely the major threat to this species, and habitat loss in central and northern Canada is believed to be negligible, it is unlikely that the short-eared owl population is affected by habitat change in the RSA. However, to be conservative, development in the RSA was assessed as having a low environmental consequence for effects on short-eared owl abundance based on changes to habitat (Table 5.3-28). Habitat suitability modelling estimates a low magnitude decline in high suitability short-eared owl habitat from the PIC to the 2013 PDC (Appendix 3.7, Section 1).

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decrease in short-eared owl habitat that is low in magnitude and environmental consequence in the RSA from the PIC to the 2013 PDC (Table 5.3-28).

The effects of development on the movement of short-eared owl in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on short-eared owl in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-28 Residual Impact Classification for Effects on Short-Eared Owl in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	negligible (0)	negligible (0)	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	low (+8)
Habitat	positive/ negative	positive low (+5)	positive low (+5)	negative low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	positive low (+8)	positive low (+8)	negative low (+8)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible (0)	negligible (0)	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	low (+8)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.18.2 Environmental Significance Determination During Construction and Operations (Short-Eared Owl)

5.3.3.2.18.2.1 Ecological Thresholds

Losses of high suitability habitat are predicted to be 5% from the PIC to the 2013 PDC. Error in regional land cover classification for habitat classified as high suitability for short-eared owl in the RSA (i.e., cut blocks, burns and non-treed wetlands) is difficult to estimate because spatial distribution of cut blocks and burns is based on a stochastic simulation by ALCES of the average expected area burned and cut over time (Appendix 3.1, Section 2.8.2). Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat may be overestimated. Therefore, classification error may increase the likelihood that landscape changes will exceed ecological thresholds.

To be conservative, effects on short-eared owl abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure, vehicle collisions and sensory disturbance. Combined, these factors are likely to result in a low environmental consequence on short-eared owl abundance in the RSA from the PIC to the 2013 PDC. Given the predicted areal extent of high suitability habitat in the RSA (371,713 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1), and the fact that the decline of this species is likely due to the degradation of coastal marshes and grasslands (COSEWIC 2009a), it is unlikely that the short-eared owl population in the RSA has been compromised by the cumulative effects of development to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to short-eared owl in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the short-eared owl population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the short-eared owl population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on short-eared owl from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.18.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because short-eared owl is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for short-eared owl according to resource management criteria.

5.3.3.2.19 Western Toad

The western toad is listed as "Sensitive" in Alberta (ASRD 2010b, internet site). Federally, the western toad is listed as "Special Concern" by COSEWIC (2002b) and "Schedule 1: Special Concern" by SARA (Government of Canada 2013, internet site).

The population of western toads appears to be stable in Alberta, while declines may be occurring in southwest British Columbia (COSEWIC 2002b). The federal listing of this species is because it is the only International Union for the Conservation of Nature (IUCN) red-listed species occurring in Canada. This red-listed status exists because many populations in the United States have either declined or been extirpated, even in relatively pristine habitats, for unknown reasons (COSEWIC 2002b). Although the cause of western toad decline is not entirely clear, it appears to be related to disease rather than habitat loss (COSEWIC 2002b). Direct mortality during the stripping of overburden for mining has the potential to affect overwintering toads. Therefore, direct mortality due to soil disturbance in the RSA may result in a low magnitude reduction in the abundance of western toads.

5.3.3.2.19.1 Environmental Consequences (Western Toad)

The cause of western toad decline appears to be related to disease that is unrelated to development in the RSA, and not habitat loss. However, direct mortality during the stripping of overburden for mining has the potential to result in the mortality of overwintering toads. Therefore, direct mortality due to soil disturbance in the RSA may result in a reduction in the abundance of western toads that is low in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-29).

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decline in high suitability western toad breeding habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-29).

The effects of development on the movement of western toad in the RSA are predicted to result in a moderate environmental consequence from the PIC to the 2013 PDC. The net effects of development on western toad in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-29 Residual Impact Classification for Effects on Western Toad in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	low (+5)	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)	low (+6)
Habitat	negative	high (+15)	high (+15)	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)	high (+16)
Movement	negative	moderate (+10)	moderate (+10)	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Net Effects	negative	low (+5)	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)	low (+6)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.19.2 Environmental Significance Determination During Construction and Operations (Western Toad)

5.3.3.2.19.2.1 Ecological Thresholds

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PDC on western toad is low. Losses of high suitability habitat are predicted to be 30% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for western toad in the RSA (i.e., water, non-treed wetlands) are estimated to have a classification error of 67%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. In addition, the amount of high suitability habitat in the RSA may have been overestimated. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, the decline of western toads appears to be due to disease rather than habitat loss, and therefore it is unlikely that habitat changes in the RSA have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to western toad in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the western toad population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are low. As the western toad population appears to be limited by disease and not habitat, the cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the western toad population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on western toad from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.19.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because western toad is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for western toad according to resource management criteria.

5.3.3.2.20 Whooping Crane

Three distinct wild populations of whooping crane occur in North America (ASRD 2003); two reintroduced populations occur in Florida (one population migrating to Wisconsin to breed), and a third, natural population, breeds in Wood Buffalo National Park and winters on the Gulf Coast in Texas (ASRD 2003). The whooping crane is federally listed as “Endangered” by COSEWIC (2000) and “Schedule 1: Endangered” by SARA (Government of Canada 2013, internet site). In Alberta, the whooping crane is listed as “At Risk” (ASRD 2010b, internet site). No whooping cranes were observed incidentally in the LSA and records of whooping cranes in the Oil Sands Region generally are few. However, based on radio telemetry data, their migratory flyway between southern wintering grounds and nesting habitat in Wood Buffalo National Park traverses the Oil Sands Region in northeastern Alberta (Environment Canada 2012b).

5.3.3.2.20.1 Environmental Consequences (Whooping Crane)

Whooping cranes are migratory in the RSA, and therefore effects to abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure and vehicle collisions on population abundance, to which exposure is very limited. Combined, these factors are likely to result in a decline in whooping crane abundance from the PIC to the 2013 PDC that is negligible in magnitude and environmental consequence in the RSA (Table 5.3-30).

Whooping cranes in the Oil Sands Region breed exclusively in the northern portion of Wood Buffalo National Park in the Northwest Territories. The majority of the RSA's wetlands remain undisturbed and therefore whooping cranes are unlikely to be affected by the availability of migratory (i.e., staging) habitat within the RSA. In addition, whooping crane movement is unlikely to be affected by development in the RSA. Therefore, effects to whooping crane habitat and movement are not assessed (Table 5.3-30).

The net effects of development on whooping crane in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

5.3.3.2.20.2 Environmental Significance Determination During Construction and Operations (Whooping Crane)

5.3.3.2.20.2.1 Ecological Thresholds

Environmental consequences of the effects of change in the RSA from the PIC to the 2013 PDC are negligible for whooping crane abundance because the species seasonally migrates through the RSA. As such, it is unlikely that changes in the RSA from the PIC have contributed to the decline of this species.

The following discusses the effects of changes in the RSA to whooping crane in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the whooping crane population in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are negligible because the species seasonally migrates through the RSA. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the whooping crane population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on whooping crane from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

Table 5.3-30 Residual Impact Classification for Effects on Whooping Crane in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

n/a = not applicable.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.20.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because whooping crane is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for whooping crane according to resource management criteria.

5.3.3.2.21 Wolverine

Wolverines are year-round residents of the boreal forest in northeastern Alberta. The wolverine is federally listed as “Special Concern” (COSEWIC 2003) and is not listed by SARA (Government of Canada 2013, internet site). Provincially, the wolverine is listed as “May Be At Risk” (ASRD 2010b, internet site). Trapping of wolverine occurs in Alberta and harvest is limited by a quota system.

The range of wolverine in Alberta has declined (Peterson 1997), with an expected associated decline in population abundance. This decline may be due to loss of habitat far from human disturbance, reduction in the availability of large carrion, and trapping pressure (Peterson 1997). Trapping harvest is currently limited by a quota system in Alberta. The population of wolverines in Alberta appears to be declining, although very few studies have been conducted and population estimates have been based mainly on historical trapping information, which is generally not a reliable method of population estimation (Petersen 1997). In Alberta, this species has been reduced to the northern portion of the province and areas along the mountains and foothills (Petersen 1997). Wolverines are uncommon carnivores in the Oil Sands Region with large home ranges (1,450 km^2 and 525 km^2 for males and females, respectively [Magoun et al. 2005]). Movement corridors and habitat connectivity in the regional landscape are likely important to the species.

5.3.3.2.21.1 Environmental Consequences (Wolverine)

Reliable data are not available for historical population trends of wolverine in the RSA. However, due to the sensitivity of wolverine populations to the availability of suitable habitat and the effects of increased access on trapper harvest, it is likely that the effects of landscape change in the RSA have resulted in a population decline. To be conservative, regional population trends for wolverine may be inferred from changes to habitat. Landscape changes in the RSA have resulted in a high magnitude decline in high suitability wolverine habitat from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in wolverine abundance and habitat that is high in magnitude and environmental consequence from the PIC to the 2013 PDC in the RSA (Table 5.3-31).

The effects of development on the movement of wolverine in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 PDC (Table 5.3-31). The net effects of development on wolverine in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

Table 5.3-31 Residual Impact Classification for Effects on Wolverine in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Habitat	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Net Effects	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

5.3.3.2.21.2 Environmental Significance Determination During Construction and Operations (Wolverine)

5.3.3.2.21.2.1 Ecological Thresholds

Due to the sensitivity of wolverine populations to the availability of suitable habitat and the effects of increased access on trapper harvest, it is likely that the effects of landscape change in the RSA may have contributed incrementally to a population decline. The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PDC on wolverine is high. Losses of high suitability habitat are predicted to be 28% from the PIC to the 2013 PDC. Regional land cover classification error does not affect predictions of high suitability wolverine habitat in the RSA because wolverines readily use all available habitats. The wolverine habitat suitability model is a core security model and is based on distance to disturbance (*May 2011, Submission of Information to the Joint Review Panel*, Appendix B). Nonetheless, error is inherent in all models, and effects to high suitability wolverine habitat may have been underestimated.

Given the predicted areal extent of remaining high suitability habitat in the RSA (1,626,478 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1) and that wolverine harvest is governed by quotas, it is unlikely that the wolverine population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to wolverine in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the wolverine population in the RSA are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the wolverine population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on wolverine from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.21.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, due to the high magnitude effects to the abundance of this federally listed species, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for wolverine according to resource management criteria.

5.3.3.2.22 Wood Bison

The wood bison is listed federally as “Threatened” by COSEWIC and “Schedule 1: Threatened” by SARA (Government of Canada 2013, internet site). Wood bison are listed as “At Risk” in Alberta (ASRD 2010b, internet site).

Wood bison are protected in Wood Buffalo National Park located in northeast Alberta and within a special wildlife management area in northwest Alberta. Otherwise, wood bison occurring on provincial lands outside of the designated management area, including wood bison in the RSA, are not protected by legislation unless they are owned as livestock. Wood bison in and around Wood Buffalo National Park are infected by the cattle diseases bovine tuberculosis and bovine brucellosis, as well as anthrax (Mitchell and Gates 2002). These diseases are believed to be the primary limitation on the range of wood bison (Mitchell and Gates 2002). The Ronald Lake wood bison herd is the only herd that occurs in the RSA, and it is currently presumed to be infected (Government of Alberta 2013). An examination of telemetry collar data shows that the home range of the Ronald Lake herd overlaps with Wood Buffalo National Park (Government of Alberta 2013), and therefore bison of the Ronald Lake herd may interact with diseased bison that occur in and around the park. However, as a result of tissue and blood tests in 2012 and 2013, the rate of disease in the Ronald Lake herd is predicted to be between 0% and 12% for tuberculosis and brucellosis (Government of Alberta 2013). Therefore, the herd appears to be infected at a rate that is lower than the sampling strategy was capable of detecting, and lower than the 30% to 50% rate of disease present in herds in and around Wood Buffalo National Park (Government of Alberta 2013).

Bison hunting is allowed outside of the protected areas to reduce the transmission of the diseases to the uninfected Hay-Zama herd within the special wildlife management area. The LSA falls outside the boundaries of the protected areas mentioned above. As such, the Ronald Lake herd is subject to unregulated hunting. Harvest pressure is associated with winter access across the Athabasca River by ice bridge (Powell and Morgan 2010). However, even with unregulated hunting associated with increased access developed for timber harvest and winter drilling programs that have occurred over the last six years and the potential for disease, there is no evidence that the Ronald Lake bison herd is decreasing, and it may be increasing (Government of Alberta 2013).

Historical wood bison range occurs throughout the regional study area (Roe 1951). Bison require early seral vegetation and strongly select for meadow and willow grassland habitats for foraging (Lartner and Gates 1991). The Richardson fire and vegetation clearing for oil and gas exploration, pipeline and transmission line rights-of-way, and forest harvest are likely to increase suitable foraging habitat for bison through the creation of early seral vegetation. In the 2013 PDC, soil disturbances due to industrial development take up only 14% of the RSA. Based on habitat suitability modelling in the regional study area, 58% (160,148 ha) of high suitability habitat for bison present in the PIC is still present in the 2013 PDC. Much of this habitat is currently not utilized by the Ronald Lake herd.

5.3.3.2.22.1 Environmental Consequences (Wood Bison)

The wood bison population in the RSA is unlikely to be limited by the availability of habitat, but rather by the effects of unregulated hunting, predation and disease (e.g., bovine tuberculosis, bovine brucellosis, anthrax). As a result of PRM, bison are likely to be displaced to alternate suitable habitat outside of the PRM footprint, where road access outside of the LSA but associated with PRM, combined with unregulated hunting, could have a detrimental effect on the herd. Although risks of interactions with infrastructure, mortality due to clearing, vehicle collisions and sensory disturbance are unlikely to have a greater than negligible effect on the population, increased access could potentially result in a decline in wood bison abundance. However, increases in existing access due to the presence of an ice bridge across the Athabasca River in winter and Teck Resources Limited's Frontier Oil Sands Mine Project winter drilling programs do not seem to have resulted in a decline in the Ronald Lake herd (Government of Alberta 2013). As a result of the potential effects of increased access to the PRM area after construction of the Athabasca River bridge, the access road to PRM will have access restrictions limiting traffic to project personnel. When implemented properly, restricting access has been proven to be an effective way to dramatically reduce incidents of hunting mortality (e.g., Crichton et al. 2004). Restricting access to project personnel along with a prohibition of firearms should effectively reduce the potential for increased hunting mortality on the Ronald Lake herd. After mitigation, the magnitude and environmental consequence of development in the RSA on wood bison abundance are predicted to be negligible from the PIC to the 2013 Base Case (Table 5.3-32). From the PIC to the 2013 PDC, the magnitude and environmental consequence of development in the RSA on wood bison abundance are predicted to be low, as increased access due PRM and other planned developments could potentially result in a decline in wood bison abundance due to unregulated hunting.

Habitat suitability modelling (Appendix 3.7, Section 1.3) predicts a decline in high suitability wood bison habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-32).

The effects of development on the movement of wood bison in the RSA are predicted to result in a high environmental consequence from the PIC to the 2013 PDC. The net effects of development on wood bison in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

5.3.3.2.22.2 Environmental Significance Determination During Construction and Operations (Wood Bison)

5.3.3.2.22.2.1 Ecological Thresholds

Wood bison in the RSA are not protected from unregulated harvest. Increased access outside the PRM footprint but constructed for PRM could result in increases to the unregulated hunting to which the Ronald Lake Herd is currently subjected. However, recent increases in access do not appear to have resulted in a decline in the size of the herd and access control will minimize the potential adverse effects of increased hunting due to increased access in the 2013 PDC. Wood bison are likely limited by disease, predation and unregulated hunting rather than habitat loss, and therefore it is unlikely that habitat loss in the RSA from the PIC have contributed to the decline of this species.

The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PDC on wood bison is low. Losses of high suitability habitat are predicted to be 42% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for wood bison in the RSA (i.e., non-treed wetland) are estimated to have a classification error of 75%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Classification error has lead to an overestimation of high suitability habitat for wood bison in the RSA, indicating that less high quality wood bison habitat is present in the RSA than was predicted by the habitat model. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (160,148 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1) and the fact that there is no evidence that the Ronald Lake bison herd is decreasing, it is unlikely that the wood bison population in the RSA has been compromised to the point that it is no longer self-sustaining and ecologically effective.

Table 5.3-32 Residual Impact Classification for Effects on Wood Bison in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[(a)]			Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[(c)]	2013 Planned Development Case
Abundance	negative	negligible (0)	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	low (+7)	low (+7)
Habitat	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Net Effects	negative	negligible (0)	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	low (+7)	low (+7)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

The following discusses the effects of changes in the RSA to wood bison in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on wood bison populations in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects are low. The wood bison population in the RSA are likely limited by disease, predation and unregulated hunting, rather than habitat loss, and there is no evidence that the Ronald Lake bison herd is decreasing, despite winter access to the herd by hunters. Therefore, the cumulative effects of development in the RSA after mitigation are not likely to exceed ecological thresholds such that the wood bison population would no longer be self-sustaining and ecologically effective. Therefore, these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on wood bison from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.22.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because wood bison is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for wood bison according to resource management criteria.

5.3.3.2.23 Woodland Caribou

Woodland caribou are listed federally as “Threatened” by COSEWIC and “Schedule 1: Threatened” by SARA (Government of Canada 2013, internet site). In Alberta, woodland caribou are listed as “At Risk” (ASRD 2010b, internet site). Woodland caribou are one of Canada’s most widely distributed large mammals (Government of Canada 2013a, internet site).

Woodland caribou are virtually absent from the LSA, which is located outside designated caribou areas. However, the Red Earth, Richardson and West Side of the Athabasca River (WSAR) woodland caribou ranges occur partially within the RSA. The annual population growth rate (i.e., lambda) for adult female caribou in the Red Earth and WSAR populations was last estimated in the winter of 2008 to 2009 to be 0.84 and 0.78, respectively, while the population trend in the Richardson range is unknown (ASRD and ACA 2010). Lambda values of less than one indicate that the woodland caribou populations in the RSA are in a state of decline. The Alberta populations have been estimated to be 170 to 206 for the Red Earth range, 204 to 272 for the WSAR range, and 150 for the Richardson range (Environment Canada 2012). It was recently estimated that the Red Earth population was likely to decline to less than 10 animals in about 25 years, the Richardson population in about 60 years, and the WSAR population in about 70 years given the current population size and rate of decline (Schneider et al. 2010). This outcome is predicted whether or not further development occurs in the RSA. This decline appears to be due to predation by wolves, which have increased in abundance due to increases in populations of white-tailed deer (Latham et al. 2011). White tailed deer appear to have increased in abundance due to the creation of early seral habitat as a result of large-scale deforestation (Latham et al. 2011).

5.3.3.2.23.1 Environmental Consequences (Woodland Caribou)

Woodland caribou populations appear to be declining to extirpation in the RSA due to the indirect effects of industrial development. This suggests a decline in woodland caribou abundance in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 PDC.

The environmental consequences of changes to high suitability woodland caribou habitat are assessed prior to reclamation from the PIC to the 2013 PDC using output from habitat suitability models and ecological context based on available data and peer-reviewed literature to help determine effect magnitude (Appendix 3.7, Section 1.3). The environmental consequences of effects to woodland caribou habitat from the PIC to the 2013 PDC are negative and high (Table 5.3-33). The majority (i.e., 93%) of effects to woodland caribou habitat from the PIC to the 2013 PDC are due to disturbances that are present in the 2013 Base Case. As a result, the environmental consequences of effects to high suitability habitat from the PIC to the 2013 PDC are the same as those from the PIC to the 2013 Base Case.

The effects to wildlife movement are assessed in part through a linkage zone analysis of the RSA, which shows a high magnitude increase from the PIC to the 2013 PDC for moose (Appendix 3.7, Section 4.0). Other wide-ranging terrestrial wildlife species like woodland caribou are expected to experience similar effects to movement. The environmental consequence of effects to woodland caribou movement from the PIC to the 2013 PDC are high (Table 5.3-33). The majority of effects to habitat from the PIC to the 2013 PDC are due to disturbances that are present in the 2013 Base Case. As a result, the environmental consequences of effects to movement from the PIC to the 2013 PDC are the same as those from the PIC to the 2013 Base Case.

The net effects to the woodland caribou population in the RSA from the PIC to the 2013 PDC are equivalent to the overall effects of development on abundance. The apparent decline of woodland caribou to extirpation in the RSA due to the indirect effects of industrial development suggests a high magnitude net effect to woodland caribou in the RSA from the PIC to the 2013 PDC (Table 5.3-33).

5.3.3.2.23.2 Environmental Significance Determination During Construction and Operations (Woodland Caribou)

5.3.3.2.23.2.1 Ecological Thresholds

Woodland caribou are virtually absent from the LSA, which is located outside designated caribou areas. However, the Red Earth, Richardson and West Side of the Athabasca River (WSAR) woodland caribou ranges occur in the RSA, and appear to be declining to extirpation. This decline appears to be due to the indirect effects of industrial development on predator-prey dynamics. The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 PDC on woodland caribou is high. The majority of these effects occur between the PIC and the 2013 Base Case. For example, over 93% of the high suitability woodland caribou habitat that is predicted to be lost from the PIC to the 2013 PDC was already lost from the PIC to the 2013 Base Case (Appendix 3.7, Section 1.3). Losses of high suitability habitat are predicted to be 53% from the PIC to the 2013 PDC. Model validation was conducted for the woodland caribou HSI model, and the model was determined to effectively distinguish between high, moderate and low suitability habitat (EIA, Volume 5, Appendix 5-4, Section 1.2.4). Nonetheless, the amount of high suitability habitat lost may be underestimated, although the magnitude of effects is already classified as high.

Table 5.3-33 Residual Impact Classification for Effects on Woodland Caribou in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[(a)]			Geographic Extent	Duration	Reversibility[(b)]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[(c)]	2013 Planned Development Case
Abundance	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+23)	high (+23)	high (+23)
Habitat	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+20)	high (+20)	high (+20)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Net Effects	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+23)	high (+23)	high (+23)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

The following discusses the effects of changes in the RSA to woodland caribou in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on the woodland caribou populations in the RSA are considered Adverse effects.
- Available data suggest that woodland caribou herds that occur in the RSA are declining to extirpation due to the indirect effects of industrial development in the 2013 Base Case. Therefore, cumulative effects of development in the RSA appear to have exceeded ecological thresholds such that the woodland caribou population is no longer self-sustaining and ecologically effective. Therefore these are considered Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on woodland caribou from the PIC to the 2013 PDC are considered Likely, Adverse and Significant.

5.3.3.2.23.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA, Therefore, because woodland caribou is federally listed and effects are high in magnitude, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant according to resource management criteria for woodland caribou.

5.3.3.2.24 Yellow Rail

Yellow rails are listed federally as a species of 'Special Concern' by COSEWIC (2009c) and are listed on Schedule 1 of SARA as 'Special Concern' (Government of Canada 2013, internet site). In Alberta, this bird has "Undetermined" status because information on population size and trends is lacking (ASRD 2010b, internet site).

Yellow rail population size and trends are relatively unknown because standardized bird survey methods are not effective at sampling for this species (COSEWIC 2009c). However, a compilation of available information suggests that this species may have declined in the last 10 years (COSEWIC 2009c). The loss and degradation of habitat, especially on southern wintering grounds, is believed to be the primary threat to yellow rails (COSEWIC 2009c).

5.3.3.2.24.1 Environmental Consequences (Yellow Rail)

The decline in yellow rails has been largely attributed to the loss of habitat within their wintering range. As such, yellow rail abundance is unlikely to be affected by habitat change in the RSA, where the availability of wetlands is not likely to be limiting. However, to be conservative, population trends for yellow rail in the RSA may be inferred from changes to habitat. Habitat suitability modelling estimates a high magnitude decline in high suitability habitat from the PIC to the 2013 PDC prior to reclamation (Appendix 3.7, Section 1). This suggests a decline in yellow rail abundance and habitat in the RSA that is high in magnitude and environmental consequence from the PIC to the 2013 PDC (Table 5.3-34).

Table 5.3-34 Residual Impact Classification for Effects on Yellow Rail in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case	2013 PRM Application Case[c]	2013 Planned Development Case
Abundance	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+21)	high (+21)	high (+21)
Habitat	negative	moderate (+10)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)	high (+21)	high (+21)
Movement	negative	negligible (0)	negligible (0)	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+21)	high (+21)	high (+21)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as "reversible/irreversible".

(c) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

The effects of development on the movement of yellow rail in the RSA are predicted to result in a negligible environmental consequence from the PIC to the 2013 PDC. The net effects of development on yellow rail in the RSA are equivalent to effects to abundance, for which predictions consider the overall influence of cumulative effects on population trajectories.

5.3.3.2.24.2 Environmental Significance Determination During Construction and Operations (Yellow Rail)

5.3.3.2.24.2.1 Ecological Thresholds

To be conservative, development in the RSA was assessed as having a high environmental consequence for effects on the abundance of yellow rail based on changes to habitat from the PIC to the 2013 PDC. However, it is unlikely that development in the RSA has contributed to a decline of this species. Declines appear to be due to habitat loss and alteration within the wintering range of yellow rail (COSEWIC 2009c). Losses of high suitability habitat are predicted to be 29% from the PIC to the 2013 PDC. Regional land cover classification data for habitat classified as high suitability for yellow rail in the RSA (i.e., non-treed wetlands) are estimated to have a classification error of 75%. Depending on the spatial distribution of land cover classification errors, the amount of high suitability habitat lost may be underestimated. Classification error has lead to an overestimation of high suitability habitat for yellow rail in the RSA, indicating that more high quality yellow rail habitat is present in the RSA than was predicted by the habitat model. Therefore, classification error may have led to an underestimation of high suitability habitat loss and an overestimation of habitat availability, increasing the likelihood that landscape changes will exceed ecological thresholds. However, given the predicted areal extent of remaining high suitability habitat in the RSA (196,575 ha in the 2013 PDC, Appendix 3.7, Table 1.3-1), and that apparent population declines appear to be due to habitat loss and alteration within the wintering range, it is unlikely that the yellow rail population in the RSA has been compromised by the cumulative effects of development to the point that it is no longer self-sustaining and ecologically effective.

The following discusses the effects of changes in the RSA to yellow rail in terms of adverse, significant and likely effects from the PIC to the 2013 PDC:

- Effects on yellow rail are considered Adverse effects.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds such that the yellow rail population would no longer be self-sustaining and ecologically effective. Therefore these are considered Not Significant effects.
- The predicted effects are considered Likely.

Therefore, the effects on yellow rail from the PIC to the 2013 PDC are considered Likely, Adverse, but Not Significant.

5.3.3.2.24.2.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). In addition, effects are determined to be Significant for all federally listed wildlife that are adversely affected by industrial development in the RSA. Therefore, because yellow rail is a federally listed species that is adversely affected, the cumulative effects of industrial development from the PIC to the 2013 PDC are determined to be Significant for yellow rail according to resource management criteria.

5.3.3.3 Effects After Reclamation

The environmental consequences associated with development on wildlife and their significance for the 2013 PDC after reclamation in the RSA are difficult to identify because reclamation plans for all developments in the 2013 PDC are not available. Therefore, the composition of the RSA landscape after reclamation is not known in any definitive manner. However, an approximation of what the 2013 PDC landscape in the RSA might look like after reclamation and the resulting effects on KIRs can be estimated by extrapolating the results of reclamation of the LSA to a regional scale, assuming that the generalized changes in the LSA are representative of what will also occur across the RSA.

Effects to wildlife after reclamation of the 2013 PDC are similar to those after reclamation of the 2013 Base Case and 2013 PRM Application Case, which are discussed in detail in Section 4.3.3.27.

5.3.4 Biodiversity Assessment

The effects of planned developments on biodiversity were previously assessed in the EIA (Volume 5, Section 7.6.4).

A biodiversity assessment is provided to explicitly tie together the interacting effects of PRM and other existing and planned developments on fish, vegetation and wildlife at the species, ecosystem, and landscape levels of biodiversity. This assessment places an emphasis on the ecosystem- and landscape-levels.

The 2013 PDC assessment is completed for those components that had a negative low, moderate or high environmental consequence in the PIC to the 2013 PRM Application Case assessment after reclamation (Section 4.3.4.4). A greater than negligible negative environmental consequence was predicted for all levels of biodiversity (Table 4.3-41). Biodiversity is assessed using the same assessment methods described in the EIA, Volume 5, Section 7.6.4, where appropriate. Any notable deviations from the EIA assessment methods are described in Appendix 3.1, Section 2.8.

5.3.4.1 Assessment Results

5.3.4.1.1 Species-Level Biodiversity Impact Analysis

The species-level biodiversity effects of the 2013 PDC relative to the PIC are addressed in Sections 5.3.2 and 5.3.3 of this appendix for vegetation and wildlife, respectively. As previously stated, suitable PIC data for fish population sizes are not available and the sampling techniques from historic studies are not comparable to current studies. Therefore, a fish and fish habitat assessment was not possible for the PIC (Section 2.3.4). In addition, the 2013 PDC is predicted to have no environmental consequences on fish and fish habitat relative to 2013 Base Case conditions (Section 3.3.5). As such, these KIRs are not considered in the species-level biodiversity impact analysis. Potential species-level effects to vegetation and wildlife resources are summarized as follows:

- In the Far Future, high rare plant potential is predicted to experience a negative residual impact with moderate environmental consequence for the 2013 PDC (Table 5.3-10).
- During construction and operations, the predicted residual impacts on abundance, habitat and movement in the 2013 PDC are negative in direction for all wildlife KIRs, with the majority of environmental consequences predicted to be moderate or high for residual impacts to abundance and habitat (Tables 5.3-11 to 5.3-34). The environmental consequences predicted for residual impacts to wildlife

movement are also negative in direction for all KIRs, but range from negligible (volant KIRs) to high (more vagile terrestrial KIRs) (Tables 5.3-11 to 5.3-34). The environmental consequences of the residual impacts to wildlife KIRs are quantitatively assessed during construction and operations only and assume that all disturbances occur simultaneously. Therefore, the predicted effects of the 2013 PDC represent worst-case scenarios (Section 5.3.3).

5.3.4.1.2 Ecosystem-Level Biodiversity Impact Analysis

Effects of the 2013 PDC on RLCCs in the RSA relative to the PIC are presented according to biodiversity potential in Figure 5.3-1 and Table 5.3-35 and are summarized as follows according to rank:

- During construction and operations, high biodiversity potential areas will decrease by 118,017 ha (22%). Non-treed wetlands and treed fen RLCCs will decrease by 19% and 24%, respectively. In the Far Future, an overall net decrease in high biodiversity potential areas of 55,073 ha (10%) will occur due to the treed fen RLCC experiencing a negative net change (Figure 5.3-1). The non-treed wetlands RLCC increases due to the addition of reclamation types such as shrubland and littoral zone to the landscape.

- Moderate biodiversity potential areas will decrease by 179,011 ha (21%) during construction and operations. All terrestrial RLCCs are affected by at least 25% compared to the amount present at the PIC. In the Far Future, moderate biodiversity potential areas will decrease by 28,038 ha (3%) (Figure 5.3-1). Treed bog/poor fen and mixedwood aspen−white spruce are the only moderate-ranked RLCCs that will experience a net decrease after reclamation relative to the PIC in the 2013 PDC. The greatest loss in area occurs to treed bog/poor fen. This RLCC is composed of peatland land cover types, which cannot be reclaimed with current technologies.

- During construction and operations, low biodiversity potential areas will decrease by 50,412 ha (6%). Each RLCC will experience a decrease in area compared to PIC conditions, with the exception of cutblock. A net increase of 83,830 ha (9%) will occur to low-ranked areas in the Far Future (Figure 5.3-1). Cutblocks comprise the majority of this increase, followed by disturbance. Coniferous jack pine−black spruce is the only natural RLCC that increases in the Far Future relative to the PIC.

Figure 5.3-1 Change in Biodiversity Potential in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case: Far Future

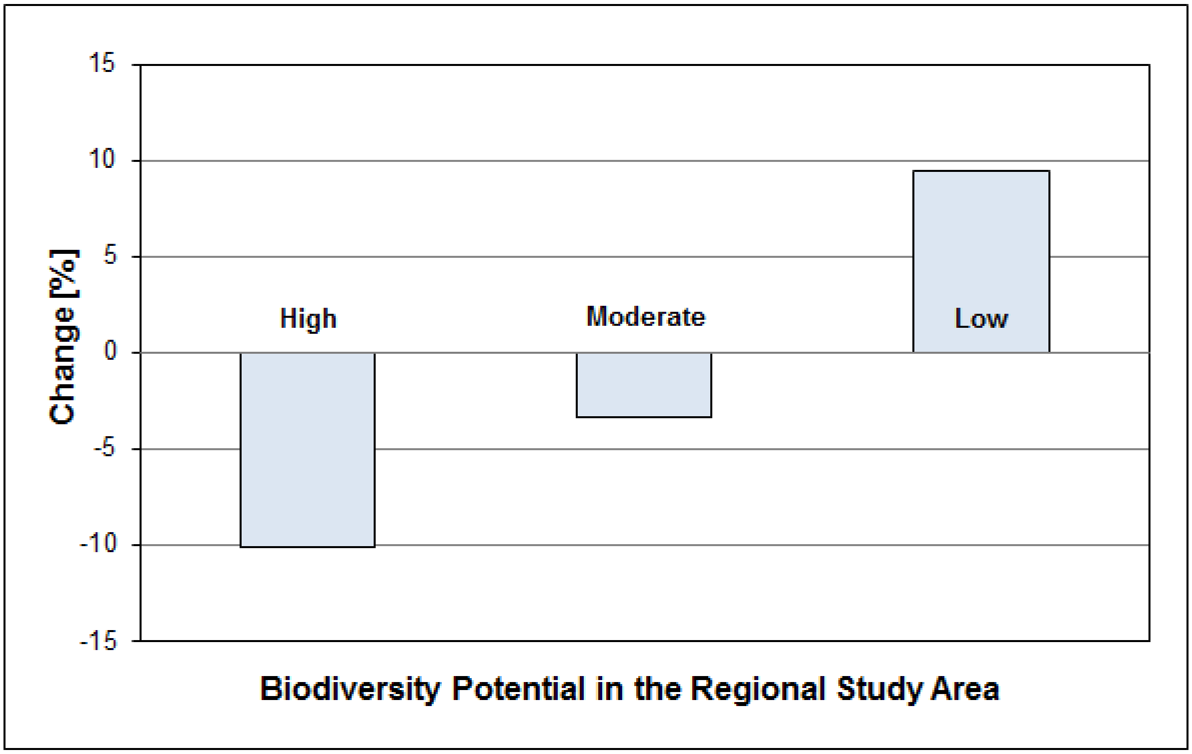

Table 5.3-35 Change in Biodiversity Potential in the Regional Study Area – Pre-Industrial Case to 2013 Planned Development Case

Regional Land Cover Class	Pre-Industrial Case	Loss/Alteration due to 2013 Base Case[a]		Loss/Alteration due to 2013 PRM Application Case		Loss/Alteration due to 2013 Planned Development Case		Far Future	Net Change due to 2013 Planned Development Case[b]	
	Area [ha]	Area [ha]	% of Resource[c]	Area [ha]	% of Resource[c]	Area [ha]	% of Resource[c]	Area [ha]	Area [ha]	% of Resource[c]
High Biodiversity Potential										
non-treed wetlands	275,397	-34,288	-12	-36,806	-13	-53,435	-19	279,441	4,044	1
treed fen	268,124	-37,755	-14	-42,769	-16	-64,582	-24	209,007	-59,117	-22
subtotal	*543,521*	*-72,042*	*-13*	*-79,575*	*-15*	*-118,017*	*-22*	*488,448*	*-55,073*	*-10*
Moderate Biodiversity Potential										
coniferous white spruce	69,421	-17,035	-25	-17,657	-25	-22,189	-32	90,385	20,964	30
mixedwood aspen−jack pine	49,528	-10,496	-21	-10,496	-21	-12,837	-26	59,510	9,982	20
mixedwood aspen−white spruce	197,394	-52,635	-27	-54,278	-27	-68,692	-35	186,820	-10,574	-5
treed bog/poor fen	471,749	-47,894	-10	-50,274	-11	-72,647	-15	403,524	-68,225	-14
water	54,040	-1,514	-3	-1,559	-3	-2,646	-5	73,854	19,815	37
subtotal	*842,132*	*-129,573*	*-15*	*-134,263*	*-16*	*-179,011*	*-21*	*814,094*	*-28,038*	*-3*
Low Biodiversity Potential										
burn	420,169	-24,044	-6	-24,470	-6	-33,279	-8	388,070	-32,098	-8
coniferous jack pine	191,070	-24,738	-13	-25,086	-13	-29,881	-16	179,186	-11,884	-6
coniferous jack pine−black spruce	44,624	-4,570	-10	-4,570	-10	-6,191	-14	64,100	19,475	44
cutblock	65	100,095	154,890	100,095	154,890	99,047	153,269	99,620	99,555	154,055
deciduous aspen−balsam poplar	233,520	-55,454	-24	-55,960	-24	-78,760	-34	232,463	-1,057	-<1
disturbance	1,557	-1,249	-80	-1,249	-80	-1,349	-87	11,396	9,839	632
subtotal	*891,004*	*-9,959*	*-1*	*-11,240*	*-1*	*-50,412*	*-6*	*974,834*	*83,830*	*9*
Not Ranked										
cloud[d]	719	-719	-100	-719	-100	-719	-100	0	-719	-100
Total	**2,277,376**	**-212,293**	**-9**	**-225,797**	**-10**	**-348,159**	**-15**	**2,277,376**	**n/a**	**n/a**

(a) Loss/alteration due to the 2013 Base Case is provided for comparative purposes.

(b) Net change is calculated as the difference between the Pre-Industrial Case and the 2013 Planned Development Case Far Future, a value upon which the environmental consequence after reclamation is assessed.

(c) This column is calculated as a percentage of Pre-Industrial Case area; the areas are not additive.

(d) Clouds on the Landsat image prevent interpretation of regional land cover class in some areas for Pre-Industrial Case; therefore, 1% of the RSA could not be ranked according to biodiversity potential.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.

5.3.4.1.3 Landscape-Level Biodiversity Impact Analysis

Results at the landscape-level of biodiversity for the 2013 PDC relative to the PIC are summarized as follows:

- In the Far Future, wetlands (including peatlands and patterned fens) are predicted to experience a negative residual impact with moderate environmental consequence in the 2013 PDC (Table 5.3-10).
- Old growth forests are predicted to experience a negative residual impact with high environmental consequence in the Far Future (Table 5.3-10).

5.3.4.2 Residual Impact Classification During Construction and Operations

The residual impacts to biodiversity in the RSA during construction and operations, from the PIC to the 2013 PDC, are presented in Table 5.3-36. The biodiversity species-level residual impact classification draws directly upon the Terrestrial Vegetation, Wetlands and Forest Resources and Wildlife and Wildlife Habitat residual impacts (Sections 5.3.2.2 and 5.3.3.2). The ecosystem- and landscape-level residual impact classifications are based on the changes presented in Sections 5.3.4.1.2 and 5.3.4.1.3 of the Biodiversity Assessment, respectively. For comparative purposes, the magnitude and overall environmental consequence of residual impacts to biodiversity from the 2013 Base Case and 2013 PRM Application Case, as found in Table 4.3-40, are also shown in Table 5.3-36.

From the PIC to construction and operations of the 2013 PDC, high rare plant potential is predicted to decrease by 22% compared to the PIC (Table 5.3-8). Therefore, the residual impact is high in magnitude. More than half of this loss in high rare plant potential occurs as a result of the 2013 Base Case. For wildlife KIRs, the magnitude of residual impacts due to construction and operations of the 2013 PDC ranges from negligible to high, with most impacts predicted to be high magnitude. As such, the overall magnitude of the residual impact at the species-level of biodiversity is considered to be high. Most species-level residual impacts are considered beyond regional in geographic extent and reversible. All residual impacts were considered to be long-term for vegetation and wildlife KIRs and were predicted to occur with high frequency.

The overall magnitude of the residual impact of construction and operations of the 2013 PDC on ecosystem-level biodiversity is considered high because the changes in high and moderate biodiversity potential areas are both greater than 20% relative to the PIC (Table 5.3-35). The residual impact is considered to be regional, because the scale of assessment is the RSA. The losses in high biodiversity potential areas occur to both the treed fen and non-treed wetlands RLCCs. Although the peatlands (i.e., fens, bogs) that constitute the majority of the treed fen RLCC cannot be reclaimed with current technologies if the soil has been disturbed (e.g., open-pit mines), non-treed wetlands can be reclaimed. Non-treed wetlands include wetlands types such as marsh (MONG), shrubland (Sh) and shrubby swamp (SONS), which are a consistent component of reclamation plans. For this reason, the overall residual impact was scored as partially irreversible. The residual impact is also considered to be long-term in duration and occur with high frequency.

At the landscape level of biodiversity, the negative residual impacts of construction and operations of the 2013 PDC are considered to be of moderate magnitude for wetlands (including peatlands) and high magnitude for old growth forests because losses to these resources are predicted to decrease by 19% and 24%, respectively, compared to PIC conditions (Tables 5.3-6 and 5.3-7). Residual impacts on these KIRs are also considered to be regional in geographic extent, long-term in duration, partially irreversible and high in frequency.

Table 5.3-36 Residual Impact Classification for Biodiversity in the Regional Study Area – 2013 Base Case, 2013 PRM Application Case and 2013 Planned Development Case – Pre-Industrial Case During Construction and Operations

Biodiversity Criteria	Direction	Magnitude			Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case[(a)]	2013 PRM Application Case[(a)(b)]	2013 Planned Development Case
species-level effects	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
ecosystem-level effects	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)	moderate (+15)	high (+20)
landscape-level effects	negative	moderate (+10)	moderate (+10)	moderate to high (+10 to +15)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)	moderate (+15)	moderate to high (+15 to +20)

(a) These values from the 2013 Base Case and 2013 PRM Application Case are provided for comparative purposes only; individual criterion scores for geographic extent, duration, reversibility and frequency reflect the 2013 Planned Development Case.

(b) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Overall, negative high environmental consequences are predicted for the species- and ecosystem-levels of biodiversity during construction and operations of the 2013 PDC. At the landscape-level, a negative moderate to high environmental consequence is predicted. The results differ from what was predicted for effects from both the 2013 PRM Application Case and the 2013 Base Case for all levels of biodiversity. Environmental consequences during construction and operations of the 2013 PDC increase from the 2013 PRM Application Case and 2013 Base Case (Table 5.3-36) because the magnitude of the residual impacts is greater when additional planned developments are considered.

5.3.4.3 Environmental Significance Determination During Construction and Operations

From the PIC to construction and operations of the 2013 PDC, effects at all levels of biodiversity are ranked as having a negative, moderate or high environmental consequence. Assessment methods for the determination of significance are discussed in Appendix 3.1, Section 2.8.3.

5.3.4.3.1 Ecological Thresholds

The following summarizes the changes to species-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PDC:

- The cumulative effects to species-level biodiversity are considered Adverse effects due to losses of vegetation and wildlife resources.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds and compromise resilience and adaptability of most plant and wildlife populations in the RSA such that their populations would no longer be self-sustaining and ecologically effective. However, development in the RSA is likely to have exceeded ecological thresholds for three wildlife species (i.e., black-throated green warbler, Canada warbler, and woodland caribou; Section 5.3.3.2).
- The predicted effects are considered Likely.

Therefore, cumulative effects to biodiversity at the species level from the PIC to the 2013 PDC are not predicted to have exceeded ecological thresholds for the majority of species, but Likely, Significant, and Adverse environmental effects have been identified for some species.

The potential for permanent change in ecosystem function as a consequence of regional development exists given the increased level of disturbance since the PIC. A biodiversity management framework for the Lower Athabasca Region that will define ecological effect thresholds is currently not available. Of the high biodiversity potential areas present in the PIC, 78% (425,504 ha; Table 5.3-35, Section 5.3.4.1.2) is estimated to remain intact during construction and operations of the 2013 PDC. This level of change is not expected to cause the ecosystem as a whole to enter an alternate stable state. Some components of the ecosystem, such as the large mammal predator-prey community, clearly have changed and the significance of these changes for individual species such as caribou is addressed at the species level (Section 5.3.3.17).

The conclusions about the significance of effects to biodiversity at the ecosystem level are associated with some uncertainty. Although some components of the ecosystem such as the large mammal community have been well studied, many ecological interactions at the ecosystem level have not been extensively studied in northeastern Alberta. Moreover, model error contributes to uncertainty. High biodiversity potential areas identified in the RSA (i.e., non-treed wetlands and treed fen RLCCs) have a classification accuracy estimated to be 40%. Because of the uncertainty in the spatial distribution of high biodiversity potential areas, losses may have been underestimated if developments more frequently affected these areas than was predicted by the model. However, the amount of high biodiversity areas in the RSA may have been underestimated because the direction of the error meant that many areas classified as low or moderate biodiversity potential actually consisted of high biodiversity potential. Therefore, although classification error may have led to an underestimation of the loss of high biodiversity potential areas in some places, there is likely more high biodiversity potential area in the RSA than predicted, which means the model was conservative and more likely to predict that ecological thresholds were exceeded based on aerial extent of high biodiversity potential areas remaining after disturbance. The following discusses the change to ecosystem-level biodiversity in terms of Adverse, Significant and Likely impacts from the PIC to the 2013 PDC:

- The cumulative effects to ecosystem-level biodiversity are considered Adverse effects because high and moderate biodiversity potential categories experience losses in areal extent.
- An ecological threshold has likely not been exceeded for biodiversity potential in the RSA given the areal extent of the resource remaining and the general intactness of ecological communities in the RSA. Therefore, this is considered to be a Not Significant effect.
- The predicted impact is considered Likely.

Therefore, the cumulative effects to ecosystem-level biodiversity from the PIC to the 2013 PDC are considered to be Likely, Adverse, but Not Significant environmental effect.

The variety and abundance of patch types (i.e., composition), how they are arranged within the matrix (configuration), and the degree of connectivity, or inversely, fragmentation, of a landscape can affect species and the ecological processes that influence them (McGarigal and Marks 1995). Landscape features, such as patch size and shape, proximity of similar patches and presence of functional corridors, have implications for species interactions, distribution and population persistence (Debinski and Holt 2000; Fahrig 2003; Fahrig et al. 2011; Noss and Harris 1986). As for ecosystem-level biodiversity, the potential for permanent change in landscape function as a consequence of regional development exists given the increased level of disturbance since the PIC. The following discusses the change to landscape-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PDC:

- The cumulative effects to landscape-level biodiversity are considered Adverse effects due to the alteration of composition, configuration, and connectivity of the landscape.
- Although thresholds are unknown, it is unlikely that an unacceptable threshold has been reached for landscape-level biodiversity in the RSA given the areal extent of the RSA that remains undisturbed in the 2013 PDC (i.e., 80%). Therefore, this is considered a Not Significant effect.
- The predicted impact is considered Likely.

Therefore, the cumulative effects to landscape-level biodiversity from the PIC to the 2013 PDC are determined to be Likely, Adverse, but Not Significant environmental effects.

5.3.4.3.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). Resource management criteria also state that effects are determined to be Significant for any adverse effects to federally listed species. High magnitude adverse and likely effects are predicted for all levels of biodiversity during construction and operations of the 2013 PDC. Therefore, cumulative effects to biodiversity from the PIC to construction and operations of the 2013 PDC are determined to be Significant for all levels of biodiversity according to resource management criteria.

5.3.4.4 Residual Impact Classification After Reclamation

The residual impacts to biodiversity in the RSA in the Far Future, from the PIC to the 2013 PDC, are presented in Table 5.3-37. The biodiversity species-level residual impact classification draws directly upon the Terrestrial Vegetation, Wetlands and Forest Resources and Wildlife and Wildlife Habitat residual impacts (Sections 5.3.2.2 and 5.3.3.2). The ecosystem- and landscape-level residual impact classifications are based on the changes presented in Sections 5.3.4.1.2 and 5.3.4.1.3 of the Biodiversity Assessment, respectively. For comparative purposes, the magnitude and overall environmental consequence of residual impacts to biodiversity from the 2013 Base Case and 2013 PRM Application Case, as found in Table 4.3-41, are also shown in Table 5.3-37.

From the PIC to the 2013 PDC, high rare plant potential is predicted to decrease by 11% compared to the PIC (Table 5.3-8). Therefore, the residual impact is moderate in magnitude. Most of this loss of high rare plant potential occurs as a result of the 2013 Base Case. For wildlife KIRs, the magnitude of residual impacts in the 2013 PDC ranges from negligible to high, with most impacts predicted to be high magnitude. As such, the overall magnitude of the residual impact at the species-level of biodiversity is considered to be high. Most species-level residual impacts are considered beyond regional in geographic extent and reversible. All residual impacts were considered to be long-term for vegetation and wildlife KIRs and were predicted to occur with high frequency.

The overall magnitude of the residual impact of the 2013 PDC on ecosystem-level biodiversity is considered low because the changes in high, moderate and low biodiversity potential areas are all 10% or less relative to the PIC (Table 5.3-35). The residual impact is considered to be regional, because the scale of assessment is the RSA. All of the net losses in high biodiversity potential areas occur to the treed fen RLCC. The peatlands (i.e., fens, bogs) that constitute the majority of this land cover class cannot be reclaimed with current technologies if the soil has been disturbed (e.g., open-pit mines). For this reason, the overall residual impact was scored as irreversible. The residual impact is also considered to be long-term in duration and high in frequency.

At the landscape level of biodiversity, the negative residual impacts of the 2013 PDC are considered to be of moderate magnitude for wetlands (including peatlands) and high magnitude for old growth forests because losses to these resources are predicted to decrease by 13% and 24%, respectively, compared to PIC conditions (Tables 5.3-6 and 5.3-7). Residual impacts on these KIRs are also considered to be regional in geographic extent, long-term in duration, high in frequency, and partially irreversible.

Table 5.3-37 Residual Impact Classification for Biodiversity in the Regional Study Area – 2013 Base Case, 2013 PRM Application Case and 2013 Planned Development Case – Pre-Industrial Case After Reclamation

Biodiversity Criteria	Direction	Magnitude			Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 Planned Development Case					2013 Base Case[(a)]	2013 PRM Application Case[(a)(b)]	2013 Planned Development Case
species-level effects	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
ecosystem-level effects	negative	moderate (+10)	moderate (+10)	low (+5)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+18)	high (+18)	moderate (+13)
landscape-level effects	negative	moderate (+10)	moderate (+10)	moderate to high (+10 to +15)	regional (+1)	long-term (+2)	irreversible/ reversible (0)	high (+2)	moderate (+15)	moderate (+15)	moderate to high (+15 to +20)

(a) These values from the 2013 Base Case and 2013 PRM Application Case are provided for comparative purposes only; individual criterion scores for geographic extent, duration, reversibility and frequency reflect the 2013 Planned Development Case.

(b) Application Case includes all existing and approved projects plus PRM.

Note: Numerical scores for ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Overall, negative high and moderate environmental consequences are predicted for the species- and ecosystem-levels of biodiversity, respectively, in the 2013 PDC at Far Future. At the landscape-level, a negative moderate to high environmental consequence is predicted. The results are the same as was predicted for effects from both the 2013 PRM Application Case and the 2013 Base Case for ecosystem-level biodiversity. Environmental consequences for the 2013 PDC increase from the 2013 PRM Application Case and 2013 Base Case for species- and landscape-level biodiversity (Table 5.3-37) because the magnitude of the residual impacts is greater when additional planned developments are considered.

5.3.4.5 Environmental Significance Determination After Reclamation

From the PIC to the 2013 PDC in the Far Future, effects at all levels of biodiversity are ranked as having a negative, moderate or high environmental consequence. Assessment methods for the determination of significance are discussed in Appendix 3.1, Section 2.8.3.

5.3.4.5.1 Ecological Thresholds

The following summarizes the changes to species-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to 2013 PDC:

- The cumulative effects to species-level biodiversity are considered Adverse effects due to losses of vegetation and wildlife resources.
- The cumulative effects of development in the RSA are not likely to exceed ecological thresholds and compromise resilience and adaptability of most plant and wildlife populations in the RSA such that their populations would no longer be self-sustaining and ecologically effective. However, development within the RSA is likely to exceed ecological thresholds for three wildlife species (e.g., black-throated green warbler, Canada warbler, and woodland caribou; Section 5.3.3.2).
- The predicted effects are considered Likely.

Therefore, the cumulative effects to biodiversity at the species level from the PIC to the 2013 PDC are not predicted to have exceeded ecological thresholds for the majority of species, but Likely, Significant, and Adverse environmental effects have been identified for some species.

As previously discussed in Section 5.3.4.3, the potential for permanent change in ecosystem function as a consequence of regional development exists given the increased level of disturbance since the PIC. A biodiversity management framework for the Lower Athabasca Region that will define acceptable regional effect thresholds is currently not available. Of the high biodiversity potential areas present in the PIC, 90% (488,448 ha; Table 5.3-35, Section 5.3.4.1.2) is estimated to remain intact in the 2013 PDC Far Future. This level of change is not expected to cause the ecosystem as a whole to enter an alternate stable state. Some components of the ecosystem, such as the large mammal predator-prey community, clearly have changed and the significance of these changes for individual species such as caribou is addressed at the species level (Section 5.3.3.17).

The conclusions about the significance of effects to biodiversity at the ecosystem level are associated with some uncertainty. Although some components of the ecosystem such as the large mammal community have been well studied, many ecological interactions at the ecosystem level have not been extensively studied in northeastern Alberta. Moreover, model error contributes to uncertainty. High biodiversity potential areas identified in the RSA (i.e., non-treed wetlands and treed fen RLCCs) have a classification accuracy estimated to be 40%. Because of the uncertainty in the spatial distribution of high biodiversity potential areas, losses may have been underestimated if developments more frequently affected these areas than was predicted by the model. However, the amount of high biodiversity areas in the RSA may have been underestimated because the direction of the error meant that many areas classified as low or moderate biodiversity potential actually consisted of high biodiversity potential. Therefore, although classification error may have led to an underestimation of the loss of high biodiversity potential areas in some places, there is likely more high biodiversity potential area in the RSA than predicted, which means the model was conservative and more likely to predict that ecological thresholds were exceeded based on aerial extent of high biodiversity potential areas remaining after disturbance.

The following discusses the change to ecosystem-level biodiversity in terms of Adverse, Significant and Likely impacts from the PIC to the 2013 PDC:

- The cumulative effects to ecosystem-level biodiversity are considered Adverse effects because high and moderate biodiversity potential categories experience losses in areal extent.
- An ecological threshold has likely not been exceeded for biodiversity potential in the RSA given the areal extent of the resource remaining and the general intactness of ecological communities in the RSA. Therefore, this is considered to be an Not Significant effect.
- The predicted impact is considered Likely.

Therefore, the cumulative effects to ecosystem-level biodiversity from the PIC to the 2013 PDC are considered to be Likely, Not Significant, Adverse, but Not Significant environmental effects.

As previously discussed in Section 5.3.4.3, the composition, configuration and degree of connectivity of a landscape can affect species and the ecological processes that influence them (McGarigal and Marks 1995). The following discusses the change to landscape-level biodiversity in terms of Adverse, Significant and Likely effects from the PIC to the 2013 PDC:

- The cumulative effects to landscape-level biodiversity are considered Adverse effects due to the alteration of composition, configuration, and connectivity of the landscape.
- Although thresholds are unknown, it is unlikely that an unacceptable threshold has been reached for landscape-level biodiversity in the RSA given the areal extent of the RSA that remains undisturbed in the 2013 PDC (i.e., 80%). Therefore, this is considered an Not Significant effect.
- The predicted impact is considered Likely.

Therefore, the cumulative effects to landscape-level biodiversity from the PIC to the 2013 PDC are determined to be Likely, Adverse, but Not Significant environmental effects.

5.3.4.5.2 Resource Management Criteria

Resource management criteria stipulate that likely effects that exceed 20% of a resource lost are Significant. Effects that exceed 20% of a resource lost are classified as being high magnitude effects (EIA, Volume 5, Section 1.3.6.1). Resource management criteria also state that effects are determined to be Significant for any adverse effects to federally listed species. High magnitude adverse and likely effects are predicted for species-level and landscape-level biodiversity after reclamation of the 2013 PDC. Therefore, cumulative effects to biodiversity from the PIC to the 2013 PDC are determined to be Significant for species- and landscape-level biodiversity after reclamation of the 2013 PDC, but are not Significant for ecosystem-level biodiversity.

5.3.5 Summary

Overall, the assessment of cumulative effects to terrestrial resources indicates substantial changes in the RSA from PIC to the 2013 PDC. Most of these changes are negative and result primarily from the cumulative effects of existing and approved developments (i.e., the 2013 Base Case). The incremental change from the 2013 Base Case to the 2013 PDC is larger for some KIRs, accounting for many of the differences between the assessed effects of development in the RSA from the PIC to 2013 PRM Application Case (Section 4) and the effects of development in the RSA from the PIC to the 2013 PDC that are assessed in this section.

An assessment to determine whether these changes constituted significant adverse effects was conducted for each terrestrial KIR and for biodiversity at the species, ecosystem, and landscape levels for which PRM effects were assessed to be greater than negligible at the LSA scale using both ecological threshold and resource management criteria approaches. Prior to reclamation, the ecological threshold approach identified significant effects for three KIRs, whereas resource management criteria identified significant effects for 25 KIRs, or 71% of all KIRs (Table 5.3-38). The addition of all planned developments, including PRM, for the PIC to 2013 PDC assessment resulted in a much larger incremental effect than observed in the PIC to 2013 PRM Application Case (Section 4). However, using both ecological thresholds and resource management criteria, most Significant effects identified for terrestrial resources were already present in the 2013 Base Case. Additional KIRs identified as significant in the PIC to 2013 PDC using resource management criteria are black bears, beaver, old growth forests, and high rare plant potential. No additional KIRs were identified as significant using ecological thresholds.

The distinction between significance approaches is important when evaluating the results presented in Table 5.3-38. As noted in Appendix 3.1, ecological thresholds produce a more appropriate and meaningful assessment of significance for conservation of terrestrial resources because they indicate whether or not populations or ecosystems have lost, or are expected to lose, the ability to sustain themselves or maintain ecological function. A significant result identified using ecological thresholds represents an important conservation concern.

The resource management criteria approach used for this assessment, on the other hand, is ecologically arbitrary for many KIRs. There is no evidence that the loss of 20% of a resource is an appropriate ecological threshold for most species, and many studies identify much higher losses (i.e., between 40% and 90%) before abrupt and non-linear, negative changes in ecological or population function occur (Monkkonen and Reunanen 1999, Rompre et al. 2010, Andren 1994, Swift and Hannon 2010). Similarly, it is generally not reasonable to assume that any adverse effect to a species at risk, no matter how small, will meaningfully alter the sustainability of the population in the RSA. However, resource management criteria do identify limits identified by resource managers or regulators beyond which losses are considered unacceptable. Significant effects identified using resource management criteria therefore represent adverse effects, but not effects that necessarily require immediate management action to achieve long-term conservation of the resource.

Table 5.3-38 Summary of Key Indicator Resource Significance Determinations for Cumulative Effects to Terrestrial Resources from the Pre-Industrial Case to the 2013 Planned Development Case

Key Indicator Resource	Before Reclamation		After Reclamation	
	RSA – Ecological Thresholds	RSA – Resource Management Criteria	RSA – Ecological Thresholds	RSA – Resource Management Criteria
Soils				
soil	-	-	n/a	Not Significant
Vegetation				
terrestrial vegetation	-	-	-	-
lichen jack pine community	-	-	-	-
wetlands	Not Significant	Not Significant	Not Significant	Not Significant
old growth forests	Not Significant	Significant	Not Significant	Significant
productive forests	-	-	-	-
high rare plant potential areas	Not Significant	Significant	Not Significant	Not Significant
high traditional use plant potential areas	-	-	-	-
Wildlife				
barred owl	Not Significant	Significant	-	-
beaver	Not Significant	Significant	-	-
black bear	Not Significant	Significant	-	-
black-throated green warbler	Significant	Significant	-	-
Canada lynx	Not Significant	Significant	-	-
Canadian toad	Not Significant	Not Significant	-	-
fisher	Not Significant	Significant	-	-
moose	Not Significant	Significant	-	-
Canada warbler	Significant	Significant	-	-
common nighthawk	Not Significant	Significant	-	-
horned grebe	Not Significant	Significant	-	-
little brown myotis	Not Significant	Significant	-	-
northern myotis	Not Significant	Significant	-	-
olive-sided flycatcher	Not Significant	Significant	-	-
peregrine falcon	Not Significant	Significant	-	-
red knot	Not Significant	Significant	-	-
rusty blackbird	Not Significant	Significant	-	-
short-eared owl	Not Significant	Significant	-	-
western toad	Not Significant	Significant	-	-
whooping crane	Not Significant	Significant	-	-
wolverine	Not Significant	Significant	-	-
wood bison	Not Significant	Significant	-	-
woodland caribou	Significant	Significant	-	-
yellow rail	Not Significant	Significant	-	-
Biodiversity				
species-level	Significant	Significant	Significant	Significant
ecosystem-level	Not Significant	Significant	Not Significant	Not Significant
landscape-level	Not Significant	Significant	Not Significant	Significant

n/a = Not applicable; - = Significance not assessed for terrestrial vegetation, wetlands and forest resources because the 2013 PDC was completed for those components that had a low, moderate or high negative environmental consequence in the LSA in the 2013 PRM Application Case assessment at Closure, and were applicable at the RSA scale (Appendix 1). Significance was not assessed some cases because terrain and soils indicators are directly reflected in changes to terrestrial vegetation, wetlands and forest resources). To be conservative, and due to uncertainty in future population trends, significance for wildlife is assessed during construction and operations only.

Note: Cumulative effects from the PIC to the 2013 PRM Application Case include and are predominantly due to existing and approved developments in the 2013 Base Case.

After reclamation the number of Significant adverse cumulative effects decreased for vegetation KIRs and effects to soils and ecosystem and landscape level biodiversity remained Not Significant. Adverse cumulative effects also would likely decline for most wildlife KIRs after reclamation, and this likely would result in a reduction of the number of Significant adverse effects, especially those detected using the 20% resource management criterion. However, spatially explicit reclamation data to evaluate the amount of high quality habitat reclaimed at the RSA scale were unavailable and significance after reclamation was not determined for wildlife KIRs, resulting in a conservative assessment.

5.4 Traditional Land Use

5.4.1 Fort McKay Community

The effects to traditional hunting, trapping, fishing, and traditional plant and berry harvesting were each assessed as high magnitude under the 2013 PDC. Due to the location of 2013 PDC land and access disturbances in relation to the community of Fort McKay, the resulting impacts are likely to be experienced by the community as a whole and affect the community of Fort McKay's ability to undertake TLU activities. The effects of the 2013 PDC on Fort McKay's traditional land use is therefore considered significant.

5.4.2 Mikisew Cree First Nation

The assessment determined that the 2013 PDC effects to MCFN traditional hunting, and plant and berry harvesting within the RSA are adverse and high in magnitude. The effects to MCFN traditional fishing within the RSA were assessed as adverse and high in magnitude for MCFN members living in Fort McMurray or communities further south, and moderate in magnitude for MCFN members living in Fort Chipewyan. The effects on MCFN traditional trapping in the RSA were assessed as adverse and moderate in magnitude for the individual(s) trapping on RFMA #2892. As a result of the high magnitude impacts on traditional hunting, and plant harvesting, and on traditional fishing for MCFN members living in Fort McMurray, the effects of the 2013 PDC are considered significant for MCFN harvesting within the RSA.

5.4.3 Athabasca Chipewyan First Nation

The assessment determined that the 2013 PDC is likely to have high magnitude effects for ACFN traditional harvesting within the RSA. As a result of the high magnitude impacts to traditional harvesting, the effects of the 2013 PDC are considered to have a substantial effect on ACFN traditional harvesting in the RSA, and are considered significant.

While the effects of the 2013 PDC on ACFN traditional harvesting activities within the RSA have been assessed as significant, the effects of the PRM, on its own, are considered not significant. Most of the 2013 PDC disturbances have been caused by existing and approved developments (i.e., 2013 Base Case). On its own, the PRM represents 1% of the area of the RSA portion of the Poplar Point Homeland Zone, and 1% of the RSA portion of the Fort McKay and Fort McMurray proximate zones. The PRM is not expected to have a substantial effect on ACFN access to preferred areas for harvesting within the RSA.

5.4.4 Fort McMurray #468 First Nation

The assessment determined that the 2013 PDC effects to FM468 traditional hunting, fishing, and plant and berry harvesting within the RSA are adverse and high in magnitude. The 2013 PDC effects to FM468 trapping in the RSA are assessed as adverse and moderate to high in magnitude. As a result of the high magnitude effects to FM468 traditional harvesting within the RSA, the effects are considered significant.

5.4.5 Fort Chipewyan Métis Local #125

The effects classification determined that the effects of the 2013 PDC to traditional hunting, trapping and plant harvesting by members of Fort Chipewyan Métis Local #125 within the RSA were adverse and high in magnitude. The effects to traditional fishing were assessed as low. The high impacts are mostly the result of impacts to the use of RFMA #1275 by the Métis RFMA holders. The available information further indicated that the large majority of traditional land use by members of Fort Chipewyan Métis Local #125 occurs north of the RSA in the larger area around Fort Chipewyan. Because the impacts within the RSA are limited to a few individuals and that the large majority of traditional land use occurs north of the RSA, the impacts of the 2013 PDC are not expected to fundamentally alter the ability of Fort Chipewyan Métis Local #125 members to practice traditional activities. As a result, the effects of the 2013 PDC on harvesting by Fort Chipewyan Métis within the RSA are considered not significant.

For the reasons identified above, the effects of PRM on its own are also considered not significant in relation to Fort Chipewyan Métis Local #125 TLU.

5.4.6 Fort McMurray Métis Local #1935

The effects classification determined that the effects of the 2013 PDC is likely to have high magnitude effects on Fort McMurray Métis Local #1935 hunting, fishing and plant harvesting within the RSA. There is not enough information to assess the effects of the 2013 PDC on trapping by Fort McMurray Métis. As a result of the high magnitude and long duration effects to traditional hunting, fishing, and plant and berry harvesting, the effects of the 2013 PDC on Fort McMurray Métis harvesting in the PDC are considered significant.

5.5 2013 Planned Development Case to Pre-Industrial Case Summary

5.5.1 Air Quality

For the comparison of the 2013 PDC to the PIC, NO_2, $PM_{2.5}$, H_2S, benzene and acrolein were assessed because other air quality parameters were predicted to be negligible in the 2013 PRM Application Case. The regional annual NO_2 predictions were above the AAAQO outside developed areas; however, the predicted annual NO_2 concentrations in the communities were below the AAAQO. The H_2S predictions at the regional communities remain below the AAAQOs. The 24-hour $PM_{2.5}$ predictions were above the AAAQO at some communities. The 2013 PDC predicted 1-hour and annual benzene exceedances at Fort McMurray, and annual acrolein exceedances at Fort McMurray. The benzene and acrolein predictions at all other communities were within applicable AAAQOs and other applicable criteria. The exceedances at Fort McMurray are primarily due to the estimated increase in emissions from future population growth in Fort McMurray. Of the 10 ambient air quality parameters assessed for the 2013 PDC, four are rated as having a low environmental consequence, two are rated as moderate, and four are rated as having a high environmental consequence.

After reclamation, there will be few sources of air emissions compared to operations and air quality levels are expected to return to near-PIC levels in the region. Therefore, the potential effects from the PIC to the 2013 PDC on air quality after reclamation are not considered a likely significant adverse environmental effect.

5.5.2 Surface Water Quality and Aquatic Health

The 2013 PDC to PIC environmental consequence rankings for aquatic health parameters are negligible or low. Therefore, they are not likely significant adverse environmental effects.

5.5.3 Terrestrial Resources

Overall, the assessment of cumulative effects to terrestrial resources indicates substantial changes in the RSA from PIC to the 2013 PDC. Most of these changes are negative and result primarily from the cumulative effects of existing and approved developments (i.e., the 2013 Base Case). The incremental change from the 2013 Base Case to the 2013 PDC is larger for some KIRs, accounting for many of the differences between the assessed effects of development in the RSA from the PIC to 2013 PRM Application Case (Section 4) and the effects of development in the RSA from the PIC to the 2013 PDC that are assessed in this section.

An assessment to determine whether these changes constituted significant adverse effects was conducted for each terrestrial KIR and for biodiversity at the species, ecosystem, and landscape levels for which PRM effects were assessed to be greater than negligible at the LSA scale using both ecological threshold and resource management criteria approaches. Prior to reclamation, the ecological threshold approach identified significant effects for three KIRs, whereas resource management criteria identified significant effects for 25 KIRs, or 71% of all KIRs (Table 5.5-1). The addition of all planned developments, including PRM, for the PIC to 2013 PDC assessment resulted in a much larger incremental effect than observed in the PIC to 2013 PRM Application Case (Section 4). However, using ecological thresholds and resource management criteria, most Significant effects identified for terrestrial resources were already present in the 2013 Base Case. Additional KIRs identified as significant in the PIC to 2013 PDC using resource management criteria are black bears, beaver, old growth forests, and high rare plant potential. No additional KIRs were identified as significant using ecological thresholds.

The distinction between significance approaches is important when evaluating the results presented in Table 5.5-1. As noted in Appendix 3.1, ecological thresholds produce a more appropriate and meaningful assessment of significance for conservation of terrestrial resources because they indicate whether or not populations or ecosystems have lost, or are expected to lose, the ability to sustain themselves or maintain ecological function. A significant result identified using ecological thresholds represents an important conservation concern.

The resource management criteria approach used for this assessment, on the other hand, is ecologically arbitrary for many KIRs. There is no evidence that the loss of 20% of a resource is an appropriate ecological threshold for most species, and many studies identify much higher losses (i.e., between 40% and 90%) before abrupt and non-linear, negative changes in ecological or population function occur (Monkkonen and Reunanen 1999, Rompre et al. 2010, Andren 1994, Swift and Hannon 2010). Similarly, it is generally not reasonable to assume that any adverse effect to a species at risk, no matter how small, will meaningfully alter the sustainability of the population in the RSA. However, resource management criteria do identify limits identified by resource managers or regulators beyond which losses are considered unacceptable. Significant effects identified using resource management criteria therefore represent adverse effects, but not effects that necessarily require immediate management action to achieve long-term conservation of the resource.

Table 5.5-1 Summary of Key Indicator Resource Significance Determinations for Cumulative Effects to Terrestrial Resources from the Pre-Industrial Case to the 2013 Planned Development Case

Key Indicator Resource	Before Reclamation		After Reclamation	
	RSA – Ecological Thresholds	RSA – Resource Management Criteria	RSA – Ecological Thresholds	RSA – Resource Management Criteria
Soils				
soil	-	-	n/a	Not Significant
Vegetation				
terrestrial vegetation	-	-	-	-
lichen jack pine community	-	-	-	-
wetlands	Not Significant	Not Significant	Not Significant	Not Significant
old growth forests	Not Significant	Significant	Not Significant	Significant
productive forests	-	-	-	-
high rare plant potential areas	Not Significant	Significant	Not Significant	Not Significant
high traditional use plant potential areas	-	-	-	-
Wildlife				
barred owl	Not Significant	Significant	-	-
beaver	Not Significant	Significant	-	-
black bear	Not Significant	Significant	-	-
black-throated green warbler	Significant	Significant	-	-
Canada lynx	Not Significant	Significant	-	-
Canadian toad	Not Significant	Not Significant	-	-
fisher	Not Significant	Significant	-	-
moose	Not Significant	Significant	-	-
Canada warbler	Significant	Significant	-	-
common nighthawk	Not Significant	Significant	-	-
horned grebe	Not Significant	Significant	-	-
little brown myotis	Not Significant	Significant	-	-
northern myotis	Not Significant	Significant	-	-
olive-sided flycatcher	Not Significant	Significant	-	-
peregrine falcon	Not Significant	Significant	-	-
red knot	Not Significant	Significant	-	-
rusty blackbird	Not Significant	Significant	-	-
short-eared owl	Not Significant	Significant	-	-
western toad	Not Significant	Significant	-	-
whooping crane	Not Significant	Significant	-	-
wolverine	Not Significant	Significant	-	-
wood bison	Not Significant	Significant	-	-
woodland caribou	Significant	Significant	-	-
yellow rail	Not Significant	Significant	-	-
Biodiversity				
species-level	Significant	Significant	Significant	Significant
ecosystem-level	Not Significant	Significant	Not Significant	Not Significant
landscape-level	Not Significant	Significant	Not Significant	Significant

n/a = Not applicable; - = Significance not assessed for terrestrial vegetation, wetlands and forest resources because the 2013 PDC was completed for those components that had a low, moderate or high negative environmental consequence in the LSA in the 2013 PRM Application Case assessment at Closure, and were applicable at the RSA scale (Appendix 1). Significance was not assessed some cases because terrain and soils indicators are directly reflected in changes to terrestrial vegetation, wetlands and forest resources). To be conservative, and due to uncertainty in future population trends, significance for wildlife is assessed during construction and operations only.

Note: Cumulative effects from the PIC to the 2013 PRM Application Case include and are predominantly due to existing and approved developments in the 2013 Base Case.

After reclamation the number of Significant adverse cumulative effects decreased for vegetation KIRs and effects to soils and ecosystem and landscape level biodiversity remained Not Significant. Adverse cumulative effects also would likely decline for most wildlife KIRs after reclamation, and this likely would result in a reduction of the number of Significant adverse effects, especially those detected using the 20% resource management criterion. However, spatially explicit reclamation data to evaluate the amount of high quality habitat reclaimed at the RSA scale were unavailable and significance after reclamation was not determined for wildlife KIRs, resulting in a conservative assessment.

5.5.4 Traditional Land Use

The effects to traditional land use activities under the 2013 PDC were determined for each of the potentially affected Aboriginal groups. The effects of the 2013 PDC were determined for hunting, trapping, fishing, and plant and berry harvesting opportunities. Land use opportunities were considered to be a combination of the availability of each underlying resource (e.g., wildlife, fish) and access to the resource. The assessment also considered the effects on traditional harvesting activities from odour, noise, visual effects, human health effects and socio-economic effects. The following discusses the effects classification and significance of the 2013 PDC to PIC on traditional land use for the potentially affected Aboriginal groups. A summary of the effects classification and significance for each of the potentially affected Aboriginal groups is found in Table 5.5-2.

5.5.4.1 Community of Fort McKay

The effects to traditional hunting, trapping, fishing, and traditional plant and berry harvesting were each assessed as high magnitude under the 2013 PDC. Due to the location of PDC land and access disturbances in relation to the community of Fort McKay, the resulting impacts are likely to be experienced by the community as a whole and affect the community of Fort McKay's ability to undertake traditional land use activities. The effects of the 2013 PDC on Fort McKay's traditional land use are therefore considered significant.

5.5.4.2 Mikisew Cree First Nation

The assessment determined that the effects to MCFN traditional hunting, and plant and berry harvesting within the RSA are adverse and high in magnitude. The effects to MCFN traditional fishing within the RSA were assessed as adverse and high in magnitude for MCFN members living in Fort McMurray or communities further south, and moderate in magnitude for MCFN members living in Fort Chipewyan. The effects on MCFN traditional trapping in the RSA were assessed as moderate to high in magnitude for the individual(s) trapping on RFMA #2892. As a result of the high magnitude impacts on traditional hunting, and plant harvesting, traditional fishing, and on traditional trapping for MCFN members living in Fort McMurray, the effects of the 2013 PDC are considered significant for MCFN harvesting within the RSA.

5.5.4.3 Athabasca Chipewyan First Nation

The assessment determined that the effects of the 2013 PDC on traditional hunting, fishing, and plant and berry harvesting within the RSA are adverse and high in magnitude. The effects to traditional trapping were assessed as adverse and high for the individuals trapping on RFMA #1714. As a result of the high magnitude impacts to traditional hunting, fishing, and plant and berry harvesting, the effects of the 2013 PDC are considered to have a substantial effect on ACFN traditional land use in the RSA, and are therefore considered significant.

5.5.4.4 Fort McMurray #468 First Nation

The assessment determined that the 2013 PDC effects to FM468 traditional hunting, fishing, and plant and berry harvesting within the RSA are adverse and high in magnitude. The 2013 PDC effects to FM468 trapping in the RSA are assessed as adverse and moderate to high in magnitude. As a result of the high magnitude effects to FM468 traditional harvesting within the RSA, the effects are considered significant.

5.5.4.5 Fort Chipewyan Métis Local #135

The effects classification determined that the effects to traditional hunting, trapping and plant harvesting by members of Fort Chipewyan Métis Local #125 within the RSA were adverse and high in magnitude. The effects to traditional fishing were assessed as low. The high impacts are mostly the result of impacts to the use of RFMA #1275 by the Métis RFMA holders. The available information further indicated that the large majority of traditional land use by members of Fort Chipewyan Métis Local #125 occurs north of the RSA in the larger area around Fort Chipewyan. Because the impacts within the RSA are limited to a few individuals and that the large majority of traditional land use occurs north of the RSA, the impacts of the 2013 PDC are not expected to substantially alter the ability of Fort Chipewyan Métis Local #125 members to practice traditional activities. As a result, the effects of the 2013 PDC on traditional land use by Fort Chipewyan Métis within the RSA are considered not significant.

5.5.4.6 Fort McMurray Métis Local #1935

The effects classification determined that the effects of the 2013 PDC on Fort McMurray Métis Local #135 on traditional hunting, fishing, and plant and berry harvesting within the RSA were adverse and high in magnitude. There is not enough information to assess the effects of the 2013 PDC on trapping by Fort McMurray Métis. As a result of the high magnitude and long duration effects to traditional hunting, fishing, and plant and berry harvesting, the effects of the 2013 PDC on Fort McMurray Métis harvesting in the PDC are considered significant.

Table 5.5-2 summarizes the effects classification for traditional uses of the land under the 2013 PDC.

Table 5.5-2 Effects Classification and Significance for Traditional Land Use Under the 2013 Planned Development Case

Aboriginal Group	Effects Classification for Traditional Land Use	Significance Prior to Reclamation
Community of Fort McKay	High	Significant
Mikisew Cree First Nation	Moderate to High	Significant
Athabasca Chipewyan First Nation	High	Significant
Fort McMurray #468 First Nation	Moderate to High	Significant
Fort Chipewyan Métis Local #125	Low to High (Effects mostly limited to use of RFMA #1275)	Not Significant
Fort McMurray Métis Local #1935	High (Trapping not assessed)	Significant

Note: All effects classifications were assessed as negative in direction, regional in extent, long term in duration and irreversible, therefore only the magnitude has been provided within the table.

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ATTACHMENT A

Frequency of Exceedance

Table A-1 Frequency of Exceedance for Big Creek

Substance of Potential Concern	Unit	CEB[a]	Pre-Industry		2018				2034			
			Pre-Industrial Case		2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case	
			Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]
Aluminum	mg/L	0.15	3.9	41.2	8.1	55.4	6.5	56.8	0.71	95	0.7	90.7
Boron	mg/L	1.5	0.41	0	0.66	0	0.68	0	0.28	0	0.28	0
Cadmium	mg/L	0.00025	0.00032	0.7	0.00067	4.7	0.00072	3.3	0.00017	0	0.00014	0
Chloride	mg/L	-	4.9	NA	4.7	NA	7.2	NA	2.9	NA	2.9	NA
Cobalt	mg/L	0.004	0.0061	1	0.0066	1.2	0.018	10.1	0.0039	0.1	0.0037	0.1
Copper	mg/L	0.0256	0.018	0	0.017	0	0.022	0	0.0068	0	0.006	0
Iron	mg/L	1.5	14	58.4	21	60.7	24	62.3	3.5	80.2	3.4	79.4
Lead	mg/L	0.005	0.0069	0.4	0.0068	0.5	0.012	0.9	0.0022	0	0.0021	0
Manganese	mg/L	1.455	2.4	2.8	2.2	1.8	6.2	10.5	0.74	0	0.63	0
Naphthenic Acids - Labile	mg/L	1	0	0	0	0	0	0	0	0	0	0
Naphthenic Acids - Refractory	mg/L	-	1.4	NA	1.4	NA	1.9	NA	0.83	NA	0.83	NA
Naphthenic Acids - Inert	mg/L		0.79	NA	0.89	NA	1.1	NA	0.57	NA	0.56	NA
PAH group 1	µg/L	0.281	0	0	0	0	0.075	0	0	0	0.0018	0
PAH group 2	µg/L	0.278	0	0	0	0	0.16	0	0	0	0.0047	0
PAH group 5	µg/L	5.6	0	0	0	0	1.2	0	0	0	0.014	0
PAH group 7	µg/L	5.9	0	0	0	0	1.5	0	0	0	0.037	0
PAH group 9	µg/L	2.3	0	0	0	0	0.32	0	0	0	0.0055	0
Selenium	mg/L	-	0.0022	NA	0.0035	NA	0.0029	NA	0.00066	NA	0.00062	NA
Sulphate	mg/L	309	109	0	105	0	160	0	75	0	76	0
Total dissolved solids	mg/L	1000	448	0	430	0	462	0	286	0	282	0
Total nitrogen	mg/L	-	2.6	NA	2.5	NA	2.5	NA	1.1	NA	1	NA
Total phenolics	mg/L	0.01	0.024	4.2	0.036	8	0.033	12.9	0.0036	0	0.0033	0
Total phosphorus	mg/L	-	0.94	NA	1.4	NA	1.1	NA	0.25	NA	0.25	NA
Vanadium	mg/L	0.0338	0.035	0.1	0.061	0.6	0.049	0.4	0.012	0	0.011	0

Table A-1 Frequency of Exceedance for Big Creek (continued)

Substance of Potential Concern	Unit	CEB[a]	2042				2052				2152			
			2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case	
			Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]
Aluminum	mg/L	0.15	0.71	95	1.1	100	2.8	34.8	2.6	30.6	3	33.7	3.4	74.7
Boron	mg/L	1.5	0.28	0	0.28	0	0.41	0	0.49	0	0.41	0	1.6	0.1
Cadmium	mg/L	0.00025	0.00017	0	0.0002	0	0.00029	0.4	0.0003	0.5	0.00031	0.6	0.0013	62.8
Chloride	mg/L	-	2.9	NA	3	NA	4.8	NA	4.9	NA	5	NA	198	NA
Cobalt	mg/L	0.004	0.0039	0.1	0.0053	0.5	0.0058	0.7	0.0059	0.7	0.0058	1	0.017	59.9
Copper	mg/L	0.0256	0.0068	0	0.012	0	0.02	0	0.015	0	0.022	0.1	0.013	0
Iron	mg/L	1.5	3.5	80.2	5.3	90.4	12	57	8.9	50.9	12	57.2	9.8	76.9
Lead	mg/L	0.005	0.0022	0	0.0035	0	0.007	0.4	0.0063	0.3	0.007	0.5	0.0055	0.2
Manganese	mg/L	1.455	0.74	0	1.2	0	3.1	2.5	1.6	0.2	3.1	2.7	2.2	0.4
Naphthenic Acids - Labile	mg/L	1	0	0	0	0	0	0	0	0	0	0	0.049	0
Naphthenic Acids - Refractory	mg/L	-	0.83	NA	0.92	NA	1.7	NA	1.2	NA	1.7	NA	12	NA
Naphthenic Acids - Inert	mg/L		0.57	NA	0.57	NA	0.87	NA	0.93	NA	0.86	NA	13	NA
PAH group 1	µg/L	0.281	0	0	0	0	0	0	0	0	0	0	0.0039	0
PAH group 2	µg/L	0.278	0	0	0	0	0	0	0	0	0	0	0.019	0
PAH group 5	µg/L	5.6	0	0	0	0	0	0	0	0	0	0	0.0023	0
PAH group 7	µg/L	5.9	0	0	0	0	0	0	0	0	0	0	0.011	0
PAH group 9	µg/L	2.3	0	0	0	0	0	0	0	0	0	0	0.0038	0
Selenium	mg/L	-	0.00066	NA	0.00078	NA	0.0018	NA	0.0017	NA	0.0018	NA	0.0023	NA
Sulphate	mg/L	309	75	0	77	0	122	0	106	0	122	0	139	0
Total dissolved solids	mg/L	1000	286	0	290	0	450	0	400	0	463	0	1090	0.1
Total nitrogen	mg/L	-	1.1	NA	1	NA	2.4	NA	2.4	NA	3.4	NA	3	NA
Total phenolics	mg/L	0.01	0.0036	0	0.0032	0	0.024	2.9	0.024	4.8	0.024	3.5	0.02	1.7
Total phosphorus	mg/L	-	0.25	NA	0.25	NA	0.83	NA	0.74	NA	0.86	NA	0.81	NA
Vanadium	mg/L	0.0338	0.012	0	0.011	0	0.035	0.1	0.035	0.1	0.035	0.1	0.031	0.1

(a) Appendix 3.6 Chronic Effects Benchmarks.

CEB = chronic effects benchmark; - = no CEB; NA = no data available.

Table A-2 Frequency of Exceedance for Eymundson Creek

Substance of Potential Concern	Unit	CEB[(a)]	Pre-Industry		2018				2034		2042	
			Pre-Industrial Case		2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 PRM Application Case	
			Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]
Aluminum	mg/L	0.15	3.7	29.7	6.4	28.4	6.4	28.4	2.8	29.4	2.8	29.4
Boron	mg/L	1.5	0.46	0	0.56	0	0.56	0	0.47	0	0.47	0
Cadmium	mg/L	0.00025	0.00035	0.9	0.00056	1.3	0.00057	1.3	0.00034	0.8	0.00034	0.8
Chloride	mg/L	-	5.1	NA	9.2	NA	9.2	NA	5.1	NA	5.1	NA
Cobalt	mg/L	0.004	0.0064	1.5	0.0058	0.8	0.0044	0.1	0.0064	1.5	0.0064	1.5
Copper	mg/L	0.0256	0.019	0	0.017	0	0.017	0	0.026	0.1	0.026	0.1
Iron	mg/L	1.5	13	56.9	15	50.4	15	50.4	12	56.3	12	56.3
Lead	mg/L	0.005	0.0077	0.5	0.0066	0.3	0.0066	0.3	0.0085	0.6	0.0085	0.6
Manganese	mg/L	1.455	2.5	1.1	2.3	0.6	2.3	0.6	3.7	2.5	3.7	2.5
Naphthenic Acids - Labile	mg/L	1	0	0	0	0	0	0	0	0	0	0
Naphthenic Acids - Refractory	mg/L	-	1.5	NA	2.5	NA	2.5	NA	1.9	NA	1.9	NA
Naphthenic Acids - Inert	mg/L		0.89	NA	1.2	NA	1.2	NA	0.99	NA	0.99	NA
PAH group 1	µg/L	0.281	0	0	1.1	10.9	1.1	11	0	0	0	0
PAH group 2	µg/L	0.278	0	0	12	27.4	12	27.4	0	0	0	0
PAH group 5	µg/L	5.6	0	0	24	2.6	24	2.6	0	0	0	0
PAH group 7	µg/L	5.9	0	0	35	3.2	35	3.3	0	0	0	0
PAH group 9	µg/L	2.3	0	0	5.3	0.4	5.3	0.4	0	0	0	0
Selenium	mg/L	-	0.0019	NA	0.0026	NA	0.0026	NA	0.0019	NA	0.0019	NA
Sulphate	mg/L	309	114	0	453	0.9	453	0.9	136	0	136	0
Total dissolved solids	mg/L	1000	462	0	660	0	660	0	481	0	481	0
Total nitrogen	mg/L	-	3.1	NA	2.8	NA	2.7	NA	3.1	NA	3.1	NA
Total phenolics	mg/L	0.01	0.023	3.7	0.039	47.6	0.039	47.6	0.025	4	0.025	4
Total phosphorus	mg/L	-	0.9	NA	1	NA	1	NA	0.73	NA	0.73	NA
Vanadium	mg/L	0.0338	0.04	0.2	0.043	0.2	0.043	0.2	0.037	0.1	0.037	0.1

[(a)] Appendix 3.6 Chronic Effects Benchmarks.

CEB = chronic effects benchmark; - = no CEB; NA = no data available.

Table A-3 Frequency of Exceedance for Pierre River

Substance of Potential Concern	Unit	CEB[(a)]	Pre-Industry		2018				2034			
			Pre-Industrial Case		2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case	
			Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]
Aluminum	mg/L	0.15	12	56.6	12	56.6	12	56.6	9.6	50.1	6.9	44
Boron	mg/L	1.5	0.43	0	0.43	0	0.43	0	0.44	0	0.44	0
Cadmium	mg/L	0.00025	0.00042	2.4	0.00049	3.1	0.00042	2.4	0.00038	1.3	0.00031	0.4
Chloride	mg/L	-	4.7	NA	4.9	NA	4.7	NA	4.8	NA	5	NA
Cobalt	mg/L	0.004	0.0071	2.8	0.0072	3.3	0.0068	0.6	0.0065	1.8	0.0059	1.9
Copper	mg/L	0.0256	0.015	0	0.015	0	0.015	0	0.016	0	0.024	0.1
Iron	mg/L	1.5	18	62	19	60.7	18	60.7	15	61	13	58.7
Lead	mg/L	0.005	0.0071	0.5	0.0071	0.5	0.0071	0.5	0.0066	0.5	0.0074	0.4
Manganese	mg/L	1.455	1.8	3.4	1.3	0	1.1	0	1.5	0.1	4.5	19.7
Naphthenic Acids - Labile	mg/L	1	0	0	0	0	0	0	0	0	0	0
Naphthenic Acids - Refractory	mg/L	-	1.4	NA	1.4	NA	1.4	NA	1.3	NA	2.1	NA
Naphthenic Acids - Inert	mg/L		0.82	NA	0.81	NA	0.82	NA	0.78	NA	1	NA
PAH group 1	µg/L	0.281	0	0	0	0	0	0	0	0	0	0
PAH group 2	µg/L	0.278	0	0	0	0	0	0	0	0	0	0
PAH group 5	µg/L	5.6	0	0	0	0	0	0	0	0	0	0
PAH group 7	µg/L	5.9	0	0	0	0	0	0	0	0	0	0
PAH group 9	µg/L	2.3	0	0	0	0	0	0	0	0	0	0
Selenium	mg/L	-	0.0027	NA	0.0028	NA	0.0027	NA	0.0023	NA	0.0021	NA
Sulphate	mg/L	309	106	0	105	0	105	0	105	0	181	0
Total dissolved solids	mg/L	1000	510	0	522	0	485	0	442	0	606	0
Total nitrogen	mg/L	-	3.3	NA	3.8	NA	3.3	NA	3.1	NA	3.1	NA
Total phenolics	mg/L	0.01	0.031	7.2	0.031	6.1	0.031	5.4	0.025	4.1	0.036	10.1
Total phosphorus	mg/L	-	1.2	NA	1.3	NA	1.2	NA	1	NA	0.87	NA
Vanadium	mg/L	0.0338	0.048	0.3	0.05	0.3	0.048	0.3	0.038	0.2	0.036	0.1
Zinc	mg/L	0.138	0.1	0	0.11	0	0.1	0	0.094	0	0.089	0

Table A-3 Frequency of Exceedance for Pierre River (continued)

Substance of Potential Concern	Unit	CEB[(a)]	2042				2052				2152			
			2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case	
			Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]
Aluminum	mg/L	0.15	8.2	51.7	6.9	43.2	9.2	55.8	9.6	54.8	9.2	55.8	9.6	54.8
Boron	mg/L	1.5	0.44	0	0.44	0	0.43	0	0.43	0	0.43	0	0.43	0
Cadmium	mg/L	0.00025	0.00041	1.6	0.00034	0.8	0.00038	1.2	0.00038	1.1	0.00038	1.2	0.00038	1.1
Chloride	mg/L	-	4.9	NA	4.8	NA	6.8	NA	6.8	NA	4.8	NA	4.8	NA
Cobalt	mg/L	0.004	0.0084	7.4	0.0059	1.2	0.0066	2	0.0064	1.6	0.0066	2	0.0064	1.6
Copper	mg/L	0.0256	0.017	0	0.016	0	0.015	0	0.015	0	0.015	0	0.015	0
Iron	mg/L	1.5	14	63.2	13	59.2	13	60.2	13	59.5	13	60.2	13	59.5
Lead	mg/L	0.005	0.0072	0.5	0.0065	0.4	0.0065	0.4	0.0065	0.4	0.0065	0.4	0.0065	0.4
Manganese	mg/L	1.455	1.7	0.2	1.9	0.3	1	0	1	0	1	0	1	0
Naphthenic Acids - Labile	mg/L	1	0	0	0	0	0.041	0	0.041	0	0.025	0	0.00035	0
Naphthenic Acids - Refractory	mg/L	-	1.2	NA	1.2	NA	1.2	NA	1.2	NA	1.2	NA	1.2	NA
Naphthenic Acids - Inert	mg/L		0.78	NA	0.81	NA	0.78	NA	0.78	NA	0.78	NA	0.78	NA
PAH group 1	µg/L	0.281	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 2	µg/L	0.278	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 5	µg/L	5.6	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 7	µg/L	5.9	0	0	0	0	0	0	0	0	0	0	0	0
PAH group 9	µg/L	2.3	0	0	0	0	0	0	0	0	0	0	0	0
Selenium	mg/L	-	0.0023	NA	0.0022	NA	0.0022	NA	0.0022	NA	0.0022	NA	0.0022	NA
Sulphate	mg/L	309	106	0	106	0	105	0	105	0	105	0	105	0
Total dissolved solids	mg/L	1000	444	0	424	0	427	0	427	0	427	0	427	0
Total nitrogen	mg/L	-	3.2	NA	2.8	NA	3.1	NA	3.1	NA	3.9	NA	3.1	NA
Total phenolics	mg/L	0.01	0.021	3.9	0.022	3.2	0.02	3.7	0.021	3.8	0.02	3.7	0.021	3.8
Total phosphorus	mg/L	-	0.89	NA	0.88	NA	0.94	NA	0.97	NA	0.94	NA	0.97	NA
Vanadium	mg/L	0.0338	0.038	0.1	0.037	0.1	0.037	0.1	0.036	0.1	0.037	0.1	0.036	0.1
Zinc	mg/L	0.138	0.089	0	0.092	0	0.094	0	0.097	0	0.094	0	0.097	0

(a) Appendix 3.6 Chronic Effects Benchmarks.

CEB = chronic effects benchmark; - = no CEB; NA = no data available.

Table A-4 Frequency of Exceedance for Redclay Creek

Substance of Potential Concern	Unit	CEB[a]	Pre-Industry		2018				2034			
			Pre-Industrial Case		2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case	
			Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]
Aluminum	mg/L	0.15	2.1	22.6	1.3	22	1.2	22.3	0.92	100	0.51	99.8
Boron	mg/L	1.5	0.16	0	0.22	0	0.73	0	0.32	0	0.16	0
Cadmium	mg/L	0.00025	0.00014	0	0.00015	0	0.00053	0.5	0.0003	2.7	0.00011	0
Chloride	mg/L	-	9.4	NA	9.3	NA	9	NA	4.9	NA	3.3	NA
Cobalt	mg/L	0.004	0.0006	0	0.00062	0	0.00087	0	0.0014	0	0.0011	0
Copper	mg/L	0.0256	0.0017	0	0.0017	0	0.0018	0	0.0038	0	0.0024	0
Iron	mg/L	1.5	8.8	39.3	9.4	39.5	11	41.9	3.9	100	2.3	76.6
Lead	mg/L	0.005	0.00074	0	0.0006	0	0.00061	0	0.001	0	0.00072	0
Manganese	mg/L	1.455	3.1	13.3	3.4	14.7	3.1	12.3	1.1	0	0.54	0
Naphthenic Acids - Labile	mg/L	1	0	0	0	0	0	0	0	0	0	0
Naphthenic Acids - Refractory	mg/L	-	1.1	NA	1.1	NA	1.5	NA	1.1	NA	0.7	NA
Naphthenic Acids - Inert	mg/L		0.77	NA	0.6	NA	1.5	NA	0.56	100	0.74	NA
PAH group 1	µg/L	0.281	0	0	0	0	0.021	0	0	0	0.0003	0
PAH group 2	µg/L	0.278	0	0	0	0	0.039	0	0	0	0.0012	0
PAH group 5	µg/L	5.6	0	0	0	0	0.54	0	0	0	0.0011	0
PAH group 7	µg/L	5.9	0	0	0	0	0.63	0	0	0	0.0029	0
PAH group 9	µg/L	2.3	0	0	0	0	0.15	0	0	0	0.0008	0
Selenium	mg/L	-	0.0015	NA	0.0014	NA	0.0021	NA	0.00061	NA	0.0004	NA
Sulphate	mg/L	309	195	0	199	0	190	0	139	0	90	0
Total dissolved solids	mg/L	1000	658	0	652	0	602	0	474	0	339	0
Total nitrogen	mg/L	-	2.2	NA	2.1	NA	2.2	NA	1.3	NA	0.94	NA
Total phenolics	mg/L	0.01	0.022	6.8	0.021	6.7	0.021	5.7	0.0018	0	0.00055	0
Total phosphorus	mg/L	-	0.39	NA	0.37	NA	0.35	NA	0.18	NA	0.13	NA
Vanadium	mg/L	0.0338	0.0022	0	0.0023	0	0.0021	0	0.0061	0	0.0037	0

Table A-4 Frequency of Exceedance for Redclay Creek (continued)

Substance of Potential Concern	Unit	CEB[a]	2042				2052				2152			
			2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case		2013 PRM Application Case		2013 Planned Development Case	
			Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]	Peak Concentration	Frequency of Exceedance [%]
Aluminum	mg/L	0.15	0.92	100	0.56	100	0.71	97	0.5	98.8	0.71	97	0.77	100
Boron	mg/L	1.5	0.32	0	0.16	0	0.19	0	0.16	0	0.19	0	0.88	0
Cadmium	mg/L	0.00025	0.0003	2.7	0.00012	0	0.00013	0	0.00011	0	0.00013	0	0.00088	100
Chloride	mg/L	-	4.9	NA	3.4	NA	3.2	NA	3.3	NA	3.2	NA	109	NA
Cobalt	mg/L	0.004	0.0014	0	0.0013	0	0.0015	0	0.0011	0	0.0015	0	0.0068	98.7
Copper	mg/L	0.0256	0.0038	0	0.0029	0	0.0029	0	0.0023	0	0.0029	0	0.0041	0
Iron	mg/L	1.5	3.9	100	2.8	99.9	2.8	72.7	2.2	61	2.8	72.9	3.5	100
Lead	mg/L	0.005	0.001	0	0.00097	0	0.00098	0	0.0007	0	0.00098	0	0.0014	0
Manganese	mg/L	1.455	1.1	0	0.82	0	0.76	0	0.53	0	0.76	0	0.79	0
Naphthenic Acids - Labile	mg/L	1	0	0	0	0	0	0	0	0	0	0	0.028	0
Naphthenic Acids - Refractory	mg/L	-	1.1	NA	0.71	NA	0.76	NA	0.69	NA	0.76	NA	7.1	NA
Naphthenic Acids - Inert	mg/L		0.56	NA	0.76	NA	0.42	NA	0.74	NA	0.42	NA	8.1	100
PAH group 1	µg/L	0.281	0	0	0	0	0	0	0	0	0	0	0.0025	0
PAH group 2	µg/L	0.278	0	0	0	0	0	0	0	0	0	0	0.014	0
PAH group 5	µg/L	5.6	0	0	0	0	0	0	0	0	0	0	0.0014	0
PAH group 7	µg/L	5.9	0	0	0	0	0	0	0	0	0	0	0.0075	0
PAH group 9	µg/L	2.3	0	0	0	0	0	0	0	0	0	0	0.0026	0
Selenium	mg/L	-	0.00061	NA	0.00048	NA	0.00047	NA	0.00037	NA	0.00047	NA	0.00099	NA
Sulphate	mg/L	309	139	0	94	0	83	0	90	0	83	0	104	0
Total dissolved solids	mg/L	1000	474	0	342	0	304	0	335	0	304	0	693	0
Total nitrogen	mg/L	-	1.3	NA	0.94	NA	0.89	NA	0.93	NA	0.99	NA	1.9	NA
Total phenolics	mg/L	0.01	0.0018	0	0.0005	0	0.0018	0	0.0008	0	0.0018	0	0.0005	0
Total phosphorus	mg/L	-	0.18	NA	0.13	NA	0.14	NA	0.14	NA	0.14	NA	0.18	NA
Vanadium	mg/L	0.0338	0.0061	0	0.0035	0	0.0046	0	0.0035	0	0.0046	0	0.01	0

[a] Appendix 3.6 Chronic Effects Benchmarks.

CEB = chronic effects benchmark; - = no CEB; NA = no data available.

ATTACHMENT B

Current Socio-Economic Issues and Responses

Table B-1 Current Socio-Economic Issues and Responses

Socio-Economic Area	Issues	Public/Private Sector Response(s)
Policing	• Recruitment and retention issues have historically made it a challenge to fill all allocated positions, but the Wood Buffalo RCMP detachment reports essentially having a full complement of members since 2011, and that recruitment to Fort McMurray is becoming easier (Durance 2013, pers. comm.). • While staff recruitment has improved in recent years, the relatively high cost of housing remains a challenge. Resourcing in rural communities, such as Fort Chipewyan, can be an issue with officer absences due to training affected by travel time (Klenk 2013, pers. comm.). • Community concerns in the region include traffic, drug, and alcohol-related offences. Traffic safety concerns take on a special importance for people living in outlying communities, because community members use Highway 63 to travel to and from Fort McMurray for access to services and amenities. • Aboriginal groups have also raised public safety concerns as a result of increasing numbers of people, such as camp workers, visiting or transiting near or through their communities and traditional lands. • RCMP priorities in the area include: traffic-related issues; organized crime and gangs; property theft; safety of citizens in the downtown core; and police-community relations in rural areas. • Criminal code offences in the urban service area were well above the provincial average (per capita) in 2011; however the crime rate in Fort McMurray has been declining year-over-year since 2008, and is at its lowest level in a decade. Fort McMurray's crime rate is in line with that of Grande Prairie, where the most recent five-year average (2007-11) is 17,450 in Fort McMurray and 16,480 in Grande Prairie. The provincial rate is 9,075 offences per 100,000 over that same timeframe (StatsCan 2013). The crime rate is likely overstated for Fort McMurray, as it is based on the Federal Census population count, which is consistently lower than that recorded in the municipal census. • Discussions with the Fort McMurray RCMP detachment supports the decreasing crime rate trend, as the detachment has seen a relative decrease in activity over the years, but remain busy (Durance 2013, pers. comm.). • In 2012 the RCMP Superintendent for Wood Buffalo stated publicly that, "the great thing about Wood Buffalo, the crime rate is no different than anywhere across the country. As a matter of fact, the crime rate for property crime and persons crime is dropping. There's a perception across the country that the boomtown is nothing but 'run amuck' type of thing; money, oil, etc. and those perceptions are not true. We, as members of the RCMP and members of the community, have to continually get that message out to other citizens across the country, that is not the case. Wood Buffalo is a very, very safe community." (FMT 2012a).	• Regional policing has benefited in recent years from increases in staffing and improvements in infrastructure, including (Durance 2013, pers. comm.): - a staff complement of 211 regular members in 2012 (an increase of 31% from 2009) and a target of 225 members by 2014; - creation of an ALERT team focusing on drugs and organized crime; - a new RCMP main detachment building in Fort McMurray, a LEEDS award-winning building featuring a forensic lab and a fully equipped gym; - a new policing facility in the Gregoire Industrial Park, set to open in the fall of 2013, to house the traffic unit and cell block facility; - a refurbished, storefront office in downtown Fort McMurray. • RCMP employees receive a cost-of-living allowance, introduced in 2007, and increased in the 2010 – 2011 period. • Industrial operators in the region often have in place: - explicit and enforced lodge, workplace, and flight policies with regards to the use of alcohol, drugs, and illegal activities; - in-lodge security, which will assist the RCMP within, and sometimes outside, their individual lease boundaries (e.g., securing accident scenes, assisting with highway closures); - limits on private vehicles brought to the project sites, reducing commuter traffic on Highway 63, thus decreasing the need for traffic enforcement. • Industry has also provided financial contributions towards additional police officer positions in the region. As an example, several of the policing positions in Fort McKay are paid for under special funding arrangements with industry (Durance 2013, pers. comm.).
Emergency Services	• Recruitment and retention challenges have eased for the Regional Emergency Services department in recent years. As of 2013, the urban component of emergency personnel is fully staffed, with the successful completion of another round of recruit hiring. However, volunteer recruitment remains a challenge in selected smaller communities. Recruitment and retention remains a top priority for the Regional Emergency Services department (Gilham 2013, pers. comm.). • Continued population growth signifies higher call volumes for the department, which saw the average annual number of fire and ambulance calls increase by 2,945 calls (33%) between 2010 and 2012 (EMS 2013, pers. comm.). • In 2013 the Regional Emergency Services department reports it continues to meet target response times for both fire and ambulance in the urban service area. However, providing comprehensive emergency response coverage to the region remains a challenge because of the large geographic coverage area. Coordination with AHS, the provincial agency responsible for ambulance delivery, remains an ongoing priority. • The department has previously raised concerns regarding the transportation of hazardous goods on Highway 63 through Fort McMurray and the response time/coverage implications with respect to traffic incidents on Highway 63.	• The RMWB continues to increase staffing and infrastructure for emergency services, particularly in the urban service area: - The number of full-time fire and ambulance staff has increased from 116 personnel in 2007, to 124 in 2011, to about 165 in 2013. - Infrastructure improvement plans over the next few years include continued fleet modernization, construction of a new station in the Parsons Creek neighbourhood, a major renovation or rebuild of Fire Hall No. 1, and construction of new (replacement) stations in Fort McKay and Anzac. • The new mobile training unit, introduced a few years ago to improve access to firefighter training in rural areas, is still in use and is working well (Gilham 2013, pers. comm.). • Industrial operators in the region often have in place: - emergency response plans, including integrated incident/crisis management teams, full-time certified emergency responders, and auxiliary emergency response teams; - mutual aid agreements with the RMWB and other oil sands companies that include: responding to motor vehicle accidents on Highway 63; advanced life support and ambulance support to rural residents, including transfers to the Fort McMurray hospital; responding to forest fire threats; responding to regional oil spills, and participating in the management of regional emergencies at the RMWB's Regional Emergency Operations Centre. • In 2010, the RMWB completed a review of 21 municipal service functions, including fire response services, in rural communities in the region. The Rural Service Delivery Review Report is intended to serve as a guiding document for the municipality to strategically direct and coordinate rural service delivery (RMWB 2010).
Health Services	• The recruitment and retention of health care professionals and support staff, a challenge experienced by health regions across the country, is intensified due to the area's remote location, limited supply of affordable housing, higher cost of living and wage competition with industry. • A concern in the region, as it is in many rural areas of the province, is adequate access to appropriate health services that is comparable to other parts of the province. • Pressure remains on health care delivery as a result of continued population growth in the RMWB, including the demands of out-of-region residents. • Visiting specialists help to increase on-site service delivery at the Northern Lights Regional Health Centre (hospital); however rotation schedules result in lack of continuity in physician oversight of patient cases (Kirschner 2013, pers. comm.). • Rural community residents are reliant on the regional hospital for many medical services and are concerned about long wait times including at the emergency department. Other health concerns include alcohol and drug use and Elder care. Residents of Fort Chipewyan have raised a number of concerns with respect to cancer rates in the community.	**Recruitment of additional physicians and other health providers** While health staffing issues remain a concern in the Wood Buffalo region, improvements have been made in recent years: • A 2009 survey, the latest available, of patients visiting the Northern Lights Regional Health Centre's emergency department found that 83% of respondents reported having a regular family doctor or specialist, as compared to only 73% in 2007 (HQCA 2010). According to the Wood Buffalo Primary Care Network website, there are 9 physicians accepting new patients. (WBPCN 2013). • According to the College of Physicians and Surgeons of Alberta, Fort McMurray has 68 physicians as of March 2013, up from 60 (13%) in 2012 (CPSA 2013). • Northern Lights Regional Hospital Administration (Bradley 2013, pers. comm.) reports: - The health zone is showing success in attracting family physicians to the community; - The hospital continues to experience high turnover rates of staff in basic positions, but is able to fill the vacancies. Recruitment and retention of specialists remains a challenge. The hospital currently has a selection of specialists available, and are in the midst of recruiting additional specialists. The hospital also continues to bring in specialists on a rotation basis, typical to a centre of that size. • Health workers in the AHS North Zone are included in the provincially funded northern living allowance program. **Additional funding to address health-related growth pressures** In response to the Radke Report, the Government of Alberta committed an additional $177 million between 2007 and 2010 to "address health-related growth pressures" in the region (Government of Alberta 2007a). More recently, the Government of Alberta provided Alberta Health Services 6% operating funding increases at the provincial level each year from 2010 to 2012 (Government of Alberta 2010a).

Table B-1 Current Socio-Economic Issues and Responses (continued)

Socio-Economic Area	Issues	Public/Private Sector Response(s)
Health Services (continued)	• Some physicians in the region are requesting payment up-front from residents with out-of-region health cards because of uncertainty that these residents are covered, or additional barriers incurred in attempting to receive remuneration from other provincial health plans (FMT 2010). • The lack of available office space, both commercially as well as in the hospital, creates challenges for local and visiting physicians. • The need remains for additional regional health infrastructure, including increased maternity beds, a continuing care facility in the region and a health and wellness centre in the northern part of the urban service area (Kirschner 2013, pers. comm.).	**Additional investments in regional health infrastructure** Since 2006, the provincial government has made more than $12 million in infrastructure improvements to the Northern Lights Regional Health Centre, including renovations of the ambulatory, emergency, intensive care and pediatric units, mechanical system upgrades, additional equipment and beds, and a new nursing station. Other changes at the hospital include: • expansion of the emergency department capacity by roughly 50%; and • temporary renovations to accommodate the growth in maternity needs. Hospital administration is currently developing a new building master plan as a means of improving utilization of the current site, which has room for expansion (Bradley 2013, pers. comm.). Other changes in health care delivery in the region include: • a new walk-in clinic, opened in the downtown area in 2013, which will help address some of the needs of patients without regular physicians; and • creation of a new fixed-wing air ambulance base with critical care team in Fort McMurray (FMT 2013). Planning is also underway for: • a long-term care facility and community health centre in the neighbourhood of Parsons Creek (FMT 2012c); and • two new community health centres in the Fort McMurray communities of Thickwood and Timberlea ($28.2 million, in planning phase) (Government of Alberta 2010b). The municipality is also considering the development of an aging in place facility in the Fort McMurray City Centre (FMT 2012d). **Reduction in emergency wait times** For the past four years (2008/09 to 2011/12), the Northern Lights Regional Health Centre emergency department discharged a higher percentage of patients within the targeted timeframe (less than 4 hours) than emergency departments in Edmonton, Grande Prairie, and Lethbridge (AHS 2013). Administration reports the Emergency Department has been able to reduce wait times while at the same time experiencing increased visits (Bradley 2013, pers. comm.). **Commitment to Fort McKay and Fort Chipewyan Health Study** To address health-related community concerns in Fort McKay and Fort Chipewyan, the provincial government is planning a three-year community health assessment, to be conducted by a research team from the University of Calgary. The study is expected to involve Fort McKay First Nation, Athabasca Chipewyan First Nation, Fort McKay Métis, and the Nunee Health Authority. It is expected that the research team and community members will work together to develop the study approach and identify health priorities. The Mikisew Cree First Nation, however, has indicated that they will not take part in the study due to concerns over the study's focus (i.e. cancer rates relative to other health issues), the level of community involvement, and ownership of the data (NP 2013). **Assistance from the oil sands industry** The oil sands industry addresses health service delivery challenges in the region through a variety of means, including: • A number of oil sands companies have their own health care facilities at their work sites to treat employees and contractors; and • Donations of funds and in-kind support to the Northern Lights Regional Health Foundation, a not-for-profit charitable organization established to strengthen health care for residents in the RMWB. Over the past five years, the Foundation has donated $10 million to AHS for regional health care initiatives. Industry support represents approximately 80% of those funds (Chaffey 2013, pers. comm.). • Several industry proponents have signed separate Memoranda of Understanding (MOUs) with the former Northern Lights Health Region (now, Alberta Health Services-North Zone) with respect to the provision of increased health services by proponents to lodge-based workers in the region.
Education	• According to Accountability Pillar Survey results from Alberta Education, between 87% and 88% of teachers, parents and students surveyed in 2012 were satisfied with the overall quality of basic education in the Fort McMurray public and separate school systems. This is comparable to the provincial average of 89%. In comparison, 79% of teachers, parents and students surveyed in the Northlands School Division – which offers educational services throughout northern Alberta, including the communities of Fort McKay and Fort Chipewyan – were satisfied with the overall quality of basic education (AE 2012). • Schools in high-growth neighbourhoods are experiencing enrolment pressures. In many cases, growth is managed through modular classrooms, although in 2013 requests for portables are on hold with Alberta Education, due to budget constraints (Gagnon 2013, pers. comm.). • High growth in new neighbourhoods, such as Parson's Creek requires additional schools to be built. • Growth in students new to Canada has required an increase in English language learning programming services (FMCSD 2012). • Challenges faced in school board operations in the region include (FMPSD 2012; FMCSD 2012; NSD 2012): - regular turnover in support staff, that take higher paying industry jobs; and - securing contractors at affordable rates, for services such as transportation, construction and maintenance. • Cost of housing has been an issue in attempting to attract and retain staff. Teachers have had difficulty finding suitable accommodation even with the provincial Cost of Living Allowance, although a recent increase in the vacancy rate has somewhat eased this challenge (Mankowski 2013, pers. comm.).	**New school infrastructure and other supports** • Ecole McTavish Junior High School opened in September 2011. Initial capacity is 800 students but is set to increase to 1,100 students when 12 portable classrooms are added (FMPSD 2011). • Holy Trinity Catholic High School, which includes a locally funded performing arts centre, opened in September 2011. The school is essentially at full capacity, and the Division has requested 8 portables for 2014 (Gagnon 2013, pers. comm.). • The Catholic and Public Boards are currently each constructing new Kindergarten to Grade 6 schools in Timberlea, which will share the same building. The combined facility, which will accommodate 1,200 students, is expected to be ready for the commencement of the 2014 school year. Another public Kindergarten to Grade 6 school is to be built in Timberlea by 2016 (FMT 2012b), while the Catholic Division expects to develop a new public elementary school in the Parsons Creek area (Mankowski 2013, pers. comm.). • Aside from new schools, the provincial government has also committed funds in recent years to other capital projects which can help increase existing capacity, including additional modular classrooms and school modernization projects. For example, Father Mercredi High School has been renovated with a new locally funded Science and Technology Centre (FMCSD 2012). • The creation of an Aboriginal Youth Entrepreneurship Program, in partnership with the Paul Martin Foundation, for students attending Father Patrick Mercredi High School. **Attraction and retention of teaching staff** • Both Public and Catholic school divisions utilize a number of measures to help in attracting and retaining staff, including housing allowances, reserved teacher housing and induction programs offering support to teachers new to the region. Both divisions report good retention and having full staffing complement.

Table B-1 Current Socio-Economic Issues and Responses (continued)

Socio-Economic Area	Issues	Public/Private Sector Response(s)
Education (continued)	• In 2012, high school completion rates (three-year rate) were 77.8% and 73.1% for Fort McMurray's separate and public school systems respectively. The provincial average was 74.1% (AE 2012). • The dropout rate for First Nations, Métis and Inuit (FNMI) students has substantially decreased in the Fort McMurray Public School District (FMPSD 2012). Challenges remain though in high school diploma exam participation and success, as well as continuation to post-secondary education. The Fort McMurray Catholic Division reports a lower drop-out rate for FNMI students than non-aboriginal students, and a 3-year completion rate that exceeds the provincial average for aboriginals (FMCSD 2012). • The delivery of education services in rural communities has a number of challenges including: limited programming due to small school population; aging school infrastructure; and difficulty in attracting and retaining school staff. • The Northlands School Division, whose student population is largely First Nations, Métis, or Inuit (FNMI), had a high school completion rate of only 17.5% in 2012, up from 13.5% in 2011 (AE 2012). Provincial Accountability Pillar education indicator results for the Athabasca Delta school in Fort Chipewyan exceed the average for the Northlands School Division, but rank below the overall provincial average (Flieger 2013, pers. comm.). • Concerns have been raised about persistently weak student learning outcomes in the Northlands School Division and other matters relating to the governance of the jurisdiction, resulting in dissolution of the former board in 2010 and appointment of a managing trustee. • Most of the challenges faced by Northlands schools within the RMWB are similar to those in other schools within the school board's jurisdiction (but outside the RMWB). One issue particular to the region is high competition with industry for support staff, including drivers and cooks. Schools in the region also have much higher industry support and related-programming in comparison to schools in other parts of the division (Barrett 2013, pers. comm.). • The presence of industry has had mixed effects with regards to education delivery in Fort Chipewyan, including (Flieger 2013, pers. comm.): - Community investment programming from industry helps fund key initiatives that complement basic education curriculum. - Employment opportunities, made possible by fly-in/fly-out (FIFO), help attract families back to the community, resulting in increasing enrolment at the Athabasca Delta school. However, FIFOs can also impact the level of parental engagement with their children's education. - Industry-related employment and training opportunities assist Aboriginal youth in finding wage employment, but sometimes have the unintended consequence of encouraging children to leave school early. • Education concerns among rural communities also include difficulty for students transitioning from a rural to urban setting to access education and training and challenges in facilitating the transfer of traditional knowledge, including language, from Elders to young people. • Keyano College has experienced increasing enrolment in recent years. However, the economic recession created resourcing challenges for the college as grant funding from Alberta Advanced Education and Technology was reduced and corporate training opportunities were cut back.	**Northlands School Division** • In 2010 the Minister of Education dismissed the Corporate Board of Northland School Division due to performance and parental concerns. A provincial trustee was appointed to undertake an inquiry and develop recommendations. A new Superintendent and team are currently implementing 48 recommendations from the review. The Education Minister will decide in fall 2013 the next steps for the Division. • According to the Division, improvements are being achieved, albeit slowly (Barrett 2013, pers. comm.). Progress to-date include: - graduation of 21 new teachers who will be returning to live and teach in communities within the Division – a factor important to long term change; - stewardship programs, that offer high school students experiential learning opportunities focusing on traditional knowledge and language retention, as well as work experience; - literacy initiative targeting early grades in support of language skills development; and - an increase in the high school completion rate in 2012. • Industry is supporting a number of school initiatives within the Division, both individually and through collaborations, like the Oil Sands Leadership Initiatives (OSLI) partnering with schools in Fort Chipewyan and Janvier. • Experiential-based learning programs are having a positive effect in student engagement, teacher retention and community relations in Fort Chipewyan (Flieger 2013, pers. comm.). • Fort Mckay First Nation is in the financial position to assume responsibility for the provision of housing for teachers in the community - an assistance to Northlands Division (Barrett 2013, pers. comm.).
Social Services	• Social and community service providers flag a number of issues linked to population growth and economic expansion, including: - work demands taking time away from family and community life; - reduced community cohesion and a sense of transience among residents; - alcohol and drug use and gambling; - displaced/terminated lodge-based workers placing additional demands on the homeless serving agencies in the region (Evasiuk 2011 pers. comm.); - high demand for affordable child care spaces (Christopher 2013, pers. comm.). • In line with many social service providers in the province, agencies in the region are challenged by the ad hoc and project-specific nature of funding sources. • A number of social and community agencies also experience difficulties in attracting and retaining personnel and volunteers. In many cases, experienced workers have been attracted away by higher-paying jobs or better working conditions in other sectors, such as the oil sands. • Decreased community cohesion and increased social and family stressors have also been raised as concerns in rural, largely Aboriginal communities, as a result of a number of issues, including: reduced engagement in traditional activities; increased work commitments; and increased availability and abuse of alcohol and drugs. • Despite the presence of a number of social issues, there are fewer social services available in Fort McKay and Fort Chipewyan as compared to the urban service area. The need for substance abuse programs has been raised in both communities. The isolated nature of both communities presents challenges for delivering services in the communities (e.g. staff recruitment, costs) as well as making it more difficult for people in these communities to access services in Fort McMurray (e.g. distances, lack of all-weather road to Fort Chipewyan).	• The RMWB developed its own 10-year plan to end homelessness which aligns with the provincial plan to end homelessness and outlines actions to build community support for Housing First. The latest homeless count (2012) indicated 326 people identified themselves as being homeless in Wood Buffalo. The homeless population remains essentially unchanged from 2010 and remains 41% below levels experienced in 2008, highlighting progress made in implementing the 10-Year plan (RMWB 2012a). • The Government of Alberta has been providing its monthly cost-of-living allowance to employees of provincially funded social service organizations in Fort McMurray since 2007. • A number of province-wide government programs have benefited the RMWB in recent years, such as Alberta's 10-year provincial strategy to end homelessness and Alberta's Making Space for Children: Child Care Space Creation Innovation Fund, including a Fort-McMurray specific top-up (ACYS 2013). • The new Fort McKay Elder and Day Care Centre opened in January 2010, replacing the original building that was destroyed by fire in 2007. • The existing nursing station in Fort Chipewyan is being renovated to serve as a full-fledged care facility for elders. Scheduled for completion by the end of 2013, the centre is funded by the MCFN along with a $500,000 contribution from Shell Canada through its Social Investment Areas program (NJ 2013). • In 2010 the RMWB completed a review of 21 municipal service functions, including family and community support services, in rural communities in the region. The Rural Service Delivery Review Report is intended to serve as a guiding document for the municipality to strategically direct and coordinate rural service delivery (RMWB 2010). • The oil sands industry has invested in a number of community projects, programs and events. The latest Oil Sands Developers Group (OSDG) member survey indicates that industry contributed over $11 million to groups and organizations in the region in 2010, and roughly $80 million over the past 8 years (OSDG 2011).

Table B-1 Current Socio-Economic Issues and Responses (continued)

Socio-Economic Area	Issues	Public/Private Sector Response(s)
Housing	• Strong population growth in Fort McMurray combined with a lack of available land and high costs of development have historically contributed to a housing shortage in Fort McMurray. • Housing costs are the principal contributor to a higher cost of living in Fort McMurray. The average price for single family dwellings more than doubled between 2003 and 2008 before dropping in 2009 in response to the economic recession. House prices began increasing again in 2010, rising to levels comparable with 2008. In 2012 house prices in Fort McMurray continued climbing, with an average sale price reaching $751,000 (FMREB 2013). • Between 2003 and 2008 rental rates roughly doubled, and vacancy dropped to near zero. Despite decreasing by 10% between 2010 and 2012, average rental rates in the Wood Buffalo region remain the highest in Alberta. Vacancy rates, which increased from 5.5% in 2010 to 9.6% in 2011, declined back to 5.9% in 2012 (CMHC 2012a). • The price of housing continues to make recruitment and retention of staff a challenge, especially in sectors where wage rates are relatively low, such as social supports and the service sector. • High housing costs and lack of affordable housing has given rise to homeowners renting out rooms on the formal or informal rental market. This has a number of effects, including: providing homeowners with mortgage assistance; driving increased density within a community; and placing pressure on neighbourhoods via increased traffic and parking congestion. • The effect of high housing costs on the residents of Fort McMurray is dependent upon income levels. For many residents, particularly those working in the oil sands sector, higher wages, as well as housing allowances, help to offset high housing prices. However, not all residents benefit from high earning opportunities. With rising house prices, lower-income residents in particular (e.g., workers employed in the service sector, lone-parent and single-income households), are put under increased pressure to find affordable accommodation. • Despite a slowdown in housing starts in recent years, the market has shown resiliency in the past by quickly increasing housing starts in response to strong demand. Housing starts in the region increased rapidly, from 861 in 2004 to 2,175 in 2007, before dropping to 780 in 2011 and 637 in 2012 (CMHC 2005, 2008, 2012b). • Many rural communities in the RMWB are also experiencing housing pressures due to a number of factors, including: increased demand from community members returning, often from Fort McMurray, to avoid high housing prices there; a relatively young population, many of whom are in early family formation and looking for owned housing; and housing policies and funding allocations by Aboriginal Affairs and Northern Development Canada (AANDC) that lag demand, resulting in a shortage of available, affordable and suitable rental and ownership housing.	**Ongoing Planning and Development** A number of planning initiatives have been completed or are underway in an effort to increase available land for residential development and other uses in the various communities in the region. Chief among these plans is the RMWB's Municipal Development Plan (MDP) which outlines the municipality's future growth plans. Other initiatives include: • the creation of the Urban Development Sub-region (UDSR) in summer 2013. The UDSR is approximately 22,386 hectares (ha) of provincial land surrounding Fort McMurray where future urban development is the primary intended land use. The intention of the UDSR is to facilitate land use planning, timely release of land for urban development and efficient infrastructure planning and construction to accommodate population growth and urban expansion (Government of Alberta 2013a,b). • adoption of the City Centre Area Redevelopment Plan and, more recently, plans towards its implementation (RMWB 2012c). • preparations for the development of new communities in Fort McMurray, including: development of the Parsons Creek Design and Outline Plan (and extension of the urban services area to include the Parsons Creek Area); and commitment of funds and a release of lands to develop the Parsons Creek and Saline Creek Plateau areas (AHUA 2009a; MM 2012). • attention to rural communities, including the development of new planning frameworks for rural RMWB communities and market demand studies regarding residential lot development in the hamlets of Fort Chipewyan and Anzac in 2011 and 2012, respectively. These studies are aimed at informing Area Structure Plans (ASP) and potential land releases from the municipality. In addition, in Fort McKay, the Métis have announced plans to construct four housing units for its members, commencing in 2013. The development of communities in the RMWB will also be influenced by other planning initiatives currently underway, most notably the Regional Structure Action Strategy (RSAS), LARP and AOSA CRISP. The RSAS process has been initiated by the RMWB to facilitate and coordinate the implementation of various planning initiatives at both the provincial and municipal levels. The RSAS includes a task force comprised of municipal, provincial and industry representatives and is expected to develop its action strategy by the end of 2013. **Support for Social and Affordable Housing** The Wood Buffalo Housing and Development Corporation (WBHDC) currently has projects underway to increase the supply of affordable housing in the region. Between November 2006 and June 2011, the WBHDC added over 680 affordable housing units, and is in the process of constructing an additional 175 units ready for occupancy by 2015. The Corporation's waiting list, which fluctuates from year to year, currently contains 490 individuals and families, 280 of which require social housing (Lutes 2013, pers. comm.). Additional support has also been provided in recent years for social and affordable housing in the region, including: • $45 million from the Government of Alberta to develop 300 affordable housing units in the RMWB (Government of Alberta 2007a); • Continuation of the northern (or housing) allowances paid to public sector workers, in place since 2007 (Government of Alberta 2007b); • $11.7 million from the Government of Alberta for the Fort McMurray Family Crisis Society to develop a 78-unit apartment, under construction in 2013, with a second phase planned (Lutes 2013, pers. comm.); and • a commitment that 20% of the 2,000 new homes associated with the first phase of Parsons Creek development will be designated as affordable housing, with rents to be set below market rate (AHUA 2009a); **Project Accommodations** • Oil sands facilities are routinely supported by construction camps. As well, several oil sands developments have, or plan to have, operations camps. Driven mostly by health and safety considerations linked to long daily commutes, operations camps also help to limit demands on the local housing market that otherwise would occur in the absence of camps.
Recreation Infrastructure and Services	• The RMWB and residents of the Wood Buffalo region have previously expressed concern regarding the limited number of recreation facilities. A number of new recreation facilities and amenities have been built in recent years in response to these concerns. • Similar to other sectors in the area, recreation service providers have experienced staff recruitment and retention challenges. • With increasing industrial development and associated population, access to backcountry areas is growing, thus increasing competition with traditional land practices. • Many campgrounds are being used as semi-permanent accommodations by mobile workers, thus reducing their availability for recreational users.	**Additional recreation facilities and amenities** The RMWB, the Province of Alberta, industry and other stakeholders have added new recreation facilities and amenities in recent years, including: the Syncrude Sports and Wellness Centre (2007); the expanded Syncrude Timberlea Athletic Park (2008), and redevelopment of MacDonald Island Park. In July 2012, RMWB council also approved a $127 million expansion at MacDonald Island Park, which includes an outdoor performance centre, community pavilion, and conference centre (MacDonald 2012). **Rural service delivery review** In 2010 the RMWB completed a review of 21 municipal service functions, including recreation programs, in rural communities in the region. The Rural Service Delivery Review Report is intended to serve as a guiding document for the municipality to strategically direct and coordinate rural service delivery (RMWB 2010). **Industry response** Industry has responded by: • providing workers with recreation opportunities in-camp, including exercise and games rooms; • providing the RMWB with data in support of its recreation planning and development; and • playing a key role in providing financing for major recreation centres in the region (e.g. MacDonald Island Park).

Table B-1 Current Socio-Economic Issues and Responses (continued)

<table>
<tr><th>Socio-Economic Area</th><th>Issues</th><th>Public/Private Sector Response(s)</th></tr>
<tr><td>Recreation Infrastructure and Services (continued)</td><td></td><td>Lower Athabasca Regional Plan (Land Use)
One of the LARP objectives is to “provide a wide range of recreation and tourism opportunities that meet the preferences of regional residents and visitors” (Government of Alberta 2012a). Among the strategies identified for achieving this objective are:
• designate new provincial recreation areas to address growing demand for recreational opportunities in the region and provide a secure land base to support tourism development;
• create new public land areas for recreation and tourism in the region that contain unique features or settings;
• develop the regional parks plan for the Lower Athabasca;
• collect regional data in the form of a recreation and tourism resource inventory that includes the completion of a scenic resource assessment inventory and a regional recreational demand and satisfaction survey; and
• in collaboration with Aboriginal and other community stakeholders and partners, coordinate the development of the Lower Athabasca Regional Trail System Plan.</td></tr>
<tr><td>Municipal Infrastructure and Services</td><td>• As the RMWB population grows, the municipality experiences increasing demand for both municipal infrastructure and services. The municipality has some concerns with meeting infrastructure and service demands, including:
- the relatively higher costs of providing infrastructure in the RMWB as compared to municipalities in the southern half of the province; and
- reduced management capacity within the municipality as a result of staff attraction and retention difficulties.
• Planned oil sands developments will drive further population growth and demand for municipal infrastructure and services.</td><td>Increased Investment
• The RMWB has invested in major infrastructure developments, including new RCMP detachment buildings and fire halls. Under the RMWB’s 2012-2014 Fiscal Management Strategy, the municipality is set to invest a further $1.7 billion in capital projects between 2013 and 2017, in addition to the $728 million in projects to be completed in 2012 (RMWB 2012b).
• The RMWB has received assistance from the provincial government in recent years, including:
- $3.6 million over 3 years (2007 to 2010) to provide strategic municipal planning support to the RMWB;
- $103 million in funding, in addition to a $136 million four-year interest-free loan, to build a replacement sewage treatment facility and an upgraded water treatment plant in Fort McMurray;
- $30 million to support the lower town site water collection system upgrader; and
- $15 million for regional landfill development.
Increased Planning
• The municipality has recently updated their Municipal Development Plan (MDP). The RMWB has also invested significant time and resources in updating their municipal infrastructure master plans to accommodate future population growth.
• A population forecasting tool and long-term municipal fiscal model for the RMWB have also been developed.
• Planning and investment currently underway assumes population levels above the population estimate associated with the PDC.
Increased Resources
• The RMWB has a number of initiatives in place to address staff recruitment and retention, including a housing allowance, relocation assistance and house equity protection.
• Growth in oil sands development has increased demands on the municipality, but it has also provided the RMWB with increased financial ability to respond to these demands. Property assessment in the Rural Service Area of the RMWB, which consists mostly of oil sands industry facilities, grew on average by 20% per year from $6.6 billion in 2005 to $29.0 billion in 2013. As planned oil sands development proceeds, non-residential assessment will continue to grow, increasing the municipality’s ability to pay for municipal services and infrastructure.
The RMWB’s Fiscal Management Strategy 2012 to 2014 notes that, “In general, the municipality is in a strong financial position”, and that the rural non-residential taxation class “will have a tax burden that provides the municipality with a balanced budget while taking into account other taxation classes” (RMWB 2012b).</td></tr>
<tr><td>Transportation</td><td>• Oil sands expansion in the RMWB has led to increased traffic throughout the region and beyond. Traffic volumes on Highway 63 over the last five years have increased by roughly (AT 2012a):
- 2% per year between Fort McMurray and the Suncor turnoff;
- 12% per year on north of Fort McKay.
• Volumes continue to increase as oil sands expansion and related population growth in the region continues. Traffic volumes outside of Fort McMurray are higher to the north than the south, reflecting the daily traffic generated between the urban service area and the oil sands facilities to the north.
• There are serious concerns among regional residents with respect to traffic safety on Highway 63. It has been reported that since 1990 approximately 125 people have died in collisions along the highway (CH 2012). It is these concerns which have led to increased scrutiny, the call for twinning Highway 63, and more recently, dissatisfaction expressed with the pace of the twinning work.
• Collision rates on both Highway 63 and 881 within the study area remain below the provincial average for comparable roadways.
• Industrial activity has resulted in an increased volume of larger vehicles and the transportation of hazardous materials in the region, including through the urban service area of Fort McMurray, creating safety concerns among residents.
• Daily and weekly shift change peaks, as well as over-dimensional load movements, result in traffic congestion within Fort McMurray and along Highway 63, as well as segments of Highway 881.
• The municipality has also raised concerns as to whether provincial planning and investment in the regional transportation network can keep pace with growth in the urban service area (i.e. the need for new transportation networks to access residential communities)</td><td>Road Infrastructure Improvements
Road infrastructure in the study area continues to undergo changes and improvements. A key component is the twinning of Highway 63, the primary roadway in the region, connecting southward with the wider provincial road network. Twinning work completed, as well as planned, includes the following segments:
• Fort McMurray to Suncor, completed in 2002;
• Suncor to Syncrude, completed in 2008; and
• Highway 69 to Highway 881/Anzac turnoff, completed in 2008.
South of Fort McMurray, the provincial government committed in 2006 to twinning a 225-km segment from north of Highway 55/Grassland to the Highway 881 turnoff. A 16-km segment north of Wandering River has been twinned and a further 36-km is currently being twinned (completion expected in 2013). A number of engineering and environmental studies have also been completed and an additional 99 km of Highway 63 is expected to be twinned by 2015 (Government of Alberta 2012b).
Several other major road infrastructure projects have also either recently completed or are underway including:
• construction of a five-lane bridge across the Athabasca River in Fort McMurray (completed in 2011);
• construction of interchanges at the intersections of Thickwood Boulevard and Confederation Way with Highway 63 (completed in 2011)
Industry has also supported a number of road improvements including:
• construction of the Suncor interchange over Highway 63; and
• improvement to the Fort McKay turnoff along Highway 63.</td></tr>
</table>

Table B-1 Current Socio-Economic Issues and Responses (continued)

Socio-Economic Area	Issues	Public/Private Sector Response(s)
Transportation (continued)		**Safety Along Highway 63** As a result of regional concerns with traffic safety on Highway 63, Mike Allen, MLA for Fort McMurray-Wood Buffalo, was named Special Advisor to the Minister of Transportation in May 2012. Based on recommendations contained within his report to the Minister, *Towards A Safer 63*, the Government of Alberta has committed to implementing certain measures, including (AT 2012b,c,d): • developing recommendations for accelerating Highway 63 twinning; • accelerating construction of new and extended passing lanes; • increasing the number of full-time integrated enforcement officers; • installing new digital signs to provide instant feedback on drivers' speed; and • increasing billboard and radio campaigns that target safe speeds, motorcycle safety, and driver attitudes. **Planning** • The Alberta Oil Sands Sustainable Development Secretariat, in co-operation with several Alberta government departments and local area municipalities, has developed the Athabasca Oil Sands Area (AOSA) Comprehensive Regional Infrastructure Sustainability Plan (CRISP) which lays out the potential infrastructure requirements, including highways, required for a future scenario in which the Athabasca Oil Sands Region (Wood Buffalo region, plus the Wabasca Desmarais region) produces six million barrels per day (bpd) (Government of Alberta 2011). • In early 2012 the Government of Alberta announced the creation of the Athabasca Oil Sands Area Transportation Coordinating Committee, a new advisory committee comprised of municipal, provincial and industry representatives who will review and make recommendations on current and future transportation needs in the region (AI 2012).
Mobile Workers	• The non-resident population has grown considerably over the past decade, from about 6,000 people in 2000 to over 40,000 in 2012 (RMWB 2012d). • Approximately 95% of the non-resident population lives in work camps. The bulk of the camp population is located to the north of Fort McMurray. There are relatively fewer workers in camps south of Fort McMurray, mostly in the Conklin area. The remaining non-resident population lives primarily in hotels, motels and campgrounds in, or near, the urban service area. • Most of the workforce camps are temporary construction camps, but there are an increasing number of permanent operations camps. As oil sands operations move farther from the urban service area, additional permanent operations lodges are being established in light of health, safety and worker efficiency considerations. • Experience has shown that mobile workers have an effect on certain services in the region, including: - increase in the number of visits to emergency and walk-in medical facilities; - increase demand on police services; and - increase demand on some social support programs. • Concerns have been expressed that mobile workers increase the sense of transience that further weakens the sense of community. • Fort McKay has expressed concern regarding the size of the non-resident population in proximity to their small community. • Concerns have also been raised in regards to the permitting and oversight of these camps by responsible authorities. The RMWB has expressed concern that the permitting process by Alberta Environment and Sustainable Resource Development (ESRD) is not well coordinated and monitoring and enforcement is insufficient.	• Because most camp-based workers reside permanently outside the region, work camps: - reduce the effects of industrial development on the resident population of the RMWB - reduce the effects of industrial development on regional service providers and infrastructure - reduce the number of workers with spouses and family members in the region who would otherwise be available to fill job vacancies in the region - allow spouses and family members of camp-based workers to remain active in the labour force in the community in which they permanently reside - spread the economic benefits of industrial development to other communities • Many effects from camp-based workers drawing on local infrastructure and services are mitigated by camp distances from Fort McMurray, restrictions on personal vehicles allowed on-site and available camp services. • As the size of the camp-based population has grown, camp providers have increased the breadth and quality of on-site camp amenities and services including security, health and recreational services. Improvements have also been made in the content and layout of individual rooms and shared spaces, quality of food services available and free-time activities offered. While these improvements serve to attract workers to the region, they also help to reduce the demands of the non-resident population on existing services and infrastructure. • The growth in the camp-based population has given rise to further work by the Oil Sands Secretariat on determining the size and nature of camps in the area, as well as discussions regarding ways of improving the coordination of camp services and locations.

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