Section E
Environmental Assessment

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E ENVIRONMENTAL ASSESSMENT

This section of the Robb Trend Mine Extension Project (Project) application constitutes the Environmental Impact Assessment (EIA) for the Project. Environmental baseline reports and impact assessments for each environmental and socio-economic discipline are contained in Consultants Reports (#1 - #14). This section includes CVRI's evaluation and summary of pertinent information for each discipline. The EIA report summarizes the anticipated environmental impacts of the Project and options for further monitoring and mitigative measures relating to these impacts. The Socio-Economic Impact Assessment is presented in detail in Consultants Report #9. A summary of these impacts is also included in this section.

The full methodology used in this assessment was provided in Section D. Within the context of this application the overall footprint is 5728.6 ha as shown in Table C.2-2. In order to evaluate the potential environmental impacts from the Project, the existing database from the area was analyzed, selected core information on each discipline from the Project area was collected and both were synthesized into an assessment. This type of assessment has the advantages of building on existing information and is therefore a reliable predictor of events. Since the Coal Valley Mine (CVM) has an operating history, a significant amount of site specific information exists, which is considerably different from a greenfield project.

The final Terms of Reference (ToR) were issued for the Project on August 4, 2011 and contained a number of conditions related to the information requirements for this EIA. These conditions from the ToR have been addressed in this section of the applications well as in the specific Consultant's Reports.

The EIA Report considers the following assessment scenarios:

- Baseline Case, which includes existing environmental conditions and existing projects or "approved" activities;
- Application Case, which includes the Baseline Case plus the Project; and
- Planned Development Case (Cumulative Effects), which includes the "Application Case", combined with past studies, existing and anticipated future environmental conditions, existing projects or activities, plus other "planned" projects or activities.

For the purposes of defining assessment scenarios, "approved" means approved by any federal, provincial or municipal regulatory authority, and "planned" means any project or activity that has been publicly disclosed prior to the issuance of the ToR or up to six months prior to the submission of the EIA Report, whichever is most recent.

The EIA Report has addressed impact concerns by identifying Valued Environmental Components (VECs). VECs are those environmental attributes associated with the Project, which have been identified to be of concern either by directly-affected stakeholders, government or the professional community. VECs consider both biophysical (*i.e.,* ecosystem) and socio-economic attributes because of the broad-based definition of environmental effect as outlined both in federal and provincial legislation.

The factors used to assess the predicted environmental effects of the Project are specific to the VECs for each biophysical or socio-economic component. For example, the assessment of environmental effects and determination of significance for each VEC which is population based (*e.g.,* fish, wildlife, vegetation) may not be applicable for those VECs which are not population based (*e.g.,* air quality, groundwater). This section identifies potential adverse effects and the assessment of their significance. Where possible, the determination of significance makes reference to existing standards, guidelines or recognized thresholds (*e.g.,* Alberta Ambient Air Quality Objectives).

E.1 AIR QUALITY

E.1.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of air quality for the proposed Project. The following section is a summary of the Air Quality Assessment that was prepared by Millennium EMS Solutions Ltd. and is included as Consultant Report #1 (CR #1). For full details of the assessment, please refer to CR #1.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the air quality component are provided in Section 2.7 and Section 3.1, and are as follows:

2.7 AIR EMISSIONS MANAGEMENT

[A] Identify the type, volume and source of air emissions for the proposed Project:

a) identify all potential sources of emissions (total particulates, PM_{10}, $PM_{2.5}$, CO (carbon monoxide), NO_x (oxides of nitrogen) and SO_2 (sulphur dioxide)) from the Project, including, but not limited to, mining activities, coal handling facilities, vehicles, roadways, and other related activities;

b) describe any mitigation, monitoring and control systems that CVRI proposes to reduce potential impacts from emissions;

c) describe the air management program to address all relevant fugitive dust and other emissions;

d) describe the annual and total greenhouse gas emissions during all stages of the project. Identify the primary sources and provide examples of calculations; and

e) describe CVRI's overall greenhouse gas management plans.

3.1 AIR QUALITY, CLIMATE AND NOISE

3.1.1 Baseline Information

[A] Discuss the baseline climatic and air quality conditions including:

a) the type and frequency of meteorological conditions that may result in poor air quality; and

b) appropriate ambient air quality parameters.

3.1.2 Impact Assessment

[A] Identify components of the Project that will affect air quality, and:

a) *describe the potential for reduced air quality resulting from the Project and discuss any implications of the expected air quality for environmental protection and public health;*
b) *estimate ground-level concentrations of appropriate air quality parameters;*
c) *discuss any expected changes to particulate deposition or nitrogen deposition patterns; and*
d) *discuss interactive effects that may occur resulting from co-exposure of a receptor to all emissions.*

[D] *Describe how air quality and noise impacts resulting from the Project will be mitigated.*

[E] *Describe the residual air quality of the Project and the Proponent's plans to manage those impacts.*

The size and location of the study areas were based on several factors and meet the requirements of AEW (2009a). The Regional Study Area (RSA) encompasses all Project emission sources and additional regional emission sources within 5 km of the Project sources (CR #1, Figure 2.3-1). Due to the large distances between the different mining areas considered in this assessment (in particular, Robb West and Robb East), a Local Study Area (LSA) was not defined.

A number of potential VECs were identified during the issue scoping process as they relate to potential human or ecosystem health effects. The air quality VECs include:

- NO2 Concentration
- SO2 Concentration
- Particulate Concentration
- CO Concentration
- Particulate Deposition
- Nitrogen Deposition
- Ozone Concentration
- VOC and PAH Concentration
- Metal Concentrations
- GHG Emissions

Modelling was done using the CALMET/CALPUFF model, and was conducted according to AEW (2009). The dispersion model was applied to the following assessment scenarios:

- Baseline Case, including all existing emissions from current CVM operations, highways (paved / unpaved), gravel roads, compressor stations, gas plants, and emissions from the community of Robb.
- Project-Only Case 1 including Project emissions when mining in Robb West is nearest to the community of Robb, the Coal Valley Mine Coal Processing Plant (Plant) plus ambient background emissions.

- the Project-only Case 2 including emissions from mining in Robb Main, the Plant plus ambient background emissions.
- the Application Case including sources included in the Baseline Case (except Yellowhead Mine) and Project Case 1.
- the Planned Development Case (PDC), including all sources in the Application case and any foreseen new developments.

Predictions were made for the maximum point of impingement (MPOI) determined using a grid of receptors as well as at 18 specific receptors (CR #1, Table 2.5-3 and Figure 2.3-1). These predictions were compared to the *Alberta Ambient Air Quality Objectives* (AAAQO), Alberta Ambient Air Quality Guideline (AAAQG, for hourly $PM_{2.5}$ only), and the Canada Wide Standards (CWS) for regulated compounds (CR #1, Table 2.4-1). The objectives refer to averaging periods ranging from one hour to one year. For modelling purposes, the hourly objectives are applied to the 9th highest predictions, and daily objectives are applied to the 2nd highest annual prediction.

E.1.2 Baseline Conditions

E.1.2.1 Background Concentrations

Background concentrations were obtained from select stations in the West Central Airshed Society (WCAS) network and from AEW's Mobile Air Monitoring Laboratory (MAML). The ambient measurements which were used as background values for the Air Quality Assessment are presented in Table E.1-1.

Table E.1-1 Ambient Background Concentrations for Modeled Criteria Air Contaminants (CACs)

Compounds	Hourly (µg/m^3)	8-Hour (µg/m^3)	24-Hour (µg/m^3)	Monthly (µg/m^3)	Annual (µg/m^3)	Data Source
SO_2	2.6	-	2.6	0	0	Hightower Ridge, 90th Percentile, December 1, 2007 – December 31, 2010 (a)
NO_2	5.6	-	-	-	1.5	Hightower Ridge, 90th Percentile, December 1, 2007 – December 31, 2010 (a)
$PM_{2.5}$	6.4	-	6.4	-	1.5	Steeper, 90th Percentile, March 1, 2009 to September 30, 2011 (a)
PM_{10}	16	-	16	-	6.3	Steeper, 90th Percentile, March 1, 2009 to September 30, 2011 (a)
TSP	32	-	32	-	13	2x PM_{10} Background Values as no TSP measurements available
CO	573	573	--	-	--	MAML – Town of Edson (b)

(a) Source: CASADATA 2011.
(b) Source: AEW 2002b.
- No AAAQO for this averaging period, therefore background concentration not required.

E.1.2.2 Baseline Concentrations

Baseline concentrations were assessed to include all existing emissions from current CVM operations, highways (paved / unpaved), gravel roads, compressor stations, gas plants, and emissions from the community of Robb. The methodology used to determine baseline concentrations is discussed in CR #1, Section 4.2. Baseline concentrations were determined to include:

- 7.00 t/d of SO_2 (summer and winter);
- 4.17 t/d of NO_x (summer and winter);
- 1.76 t/d of CO (summer and winter);
- 22.4 t/d (summer);10.1 t/d (winter) of TSP;
- 5.82 t/d (summer); 2.82 t/d (winter) of PM_{10}; and
- 0.65 t/d (summer); 0.35 t/d (winter) of $PM_{2.5}$.

E.1.3 Potential Impacts

The Project will result in atmospheric emissions from fossil fuel combustion sources, fugitive emissions from mine equipment, refurbished Plant, soil handling, coal movement and wheel entrainment. At sufficiently high concentrations, these air emissions can have direct and indirect effects on humans, animals, vegetation, soil and water.

Project Cases 1 and 2 were chosen to assess the impact of the Project on the community of Robb. The other possible mining scenarios, including Robb Centre, are expected to have a negligible effect on Robb. The air quality impact assessment for Project Case 1 includes mining in Robb West, Robb East and increased emissions from the Plant. The air quality impact assessment for Project Case 2 includes mining in Robb Main and emissions from the Plant. The mining scenarios and related emission estimates are described further in CR #1, Section 4.1.

Emission sources within the RSA are summarized in Tables E.1-2 (summer road conditions) and Table E.1-3 (winter). From the tables, the following observations are relevant:

- Project Case 1 emissions are higher than Project Case 2 emissions and therefore are appropriate to use in the Application and PDC emission scenarios;
- gas plants are the largest regional source of SO_2 and CO emissions;
- proposed Project operations are the largest regional source of NO_X and particulate emissions; and
- winter conditions substantially reduce emissions from roadways but no other sources.

Table E.1-2 Summary of RSA Maximum Daily Emissions (kg/d) - Summer Conditions

No.	Description	SO_2	NO_x	CO	TSP	PM_{10}	$PM_{2.5}$
1.	Robb West Mine Emissions	3.8	230	558	476	248	32.9
2.	Robb East/Centre Mine Emissions	0.8	50	7	368	168	23.5

Table E.1-2 Summary of RSA Maximum Daily Emissions (kg/d) - Summer Conditions

No.	Description	SO_2	NO_x	CO	TSP	PM_{10}	$PM_{2.5}$
3.	Robb Main Mine Emissions (Project Case 2)	4.2	247	606	465	254	28.9
4.	Robb West Total for Haul Roads	6.0	1,489	125	17,048	4,764	506
5.	Robb East/Centre Haul Roads	5.4	1,344	96	11,858	3,295	345
6.	Robb Main Haul Road (Project Case 2)	6.9	1,733	88	8,152	2,372	259
7.	Plant Operations (Refuse Hauling, and Piles) (all emission scenarios),	0.4	113	18.9	409	130	10.8
8.	Plant Stack Emissions (all emission scenarios)	5.2	348	21	514	250	69
9.	Public Roads (Baseline and Application / PDC)	1.8	54	26	15,682	3,811	385
10.	Gas Plants, Compressor Stations (Baseline and Application / PDC)	6,967	2,991	1,653	28	28	14
11.	Yellowhead Mine and Haul Road (Baseline)	26	663	33	5,805	1,604	174
12.	Community of Robb (Baseline and Application / PDC)	0.05	1.16	3.46	0.28	0.21	0.14
TOTAL for Baseline Case (kg/d)		**7,000**	**4,170**	**1,755**	**22,438**	**5,823**	**653**
TOTAL for Project Only Case 1 (kg/d)		**21.6**	**3,574**	**826**	**30,673**	**8,855**	**987**
TOTAL for Application /PDC Cases (kg/d)		**6,990**	**6,620**	**2,508**	**46,383**	**12,694**	**1,386**
TOTAL for Project Only Case 2 (kg/d)		**16.7**	**2,441**	**734**	**9,540**	**3,006**	**368**

Note: all emissions refer to Project Case 1 unless otherwise noted.

Table E.1-3 Summary of RSA Maximum Daily Emissions (kg/d) - Winter Conditions

No.	Description	SO_2	NO_x	CO	TSP	PM_{10}	$PM_{2.5}$
1.	Robb West Mine Emissions	3.8	230	558	461	241	32.8
2.	Robb East/Centre Mine Emissions	0.8	50	7.3	362	166	22.7
3.	Robb Main Mine Emissions (Project Case 2)	4.2	247	606	433	240	27.0
4.	Robb West Total for Haul Roads	5.8	1,452	122	8,251	2,307	252.0
5.	Robb East/Centre Haul Roads	5.3	1,317	94	5,688	1,581	173
6.	Robb Main Haul Road (Project Case 2)	6.9	1,720	88	3,966	1,156	136
7.	Plant Operations (Refuse Hauling, and	0.4	113	18.9	409	130	10.8

Table E.1-3 Summary of RSA Maximum Daily Emissions (kg/d) - Winter Conditions							
No.	**Description**	**SO_2**	**NO_x**	**CO**	**TSP**	**PM_{10}**	**$PM_{2.5}$**
	Piles) (all emission scenarios),						
8.	Plant Stack Emissions (all emission scenarios)	5.2	348	21	514	250	69
9.	Public Roads (Baseline and Application / PDC)	1.8	54	26	3,329	806	85
10.	Gas Plants, Compressor Stations (Baseline and Application / PDC)	6,967	2,991	1,653	28	28	14
11.	Yellowhead Mine and Haul Road (Baseline)	26	663	33	5,805	1,604	174
12.	Community of Robb (Baseline and Application / PDC)	0.05	1.16	3.46	0.28	0.21	0.14
TOTAL for Baseline Case (kg/d)		**7,000**	**4,170**	**1,755**	**10,085**	**2,818**	**353**
TOTAL for Project Only Case 1 (kg/d)		**21.3**	**3,510**	**821**	**15,685**	**4,675**	**560**
TOTAL for Application / PDC Cases (kg/d)		**6,990**	**6,556**	**2,504**	**19,042**	**5,509**	**659**
TOTAL for Project Only Case 2 (kg/d)		**16.7**	**2,428**	**734**	**5,322**	**1,776**	**243**

Note: all emissions refer to Project Case 1 unless otherwise noted.

E.1.3.1 Sulphur Dioxide (SO_2)

The CALPUFF model was used to estimate the concentration of SO_2 that would occur for the assessment scenarios. The change in the RSA MPOI values between the Baseline and Application cases was negligible to small. Modeling predicted a slight increase or no change in the ground-level SO_2 concentrations at special receptor locations. No exceedances of the AAAQO were predicted for any of the averaging periods, for any modelling case (CR #1, Table 5.1-1). The patterns of SO_2 concentration for the 9th highest hourly, 2nd highest daily, monthly, and annual averages for the assessment scenarios are shown on CR #1, Figures 5.1-1 to 5.1-8, respectively. The maximum predicted concentration in the RSA and nearest the community of Robb are listed in Table E.1-4.

Table E.1-4 Summary of Key Predicted Air Quality Concentrations

	SO_2				NO_2		CO		$PM_{2.5}$	PM_{10}	TSP
	9th Highest 1-hr	2nd Highest 24-hr	Monthly	Annual	9th Highest 1-hr	Annual	9th Highest 1-hr	CO Max 8-hr	2nd Highest 24-hr	2nd Highest 24-hr	2nd Highest 24-hr
Baseline Case											
RSA Maximum (μg/m^3)	117	24	3.4	1.0	140	9.3	2,489	1,982	10	40	95
Maximum near Robb (μg/m^3)	65	15	1.6	0.4	126	4.1	770	715	10	40	95
Application and Planned Development Cases											
RSA Maximum (μg/m^3)	117	24	3.4	1.0	261	15	5,506	2,860	10	41	98
Maximum near Robb (μg/m^3)	81	17	2.6	0.9	261	15	5,506	2,860	10	41	98
AAAQO (μg/m^3)	450	125	30	20	300	45	15,000	6,000	30	50	100
Application increase relative to Baseline (%) – RSA Max	0	0	0	0	86	61	121	44	0	3	3
Application increase relative to Baseline (%) – Robb Area Maximum	25	13	63	125	107	266	615	300	0	3	3

Note : "Robb Area Maximum" referes to predictions associated with Robb West Operations within about 5 km of the community

E.1.3.2 Nitrogen Dioxide (NO_2)

Using the Ozone Limiting Method (OLM) the model resulted in no predicted exceedances of the AAAQOs of NO_2 for any of the assessment scenarios at any averaging period (CR #1, Table 5.2-1). In compliance with the Air Quality Model Guidelines (AEW, 2009a), NO_2 ground-level concentrations, were also predicted by the Total Conversion Method (CR #1, Table 5.2-1). All predictions with the OLM are well below AAAQOs. The patterns of NO_2 concentration for the 9th highest hourly and annual averages for the assessment scenarios are shown on CR #1, Figures 5.2-1 to 5.2-4, respectively. The maximum predicted concentration in the RSA and nearest the Community of Robb are listed in Table E.1-4.

E.1.3.3 Carbon Monoxide (CO)

The CALPUFF model was used to estimate the concentration of CO that would occur for the assessment scenarios. No exceedances of the AAAQO's were predicted for any of the averaging periods, for any modelling case (CR #1, Table 5.3-1). The patterns of CO concentration for the 9th highest hourly and 8-hour average for the assessment scenarios are shown on CR #1, Figures 5.3-1 to 5.3-4, respectively. The maximum predicted concentration in the RSA and nearest the community of Robb are listed in Table E.1-4.

E.1.3.4 Particulate Matter less than 2.5 microns ($PM_{2.5}$)

The CALPUFF model was used to estimate the concentration of ground-level $PM_{2.5}$ for each of the assessment scenarios. The secondary production of nitrates and sulphates within the dispersion model was included in the predicted results along with direct emissions. To account for the mitigating influences of forested vegetation, the predictions were reduced by 75%, less than the minimum recommended reduction. The ambient background concentration was added after the reduction. The hourly air quality guideline and the daily air quality objective were not exceeded for any of the assessment scenarios (CR #1, Table 5.4-1). The patterns of $PM_{2.5}$ concentration for the 2^{nd} highest daily average for the assessment scenarios and the Project only cases are shown on CR #1, Figures 5.4-1 to 5.4-3, respectively. The maximum predicted concentration in the RSA and nearest the Community of Robb are listed in Table E.1-4.

E.1.3.5 Particulate Matter less than 10 microns (PM_{10})

The CALPUFF model was used to estimate the concentration of ground-level PM_{10} for each of the assessment scenarios. As with $PM_{2.5}$, to account for the mitigating influences of forested vegetation, the predictions were reduced by 75%, less than the minimum recommended reduction. The predicted PM_{10} concentrations are compared to the 2^{nd} highest daily air quality objective for British Columbia (B.C.) as no AAAQO exists for this compound. When the mitigated approach is considered, the B.C. Air Quality Objective (BCAQO) is not exceeded for any of the assessment scenarios (CR #1, Table 5.5-1). The patterns of PM_{10} concentration for the 2^{nd} highest daily average for the assessment scenarios and the Project only cases are shown on CR #1, Figures 5.5-1 to 5.5-3, respectively. The maximum predicted concentration in the RSA and nearest the Community of Robb are listed in Table E.1-4.

E.1.3.6 Total Suspended Particulate Matter (TSP)

The CALPUFF model was used to estimate the concentration of ground-level TSP for each of the assessment scenarios. As with $PM_{2.5}$ and PM_{10}, it is expected that the surrounding vegetation will reduce the predicted ground-level concentrations of TSP by 75%. With mitigation, there were no exceedances of the annual TSP objective at the RSA MPOI, near Robb area or at any special receptors (CR #1, Table 5.6-1). The patterns of TSP concentration for the 2^{nd} highest daily average for the assessment scenarios and the Project only cases are shown on CR #1, Figures 5.6-1 to 5.6-3, respectively. The maximum predicted concentration in the RSA and nearest the community of Robb are listed in Table E.1-4.

In accordance with the ToR, TSP deposition was estimated using CALPUFF. Predictions do not include the mitigating effects of vegetation and are compared to Alberta dustfall objectives. Maximum TSP deposition for both the Baseline and Application cases occurs along the Robb Road. In general, the greatest effects of TSP deposition are found near all unpaved road sources. These maximum predictions are much less than the dustfall guidelines (CR #1, Table 5.7-1), which are meant to address the nuisance effects of dust particles larger than TSP.

E.1.3.7 Nitrogen Deposition

Deposition of nitrogen can lead to eutrophication in water bodies or changes in growth rates of terrestrial vegetation, and its calculation includes both wet (removal in precipitation) and dry (direct contact with surface features) processes. The results of CALPUFF modelling indicate that the regional maximum predicted nitrogen deposition was 4.8 kg/ha/yr for Baseline and 5.7 kg/ha/yr Application and Planned Development cases (CR #1, Table 5.8-1).

E.1.3.8 Volatile Organic Compounds (VOCs) and Polycyclic Aromatics (PAHs)

The Project generates trace chemical compounds from fuel combustion at the plant and fuel combustion for vehicles and mine equipment. The chemical compounds assessed have been identified as those emitted by the proposed Project that may potentially have a deleterious effect on human health if present in air in sufficient concentration, and whose concentrations are subject to AAAQOs.

There is limited availability of ambient measurements for some Chemicals of Potential Concern (COPC) so measurements from outside the RSA were used. For some species, this resulted in very conservative modelling predictions (for all cases). No exceedances of AAAQOs were predicted for any COPC and, in most cases, the concentrations at the RSA MPOIs are many orders of magnitude below the AAAQOs (CR #1, Table 5.9-1 to 5.9-6).

E.1.3.9 Metals

Sources of metals include tail pipe emissions from diesel combustion, combustion of coal in the dryer, and fugitive emissions from re-suspension of road dust and material handling in pit operations. The metals considered in this assessment are based on those available in site measurements of soil and overburden. Not all metals have associated diesel combustion emission factors and if there were no emission factors available for a particular species, then the primary emission source would be from the soil/dust component.

In addition, there is limited availability of background ambient measurements for metals so measurements from outside the RSA were used. Ambient measurements tend to be available from areas with higher levels of industrialization than the Robb area, so the background concentrations introduce additional conservatism to the predictions. For some species, this resulted in very conservative predictions as the modeling predictions (for all cases) were much smaller than the background values. These two considerations, as well as the change in diesel combustion emissions from Tier 1 to 3 (current equipment that will be part of the Baseline) to Tier 4 (Application and PDC cases), influenced the magnitude of metal predictions.

No exceedances of AAAQOs are predicted for chromium, lead, manganese and nickel in any assessment case or at any location (CR #1, Table 5.10-2 to 5.10-5). The hourly objective for arsenic was exceeded at the RSA MPOI and at one of the special receptors (the former cabin at Coalspur) in the Baseline case (CR #1, Table 5.10-1). This exceedance was eliminated in the Application case due to the cessation of Baseline mining activities and the transition to a Tier 4 haul fleet.

E.1.3.10 Odour

Operation of diesel powered mine and haul fleets may result in odorous emissions. In order to assess potential odour impacts, the predicted maximum air concentrations for compounds are compared with established odour thresholds. As odour can be perceived within a short time span, the air concentration used in the comparison was based on a three-minute averaging period.

The 9th highest hourly predictions for the compounds were converted to a three-minute average using the following equation:

The complete results of predictions for each COPC compared to their respective odour thresholds are provided in CR #1, Appendix D. The mean odour threshold was met or exceeded by the 3-minute prediction for nitrogen dioxide only (CR #1, Table 5.11-1). Exceedance of the average odour threshold was predicted to occur infrequently (0.01% of the time) at the RSA MPOI (CR #1, Table 5.11-2), which is located on the Project mine permit boundary just south of the soil hauling area.

E.1.3.11 Ozone

Surface O_3 can be formed through photochemical production from emissions of anthropogenic NO_x, anthropogenic VOCs, and biogenic VOC compounds. The potential is greatest during summer periods characterized by high ambient temperatures (*i.e.* above 30°C) and stagnant weather conditions (*i.e.* low wind speeds).

Fox and Kellerhaus (2008) used the CMAQ model to estimate future O_3 concentration throughout Alberta that could result from foreseeable emission increases. Of the source sectors considered in the study, those most applicable to the RSA were oil and gas and power generation; future emission increases in these sectors were estimated to be negligible and about 25%, respectively. On-road emission changes were also negligible and are likely to decline with new emission reduction advances. Under these assumptions, there was at most a 1% increase in the 4th highest daily maximum eight-hour O_3 concentration (the metric used in the CWS).

When the Project proceeds, it is accompanied by the cessation of activity in Yellowhead and Mercoal Mines, and in this sense the Project results in a relocation of current mining activity rather than wholly new incremental O_3 precursor emissions. Therefore, the CMAQ model approach indicated a negligible change in regional O_3 concentrations with the addition of the Project.

E.1.4 Cumulative Effects Assessment

The PDC includes all sources in the Application case and any foreseen new developments. As no planned projects have been identified in the RSA, the PDC is identical to the Application Case. As a result an assessment of cumulative effects was not conducted.

E.1.5 Mitigation and Monitoring

E.1.5.1 Mitigation

In order to reduce potential impacts of the Project on air quality CVRI will:

- systematically apply water to haul roads to minimize dust;
- retain snow cover on roads unless the cover would compromise the safety of vehicle operations;
- utilize gravel or crushed rock on the haul roads as it produces less dust than clay and sandy surfaces;
- apply water during soil handling activities conducted in the summer, where accessible;

- maintain the active surface of haul roads to reduce effective silt content on the running surface;
- reclaim mined areas as soon as possible after mining is completed; and
- retain trees and bushes between mine aras and the community of Robb.

E.1.5.2 Monitoring

In order to track the effectiveness of the mitigation measures CVRI will:

- conduct monitoring as required in the EPEA approval;
- establish a continuous ambient air quality monitoring station in or near the community of Robb three years before opening Robb Main and continue until mining operations at Robb East are completed, include monitoring of 10-m wind speed and wind gust, 10-m wind direction, temperature, $PM_{2.5}$ and TSP; and
- conduct passive sampling at the community of Robb for NO_2.

E.1.6 SUMMARY OF VECS

Table E.1-5 summarizes air quality impact ratings for Project residual effects. Overall, residual air quality impacts relevant to the Project were considered to be insignificant for several reasons. Project contributions to predicted concentrations at the RSA MPOI and at local receptors were typically very small in an absolute sense. The addition of the Project did not result in exceedances of the CWS and AAAQOs or odour thresholds. All Project air quality impacts are reversible and the ambient air quality is expected to revert to its original state after the Project ceases to operate. As predictions in the PDC case were the same as those in the Application case, the ratings and conclusions above are applicable to it as well.

Table E.1-5 Summary of Impact Significance on Air Quality Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
1. NO_2 Concentration												
	Potential human health effects and odour	Section E.1.5	Project Residual and Cumulative	Local	Long	Continuous	Reversible in long term	Moderate. Potential for odour at the Project permit boundary.	Negative	High (NO_X emissions from combustion well understood)	High	Insignificant
2. SO_2 Concentration												
	Potential human health and vegetation effects	Section E.1.5	Project Residual and Cumulative	Local	Long	Continuous	Reversible in long term	Low for short term; moderate for annual	Negative	High (sulphur content in fuel known)	High	Insignificant
3. Particulate Concentration												
	Potential human health effects and visibility impairment	Section E.1.5	Project Residual and Cumulative	Local (adjacent to haul roads or active pits)	Medium	Continuous	Reversible in long term	Low for $PM_{2.5}$ and TSP; moderate for PM_{10}	Negative	Moderate (greater uncertainty in fugitive emission factors and secondary PM formation)	High	Insignificant
4. CO Concentration												
	Potential human health effects	Section E.1.5	Project Residual and Cumulative	Local	Long	Continuous	Reversible in long term	Moderate	Negative	High (CO emissions from combustion well understood)	High	Insignificant
5. Particulate Deposition												
	Potential vegetation effects and nuisance	Section E.1.5	Project Residual and Cumulative	Local (adjacent to haul roads or active pits)	Medium	Continuous	Reversible in long term	Moderate	Negative	Moderate (more uncertainty in deposition estimates)	High	Insignificant

Table E.1-5 Summary of Impact Significance on Air Quality Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
6. Ozone Concentration												
	Potential human health effects	Based on management of precursors	Project Residual and Cumulative l	Regional	Long	Continuous	Reversible in long term	Low	Negative	Moderate (based on provincial scale modeling)	High	Insignificant
7. VOC and PAH Concentration												
	Potential human health effects and odour	Section E.1.5	Project Residual and Cumulative	Local	Long	Continuous	Reversible in long term	Moderate	Positive	Moderate (products of incomplete combustion less certain)	Medium	Insignificant
8. Metal Concentrations												
	Potential human and ecological health effects	Section E.1.5	Project Residual and Cumulative	Local (adjacent to haul roads)	Long	Continuous	Reversible in long term	Low	Negative/ Positive	Moderate (contribution of crustal sources more variable)	Medium	Insignificant

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant, Significant

E.2 AQUATICS

E.2.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of aquatic resources for the proposed Project. The following section is a summary of the Aquatic Resources Impact Assessment that was prepared by Pisces Environmental Consulting Services Ltd. and is included as Consultant Report #2 (CR #2). For full details of the assessment, please refer to CR #2.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the aquatic resources component are provided in Section 3.5, and are as follows:

3.5 AQUATIC ECOLOGY

3.5.1 Baseline Information

[A] Describe and map the fish, fish habitat and aquatic resources, (e.g., aquatic and benthic invertebrates) of the lakes, rivers, streams, ephemeral water bodies and other waters. Describe the species composition, distribution, relative abundance, movements and general life history parameters of fish resources. Also identify any species that are:

- *a) listed as "at Risk, may be at Risk and Sensitive" in the Status of Alberta Species (Alberta Sustainable Resources Development);*
- *b) listed in schedule 1 of the federal Species at Risk Act; and*
- *c) listed as "at Risk" by COSEWIC*

[B] Describe and map existing critical or sensitive areas such as spawning, rearing and overwintering habitats, and seasonal habitat use including migration and spawning routes.

[C] Describe the current and potential use of fish resources by Aboriginal, sport or commercial fisheries.

[D] Identify the key aquatic indicators that CVRI used to assess the Project's impacts. Discuss the rationale for their selection.

3.5.2 Impact Assessment

[A] Describe the potential impacts to fish, fish habitat, and other aquatic resources (e.g., stream alterations and changes to substrate conditions, water quality and quantity) considering:

- *a) fish tainting, survival of eggs and fry, chronic or acute health effects, and increased stress on fish populations from release of contaminants, sedimentation, flow alterations, temperature and habitat changes;*
- *b) potential impacts on riparian areas that could affect aquatic biological resources and productivity;*
- *c) the potential for increased fishing pressures in the region that could arise from the increased workforce and improved access resulting from the Project. Identify the implications on the fish resource and describe any mitigation strategies that might be*

planned to minimize these impacts, including any plans to restrict employee and visitor access;

d) changes to benthic invertebrate communities that may affect food quality and availability for fish; and

e) the potential for increased fragmentation of aquatic habitat.

[B] Discuss the design, construction and operational factors to be incorporated into the Project to minimize impacts to fish and fish habitat and protect aquatic resources.

[C] Identify plans proposed to offset any loss in the productivity of fish habitat. Indicate how environmental protection plans address applicable provincial and federal policies on fish habitat including the development of a "No Net Loss" fish habitat objective.

[D] Describe the effects of any surface water withdrawals considered including cumulative effects on fish, fish habitat and other aquatic resources.

The LSA for the aquatics component of the EIA was selected based on the Project area boundaries, drainage basin characteristics, and encompassed the spatial area where Project-specific effects associated with mining activities may occur (CR# 2, Figure 2). This included watercourses and water bodies within the Embarras River watershed, including the Erith River and several watercourses in the Erith sub-basin, as well as one tributary to the Pembina River (CR#2, Table 2.1).

The RSA, selected as the spatial boundary for the cumulative effects assessment for aquatic resources, encompassed the LSA and the following (CR# 2, Figure 2):

- the Embarras River from its confluence with Jackson Creek downstream to its confluence with the McLeod River;
- the Erith River basin excluding tributaries in the lower part of the basin;
- Lund Creek from the headwaters to the confluence with the Embarras River;
- Lendrum Creek from the headwaters to the confluence with the Embarras River; and
- the Pembina River from its confluence with the unnamed tributary (PET1) that drains the southeast end of the Project mine permit area to approximately 10 km downstream.

Outside the RSA, the Project is not expected to have any impact on the aquatic habitat conditions and aquatic resources.

VECs were selected to assess the significance of potential impacts to aquatic resources within the LSA and RSA (CR #2, Section 3.2.3). The VECs selected for assessment include:

- Arctic Grayling;
- Bull Trout;
- Rainbow Trout (Athabasca); and
- Benthic Invertebrates.

E.2.2 BASELINE CONDITIONS

The baseline assessment included a review of existing information and field investigations. While existing information provides historical context, the data gathered during field investigations is the key source of information for assessing impacts to aquatic resources arising from the Project.

E.2.2.1 Fish Populations

During baseline field investigations fish presence was confirmed in 53 of the 84 sites sampled in 42 waterbodies in and adjacent to the Project (CR #2, Table 4.2, and Figures 5 to 7). Fifteen different fish species were captured and identified in existing information including:

- Arctic Grayling (ARGR);
- Brook Stickleback (BKST);
- Brook Trout (BKTR);
- Bull Trout (BLTR);
- Burbot (BURB);
- Lake Chub (LKCH);
- Longnose Dace (LNDC);
- Longnose Sucker (LNSC);
- Mountain Whitefish (MNWH);
- Northern Pike (NRPK);
- Pearl Dace (PRDC);
- Rainbow Trout (RNTR);
- Spoonhead Sculpin (SPSC);
- Trout Perch (TRPR); and
- White Sucker (WHSC).

Rainbow trout were the most common and widespread species within the LSA and RSA and were found in 38 of the 42 waterbodies sampled. Rainbow trout were most abundant in Erith River tributary #1, Bacon Creek, Lendrum Creek tributary #1, Halpenny Creek and in Bryan Creek (site BR-2). Densities at sample sites in these creeks ranged from over 6.9 fish/100 m^2 to 19.2 fish/100 m^2 (CR# 2, Figure 3).

Bull trout, burbot, lake chub, longnose sucker, and spoonhead sculpin were encountered much less frequently than rainbow trout but were still found at a number of different locations. Other species, including arctic grayling, brook stickleback, brook trout, longnose dace, mountain whitefish, northern pike, pearl dace, trout-perch, and white sucker were rare and were only found in one or two waterbodies.

None of the species captured are listed under the federal *Species at Risk Act* (2003). Provincially, there is one species listed as *At Risk* (Rainbow Trout), one species listed as *May be at Risk* (Spoonhead Sculpin), two species that are listed as *Sensitive* (Arctic Grayling, Bull

Trout), one species listed as *Undetermined* (Pearl Dace), one species listed as *Exotic/Alien* (Brook Trout), and the remaining species are listed as *Secure*.

E.2.2.2 Fish Species Richness and Biodiversity

The species richness of streams within the LSA was determined by comparing the number of species present in specific watercourses within the LSA to the total number of species potentially present. The species richness of streams within the LSA is presented in Table E.2-1.

Table E.2-1 Ranking of Streams in the Robb Trend LSA According to their Fish Species Richness.

Watercourse	Ranking[1]	Number of species (% of potential)
Robb West		
Bryan Creek	1	1 of 10 potential species (10%)
Bryan Creek tributary #2 (BRT2)	1	1 of 10 potential species (10%)
Embarras River (in RSA)	4	10 of 10 potential species (100%)
Embarras River tributary #1 (EMT1)	1	1 of 10 potential species (20%)
Jackson Creek	1	2 of 10 potential species (20%)
Robb Main		
Hay Creek	1	2 of 10 potential species (20%)
Erith River	4	11 of 11 potential species (100%)
Erith River tributary #1 (ERT1)	2	3 of 11 potential species (27%)
Erith River tributary #2 (ERT2)	1	2 of 11 potential species (18%)
Erith River tributary #3 (ERT3)	1	1 of 11 potential species (9%)
Erith River tributary #5 (ERT5)	1	2 of 11 potential species (18%)
Erith River tributary #7 (ERT7)	1	1 of 11 potential species (9%)
Erith River tributary #8 (ERT8)	0	No fish present
Erith River tributary #10 (ERT10)	1	2 of 11 potential species (18%)
Erith River tributary #12 (ERT12)	1	1 of 11 potential species (9%)
Bacon Creek	1	2 of 11 potential species (18%)
Robb Centre		
Halpenny Creek	3	6 of 11 potential species (55%)
Halpenny Creek tributary #1 (HLT1)	1	1 of 11 potential species (9%)
Halpenny Creek tributary #2 (HLT2)	1	2 of 11 potential species (18%)
Halpenny Creek tributary #4 (HLT4)	0	No fish present

Table E.2-1 Ranking of Streams in the Robb Trend LSA According to their Fish Species Richness.

Watercourse	Ranking(1)	Number of species (% of potential)
Halpenny Creek tributary #5 (HLT5)	1	1 of 11 potential species (9%)
Lendrum Creek	1	1 of 11 potential species (9%)
Lendrum Creek tributary #1 (LET1)	1	2 of 11 potential species (18%)
Lendrum Creek tributary #3 (LET3)	1	1 of 11 potential species (9%)
Robb East		
Lund Creek	1	1 of 11 potential species (9%)
Lund Creek tributary #1 (LDT1)	1	2 of 11 potential species (18%)
Lund Creek tributary #2 (LDT2)	0	No fish present
Lund Creek tributary #3 LDT3)	1	1 of 11 potential species (9%)
Lund Creek tributary #4 (LDT4	0	No fish present
Lund Creek tributary #5 (LDT5)	0	No fish present
Lund Creek tributary #7 (LDT7)	0	No fish present
Pembina River tributary #1 (PET1)	1	2 of 14(2) potential species (14%)

(1) 1 - Very low, 2 – Low, 3 – Moderate, 4 – High.
(2) From species list reported by Blackburn and Johnson (2004)

The presence or absence of listed species and species richness rankings were used to rank overall fish species diversity for watercourses in and adjacent to the Project by adding the individual ranks of the two indicators; species status and species richness. Combining the two indicators provides an overall score for fish species diversity (biodiversity ranking). A biodiversity ranking for each of the watercourses in the LSA is presented in Table E.2-2.

Table E.2-2 Ranking of Study Streams in the Robb Trend According to their Biodiversity.

Watercourse	Ranking(1)	Ranking Description
Robb West		
Bryan Creek	3	Moderate
Bryan Creek tributary #2 (BRT2)	3	Moderate
Embarras River (in RSA)	4	High
Embarras River tributary #1 (EMT1)	1	Low
Jackson Creek	3	Moderate

Table E.2-2 Ranking of Study Streams in the Robb Trend According to their Biodiversity.

Watercourse	Ranking[1]	Ranking Description
Robb Main		
Hay Creek	3	Moderate
Erith River	4	High
Erith River tributary #1 (ERT1)	3	Moderate
Erith River tributary #2 (ERT2)	3	Moderate
Erith River tributary #3 (ERT3)	3	Moderate
Erith River tributary #5 (ERT5)	3	Moderate
Erith River tributary #7 (ERT7)	3	Moderate
Erith River tributary #8 (ERT8)	0	-
Erith River tributary #10 (ERT10)	3	Moderate
Erith River tributary #12 (ERT12)	3	Moderate
Bacon Creek	3	Moderate
Robb Centre		
Halpenny Creek	4	High
Halpenny Creek tributary #1 (HLT1)	3	Moderate
Halpenny Creek tributary #2 (HLT2)	3	Moderate
Halpenny Creek tributary #4 (HLT4)	0	-
Halpenny Creek tributary #5 (HLT5)	3	Moderate
Lendrum Creek	3	Moderate
Lendrum Creek tributary #1 (LET1)	3	Moderate
Lendrum Creek tributary #3 (LET3)	3	Moderate
Robb East		
Lund Creek	3	Moderate
Lund Creek tributary #1 (LDT1)	3	Moderate
Lund Creek tributary #2 (LDT2)	0	-
Lund Creek tributary #3 LDT3)	3	Moderate
Lund Creek tributary #4 (LDT4	0	-
Lund Creek tributary #5 (LDT5)	0	-

Table E.2-2 Ranking of Study Streams in the Robb Trend According to their Biodiversity.

Watercourse	Ranking(1)	Ranking Description
Lund Creek tributary #7 (LDT7)	0	-
Pembina River tributary #1 (PET1)	1	Low

(1) 1 - Very low, 2 – Low, 3 – Moderate, 4 - High

E.2.2.3 Fish Habitat

The Embarras River and the Erith River are both large watercourses that provided year-around habitat for a number of fish species. Habitat utilization of most of the other watercourses within the LSA was mostly limited to rainbow trout that occupy these streams for various life cycle phases. Table E.2-3 presents categorical rankings of the potential for streams within the LSA to provide spawning, rearing, overwintering, migration, and feeding habitat and also provides a summary of habitat utilization information based on sampling results from field investigations.

Table E.2-3 Habitat Potential/Utilization and Ranking for Streams in the LSA.

Waterbody	Habitat Potential Utilization					Limiting Factors	Overall Rank
	Spawning		Rearing	Overwintering	Feeding		
Robb Trend West							
Bryan Creek Reach 1	High	RNTR	High	Moderate	High	–limited cover –beaver dams –absence of Class 1 (>1m deep) habitat	High
Bryan Creek Reach 2	None		Low	Moderate	Moderate	–limited cover –beaver dams –lack of gravel/cobble –low pool frequency	Low
Bryan Creek Reach 3	High	RNTR	High	Low	Moderate	–limited cover –beaver dams –limited Class 1 habitat –low pool frequency	High
Bryan Creek Reach 4	None		Low	Moderate	Moderate	–beaver dams –lack of gravel/cobble –absence of pool habitat	Low
BRT2	Low	RNTR	Low	None	Low	–limited flows –absence of Class 1 habitat –absence of pool habitat	Low
Embarras River	Moderate	ARGR BKTR MNWH RNTR	Moderate	High	High	–low pool frequency –limited cover	High
EMT1	Low	NRPK	Low	None	Moderate	–absence of Class 1 habitat –low pool frequency –lack of gravel/cobble	Low

Table E.2-3 Habitat Potential/Utilization and Ranking for Streams in the LSA.

Waterbody	Habitat Potential Utilization					Limiting Factors	Overall Rank
	Spawning		Rearing	Overwintering	Feeding		
						–low winter dissolved oxygen	
Jackson Creek	None		Low	None	Low	–limited flows –absence of Class 1 habitat –low pool frequency	Low
Robb Trend Main							
Hay Creek Reach 1	None		Moderate	None	Low	–absence of Class1 habitat –absence of pool habitat –no winter flow	Low
Hay Creek Reach 2	None		Low	None	Low	–limited Class 1 habitat –low pool frequency –beaver dams –no winter flow	Low
Hay Creek Reach 3	None		None	None	Low	–beaver dams –absence of pool habitat –lack of gravel/cobble –no winter flow	Low
Erith River Reach 1	Moderate	MNWH RNTR	High	Moderate	High	–limited cover –beaver dams –low pool frequency	High
Erith River Reach 2	Low	MNWH RNTR	Moderate	Moderate	High	–limited cover –beaver dams –low pool frequency –limited Class 1 habitat	High
Erith River Reach 3	Moderate	RNTR	High	Moderate	High	–limited cover –beaver dams –absence of pool habitat –limited Class 1 habitat	High
Erith River (ER-7)	Low	RNTR	Moderate	Low	Moderate	–limited Class 1 habitat –low pool frequency	Moderate
ERT1	High	RNTR	High	None	High	–absence of Class 1 habitat –limited flows	High
ERT2	Low	RNTR	Low	None	Low	–limited flows –absence of Class 1 habitat –low pool frequency –lack of gravel	Low
ERT3	None		None	Low	Low	–beaver dams –low winter dissolved O2 –lack of gravel/cobble –limited flows	Low
ERT5	Low	RNTR	Moderate	None	Moderate	–beaver dams –limited flows –absence of Class 1 habitat	Low
ERT7	None		Low	None	Low	–limited flows –absence of Class 1 habitat	Low
ERT8	None		Low	None	Low	–limited flows	Low

Table E.2-3 Habitat Potential/Utilization and Ranking for Streams in the LSA.

Waterbody	Habitat Potential Utilization					Limiting Factors	Overall Rank
	Spawning		Rearing	Overwintering	Feeding		
						–absence of Class 1 habitat –low pool frequency	
ERT10	None		Moderate	None	Moderate	–absence of Class 1 habitat –lack of gravel	Low
ERT12	Low	RNTR	Low	None	Moderate	–limited flows –absence of Class 1 habitat –absence of pool habitat	Low
Bacon Creek	High	RNTR	High	Low	Moderate	–absence of Class 1 habitat –limited pool frequency –limited cover	High
Robb Trend Centre							
Halpenny Creek Reach 1	Moderate	RNTR	Moderate	Moderate	Moderate	–absence of Class 1 habitat –low pool frequency	High
Halpenny Creek Reach 2	None		Low	High	Low	–absence of gravel/cobble –lack of cover –beaver dams	Low
Halpenny Creek Reach 3	High	RNTR	High	Low	High	–absence of Class 1 habitat –low pool frequency –low winter flows	High
HLT1	High	RNTR	Moderate	None	Moderate	–fish passage issues –low pool frequency –absence of Class 1 habitat	Moderate
HLT2	None		Low	Moderate	Low	–limited flows –low pool frequency –lack of gravel/cobble	Low
HLT4	None		Low	None	Low	–limited flows –absence of Class 1 habitat –absence of pool habitat –lack of gravel/cobble	Low
HLT5	None		Low	None	Low	–limited flows –absence of Class 1 habitat –absence of pool habitat –lack of gravel	Low
HLT9	Low	RNTR	Low	None	Low	–limited flows –absence of Class 1 habitat –lack of cover	Low
Lendrum Creek Reach 1	Moderate	RNTR	High	High	Moderate	–low pool frequency –lack of gravel/cobble –limited cover –beaver dams –low winter dissolved O2	High
Lendrum Creek Reach 2	Low	RNTR	Moderate	Low	Moderate	–absence of Class 1 habitat –low pool frequency –lack of gravel/cobble	Moderate

Table E.2-3 Habitat Potential/Utilization and Ranking for Streams in the LSA.

Waterbody	Habitat Potential Utilization					Limiting Factors	Overall Rank
	Spawning		Rearing	Overwintering	Feeding		
						–limited cover –beaver dams	
LET1	Moderate	RNTR BURB	Moderate	Low	Moderate	–limited flows –absence of Class 1 habitat –low pool frequency –limited cover –beaver dams	Moderate
LET3	High	RNTR	High	Moderate	Moderate	–low pool frequency –limited cover –lack of gravel/cobble	High
Robb Trend East							
Lund Creek	High	RNTR	Moderate	None	Moderate	–absence of Class 1 habitat –low pool frequency	Moderate
LDT1	Low	RNTR	Low	Low	Moderate	–limited flows –absence of Class 1 habitat –limited cover	Low
LDT1A	None		Low	None	Low	–limited flows –absence of Class 1 habitat –low pool frequency	Low
LDT1C	None		Low	None	Low	–limited flows –absence of Class 1 habitat –low pool frequency	Low
LDT1D	None		None	None	Low	–limited flows –absence of Class 1 habitat –low pool frequency –steep gradient –fish passage issues	Low
LDT2	None		None	None	Low	–limited flows –absence of Class 1 habitat –low pool frequency –lack of gravel	Low
LDT3	Low	RNTR	Low	None	Moderate	–limited flows –absence of Class 1 habitat	Low
LDT3A	None		None	None	Low	–limited flows –absence of Class 1 habitat –lack of gravel –steep gradient –limited cover	Low
LDT4	None		None	None	Low	–limited flows –absence of Class 1 habitat –lack of gravel –limited cover	Low
LDT5	None		None	None	Low	–limited flows –absence of Class 1 habitat –lack of gravel	Low
LDT7	None		None	None	Low	–limited flows –absence of Class 1 habitat	Low

Table E.2-3 Habitat Potential/Utilization and Ranking for Streams in the LSA.

Waterbody	Habitat Potential Utilization					Limiting Factors	Overall Rank
	Spawning		Rearing	Overwintering	Feeding		
						–lack of gravel	
PET1	High	BKTR	Moderate	Moderate	Moderate	–limited cover –lack of gravel/cobble	High
PET1A	None		None	None	Low	–limited flows –discontinuous channel	Low
PET1B	None		None	None	Low	–limited flows –discontinuous channel	Low

E.2.2.4 Lower Trophic Resources

Baseline benthic invertebrate surveys were conducted on nine watercourses within the Robb Trend (CR #2, Figures 5, 7, 8 and 11). Ephemeroptera, Plecoptera and Trichoptera taxa dominated the benthic invertebrate communities at nearly all lotic (flowing) sample sites (CR #2, Figures 14 to 17). Chironomidae and Coleoptera were the only other two groups that commonly made up more than five percent of the remaining taxa.

Epilithic algae results found substantial variation of chlorophyll ‘a’ within water bodies, and between replicate samples. Variability in algal biomass levels has previously been documented (Wolanksi 1999) and difficulties surrounding sampling of epilithic algae have been discussed (Weitzel 1979, Stevensen and Lowe 1986). Physical factors including depth, discharge, and current velocity can strongly impact the standing crop of epilithic algae while turbidity, light penetration and temperature are also known to affect algal biomass.

E.2.3 PREDICTED CONDITIONS

The issues identified as potentially affecting fish habitat potential, the abundance, health and survival of fish populations (in general) and the abundance, health and survival of VECs within the RSA and LSA were principally related to:

- potential changes to physical habitat components;
- potential changes to water quality (sediment and other chemical contaminants);
- potential changes to flow regime; and
- potential changes to the fisheries resource access.

Other Project specific impacts related to surface water quality (sediment and contaminant introduction that might enter the aquatic system and affect the biota), and surface water quantity (changes in flow regimes) are addressed in Section E.11 and Section E.6. Those impacts were then assessed in terms of potential effects on aquatic resources and habitat, and ultimately interpreted in terms of potential effects on VECs.

E.2.3.1 Direct Habitat Impacts

Components of the Project with the potential to result in direct habitat loss or alteration within the Project mine permit boundary are generally related to land clearing and haulroad crossings (construction phase), stream diversions (operation and reclamation phase) and end pit lake development (reclamation phase). Settling ponds will be constructed off-channel or will be situated upstream of viable fish habitat and are not expected to directly impact fish habitat. The potential for forest clearing as a result of the Project to affect temperature regimes in watercourses is minimal since relatively small percentage of areas, consisting of moderately narrow strips extending across the various watersheds, will be cleared.

The Project development will require the installation of 14 watercourse crossings (Figure C.4-1). The proposed crossings are expected to have minimal impact on physical habitat availability (Table E.2-4). The structures will be in service for the life of the Project but will be removed and creek channels reclaimed following completion of mining activities.

The Project development will also require the development of approximately 15 watercourse diversions (Figure C.4-1). A description of planned diversions and associated habitat impacts are summarized in Table E.2.-5.

Table E.2-4 Description of Habitat and Analysis of Direct Habitat Impacts for the Haulroads.

Watercourse	Typical Culvert Diameter	Crossing Type[1]	Fish Habitat Present (overall rank)	Habitat Impact
Robb Main				
Erith River	3.6 m	3	–High habitat potential/utilization	–None since arch culvert will not have an instream footprint
ERT4	2.2 m	1	–Sub-marginal (no rank)	–None since habitat is sub-marginal and fish use is not expected
ERT5	3.0 m	2	–Low habitat potential/utilization	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width
ERT6	1.4 m	TBD[2]	–Historical record of RNTR –Further assessment to be conducted	–TBD based on additional site investigation
ERT8	2.2 m	2	–Low habitat potential/utilization	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width
ERT10	2.6 m	2	–Low habitat potential/utilization	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width
Robb Centre				
HLT1	3.0 m	2	–Moderate habitat potential/utilization	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width
HLT9	2.2 m	2	–Low habitat potential/utilization	–Low since culvert will be designed to accommodate fish

Table E.2-4 Description of Habitat and Analysis of Direct Habitat Impacts for the Haulroads.

Watercourse	Typical Culvert Diameter	Crossing Type[1]	Fish Habitat Present (overall rank)	Habitat Impact
Robb Main				
				passage and will be sized to exceed bankfull width
HLT9A	2.2 m	2	–Low habitat potential/utilization	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width
Robb West				
Bryan Creek	3.0 m	2	–Low habitat potential/utilization in this section of Bryan Creek	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width
BRT2	2.4 m	TBD	–Low habitat potential/utilization	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width
BRT2A	2.0 m	TBD	–Low habitat potential/utilization	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width
EMT3	1.0 m	TBD	–TBD	–TBD
Jackson Creek	2.0 m	2	–Low habitat potential/utilization	–Low since culvert will be designed to accommodate fish passage and will be sized to exceed bankfull width

[1] Type 1 is a minor culvert with no fish, Type 2 is with fish passage provisions, Type 3 is arch with no instream disturbance
[2] TBD – To be determined based on future field investigations

Table E.2-5 Description of Planned Diversions and Associated Habitat Impacts

Watercourse	Diversion[1]		Fish Habitat Impacted[2]		
	Length	Method	Length	Area[3]	Habitat Present (overall rank)
Robb Main					
Erith River	5000 m	in pit	10,500 m	67485 m^2	–High habitat potential/utilization –Most of Reach 1, all of Reach 2 and the lower part of Reach 3 will be impacted
ERT1 ERT1A	700 m TBD	in pit	2315 m 157 m	5834 m^2 102 m^2	–High habitat potential/utilization in ERT1 –Low habitat potential/utilization in ERT1A, natural impediments preclude fish use further upstream
ERT2	TBD	over pit/ in pit	264 m	406 m^2	–Low habitat potential/utilization

Table E.2-5 Description of Planned Diversions and Associated Habitat Impacts

Watercourse	Diversion[1]		Fish Habitat Impacted[2]		
	Length	Method	Length	Area[3]	Habitat Present (overall rank)
ERT3	TBD	in pit	507	7751 m^2	–Low habitat potential/utilization, habitat considered sub-marginal further upstream
Bacon Creek	1650 m	in pit	1424 m	2777 m^2	–High habitat potential/utilization –In addition to the 1650m of impacted channel ~2km of channel downstream of diversion will be subject to a ~70% reduction in flow (Matrix 2012; CR#6)
Hay Creek	2250 m	TBD[4]	562 500	1804 m^2 TBD	–Low habitat potential/utilization
Robb Centre					
Halpenny Creek	170 m	cutoff	1762 m	7601 m^2	–Low habitat potential/utilization in Reach 2 –High habitat potential/utilization in Reach 3
	270 m	over pit			
	510 m	cutoff			
HLT1	920 m	in pit/pump	1237 m	2239 m^2	–Moderate habitat potential/utilization
HLT2	1350 m	in pit/pump	246 m	219 m^2	–Low habitat potential/utilization
Lendrum Creek	2450 m	in pit/pump	4335 m	17468 m^2	–Moderate habitat potential/utilization in Reach 2
LET1	940 m	in pit/pump	952 m	1923 m^2	–Moderate habitat potential/utilization
LET3	450 m	pump/flume / in pit	1167 m	22161 m^2	–High habitat potential/utilization
Robb East					
Lund Creek	400 m	pump/over pit/ inpit	2461	11,026	–Moderate habitat potential/utilization
	2200 m	pump	~2000	TBD[4]	–Habitat downstream of inventory section to the confluence with LDT3 may be dewatered in final reclamation if flows are diverted through lakes as preliminary plans indicate –Habitat potential of this section TBD if required
LDT1 LDT1A	625 m TBD	pump/in pit	909 785	2990.6 1091	–Low habitat potential/utilization
LDT3	100 m	over pit	806	2507	–Low habitat potential/utilization
	200 m	pump			
	800 m	in pit			
LDT4	TBD	TBD	TBD	TBD	–Upper limits of this tributary may be disturbed depending on pit boundaries –Low habitat potential/utilization
LDT5	TBD		198	154	–Low habitat potential/utilization, habitat considered sub-marginal further upstream
PET1	300 m	pump/inpit	1587	5236	–High habitat potential/utilization in PET1

Table E.2-5 Description of Planned Diversions and Associated Habitat Impacts

Watercourse	Diversion[1]		Fish Habitat Impacted[2]		
	Length	Method	Length	Area[3]	Habitat Present (overall rank)
PET1A	TBD		600	TBD	–Low habitat potential/utilization in PET1A
Robb West					
Bryan Creek	250 m	around pit			–High habitat potential/utilization in Reach's 1 and 3 –Low habitat potential/utilization in Reach 2 –Potential for additional disturbance upstream of habitat inventory section depending on final pit plans
			4244	14,208	
	305 m	cutoff	2000	TBD	
	1800 m	pump			

[1] Information from Matrix (2012, CR #6))
[2] Calculations based on preliminary mine and reclamation plans and habitat inventory data and is subject to refinement based on subsequent mine planning
[3] Based on wetted widths
4 TBD – To be determined as mine planning progresses

A total of 12 end pit lakes will be constructed in the Project area (Table C.4-4). Direct habitat alteration of watercourses due to the development of the lakes is included in the calculation of habitat impacts provided in Table E.2-5. The final design of the end pit lakes will be prepared at the licensing stage of the Project. Some of the lakes may be constructed to preclude fish access but conceptually, the lakes will be designed to maximize habitat and biological diversity and use by native fish populations. Final design will incorporate guiding principles that are described in the draft guidelines for end pit lake development at coal mine operations (EPLWG 2004) and/or procedures provided in similar guideline documents that may be available in the future.

E.2.3.2 Changes in Flow Regime

Activities conducted throughout the construction, operation, and reclamation phases of the Project can affect flow regime. Potential impacts to hydrology as a result of Project operations are identified and discussed in Section E.6 and CR# 6 and include haulroads, waste rock piles, mine pits and dewatering, impoundments, and water diversions. In general, these components will have a minor effect on flows and are not expected to significantly affect aquatic habitat. There is potential for substantial changes to habitat availability in some watercourses due to alterations to drainage patterns and flow regimes as a result of planned diversions. Table E.2-6 provides a description of potential changes to the flow regimes of watercourses draining the Project area and includes a summary of the corresponding impact on fish habitat.

Table E.2-6 Summary of Surface Flow Impacts and Corresponding Effects on Habitat Availability.

Watershed	Description of Potential Change to Flow Regime[1]	Description of Potential Impact to Fish Habitat
Erith River	–Flow regulation due to settling ponds –10% reduction in peak flows –Maintenance or slight increase in low flows –Overall modest change in annual runoff	–Negligible, no significant impact to fish habitat expected
Bacon Creek	–Approximately 70% of lower basin lost due to diversion –2.4 km long channel remaining with ~30% of flow	–Reduced habitat availability for 2.4km downstream of pits –Impacted habitat has high potential/utilization ranking
Halpenny Creek	–Approximately 20% of flows altered depending on various diversions. –Impacts expected to be short term (temporary diversions) –Flow regulation due to settling ponds –Increased total annual runoff due to road runoff	–Short term impacts to habitat availability may occur depending on the timing and quantity of the diversions. –Impacted habitat has high potential/utilization ranking
Embarras River	–Small footprint upstream of Robb, impacts during mining expected to be negligible –Maximum estimated impacts downstream of Robb equate to: 3% decrease in high flows, 10% increase in low flows, and negligible change in mean annual flows	–Negligible, no significant impact to fish habitat expected
EMT1	–Runoff rates reduced corresponding to 16% or more reduction in downstream flows near mouth	–Minimal impact expected, reduction in flows is close to 15% reduction permitted by Alberta IFN Guidelines (2011) –Impacted habitat has low potential/utilization ranking
Hay Creek	–Up to 50% reduction in peak flows –Up to 200% increase in low flows –Mean annual runoff may temporarily increase by as much as 25% during pit, groundwater dewatering	–Negligible, no significant impact to fish habitat expected
Bryan Creek	–Moderation of peak flows –Increase in low flows –Mean annual runoff may temporarily increase by as much as 20% during pit, groundwater dewatering	–Negligible, no significant impact to fish habitat expected
Lendrum Creek	–Moderation of peak flows –Increase in low flows –Mean annual runoff may temporarily increase by as much as 20% during pit, groundwater dewatering	–Negligible, no significant impact to fish habitat expected
Lund Creek	–Moderation of peak flows –Increase in low flows –Mean annual runoff may temporarily increase by as much as 25% during pit, groundwater dewatering	–Negligible, no significant impact to fish habitat expected –Potential loss of upper portion of creek to LDT3 if flows are diverted through lakes permanently
PET1	–98% of watershed will be re-directed into Lund Creek	–Loss of lower portion of creek downstream of Lund Lake –Impacted habitat has high potential/utilization ranking
White Creek	–Minor influence, 0.6% of watershed re-directed to Bryan Creek	–Negligible, no significant impact to fish habitat expected

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Table E.2-6 Summary of Surface Flow Impacts and Corresponding Effects on Habitat Availability.

Watershed	Description of Potential Change to Flow Regime[1]	Description of Potential Impact to Fish Habitat
Mitchell Creek	–Minor influence, 2% of watershed re-directed to Hay Creek	–Negligible, no significant impact to fish habitat expected
Pembina River	–Minor influence, <2% decrease in flows in Pembina River due to permanent diversion of PET1.	–Negligible, no significant impact to fish habitat expected

[1] All information from CR#6

Some changes in the flow regime in watercourses will occur at reclamation when the end-pit lakes are filled (Section E.6.3.2, CR# 6). During the filling period, downstream flows in receiving watercourses will decrease. Impacts to fish habitat as a result of pit filling is expected to be minimal since it is assumed that lake filling will be gradual in order to maintain downstream flows and instream flow guidelines (AENV 2011) will be adhered to. Once filled, the end pit lakes will result in some attenuating effect on flows in receiving waterbodies (Section E.6, CR# 6). In general, peak flows will be reduced and low flows will be increased. These potential changes in peak flows are not expected to significantly affect downstream channel size (Section E.6, CR# 6) but a long-term gradual channel entrenching, with less meandering and steeper channel slope may occur which could result in changes to habitat composition over time.

E.2.3.3 Changes in Water Quality

Changes in water quality that impact aquatic habitat are primarily related to potential increases in sediment loads in streams within the LSA and RSA. During mining operations, potential sediment sources that can result in adverse effects to aquatic habitat include:

- runoff from the Erith, Halpenny, and Robb West haulroads;
- runoff from spoil piles;
- discharge from impoundments and related water management facilities associated with water management during pit development; and
- discharge from diversions associated with water management during pit development.

Well-established mitigation measures will be implemented to reduce potential sediment effects to a minimum and potential effects of construction activities on surface water quality are expected to be insignificant (Section E.11.4.1, CR# 11). Adverse effects to fish habitat as a result in changes to water quality is not expected.

E.2.3.4 Fish Populations in the LSA

Direct Habitat Loss/Alteration

Project components that have potential to result in direct impacts to fish habitat are related to watercourse crossings, water diversions, development of mine pits, reclamation of end pit lakes, and other activities.

CVRI will work with Fisheries and Oceans Canada (DFO) in developing a habitat compensation plan with the goal of maintaining productive fish habitat and addressing potential habitat disturbance, alteration, or destruction resulting from the Project.

Permanent alteration to aquatic habitat as a result of the Project is expected to be limited to those watercourses that will be directly impacted by temporary and permanent diversions. This includes the sections of streams that will be diverted and also comprises those portions that will be adversely affected due to significant changes in flows. A summary of preliminary estimates of fish habitat alteration and losses associated with the Project is presented in Table E.2-7.

Table E.2-7 Summary of Habitat Alteration/loss in Watercourses Affected by the Robb Trend Project.

Watercourse/Drainage	Estimated Habitat Footprint (m^2)	Comment
Erith River	67,485	–Direct habitat impact due to temporary and permanent diversions
ERT1,1A	5,936	–Direct habitat impact due to temporary and permanent diversions
ERT2	406	–Direct habitat impact due to temporary and permanent diversions
ERT3	7,751	–Direct habitat impact due to temporary and permanent diversions
Bacon Creek	2,777	–Direct habitat impact due to temporary and permanent diversions
	TBD[1]	–~2.4km of stream channel will receive 70% less flow post reclamation
Hay Creek	1804 m^2 TBD	–Direct habitat impact due to temporary and permanent diversions
Halpenny Creek	7,601	–Direct habitat impact due to temporary and permanent diversions
HLT1	2,239	–Direct habitat impact due to temporary and permanent diversions
HLT2	219	–Direct habitat impact due to temporary and permanent diversions
Lendrum Creek	17,468	–Direct habitat impact due to temporary and permanent diversions
LET1	1,923	–Direct habitat impact due to temporary and permanent diversions
LET3	22,161	–Direct habitat impact due to temporary and permanent diversions
Lund Creek	11,026	–Direct habitat impact due to temporary and permanent diversions
	TBD	–~ 2km of stream channel downstream of diversion may be dewatered in final reclamation plan.
LDT1,1A	4,082	–Direct habitat impact due to temporary and permanent diversions
LDT3	2,507	–Direct habitat impact due to temporary and permanent diversions
LDT4	TBD	–Direct habitat impact due to temporary and permanent diversions
LDT5	154	–Direct habitat impact due to temporary and permanent diversions
PET1,1A	5236 – PET1 TBD – PET1A	–Direct habitat impact due to temporary and permanent diversions
Bryan Creek	14,208 TBD	–Direct habitat impact due to temporary and permanent diversions

1 TBD – To be determined based on future mine planning and field investigations

A detailed compensation plan will be developed and refined in subsequent planning phases as further mine plan details become available and following consultations with regulators and stakeholders. The compensation plan will consider the hierarchy of compensation preferences as outlined in *Fisheries and Oceans Canada Practitioners Guide to Habitat Compensation* (2006) and the *Policy for Management of Fish Habitat* (DFO 1986).

Changes in Flow Regime

No significant changes in flows are anticipated during the construction and as such impacts to fish populations are not expected. For most watercourses, the impacts to fish populations as a result of these flow changes is expected to be minimal since low flows will be maintained (or slightly increased) and peak flows will be moderated.

The impacts to fish populations as a result of the pit filling is expected to be minimal since it is assumed that lake filling will be gradual in order to maintain downstream flows and instream flow guidelines (AENV 2011) will be adhered to. Instream flow monitoring and pump bypasses will be established on lakes during filling to ensure that only 15% of the inflow will be used to fill the lakes. The moderation of peak flows and low flows may benefit fish populations by reducing the intensity of high flow events that can adversely affect fish, particularly during the early life stages.

Changes in Water Quality

Sediment and certain chemical contaminants that may have chronic or lethal effects on aquatic biota have the potential to enter the aquatic ecosystem during mining operations. The effects of Project activities on surface water quality were assessed (Section E.11, CR # 11) and determined that impacts were primarily related to construction activities, the use of nitrogen-based explosives, impoundments operation, and end-pit lake water quality.

Well established mitigation measures will be implemented to reduce potential sediment effects to a minimum and potential effects of construction activities on surface water quality are expected to be insignificant. No adverse effects on fish populations within the LSA are expected due to water quality changes as a result of construction activities.

Surface runoff during mining operations and discharge from impoundments and diversions has potential to increase sediment loads in receiving waterbodies. Nitrogen-based explosives will be used during mining and has potential to leach into surface waters. A water quality model was used to predict surface water quality downstream of impoundments. Results showed that the effect of impoundment operation on surface water quality is likely to be insignificant and as such effects of impoundment discharge on fish populations in the LSA are expected to be insignificant. Proven mitigation strategies will be employed to reduce the effect of using nitrogen-based explosives such that water quality is not expected to be significantly affected due to the use of the explosives (Section E.11, CR# 11). Potential impacts to fish populations as a result of nitrogen introductions are not expected.

Water quality within the proposed end-pit lakes is expected to be similar to existing lakes and will likely be suitable for aquatic life (Section E.11, CR# 11). Effects on fish populations in the LSA due to end-pit lake water quality are expected to be insignificant.

Changes in Resource Access and Utilization

Current road access to the Project is via a network of logging roads. Much of the Project is accessible by off-road vehicles via numerous cutlines and trails. Private haulroads will be constructed to the mine permit area and will be closed to public use. The proposed Project will result in a temporary reduction in access to many of the waterbodies on, or adjacent to, the Project mine permit boundary.

The utilization of aquatic resources is highly regulated, such that allowable harvests, if any, are related to an available surplus and not the accessibility of the resource.

E.2.3.5 Effects on Fish Populations in the RSA

Activities associated with the Project that have potential to directly impact fish habitat and, consequently, fish populations will not extend into the RSA.

The impacts to fish populations as a result of the mining and pit filling is expected to be minimal since it is assumed that downstream flows will be managed to adhere to instream flow guidelines (AENV 2011). In general, peak flows will be reduced and low flows will be increased. This attenuating effect may have some impact on fish habitat composition and could also benefit fish populations by reducing the intensity of high flow events that can adversely affect fish, particularly during the early life stages.

Potential changes in surface water quality in the RSA were assessed as insignificant (Section E.11, CR# 11) and are not expected to significantly impact fish populations in the RSA.

No additional access to water bodies in the RSA is expected to occur as a result of the Project.

E.2.3.6 Effects on Benthic Invertebrate Communities

Direct Habitat Loss/Alteration

Disturbances to watercourses due to haulroad crossings are not expected to have significant impact on the benthic invertebrate community since the instream footprint associated with these works will be minor in comparison to the available benthic habitat in each impacted watercourse.

Disturbances to watercourses due to diversions are expected to be short-lived and are not considered to be significant to the benthic community given the ability of benthic invertebrates to rapidly colonize disturbed or newly constructed habitat.

The 12 end pit lakes will be constructed to maximize habitat and biological diversity for benthic invertebrate communities. Historical sampling of existing end pit lakes within the CVM suggests that the lakes, over time, will be able to develop benthic invertebrate communities (Hatfield 2008).

Changes in Flow Regime

As described in Section E.6, some temporary and permanent changes in the flow regime in watercourses draining the Project will occur as a result of disturbances to drainage basins. In general, peak flows will be reduced and low flows will be increased in receiving waterbodies downstream of the end pit lakes. Minimum flows will be maintained to downstream of the lakes to minimize potential adverse effects to benthic invertebrate populations.

Changes in Water Quality

Adverse effects on benthic invertebrate populations within the LSA are not expected due to water quality changes as a result of mining activities. Water quality within the proposed end-pit lakes is expected to be similar to existing lakes and will likely be suitable for aquatic life (Section E.11, CR# 11); therefore, effects on benthic invertebrate populations in the LSA due to end-pit lake water quality are expected to be insignificant.

E.2.3.7 Effects on Valued Environmental Components

Aquatic resources issues related to construction, operation, and reclamation of the Project were generally linked to potential changes to physical habitat components, changes in flow regimes, changes in surface water quality, and changes in resource access. Measures to reduce or mitigate potential effects have been identified (Section E.2.5).

Rainbow Trout

Evidence collected during baseline investigations indicate the Rainbow Trout are distributed throughout the LSA and are the most common species in streams within and adjacent to the Project (CR #2, Table 4.2). Many of the watercourses are utilized for all life cycle phases and provide critical spawning or overwintering habitat while some of the smaller tributary streams provide seasonal feeding habitat only.

Habitat impacts that will affect Rainbow Trout are related to watercourse crossings and temporary and permanent stream diversions that will either directly impact fish habitat or will alter flow regimes downstream of the diversions such that habitat quantity and/or quality is reduced. General mitigation measures for watercourse crossings, stream diversions and flow management will be implemented .As well, the NNL compensation plan will include habitat compensation and enhancement measures.

Potential impacts related to impediments to fish passage caused by haulroad crossings and diversions will be mitigated by designing the crossings structures to accommodate fish passage and by completing the diversions in a manner that provides for fish movements past the diversion area (where it is deemed necessary).

Potential adverse effects associated with the short-term reduction of surface flows during filling of end pits will be monitoring and adaptive management of stream diversions to ensure that base flows are maintained will be employed.

Water quality effects will be mitigated by implementation of appropriate erosion control measures during instream construction, implementation of a surface water management plan during mining operations, and revegetation of exposed ground and riparian areas at Project closure.

Rainbow Trout is a popular sport fish species. There is a ‘zero catch limit’ imposed on Rainbow Trout in the Embarras River basin with the exception of the Erith River and its tributaries which has a limit of two Rainbow Trout over 25 cm. There are no potential effects related to increased resource utilization since the Project is not expected to result in increased public access to the Erith River.

The Project is not expected to have a negative effect on this VEC species, with mitigation measures in place. The potential impact of the Project on Rainbow Trout is considered insignificant.

Bull Trout

Bull Trout were captured infrequently (Erith River and ERT1 only) during baseline investigations but they have been found in the Erith River and several Erith River tributaries, including Bacon Creek and Halpenny Creek in the past (CR #2, Table 4.2).

Habitat impacts that will affect Bull Trout are primarily related to watercourse crossings and temporary and permanent stream diversions will either directly impact fish habitat or will alter flow regimes downstream of the diversions such that habitat quantity or quality is reduced. These impacts will be mitigated by the application of the general mitigation measures for watercourse crossings, stream diversions and flow management and through implementation of the NNL compensation plan.

Potential impacts related to impediments to fish passage caused by haulroad crossings and diversions will be mitigated by designing the crossings structures to accommodate fish passage and by completing the diversions in a manner that provides for fish movements past the diversion area (where it is deemed necessary).

Potential adverse effects associated with the short-term reduction of surface flows during filling of end pits will be mitigated through monitoring of base flows and adaptive management of stream diversions to ensure that base flows are maintained.

Potential water quality effects are mitigatable through implementation of a surface water management plan during construction activities and operation of the Project. After Project closure and reclamation, activities with the potential to generate sediment will cease and revegetation of exposed ground and riparian areas will mitigate potential for sedimentation due to surface run-off.

Bull trout is a popular sport fish species but is not subject to harvest in Alberta. There are no potential effects related to increased resource utilization as the developments will not result in increased public access to watercourses occupied by Bull Trout. In addition, the potential effects of increased resource utilization are addressed by the fisheries regulation regime currently in effect for the Province, which stipulate a ‘zero catch limit’ for Bull Trout.

With the above noted mitigation measures, the Project is not expected to have a negative effect on this VEC species. The potential impact of the Project on Bull Trout is considered insignificant.

Arctic Grayling

Arctic Grayling presence was not documented in the LSA during baseline assessment however they were found in the Embarras River. In addition, Grayling have been captured in the Erith River (within the LSA) in the past (CR #2, Table 4.2).

Given the distribution pattern of Arctic Grayling, potential impacts to this VEC relate primarily to water quality effects, including sediment effects, on Arctic Grayling habitat, and Arctic Grayling directly. Potential water quality effects are mitigatable through implementation of the surface water management plan during construction activities and operation of the Project. After Project closure and reclamation, activities with the potential to generate sediment will cease and revegetation of exposed ground and riparian areas will mitigate potential for sedimentation due to surface run-off.

Habitat impacts that may affect Arctic Grayling are related to temporary and permanent stream diversions on the Erith River. These impacts will be mitigated by the application of the general mitigation measures for stream diversions and flow management and through implementation of the NNL compensation plan. Potential adverse effects associated with the short-term reduction of surface flows during filling of end pits will be mitigated through monitoring of base flows and adaptive management of stream diversions to ensure that base flows are maintained.

Arctic Grayling is a popular sport fish species. There is a 'zero catch limit' imposed on Grayling in the Embarras River basin with the exception of the Erith River and its tributaries which has a limit of two Arctic Grayling over 35 cm. There are no potential effects related to increased resource utilization as the developments will not result in increased public access to the McLeod River or Embarras River.

With mitigation measures, the Project is not expected to have a negative effect on this VEC species. The potential impact of the Project on Arctic Grayling is considered insignificant.

Benthic Invertebrates

The principal potential impact to benthic invertebrate populations is related to changes in water quality, including sediment loads, in streams within and adjacent to the Project. Potential water quality effects are mitigable through implementation of the surface water management plan during construction activities and operation of the Project. After Project closure and reclamation, activities with the potential to generate sediment will cease and revegetation of exposed ground and riparian areas will mitigate potential for sedimentation due to surface run-off.

Stream diversions and major flow regime changes (that reduce habitat quantity or quality) will result in the loss of benthic invertebrate habitat. These losses will be small in comparison to the amount of benthic habitat that is available in the impacted streams, and will likely be short-lived given the ability of benthic invertebrates to rapidly colonize new or previously disturbed habitat. Overall, the adverse effects to benthic populations associated with the loss of habitat will be mitigated through implementation of the NNLP, which will provide benthic invertebrate habitat in the form of permanent diversion channels and end pit lakes.

Potential adverse effects associated with the short-term reduction of surface flows during filling of in pit ponds will be mitigated through monitoring of base flows and adaptive management of stream diversions to ensure that base flows are maintained.

With mitigation measures in place, the Project is not expected to have a negative effect on this VEC. The potential impact of the Project on benthic invertebrates is considered insignificant.

E.2.4 CUMULATIVE EFFECTS ASSESSMENT

The landscape in the RSA has been historically impacted by mining, timber harvesting, road and railway corridors and natural gas activities. These activities are also expected to persist into the future.

Mitigation strategies employed for the Project are based on proven, effective, methodologies that have been used by CVRI and other industries in the past. Through proper implementation of these strategies the Project specific effects arising from the Project are expected to be fully mitigated and are not expected to contribute to cumulative effects.

Potential local effects on the fisheries VECs associated with direct habitat loss or alteration are expected to be fully mitigated with properly implemented mitigation strategies. Therefore, no cumulative effects on fisheries VECs associated with direct habitat loss or alteration are expected.

While conservative assumptions have led to the prediction of some localized changes in water quality as a result of the Project, water quality modeling has predicted virtually no statistically significant changes in water quality concentrations or frequency of guideline exceedances in the RSA downstream of the Project (Section E.11, CR# 11). Even so, CVRI has proposed to implement a surface water management plan throughout the life of the Project. As the incremental effect of the Project on water quality in the Embarras River and Erith River is negligible (Section E.11), cumulative effects on the fisheries VECs associated with changes in water quality are not anticipated.

TSS is not expected to change significantly in the Embarras River or Erith River downstream of the Project (Section E.11, CR# 11) and the cumulative effect of sediment loading will be insignificant compared to natural variations (Section E.6, CR# 6), with properly implemented mitigation measures. Since no measurable changes in sediment concentrations or sediment loading is expected to occur in either the Embarras River or the Erith River downstream of the Project, no cumulative effects on the fisheries VECs associated with sediment introduction is expected.

Cumulative effects on flows may actually be lower than the Project specific case since forest harvesting activities and other non-mine disturbances in the drainage area including cleared road areas tend to increase average and peak runoff rates which may partially offset the reduced runoff rates and reduced peak flows expected from Project operations (Section E.11, CR# 11). Overall the effects of changes to the flow regime in the area near the Project will be mitigated by implementation the surface water management plan including management of flows to meet the established criteria for instream flow needs. The effects of the Project and other activities on river flows diminish with downstream direction such that they are near negligible (Section E.6, CR# 6). As such, impacts to aquatic VECs associated with changes in surface hydrology in the RSA are not expected.

E.2.5 Mitigation and Monitoring

E.2.5.1 Mitigation

In order to reduce potential impacts of the Project on aquatic resources CVRI will:

- implement a surface water management plan throughout the life of the Project;
- implement an emergency response plan including methods for spill containment in streams and site clean-up;
- design and construct defined watercourse crossings to meet the regulatory requirements for approval under the provincial *Water Act* and federal *Fisheries Act*;
- consider sensitive periods during construction planning by either planning construction to avoid these periods or implementation of site specific mitigation (*i.e.,* redd surveys, fish salvage, sediment monitoring);
- isolate the instream work site if flowing water is present at time of construction;
- complete fish rescue and release from isolated areas where required;
- implement sediment and erosion controls prior to work and maintenance during the work phase until the site has been stabilized;
- implement measures to minimize introduction of deleterious substances during construction including cleaning, servicing, and fuelling of equipment well away from water bodies;
- revegetate disturbed areas around crossing sites;
- reclaim streambed and stream banks as appropriate;
- maintain downstream flows;
- use appropriate sizing of diversion channels and/or pump;
- armour and/or line channels or use of flumes where appropriate;
- place and stockpile excavated materials in a location that is well away from the channel route;
- divert flow gradually into constructed channels to minimize potential erosion and mobilization of sediment;
- construct open channel diversions that allow for the movements of fish;
- develop and implement a stream flow management plan for each diversion to maintain instream flows;
- identify habitat compensation measures and implement at specific sites as needed, in consultation with DFO, Alberta Sustainable Resource Development (ASRD), and stakeholders, in order to address NNL of habitat productivity; and
- restrict public access on haul roads or other access routes.

E.2.5.2 Monitoring

In order to monitor the effectiveness of the mitigation measures CVRI will:

- monitor flows and TSS at all settling ponds;

- conduct regular inspections of all drainage works;
- expand the existing CVM aquatics monitoring program to include additional benthic macroinvertebrate sample sites;
- implement a water quality monitoring program for the life of the Project designed to meet the requirements of the Project approval;
- conduct long term monitoring of flow in each main creek to document critical low flow conditions during pit filling periods and to define the need for any bypass pumping to maintain in-stream flows;
- monitor components of the compensation plan, (*i.e.,* fish habitat enhancement structures) post-construction to assess the effectiveness of the compensation and to identify modifications that will be made (if necessary);
- evaluate end pit lakes to assess fish use, biological productivity, water quality, and other physical properties (*i.e.* thermal regime);
- implement TSS/turbidity monitoring during instream work if deemed necessary due to site conditions or timing of works; and
- monitor downstream flows to ensure instream flow needs are met.

E.2.6 SUMMARY OF VECS

Table E.2-8 provides a summary of impacts on aquatic resource VEC's. Potential impacts to the selected VECs relate primarily to direct physical habitat alteration/loss, changes in surface water hydrology, and surface water quality issues. Habitat effects primarily impact Rainbow Trout which were most abundant and widespread in the streams directly affected by the proposed diversions. Potential adverse effects to other VECs species relate primarily to surface water hydrology and water quality issues. With mitigation there will be an insignificant impact on the VEC's identified.

Table E.2-8 Summary of Impact Significance on Aquatic Resource Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
Rainbow Trout												
	Habitat alteration, changes in surface hydrology, sedimentation and other changes in water quality	NNLP, Flow management, Surface water management plan, Construction timing, Fish salvage	Project	Local	Long	Occasional	Reversible	Low	Negative	High	Low	Insignificant
			Residual	Local	Long	Occasional	Reversible	Low	Negative	High	Low	Insignificant
			Cumulative	No cumulative effects as project contribution to effect can be fully mitigated								
Bull Trout												
	Habitat alteration, changes in surface hydrology, sedimentation and other changes in water quality	NNLP, Flow management, Surface water management plan, Construction timing, Fish salvage	Project	Local	Long	Occasional	Reversible	Low	Negative	High	Low	Insignificant
			Residual	Local	Long	Occasional	Reversible	Low	Negative	High	Low	Insignificant
			Cumulative	No cumulative effects as project contribution to effect can be fully mitigated								
Arctic Grayling												
	Sedimentation and other changes in water quality habitat alteration, changes in surface hydrology,	NNLP, Flow management, Surface water management plan, Construction timing, Fish salvage	Project	Local	Long	Occasional	Reversible	Low	Negative	High	Low	Insignificant
			Residual	Local	Long	Occasional	Reversible	Low	Negative	High	Low	Insignificant
			Cumulative	No cumulative effects as project contribution to effect can be fully mitigated								
Benthic Invertebrates												
	Habitat alteration, changes in surface hydrology, sedimentation and other changes in water quality	NNLP, Flow management, Surface water management plan	Project	Local	Long	Occasional	Reversible	Low	Negative	High	Low	Insignificant
			Residual	Local	Long	Occasional	Reversible	Low	Negative	High	Low	Insignificant
			Cumulative	No cumulative effects as project contribution to effect can be fully mitigated								

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant, Significant

E.3 HYDROGEOLOGY

E.3.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted a hydrogeological assessment for the proposed Project. The following section is a summary of the Hydrogeological Assessment that was prepared by Millennium EMS Solutions Ltd. and is included as Consultant Report #3 (CR #3). For full details of the assessment, please refer to CR #3.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the groundwater component are provided in Section 3.2, and are as follows:

3.2 HYDROGEOLOGY

3.2.1 Baseline Information

[A] Provide an overview of the existing geologic and hydrogeologic setting from the ground surface down to, and including, the coal zones, and if applicable, to the base of any deeper strata that would be potentially impacted by mining. Document any new hydrogeological investigations, including methodology and results, undertaken as part of the EIA, and:

- *a) present regional and Project Area geology to illustrate depth, thickness and spatial extent of lithology, material (behavior) properties, stratigraphic units and structural features such as faults and fractures;*
- *b) present regional and Project Area hydrogeology describing:*
  - *i) the major aquifers, aquitards and aquicludes (Quaternary and bedrock), their spatial distribution, properties, hydraulic connections between aquifers, hydraulic heads, gradients, groundwater flow directions and velocities. Include maps and cross sections with the location of wells and/or control points,*
  - *ii) the chemistry of groundwater aquifers including baseline concentrations of major ions, metals and hydrocarbon indicators,*
  - *iii) the potential discharge zones, potential recharge zones and sources, areas of groundwater-surface water interaction and areas of Quaternary aquifer-bedrock groundwater interaction,*
  - *iv) water well development and groundwater use, including an inventory of groundwater users,*
  - *v) the recharge potential for Quaternary aquifers, and*
  - *vi) potential hydraulic connection between coal zones and other aquifers resulting from Project operations.*

3.2.2 Impact Assessment

[A] Describe Project components and activities that have the potential to affect groundwater resource quantity and quality at all stages of the Project.

[B] Describe the nature and significance of the potential Project impacts on groundwater with respect to:

- *a) inter-relationship between groundwater and surface water in terms of surface water quantity and quality;*

b) implications for terrestrial or riparian vegetation, wildlife and aquatic resources including wetlands;

c) changes in groundwater quality and quantity;

d) conflicts with other groundwater users, and proposed resolutions to these conflicts;

e) potential implications of seasonal variations; and

f) groundwater withdrawal for Project operations, including any expected alterations in the groundwater flow regime during and following Project operations.

[C] Describe programs to manage and protect groundwater resources including:

a) the early detection of potential contamination; and

b) groundwater remediation options in the event that adverse effects are detected.

Mining operations have occurred at the CVM since 1978. Previous to the CVM, there had been surface and underground coal mining in the area from the early 1900's to 1950's. Information regarding the characteristics of groundwater in the area has been available since 1975.

In order to evaluate the potential environmental impacts from the Project the existing database from the area was analyzed, selected core hydrogeological information (water levels, hydraulic conductivities and water chemistry) from the Project area were collected, and both were synthesized into an appropriate assessment. This type of assessment has the advantages of building on existing information and is therefore a reliable predictor of events.

Previous environmental assessments (Luscar 1999, 2005; CVRI 2008) have demonstrated that hydrogeological impacts of mining in this area will not extend beyond the boundary of the mine permit. Therefore, the local study area (LSA) will be the Project mine permit boundary (CR# 3, Figure 1.0-1) and there is no differentiation between the LSA and regional study area (RSA) for the purposes of the hydrogeological assessment.

VECs were selected to assess the significance of potential impacts to groundwater within the LSA and RSA (CR #3, Section 4.3). The VECs selected for assessment include groundwater quantity and quality and how they relate to the water wells in the Hamlet of Robb.

E.3.2 BASELINE SETTING

The majority of the Project lies in the drainage basin of the McLeod River but several kilometres in the southeast end of the proposed Project are in the Pembina River drainage basin. The coal seams are those of the Paskapoo Formation; the same seams that have been mined in all previous mining operations. In this setting, the mine will be situated on the east limb of a now-eroded anticline that dips to the northeast. The workings of two underground mines are present in the vicinity of Robb (CR #3, Figure 3.2-1). These mines worked the Val d'Or seam and it is presumed that they are now flooded with water though the elevation has not been established.

In addition to the review of historical monitoring information baseline information was obtained from a monitoring network consisting of six lines of piezometers (CR #3, Figure 1.4-1) extended perpendicular to the Robb Trend East. Water levels have been measured in all of the wells on several occasions. Water samples for major ion and trace metals analysis have been collected from selected wells.

E.3.2.1 Hydraulic Conductivity

A synthesis of 74 hydraulic conductivities determined in the historical information has noted that the maximum value observed was 3.7 x 10^{-3} m/s while the minimum was 3.4 x 10^{-9} m/s with a median value of 2.9 x 10^{-6} m/s. The million-fold range of hydraulic conductivity is not unusual given the fact that the nature of the rock can range from solid, intact strata to collapsed coal seams in abandoned underground workings.

Some of the hydraulic conductivity values (Luscar 1999a) are from investigations whose objective was to target plant groundwater supply. In this context, there may be a bias toward high hydraulic conductivities since low values would not have been tested.

E.3.2.2 Groundwater Chemistry

Sixty water samples have been collected from piezometers in the Project area. Generally, groundwater in the Project will have TDS less than 800 mg/L, will be sodium bicarbonate in nature and pH may be expected to be approximately 9. This information was compared to the historical monitoring data and it was demonstrated that groundwater chemistry throughout the areas previously mined is similar to the proposed Project (Table E.3-1).

Table E.3-1 Average Chemical Concentrations

Parameter	Locality				
	Robb Hamlet[1]	Robb Trend[2]	West Extension & Yellowhead[3]	South Extension & Mercoal[4]	Coal Valley Mine[5]
Calcium	25	18	15	27	29
Magnesium	8	5	6	2.2	6.6
Sodium	128	146	312	84	112
Potassium	1.2	1.9	1.6	1.2	1.7
Carbonate	17	26	41	35	62
Bicarbonate	381	425	777	282	325
Sulphate	52	15	11	3.6	20
Chloride	16	14	40	2	9
pH	8.5	8.7	8.7	8.4	7.6
TDS	451	417	792	271	346

1 further details provided in CR #3, Section 2.3.10
2 further details provided in CR #3, Section 3.4.4
3 further details provided in CR #3, Section 2.3.2.4
4 further details provided in CR #3, Section 2.3.2.3
5 further details provided in CR #3, Section 2.3.2.1

Average trace element chemistry in Project piezometers and from historical monitoring data is shown in Table E.3-2. For a point of reference, these statistics are compared to the freshwater aquatic guidelines that are applicable in Alberta (Alberta Environment 1999). This comparison is valuable since pit dewatering will result in discharge of this water to surface water bodies.

Maximum observed values of arsenic, iron, manganese and selenium exceed freshwater aquatic guidelines, just as they do in the South Extension and Mercoal mining areas (CR #3, Section 2.3.2). However, in the Project, copper, lead and zinc do not exceed guidelines and selenium is notably lower. Due to the generally lower TDS concentrations, the trace elements in the Project groundwater is generally lower in concentration than has been observed in South Extension or Mercoal.

Table E.3-2 Average Water Chemistry – Trace Constituents.

Trace Parameters	Freshwater Aquatic Limit	Robb Trend	West Extension and Yellowhead Tower	South Extension, Mercoal East and Mercoal West
Aluminum	0.1	0.3	0.4	0.3
Arsenic	0.005	0.004	0.003	0.006
Cadmium	0.033	0.0002	0.0003	0.00001
Chromium	0.007	0.001	0.004	0.0015
Copper	0.016	0.002	0.009	0.007
Iron	0.3	0.22	0.37	0.26
Lead	0.002	0.0004	0.001	0.002
Manganese	0.05	na	0.016	0.2
Mercury	0.0001	na	na	na
Molybdenum	0.073	0.008	0.0014	0.0023
Nickel	0.052	0.003	0.0017	0.0015
Selenium	0.001	0.001	0.001	0.001
Silver	0.001	na	0.004	na
Thallium	0.0008	0.0001	0.0003	na
Zinc	0.03	0.003	0.016	0.012

Notes: All units in mg/L
na = not calculated
All values assume hardness of 100 mg/L

E.3.2.3 Groundwater Flow

The hydrogeological regimes in the Project are depicted by a number of hydrogeological cross sections which are coincident with the six "monitor well sections" (CR #3, Figure 3.4-1 to 3.4-6). The details of the physical framework of the hydrogeological regime of the Project are fundamentally the same as has been observed (CR #3, Section 2.3.3) for all of the previous operations in this area. These are summarized as follows:

- Quaternary deposits are predominantly glacial till less than 10 m thick. Deposits that might qualify as "aquifers" (as defined by AEW) have not been encountered and are anticipated to be insignificant.

- Fracture- and joint- based groundwater flow focussing on the coal seams as a result of more abundant fractures in those units.
- Paskapoo Formation consisting of shale and indurated shaley siltstones and sandstones.

E.3.2.4 Water Supplies in Robb

The community of Robb relies on water wells to supply individual homes. For the purpose of this assessment three distinct residential areas have been identified:

- Upper Robb which is located in the northwest quarter of section 15, is generally in a higher elevation above and further from the Embarras River and in an area where coal is found at a depth of 150 m;
- Lower Robb which is located in the southwest quarter of section 14, is approximately 1000 m southeast of Upper Robb, is generally located upstream and near the floodplain of the Embarras River and south of the main Val d'Or coal seam; and
- Mile 34 which is located in the northwest quarter of section 10, approximately 1000 m further upstream from Lower Robb and is generally on the broad floodplain of the Embarras River.

Two observation well sites have been established in the community of Robb (Upper Robb and Lower Robb) each with two individual observation wells of different depth (CR #3, Table 3.4-1). The depths of these wells are representative of the depths of most water wells in the community of Robb and therefore represent water level changes that would have been experienced by most wells in the community during the period of observation. Hydrographs of the water level in these wells indicate the following:

- The depths of 50 and 95m in the observation wells in Upper Robb (CR #3, Figure 3.4-7) bracket the depths of more than 50% of the domestic wells (appearing in the GIS) in Robb and therefore are a good representation of the wells in the Community of Robb. Both wells have a water depth of approximately 20 m below ground, with the deeper observation well having water levels that are generally 2 to 3 m above those of the shallower well. Both wells showed an annual range of water level of less than 2 m with the shallower well (30 m deep) showing a typical annual groundwater cycle of declining levels in late summer through winter and rising levels from spring to summer and the deeper well (95 m deep) showing an unexplained gradual rise in water levels. The Lakeside Mine is located to the south of this residential area and is already discharging to an approximate elevation of approximately 1110 m. Therefore the impact of dewatering the groundwater to this elevation has already been expressed for the past decades.
- Observation wells in Lower Robb (CR #3, Figure 3.4-8) have water levels approximately at ground surface, several metres above the level of the nearby Embarras River. The shallow well has water levels that tend to be approximately one metre above those of the deeper well. Both wells show an annual cycle of lower levels in the fall and winter and higher levels in the spring. The Lakeside Mine is located to the south of this residential area and is already discharging to an approximate elevation of approximately 1,110 m. Therefore the impact of dewatering the groundwater to this elevation has already been expressed for the past decades.

E.3.3 POTENTIAL IMPACTS

In general, the effects of mining on groundwater and the resulting impacts may be placed into two categories:

- those dealing with groundwater levels, and
- those dealing with groundwater quality.

E.3.3.1 Effects on Surface Water Quantity

Watercourses in the Project area receive groundwater from shallow flow systems. To a greater or lesser extent groundwater contributes flow to these watercourses throughout the year. It is possible that at higher elevations in the drainage basins the water table will fall below the stream bed, in the fall or winter, and groundwater would then cease to contribute to flow until spring. At lower elevations in the drainage basin, there is a higher probability that groundwater contributions will continue year round. At these lower elevations, the proportion of groundwater in total flow would be relatively small in spring and summer and higher in fall and winter.

When mine pits are adjacent to water courses there will be a tendency for dewatering of the adjacent pit to draw water that would, for a portion of the year, have entered that water body. This will be relatively more important in times of low flow such as fall and winter than at times when there is abundant precipitation to generate surface runoff. Such a drainage phenomenon might be anticipated when pits are within 100 m of a water course.

The operating procedure for pit dewatering is to return the water to the local drainage course. This will have the net effect of an insignificant change in the volume of flow in the water course.

E.3.3.2 Effects on Surface Water Quality

The general practice at the CVM has been to discharge groundwater entering the mine areas to nearby surface water courses after being treated in settling ponds. It has been shown that the quality of groundwater in the two Project areas are 1) similar to groundwater chemistry in present and past mining areas in Coal Valley, and 2) of acceptable quality for discharge to surface water bodies (Section E.3.2.2).

There will be an insignificant impact on surface water quality caused by the discharge of groundwater from the pits.

E.3.3.3 Effects on Groundwater Levels

Dewatering of mine pits in the CVM has been accomplished by pumping from collection sumps. In this process, groundwater and precipitation entering the pit are pumped to a nearby pit for storage or to an impoundment for treatment prior to release. Dewatering by means of wells has not been used since the 1980's.

A key characteristic of this method of controlling water is that drawdown of the water table adjacent to the pit does not take place below the elevation of the base of the collection sump. This is substantially different than would be the case if water wells were used for dewatering.

The pit dewatering method used at CVM creates a maximum drawdown approximately equal to the depth of the pit below the water table.

Because of the steep dip of the geological structure of the area drawdown of groundwater levels take place in a cross-formational direction. Declines in water levels will be transmitted across formations rather than along the formations. Hydrogeologists commonly assume that the ratio of permeability along a formation to that across a formation is of the order of 0.1. Therefore, in this area, the tendency of water level drawdown to spread laterally away from a pit is significantly less than if the geological structure had the beds in a horizontal attitude.

CVRI has monitored the drawdown of groundwater levels in response to the approach and operation of a mining pit (CR #3, Appendix C-1 and C-2) and found:

- in one case significant drawdown due to mining may have extended to a distance of approximately 200 m from the pit,
- in the other case, significant drawdown was not identified beyond 50 m from the pit,
- taking into consideration the above distances, groundwater drawdown at distance from the pit was:
  - approximately in the range of natural variations, and
  - recovered to background conditions within nine months.
- reclamation conditions, such as end-pit lake elevations, will influence post-mining water levels, however evidence from previous monitoring leads to the conclusion that this is not widespread.

This information shows that impact of pit dewatering is not widespread and groundwater levels return to normal in less than one year. Therefore impact is insignificant.

E.3.3.4 Effects on Groundwater Chemistry

There are two issues with respect to how changes in groundwater chemistry may affect the quality of groundwater in the vicinity of the Project pits. These issues can be summarized as 1) changes resulting from the removal and placement of mine spoil, and 2) changes due to spills and leaks.

Mine Spoil

Toe springs are a characteristic of spoil dumps that are external to the mine pit. CVM does not currently have many external dumps because it is largely a dragline operation. Water chemistry of four springs at the toes of major mine spoil dumps in the CVM have been monitored since 2000 (CR #3, Table 2.3-2). All parameters fall within acceptable ranges observed elsewhere in the area and presented in Table E.3-2. The monitoring of toe springs at CVM has demonstrated that there are no significant impacts from spoil on water chemistry.

While the maximum nitrate value is notable, the eleven years of information at each of the four sampling locations show declining nitrate concentrations with time. Hackbarth Environmental (1999) presented an assessment of the behaviour of nitrate in mine spoil. Hackbarth determined that nitrate may be elevated above background in mines (or portions of mines) where significant amounts of explosives were used. He further determined that the nitrate was leached out after several years. Thus, the occurrence of nitrate is self-mitigating. The impact of nitrate on groundwater chemistry is insignificant.

Release of selenium from rock dumps into surface water has been noted at mountain mines in Alberta and British Columbia. A review of 92 selenium values from the groundwater monitoring wells demonstrate that prior to mining the highest concentration was 0.006 mg/L and the average concentration was slightly above 0.001 mg/L (CR #3, Table 2.3-7). A review of 36 selenium values from the groundwater monitoring wells post-mining demonstrate that the highest concentration post-mining was 0.0013 mg/L and the average concentration was slightly below 0.001 mg/L. The fact that the statistics appear to indicate that selenium concentrations go down after mining in an area is likely just a function of dealing with values that are: 1) close to the method detection limit and 2) can vary naturally in the order of several micrograms per litre. The appropriate interpretation is that there is no indication that mining affects selenium concentrations in groundwater.

The environmental impact of mine spoil on groundwater quality is therefore insignificant.

Spills and Leaks

Hydrocarbon fuels will be present in the Project mobile equipment, vehicles and in bulk storage. There is a potential for spills or leaks of these hydrocarbons.

Spills from equipment and vehicles will be the result of accidents. In this situation, there will be rapid response and clean up. The probability that such an event could cause an impact on groundwater quality is remote. The impact is therefore insignificant.

There will be the bulk storage of hydrocarbons fuels within the Project area. These facilities will be constructed to meet current provincial requirements for the storage of bulk fuels. Currently, this means the construction of containment facilities with low permeability materials. This minimizes the probability of an undetected leak and similarly reduces the risk of impact to groundwater quality. The possibility of impact is therefore remote.

E.3.3.5 Effects on Water Wells in Robb

The Project includes removal of the remaining coal from the upper portions of the Lakeside and Bryan mines. On the southeast side of the community of Robb this will mean lowering the water level to an elevation of approximately 1050 m. This will partially dewater these workings and effectively create a drawdown of water levels in the Val d'Or seam under the community of Robb to an elevation of 1050 m. On the northwest side of the community of Robb the Project is to extend the pit to an elevation of approximately 1040 m thus completely emptying the Bryan Mine of water.

Unacceptable drawdown of water levels in wells is likely to occur when mining operations are active in the areas of the Lakeside and Bryan Mines. This impact will be highest for shallow wells located close to these areas and much less for wells which are deeper and/or located farther away from the former underground mines.

In all cases, deepening of existing wells represents a viable mitigation. CVRI will inventory water wells in all three residential areas of Robb as mining approaches the Lakeside Mine in approximately 2029. If required at that time, a plan will subsequently be developed in consultation with the community that may include:

- deepening or replacement of wells that are judged to be at high risk,
- monitoring of observation wells to provide notice of diminishing water supply, and
- procedures to provide an emergency water supply should residents experience an interruption of their water supply.

This will mitigate impacts when mining is active near Robb.

As mining progresses beyond Robb the water diversion in the Lakeside and Bryan Mine's will cease and the groundwater levels will begin to rise beneath the community of Robb. With this rise in water levels the potential for impact will decline; particularly as many of the wells in Robb may have been previously deepened.

There will be no significant impact in the residual or cumulative sense.

E.3.3.6 Impact on Terrestrial Vegetation, Wildlife and Aquatic Resources

It has been demonstrated that significant drawdown of groundwater levels does not typically extend 100 m beyond a mine pit. Additionally, these declines in water table have been shown to be temporary. Typically, other mine activities, including spoil storage, roadways and similar support features, are taking place on the areas that may be impacted by declining water levels.

As these areas are normally subject to extensive disturbance, any plant or animal ecosystems within this distance from a pit will have been temporarily removed and will be subject to replacement according to the reclamation plan.

The impact of water table drawdown within approximately 100 m of pits is therefore insignificant because original ecosystems will have been removed. Since groundwater levels recover after mining the pre-mining water table is generally available to be incorporated into the reclamation planning. Other than possible permanent lowering of the local water table adjacent to end-pit lakes, the water table will not play a role in the process of restoration of local ecosystems.

E.3.4 CUMULATIVE EFFECTS ASSESSMENT

E.3.4.1 Groundwater Quantity

Groundwater levels in the immediate vicinity of the reclaimed mine pits will be modified. The re-contoured land surface plus the selective addition of end-pit lakes and wetlands will create a very localized change in groundwater conditions. Groundwater that moved through the subsurface to discharge to local streams will be diverted to discharge in the end-pit lakes and wetlands. The end-pit features will present a water surface that will result in a minor amount of evaporation that would not have taken place prior to mine operations. This minor amount of evaporation will not be of consequence to the local or regional groundwater regimes.

E.3.4.2 Groundwater Quality

It has been shown that groundwater moving through spoil may have enhanced concentrations of calcium and sulphate (CR #3, Table 2.3-2). The change in concentrations does not exceed any potentially-applicable guidelines such as drinking water or freshwater aquatic life. The impact is insignificant and this rating is supported by the facts that:

- the water discharging from toe springs is relatively small in volume and upon entering the surface water system it is diluted by other water from non-spoil area;
- the water within the spoil that remains in the subsurface as groundwater will mix with other, non-impacted, groundwater; and
- the groundwater in the spoil will be part of the shallow groundwater system which, according to Vogwill (1983), concentrates the majority of groundwater to discharge in local topographic lows. Thus, the impacted water is diluted by mixing with other groundwater and subsequently discharges to surface water where it is mixed further.

While there may be a theoretical potential for a cumulative impact, the situation is such that any change would not be discernable considering the normal ranges of concentrations of calcium and sulphate in the area. Considering the combined effects of dilution and natural variations, there will be no observable cumulative effects on groundwater chemistry that would translate into a groundwater quality issue.

E.3.5 Mitigation and Monitoring

E.3.5.1 Mitigation

In order to reduce potential impacts of the Project on groundwater CVRI will:

- inventory wells in the community of Robb and work with the community to develop an action plan in case an unacceptable drawdown of water levels occurs; and
- continue with implementation of the existing spill response plan.

E.3.5.2 Monitoring

In order to monitor the effectiveness of the mitigation measures CVRI will:

- monitor shallow groundwater conditions as required in the EPEA approval;
- monitor water chemistry in selected springs on an on-going basis;
- monitor water levels and water chemistry in selected monitoring wells on an ongoing basis;
- establish observation wells into the Mynheer and Wee seams beneath Robb; and
- select existing observation wells established for the Project for on-going monitoring.

E.3.6 Summary of VECs

A summary of the predicted effects on groundwater VECs is included in Table E.3-3.

The CVM has been operating for over 35 years. During this time numerous assessments have been conducted that can be used to gain an understanding of the impact of mining on groundwater in the area. After 35 years of mining activity in the CVM there have been no significant changes to groundwater chemistry or adverse impacts on groundwater levels.

The fact that no impacts have been documented, combined with the fact that the Project will be in a similar hydrogeological regime is incontrovertible evidence of the anticipation of insignificant impact in the Project area with the notable exception of impact to water wells in the community of Robb. It has been concluded that the Project will have an insignificant impact on groundwater in the area and with mitigation the community of Robb will have a continued supply of potable water (well or otherwise).

Table E.3-3 Summary of Impact Significance on Groundwater Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
1. Impacts on Water Wells												
	Wells in Robb	Water Well Replacement Policy	Project	Local	Short	None	R-ST	Low	Neutral	High	Moderate	Insignificant
			Residual	Local	Short	None	R-ST	Low	Neutral	High	Moderate	Insignificant
			Cumulative	Local	Short	None	R-ST	Low	Neutral	High	Moderate	Insignificant

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant- (No Impact, Low Impact, Moderate Impact), Significant (High Impact)

E.4 HISTORICAL RESOURCES

E.4.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of historical resources for the proposed Project. The following section is a summary of the Historical Resource Impact Assessment (HRIA) that was prepared by Lifeways of Canada Limited and is included as Consultant Report #4 (CR #4). For full details of the assessment, please refer to CR #4.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the historical resource component are provided in Section 4, and are as follows:

4 HISTORICAL RESOURCES

[A] Describe the Historic Resource Impact Assessment (HRIA) work done for the Project, and provide a schedule for any future work.

[B] Describe the implications of the findings of the HRIA work on Project design and scheduling.

[C] Describe any Project uncertainties arising from the need for future HRIA work.

Section 33 of the *Alberta Historical Resources Act* outlines the requirement to conduct a HRIA and submit a report to the Minister prior to undertaking any activities. As such, the objective of the HRIA is to meet the requirements outlined in the *Alberta Historical Resources Act* and various regulations and guidelines and to obtain clearance for development from Alberta Culture and Community Services (ACCS).

The LSA utilized for the HRIA is defined as the Project mine permit area and the RSA is an area within 10 km of the LSA (CR #4, Figure 7). Ten kilometres is often seen as a reasonable sphere of movement on a daily basis for human groups occupying and using the region. The RSA incorporates portions of a number of the meaningful drainages in the region known to have associated historical resources. The RSA includes meaningful regional geographical and topographic variability including portions of the Embarras Plateau to the southwest, the Edson Lowlands to the northeast, and strong ridge systems in between. In addition, the RSA includes portions of the historic Coal Branch area, the early settlements of which had a strong influence on the types of historic period materials to be found in both the RSA and LSA.

HRIA field studies and subsequent analyses and reporting focused on the precontact archaeological sites and historic sites known and predicted to be present in the Project area. The assessment of impacts to historical resources and the mitigation of these impacts is an ongoing process that will be completed prior to development of the mine. The methodology undertaken included compilation of a historical resources overview, consultation with persons knowledgeable of the area and initiation of field program. The field program consisted of surface examination of areas exhibiting a potential for yielding prehistoric or historic sites. Shovel testing was undertaken at discovered sites and in areas of potential historic sites.

E.4.2 Baseline Conditions

In the Province of Alberta, historical resources are defined and regulated under the Alberta *Historical Resources Act*. Historical resources include historic, archaeological, and palaeontological resources. The Project is located in close proximity to historic Coal Branch towns that results in elevated potential for the presence of historic period sites.

Historic sites are those sites that post-date the exploration and settlement of an area by peoples primarily of Euro-Canadian descent and "Western European Culture." They may include sites with standing structures/structural remains such as towns, mining camps, cabins, mines, prospects, graves, trails, roads, and railroads.

Archaeological sites related to aboriginal peoples who seasonally and occasionally occupied these lands over the past 10,000 years are known and were predicted to exist within the Project area. These sites include surface and buried sites. Areas, particularly along the Erith River, White Creek, and Bryan Creek, have high potential for significant precontact archaeological sites. Many of the legal subdivisions within the Project area were listed as historical resources value (HRV) 4 or 5 for archaeological sites.

Palaeontological sites and fossils include both surficial and bedrock deposits and the fossilized remains of both living and extinct species of plants and animals. During the early planning phases of the Project a palaeontological historical resources overview (HRO) was submitted to staff of the Royal Tyrrell Museum to determine official palaeontological requirements for the Project. The Royal Tyrrell Museum indicated that the Project did not require a palaeontological HRIA; instead staff of the Royal Tyrrell Museum would visit the area periodically to inspect bedrock exposures which occur at limited locations in the Project area.

E.4.2.1 Historical Resources Potential

The majority of the Robb Main, Center and East area is considered to be of low archaeological potential. A series of large northwest-southeast ridges with intervening low wet terrain runs through the area. Large tracks of wet muskeg are found in the lower terrain. Existing disturbances are from pipelines, oil and gas wells pads, access roads, and extensive harvested areas. Specific landforms along river and creek systems (Embarras, Erith, Bacon, Lendrum, Hay and Halapenny Creek, and a number of unnamed tributaries) and along the northwestern periphery of the area have high potential for archaeological sites. The undulating ridge system that runs through the area has several known archaeological sites. Numerous historical sites and precontact archaeological sites have been recorded in this development area.

Much of the Robb West area has a low or moderate potential for precontact archaeological sites and archaeological potential. Much of the terrain has many side slopes, is poorly drained, and has steep valleys with intermittent watercourses. The area has a high percentage of surface disturbance including roads, seismic exploration cutlines, the Bryan Mine, and harvested areas. Lands along Bryan Creek have a high potential for significant precontact archaeological sites. The historic Bryan Mine and one other historical site have been recorded within this development area.

The Bryan Corridor consists largely of terrain with steep slopes, small drainages deeply incised between ridges, and poorly drained terrain. Disturbances within the corridor consist of roads, pipelines, and historical logging. The area has a low historical resource potential with isolated areas, particularly along Bryan Creek, having high potential for significant precontact archaeological sites.

The Erith corridor is roughly centered on the headwaters of the Erith River where it exits the Embarras Plateau. Low terrace landforms are found in undulating terrain along the river with more rugged terrain to the south. Industrial disturbances include harvesting, seismic cutlines, a network of gravelled logging roads, and oil and gas developments. The Erith Corridor has the highest historical resources potential within the Project area. Prior to the HRIA field program, nine sites had been recorded in the Erith Corridor.

The Halpenny Corridor terrain consists of side slopes, poorly drained terrain, steep valleys with intermittent watercourses, and level terrain well back from watercourses. Industrial disturbances (large and small pipelines, seismic trails, oil and gas well pads) have impacted portions of the corridor. The Halpenny Corridor has the lowest overall historical resources potential within the Project area and has low to moderate potential landforms for unrecorded precontact archaeological and archaeological sites.

E.4.2.2 Site Assessment

The assessment of sites was accomplished through surface survey and subsurface prospecting of high potential zones and ground-truthing of other areas. Field reconnaissance focused on systematic traverse and shovel testing of high potential landforms within the high potential zones (CR #4, Figures 1 to 4). The field program involved completion of 1838 shovel tests. This is in addition to the 272 shovel tests previously undertaken prior to coal exploration activities and 505 shovel tests completed in support of other developments and shovel tests completed in support of the Dennison mine project. Over the years approximately 3000 shovel tests have been excavated in the Project area.

The HRIA programs recorded 67 precontact and historic sites associated with the Project area. Of the 67 sites, 60 are within the proposed mine permit area and 36 are found within the Project footprint (Table E.4-1).

There were no palaeontological remains identified in the development zones and there were not any significant bedrock exposures identified.

Table E.4-1 Archaeological Sites Recorded in the Robb Trend Project Area

Borden Number	Site Class	Site Type	Archaeological Significance	Location(1)	Recommendations
FfQd-14	Precontact	Isolated Fine	local	Project Footprint	no further work required
FfQd-15	Precontact	Scatter <10	local	Mine Permit Boundary	no further work required
FgQd-6	Precontact	Scatter <10	local	Project Footprint	no further work required
FgQd-7	Historic	Historic camp	High local	Project Footprint	historical research and Stage I mitigation
FgQd-8	Historic	Historic camp	High local/ regional	Outside of Mine Permit Area	historical research and Stage I mitigation program
FgQe-31	Precontact	Campsite	Local	Project Footprint	no further work required
FgQe-34	Precontact	Scatter >10	Local	Project Footprint	no further work required
FgQe-35	Precontact	Scatter <10	local	Project Footprint	no further work required
FgQe-65	Precontact	Scatter <10	Local	Mine Permit Boundary	no further work required
FgQe-66	Precontact	Scatter <10	High local	Project Footprint	no further work required
FgQe-67	Precontact	Scatter >10	local	Outside of Mine Permit Area	no further work required
FgQe-68	Precontact	Scatter <10	local	Project Footprint	no further work required
FgQe-69	Precontact	Workshop	local	Project Footprint	no further work required
FgQe-70	Precontact	Scatter <10	local	Project Footprint	no further work required
FgQe-71	Precontact	Campsite	Regional	Project Footprint	Stage I mitigation
FgQe-72	Precontact	Isolated find	Local	Outside of Mine Permit Area	no further work required
FgQe-73	Precontact	campsite	Local	Mine Permit Boundary	no further work required
FgQe-74	Precontact	Workshop	High local	Mine Permit Boundary	no further work required
FgQe-75	Precontact	Campsite	High local	Project Footprint	no further work required
FgQf-70	Precontact	Campsite	local	Mine Permit Boundary	no further work required
FgQf-71	Precontact	Scatter <10	local	Mine Permit Boundary	no further work required
FgQf-72	Precontact	Campsite	High local	Mine Permit Boundary	Stage I mitigation program

Table E.4-1 Archaeological Sites Recorded in the Robb Trend Project Area

Borden Number	Site Class	Site Type	Archaeological Significance	Location(1)	Recommendations
FgQf-73	Precontact	Isolated find	local	Mine Permit Boundary	no further work required
FgQf-74	Precontact	Scatter <10	local	Mine Permit Boundary	no further work required
FgQf-154	Precontact	Isolated find	local	Mine Permit Boundary	no further work required
FgQf-157	Precontact	Workshop	High local	Mine Permit Boundary	Stage I mitigation program
FgQf-186	Precontact	Scatter <10	local	Project Footprint	no further work required
FgQf-187	Precontact	Scatter >10	local	Outside of Mine Permit Area	no further work required
FgQf-188	Precontact	Isolated find	local	Mine Permit Boundary	no further work required
FgQf-189	Precontact	Scatter <10	local	Mine Permit Boundary	no further work required
FgQf-190	Precontact	Campsite	High local	Mine Permit Boundary	Stage I mitigation program
FgQf-191	Precontact	Campsite	Regional	Mine Permit Boundary	Stage I mitigation program
FhQf-18	Precontact	Isolated find	Local	Project Footprint	no further work required
FhQf-19	Precontact	Scatter <10	Unknown	Mine Permit Boundary	no further work required
FhQf-20	Precontact	Campsite	High local	Project Footprint	no further work required
FhQf-21	Precontact	Isolated find	local	Mine Permit Boundary	no further work required
FhQf-23	Historic	Mine	High local	Mine Permit Boundary	historical research and Stage I mitigation
FhQf-26	Precontact	Isolated find	unknown	Outside of Mine Permit Area	no further work required
FhQf-37	Precontact	Scatter<10	local	Project Footprint	no further work required
FhQf-38	Precontact	campsite	High local	Project Footprint	Stage I mitigation
FhQf-39	Precontact	Isolated find	local	Project Footprint	no further work required
FhQf-105	Precontact	Isolated find	local	Outside of Mine Permit Area	no further work required
FhQf-106	Precontact	Workshop	Regional	Project Footprint	Stage I mitigation
FhQf-107	Precontact	Workshop	High local	Mine Permit Boundary	no further work required

Table E.4-1 Archaeological Sites Recorded in the Robb Trend Project Area

Borden Number	Site Class	Site Type	Archaeological Significance	Location(1)	Recommendations
FhQf-108	Precontact	Scatter <10	High local	Mine Permit Boundary	no further work required
FhQf-109	Precontact	Scatter <10	High local	Project Footprint	no further work required
FhQf-110	Precontact	Campsite	High local	Project Footprint	Stage I mitigation
FhQf-111	Historic	Historic settlement	High local	Outside of Mine Permit Area	historical research and Stage I mitigation
FhQf-112	Precontact	Isolated find	local	Project Footprint	no further work required
FhQf-113	Historic	Historic trench	local	Project Footprint	no further work required
FhQf-114	Precontact	Isolated find	local	Project Footprint	no further work required
FhQf-115	Precontact	Campsite	local	Project Footprint	no further work required
FhQF116	Precontact	Scatter<10	local	Project Footprint	no further work required
FhQf-117	Precontact	Isolated find	local	Project Footprint	no further work required
FhQf-118	Precontact	Scatter <10	local	Mine Permit Boundary	no further work required
FhQf-119	Historic	Mine	High local	Project Footprint	historical research and Stage I mitigation
FhQf-120	Precontact	Isolated find	local	Mine Permit Boundary	no further work required
FhQg-121	Historic	Dwelling	High local	Project Footprint	historical research and Stage I mitigation
FhQg-79	Precontact	Isolated find	local	Project Footprint	no further work required
FhQg-80	Precontact	Isolated find	local	Project Footprint	no further work required
FhQg-81	Precontact	Scatter<10	local	Project Footprint	no further work required
FhQg-82	Precontact	Isolated find	local	Project Footprint	no further work required
FhQg-83	Precontact	Scatter <10	local	Project Footprint	no further work required
FhQg-84	Precontact	Campsite	Regional	Project Footprint	Stage I mitigation
FhQg-85	Historic	Dwelling	High local	Project Footprint	historical research and Stage I mitigation
FhQg-86	Historic	Dwelling	High local	Mine Permit Boundary	historical research and Stage I mitigation

Table E.4-1 Archaeological Sites Recorded in the Robb Trend Project Area

Borden Number	Site Class	Site Type	Archaeological Significance	Location[1]	Recommendations
FhQg-87	Precontact	Isolated find	local	Mine Permit Boundary	no further work required

(1) "Project Footprint" – site found within the Project Footprint; "Mine Permit Boundary" – site within the mine permit boundary but outside of the Project Footprint; "Outside of Mine Permit Area" – site was found outside of the currently proposed Mine Permit Boundary

E.4.3 POTENTIAL IMPACTS

Archaeological sites located within the Project footprint will be disturbed; however, CVRI will work with ACCS to determine the mitigation strategy for each site and disturbance will not occur until clearance is issued by ACCS under the *Historical Resources Act*. Of the 36 sites found within the Project footprint, it has been recommended that CVRI undertake additional mitigation at nine sites prior to development.

Archaeological sites located outside the Project footprint will be mitigated should the Project footprint be expanded to include these sites. In this scenario, CVRI will again work with ACCS to determine the mitigation strategy for each site and disturbance will not occur until clearance is issued by ACCS under the *Historical Resources Act*.

Due to changes to the proposed mine permit area or Project footprint subsequent to the HRIA program, several small areas have not had an HRIA completed (CR #4, Table 3 and Figure 8). Some of these areas have low to moderate potential and no further work is required, other portions have higher potential and additional work will be undertaken as required by ACCS prior to development in these areas.

E.4.4 CUMULATIVE EFFECTS ASSESSMENT

Cumulative effects on historical resources include those directly related to the Project in relation to those from other past, present, and future development projects in the region which have or may disturb historical resources. Cumulative effects on historical resources are assessed by comparing HRIA results in the LSA to those in the RSA. The overall known site loss in relationship to site significance, and the effects of this on the ability of archaeologists to interpret historical resources in the future is considered.

Of the sites found within the LSA, 36 will be disturbed or removed during Project development. Twenty-seven of these sites are considered to be of low historical potential. That is, the artifact density, diversity, and distributions at those sites indicate that excavation or other forms of recording is unlikely to contribute any meaningful understanding of the past. Five precontact sites and four historic period sites that have the potential to contribute to the knowledge of the area will be removed. These sites are considered to be of high local or regional archaeological significance. This information will be valuable in assessing and interpreting historical resources in the region in the future.

Within the RSA, a total of 504 archaeological sites have been recorded (CR #4, Table 2) which includes those recorded for the Project. Of the 504 sites in the RSA database 406 are precontact sites, 84 are historic period sites, and 14 are known to have both precontact and historic components. Thirty-five percent of the previously recorded sites were or are considered to be worthy of additional investigation for data recovery prior to disturbance.

Following development of the Project, 75% of the known, significant historical resources in the surrounding region will be extant and available for future study of both Precontact and Historic periods. An unknown but large number of significant sites are assumed to be present in undeveloped portions of the region, likely numbering well into the hundreds. As historical resources are not mobile, the precise impact of future development on these resources can only truly be assessed once those developments are proposed and HRIA work is undertaken. However, given that previous development in the region has affected somewhere between 20-25% of the land base, yet 75% of the significant sites within those areas have been fully or partially preserved. Many of those removed have been appropriately studied and information collected prior to removal, so we can expect that implementation of the *Historical Resources Act* on any future developments will result in an appropriate balance between information loss, information gain from mitigation, and preservation of a large sample of sites for future research.

The development of the Project, in combination with existing developments and possible future development, will not have a deleterious cumulative effect on historical resources in the area. Any losses are typically offset by the data gained during mitigation activities, which are typically the only source of information on the historical resources in the area.

E.4.5 MITIGATION AND MONITORING

E.4.5.1 Mitigation

In order to reduce potential impacts of the Project on historical resources CVRI will:

- obtain clearance from ACCS, as required, prior to development; and
- undertake mitigation measures as recommended and agreed upon with ACCS.

E.4.4.2 Monitoring

If a historical resource is encountered during mining that has not been identified under an HRIA CVRI will stop work in the area until ACCS has been notified and the appropriate mitigation measures put in place.

E.4.6 SUMMARY

The HRIA works completed for the Project have resulted in the recording of 67 sites in the Project area. These sites range considerably in size, age, and significance. Nine sites within the Project footprint require further investigation prior to disturbance and eight sites have been identified outside the disturbance footprint that will require further investigation should CVRI include these areas in the disturbance footprint. As well, there are small areas that have not been subjected to an HRIA which are to be completed before disturbance activities proceed.

All outstanding HRIAs are to be submitted to ACCS. Mitigation measures approved by ACCS will be conducted by CVRI prior to disturbance activities taking place. CVRI is to obtain clearance from ACCS before commencing with developments.

E.5 HUMAN HEALTH

E.5.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of human health risk for the proposed Project. The following section is a summary of the Human Health Risk Assessment that was prepared by Intrinsik Environmental Sciences Inc. and is included as Consultant Report #5 (CR #5). For full details of the assessment, please refer to CR #5.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the human health component are provided in Section 6, and are as follows:

6 PUBLIC HEALTH AND SAFETY ASSESSMENT

[A] Describe any features or characteristics of the Project that may have implications for public health or the delivery of regional health services that are different from the existing Coal Valley Mine. Determine whether there may be implications for public health arising from the Project that are different from the existing Coal Valley Mine. Specifically:

- *a) assess the potential health implications of the compounds that will be released to the environment from the Project in relation to exposure limits established to prevent acute and chronic adverse effects on human health;*
- *b) provide the data, exposure modeling calculations, and describe the methods the Proponent used to assess impacts of the Project on human health and safety;*
- *c) provide information, including chemical analyses and modeling results, on samples of selected environmental media (e.g., soil, water, air, vegetation, wild game, etc.) used in the assessment;*
- *d) discuss the potential for changes to water quality, air quality and soil quality to increase human exposure to contaminants taking into consideration all Project activities;*
- *e) identify the human health impact of the potential contamination of country foods and natural food sources taking into consideration all Project activities;*
- *f) document any health concerns raised by stakeholders during consultation on the Project;*
- *g) document any health concerns identified by aboriginal communities or groups resulting from impacts of existing development and of the Project specifically on their traditional lifestyle and include an aboriginal receptor type in the assessment;*
- *h) assess the cumulative human health impacts to receptors, including First Nations and Métis receptors;*
- *i) as appropriate, describe anticipated follow-up work, including regional cooperative studies. Discuss how such work will be implemented and coordinated with ongoing air, soil and water quality initiatives;*
- *j) describe the potential health impacts resulting from higher regional traffic volumes and the increased risk of accidental leaks and spills; and*
- *k) discuss mitigation strategies to minimize the potential impact of the Project on human health.*

[B] Describe those aspects of the Project that may have implications for public safety. Determine whether there may be implications for public safety arising from the Project. Specifically:

- *a) describe the CVRI's emergency response plan, including public notification protocol and safety procedures, to minimize adverse environmental effects, including emergency reporting procedures for spill containment and management;*
- *b) document any safety concerns raised by stakeholders during consultation on the Project;*
- *c) describe how local residents will be contacted during an emergency and the type of information that will be communicated to them;*

d) describe the existing agreements with area municipalities or industry groups such as safety cooperatives, emergency response associations, regional mutual aid programs and municipal emergency response agencies;

e) describe the potential safety impacts resulting from higher regional traffic volumes; and

f) discuss mitigation plans to ensure workforce and public safety for all stages of the Project. Include prevention and safety measures for wildfire occurrences, accidental release or spill of chemicals to the environment and failures of structures retaining water or fluid wastes.

The Human Health Risk Assessment (HHRA) describes the nature and significance of potential short-term (acute) and long-term (chronic) health risks to people associated with exposure to the Chemicals of Potential Concern (COPCs) emitted or released from the proposed Project. The HHRA examines potential health risks attributable to the Project in combination with existing developments.

The HHRA focused on the potential health risks associated with chemical concentrations in two study areas:

- Local Study Area, consisting of a 10 km (North-South) by 13 km (East-West) area centered on the west side of the Project area where the greatest intensity of mining activity and associated emissions are expected.
- Regional Study Area, consisting of a 50 km (east to west) by 47 km (north to south) area surrounding the Project.

The HHRA assessed both short and long term health risks to people associated with the chemicals emitted from the Project. The two exposure durations used in the assessment can be described as follows:

- acute: exposure extends over a time period covering minutes to a day; and
- chronic: exposure occurs continuously or regularly over extended periods, lasting for periods of months to years, and possibly extending over an entire lifetime.

Although the operational life of the Project is estimated to be 25 years, the HHRA assumed that the chemical emissions attributable to the Project would continue for a period of 80 years. The assumption of 80 years coincides with a person's assumed lifespan (Health Canada 2009a).

E.5.2 Assessment Approach

Potential human health risks associated with Project emissions or releases were examined using a conventional risk assessment paradigm. The risk assessment paradigm is consistent with those developed by Alberta Health and Wellness (AHW 2011), Health Canada (2009a), the Canadian Council of Ministers of the Environment (CCME 2006), and the U.S. Environmental Protection Agency (US EPA OSW 2005). This methodology has been endorsed by a number of provincial regulatory authorities in the past, including AEW, Alberta Health and Wellness (AHW) and the Alberta Energy Resources and Conservation Board (ERCB).

The risk assessment paradigm involves four steps:

- problem formulation;
- exposure assessment;
- toxicity assessment; and
- risk characterization.

E.5.2.1 Problem Formulation

Problem formulation is the initial step of the assessment in which all chemicals associated with Project emissions or releases are identified, people potentially at risk are characterized, and relevant exposure pathways are identified. The problem formulation step "sets the stage" for the detailed analysis of the HHRA.

Identification of COPCs

The COPCs for the Project were identified through the development of a comprehensive inventory of chemicals emitted from the Project and to which people might be exposed. Development of the initial chemical inventory considered both possible Project air emissions and Project affected water releases. As the Project will not release any chemicals into groundwater or surface water, the COPCs for the HHRA were based on air emissions only. Certain COPCs that may deposit to the surrounding terrestrial environment and possibly persist or accumulate in the environment were identified. People could be exposed to these COPCs via secondary pathways, related to soil, food and water.

The selection of COPCs for this Project also took into consideration whether or not sufficient toxicological information is available to assess the health risks. When toxicological information was not available, the HHRA searched for the availability of chemical surrogates to represent any of the substances or groups of substances.

Consideration was given to the inherent physical/chemical properties of each COPC that would influence its fate and persistence in the environment, and subsequently its potential presence in secondary pathways of exposure. This was accomplished by comparing the physical/chemical properties of the COPCs (*i.e.,* molecular weight, vapour pressure, and Henry's Law constant) against pre-established criteria to identify those substances that could deposit from the air onto nearby lands and/or surface waters.

The COPCs used in the assessment are listed in CR #5, Table 3-1 and in general include:

- criteria air contaminants (CACs);
- metals;
- polycyclic aromatic carbons (PAHs);
- petroleum hydrocarbon (PHC) fractions; and
- volatile organic compounds (VOCs).

Characterization of People Potentially at Risk

People in the region who have the highest potential health risks associated with Project emissions include individuals who might be: 1) most highly exposed to Project emissions; and/or 2) more sensitive or susceptible to Project emissions. In this regard, consideration was given to:

- the people that are known or anticipated to spend time near the Project;
- the physical characteristics of the people in the region that could result in increased exposure;
- the lifestyles of the individuals in the region that could result in increased exposure (*e.g.,* consumption patterns, portions of diet obtained locally); and
- sensitive or more susceptible individuals in the region (*e.g.,* infants and young children, the elderly, individuals with compromised health).

Recognizing that people use the area in the immediate vicinity of the Project for recreational or traditional activities (Aboriginal Stakeholders) such as hunting, trapping and plant gathering, the HHRA included an assessment of potential adverse health risks to people active along the boundary of the Project area; specifically, at the location along the fence-line for which the highest ground-level air concentrations of the COPCs were predicted to occur.

Eighteen discrete locations within the RSA were selected for consideration in the HHRA, with six falling within the LSA (CR #5, Figure 2). The 18 receptor locations included in the HHRA were grouped according to their assumed land-use. It was assumed that the physical characteristics of people in each group were generally similar. The discrete receptor locations were organized into the following groups in the HHRA:

- LSA-MPOI: Local MPOI and includes people who may be present at the locations where the highest COPC concentration could occur in the LSA.
- RSA-MPOI: The location where the highest COPC concentration could occur in the RSA.
- Residents: It was assumed that these individuals live permanently in the area, and practice a lifestyle that involves a high level of consumption of local country foods, garden vegetables and traditional plants. It also includes individuals who may use the cabins located in the RSA as a temporary shelter while engaged in activities such as hunting, fishing or trapping. Although the exact frequency of use is not documented, for the purposes of the HHRA, it was assumed that these individuals use these recreational areas on a regular basis for several months per year.
- Recreational: This group includes individuals who may visit local campgrounds or other sites for recreational purposes (*e.g.,* fishing or hunting) for various durations of time (days, months) but do not permanently reside in the area.

Potentially long-term exposed individuals residing in the RSA may be exposed through multiple pathways. All age classes (life stages) were considered in a multiple pathway exposure assessment. The five receptor life stages that were included in the HHRA are consistent with Health Canada guidance (Health Canada 2009a):

- infant (0 to 6 months = 0.5 years);
- toddler (7 months to 4 years = 4.5 years);

- child (5 to 11 years = 7 years);
- adolescent (12 to 19 years = 8 years); and
- adult (20 to 80 years = 60 years).

For the assessment of carcinogens, a "composite individual" who represents all life stages (*e.g.,* from infant to adult) was used to represent cumulative exposure over an 80-year lifetime.

Exposure Pathways Identification

For human exposure to take place (and potential health risks to occur), exposure pathways must exist that link Project emissions to exposure by humans. Based on predicted Project air emissions, local residents and persons spending any time near the Project site or in local communities could be exposed via inhalation of COPCs to the atmosphere from the Project.

Local permanent and seasonal individuals would also be potentially exposed to COPCs through secondary pathways including ingestion of local country foods and through dermal contact. The following exposure pathways were included in this HHRA:

- inhalation of air;
- inhalation of dust;
- ingestion of soil (inadvertent);
- ingestion of water;
- ingestion of local above-ground plants (including fruit and vegetables);
- ingestion of local below-ground plants (root vegetables);
- ingestion of local traditional plants (Labrador tea and cattail);
- ingestion of local fish;
- ingestion of local wild game (moose, snowshoe hare and ruffed grouse);
- ingestion of water while swimming;
- dermal contact with water; and
- dermal contact with soil.

E.5.2.2 Exposure Assessment

Potential exposures to COPCs were estimated based both on ambient measurements (for baseline conditions) and predictive exposure modelling for COPCs that will be emitted from the Project.

Air dispersion models were used to estimate maximum air concentrations resulting from Project emissions (Section E.1). Exposure models were then used to estimate potential human exposures based on predicted air concentrations as well as through other environmental media including soils and country foods.

Inhalation Assessment

Inhalation exposure estimates were based on the results of the air dispersion modeling that was described in the Air Quality Assessment (Section E.1). Predicted air concentrations were presented over different averaging periods (*e.g.,* 10-minute, 1-hour, 8-hour, 24-hour and annual) to allow for the assessment of both acute and chronic health risks. In addition, predicted air concentrations were presented for various assessment cases (*i.e.,* Base Case, Application Case and PDC) to characterize risks from the Project in combination with existing and proposed sources.

Multiple Exposure Pathway Assessment

For the assessment of exposure pathways other than inhalation, physical and chemical screening was performed to identify organic COPCs emitted from the Project that may deposit to the surrounding terrestrial environment and possibly persist or accumulate in sufficient quantities for people to be exposed via soil, food and water pathways. For this purpose, only relatively non-volatile COPCs were considered, including PAHs and VOCs. Metals were automatically included in the multiple pathway exposure assessment. The CACs were automatically excluded from the multiple pathway exposure assessment as these chemicals predominantly exist in air and therefore they strictly relate to inhalation exposures.

The volatility and accumulation potential of these organic COPCs required further consideration based on physical and chemical properties that influence their fate and persistence in the environment.

The results of the physical-chemical screening revealed that 17 organic COPCs are eligible for inclusion in the multiple pathway assessment, provided that defensible exposure limits are available (CR #5, Table 3-7).

E.5.2.3 Toxicity Assessment

The toxicity assessment involves having an understanding of the critical toxicological effects that can result from exposure to the COPCs and the condition in which these effects might occur. Potential health effects associated with exposures to the COPCs, along with the basis and selection of the exposure limits, are described in CR # 5, Appendix A.

When evaluating the toxicological potential for a substance in relation to health, consideration must be given to the dose to which a person is exposed, as the dose determines the type and potentially the severity of any adverse effects that may be observed. In addition, consideration must be given to the route of exposure (*i.e.,* inhalation, oral, or dermal), as the route of exposure influences absorption, distribution and excretion of the toxicant.

Two categories of COPCs were assessed based upon their mechanism of toxicity: threshold and non-threshold COPCs. Threshold substances are generally those that require that a certain level of exposure (or minimum dose) be exceeded before toxic effects occur. In general, threshold substances are non-carcinogenic (*i.e.,* non-cancer causing), but there are some chemicals that demonstrate a mode of carcinogenicity that has a threshold. Non-threshold substances are carcinogens capable of producing cancer through one or more possible mechanisms (*e.g.*, mutagenicity, cytotoxicity, inhibition of programmed cell death, mitogenesis [uncontrolled cell proliferation] and immune suppression) that, in theory, do not require the exceedance of a threshold (US EPA OSW 2005).

Exposure Limits

Exposure limits (also known as toxicological reference values or TRVs) that have been developed by scientific and/or regulatory agencies aimed at the protection of human health were identified for each of the COPCs on both an acute and chronic basis. Separate assessments were completed for both the acute and chronic exposure scenarios in recognition of the fact that the toxic response produced by chemicals and the target tissues affected can change, depending on whether exposure is short term (acute) or long term (chronic). As a result, different exposure limits were selected for each chemical included in the acute and chronic assessments (CR #5, Tables 3-12 to 3-14).

Chemical Mixtures

Given that chemical exposures rarely occur in isolation, the potential health effects associated with mixtures of the COPCs were assessed in the HHRA (CR #5, Table 3-17). Potential additive interactions were identified for specific COPCs that may cause:

- eye irritation;
- nasal irritation;
- respiratory irritation;
- kidney toxicity;
- liver toxicity;
- reproductive and developmental effects;
- neurotoxicity;
- gastrointestinal toxicity; and
- lung tumours.

E.5.2.4 Risk Characterization

This final step of the risk assessment involves comparing estimated exposures (identified in the exposure assessment) with exposure limits (identified in the toxicity assessment) to determine potential health risks for the different assessment cases. Risk estimates are presented as potential Project-specific effects and cumulative effects for both acute and chronic exposures. The potential health risks associated with emissions from the Project are expressed as Risk Quotients (RQs) for the non-carcinogenic COPCs and as Incremental Lifetime Cancer Risks (ILCRs) for the carcinogenic COPCs.

Risk quotient (RQ) values were calculated by comparing the predicted levels of exposure for the non-carcinogenic COPCs to their respective exposure limits that have been developed by regulatory and scientific authorities (CR # 5, Appendix B). Interpretation of the RQ values was as follows:

- **RQ ≤ 1** Indicates that the estimated exposure is less than or equal to the exposure limit (*i.e.,* the assumed safe level of exposure). RQ values less than or equal to 1.0 are associated with negligible health risks, even in sensitive individuals given the level of conservatism incorporated in the derivation of the exposure limit and exposure estimate.

- **RQ >1** Indicates that the exposure estimate exceeds the exposure limit. This suggests an elevated level of risk, the significance of which must be balanced against the degree of conservatism incorporated into the risk assessment (*i.e.,* the margin of safety is reduced but not removed entirely).

Health Canada and AEW have specified an incremental (*i.e.,* over and above background) lifetime cancer risk of one in 100 000, which these agencies consider acceptable, tolerable or essentially negligible (AEW 2009; Health Canada 2009a). The ILCR values are calculated by comparing the predicted level of exposure to carcinogenic COPC's to their carcinogenic exposure limit. Interpretation of the ILCR values proceeded as follows:

- **ILCR ≤ 1.0** Denotes an ILCR that is below the benchmark ILCR of 1.0 in 100,000 (*i.e.,* within the accepted level of risk set by AEW and Health Canada).
- **ILCR > 1.0** Indicates an ILCR that is greater than the *de minimus* risk level of 1.0 in 100,000, the interpretation of which must consider the conservatism incorporated into the assessment.

E.5.3 PREDICTED CONDITIONS

Separate assessments were completed for acute and chronic exposures, based on the duration of exposure to each COPC. Risk estimates were summarized according to:

- acute inhalation;
- chronic inhalation; and
- chronic multiple pathways.

The discussion of the results focuses on risk estimates that exceeded 1.0, as these cases could signify potential health risks.

E.5.3.1 Acute Inhalation

For the vast majority of the COPCs, predicted acute RQ values did not exceed 1.0 under any of the three development cases (CR #5, Tables 4-1 to 4-4). Where RQ values were less than 1.0, potential health risks for these COPCs and scenarios were considered to be negligible.

Predicted acute RQ values that exceeded 1.0, include:

- arsenic at the RSA MPOI and R6 location;
- nitrogen dioxide at the LSA MPOI and RSA MPOI; and
- sulphur dioxide at the RSA MPOI.

A RQ of 2.1 was predicted for arsenic for the RSA MPOI and a RQ of 1.1 was predicted for the R6 location in the Baseline Case. RQ values were predicted to be below 1.0 in the Application Case at the RSA MPOI and R6 location. The decrease in RQ value is due the assumption in the Air Quality Assessment (Section E.1) that the mine fleet associated with the Project will convert from Tier 1 to Tier 4 engines.

Adverse effects from acute exposures to arsenic are not expected at these locations due to the following:

- The acute RQ values were based on the predicted maximum hourly concentration. The predicted frequency or probability of exceeding the acute exposure limit is very low.
- Based on the results of the Air Quality Assessment (Section E.1), the probability of exceeding the arsenic exposure limit of 0.2 µg/m3 at the RSA MPOI in the Baseline Case is 0.2% on an hourly basis.
- Based on the results of the Air Quality Assessment (Section E.1), the probability of exceeding the arsenic exposure limit of 0.2 µg/m3 at the R6 location in the Baseline Case is less than 0.1% on an hourly basis. The RQ value for the 1-hour 99.9th percentile in the Baseline Case was predicted to be 5.9E-01.
- The exceedance only occurs in the Baseline Case and the Application RQ values are below 1.0.
- The acute exposure limit incorporated an uncertainty factor of 1,000.
- The location where the RSA MPOI RQ value exceeds 1.0 is predicted within an existing mine boundary (*i.e.,* Yellowhead Haul Road) where the likelihood of exposure is expected to be limited.

A RQ of 1.4 was predicted for nitrogen dioxide at the LSA MPOI and the RSA MPOI in the Application Case. The highest predicted 1-hour air concentration of NO_2 (as per the U.S. EPA statistic) for the locations included in the HHRA is 254 µg/m^3. This concentration is within the range of concentrations in the literature where variable responses have been observed in asthmatics, but not healthy individuals.

In addition to the conservatism incorporated in the NO_2 exposure limit, the probability with which exceedances may occur is very low. For the both the RSA and LSA MPOI location, less than 0.21% of the predicted data were above 190 µg/m^3 in one of the 5 years modeled and the average was predicted to be 0.084% for the five years modeled. On average, less than 0.002% (less than 1 hour in 5 years) of the predicted data were above 560 µg/m^3. The predicted probability of hourly exceedances of acute NO_2 health benchmarks at the LSA and RSA MPOI location are very low suggesting that the probability of adverse effects is not expected.

RQ values for 10-min SO_2 were predicted to be above 1.0 at the RSA MPOI (RQ=2.4). The degree of conservatism incorporated into the SO_2 exposure limit must be considered in the interpretation of the likelihood of potential adverse health effects with the predicted exceedance at the RSA MPOI. A review of the scientific literature indicates that no adverse effects among healthy individuals are observed for brief periods of exposure to concentrations of SO_2 less than 1300 µg/m^3 (CR #5, Table 4-7). The maximum predicted hourly SO_2 concentration at the RSA MPOI (740 µg/m^3) in the Baseline and Application Case are within the range of air concentrations where increased airway resistance and potential bronchoconstriction in asthmatic or sensitive individuals is observed when engaged in moderate exercise. All changes in airway resistance are reversible and shortness of breath or other clinical signs may be observed depending on severity of the asthmatic condition. The probability of exceeding the WHO 10-min SO_2 exposure limit of 500 µg/m^3 at the RSA MPOI is less than 0.002% (*i.e.,* 1 hour in

5 years or 43,824 hours). Finally, the maximum concentration of SO_2 in the Application Case is predicted to occur within close proximity to the Project permit boundary (Section E.1).

Based on the low likelihood of SO_2 concentrations exceeding guidelines, the conservatism incorporated in the exposure limit and the low likelihood that an individual will be present at the MPOI at the exact time when maximum concentrations are reached, the predicted acute SO_2 risks are likely overstated and adverse impacts from short-term exposures to SO_2 at the RSA MPOI are not expected.

E.5.3.2 Chronic Inhalation Assessment

Chronic inhalation risks were evaluated for the resident group only. The MPOI locations were not evaluated on a chronic basis as they are intended to reflect worst-case exposure to a hypothetical, transient person who might be in the area when worst case emissions and meteorological conditions are occurring. As such, the chronic inhalation pathway is not considered relevant to the LSA MPOI or RSA MPOI. In addition, the recreational group was not assessed on a chronic basis as it was assumed that exposures for extended periods of time would not occur at these locations.

Non-Carcinogens

All chronic RQ values were less than 1, suggesting that the predicted long-term air concentrations of the COPCs are not expected to result in adverse health effects (CR #5, Table 4-8). The predicted RQ values for the Baseline and Application Cases were generally very similar suggesting that the contributions of the Project with respect to air emissions will likely have a negligible impact on health.

Carcinogens

All predicted ILCR values were predicted to be less than 1 in 100,000 (CR #5, Table 4-9), indicating that the incremental contributions from the Project emission sources are associated with an essentially negligible degree of risk.

E.5.3.3 Chronic Multiple Exposure Pathway Assessment

The HHRA assumed that people living in the area on either a permanent or seasonal basis (*i.e.,* the resident group) were exposed to COPCs via multiple exposure pathways over their entire lifetime (80-years). The LSA-MPOI, RSA-MPOI and recreational group were excluded from the multiple pathway assessment, as these do not represent locations where people are likely to spend extended periods of time.

Non-Carcinogens

For all of the COPCs, negligible changes in RQ values were predicted between the Baseline and Application Cases (CR #5, Table 4-10) indicating that the incremental change associated with the Project is negligible. Overall, the potential for adverse non-carcinogenic health impacts is anticipated to be low.

All multiple pathway RQ values for the Baseline and Application Cases for the resident group were less than 1.0, with the exception of:

- manganese (RQ value = 2.5 [Baseline and Application Case for toddler life stage] RQ value = 1.3 [Baseline and Application Case for adult life stage]), and
- methyl mercury (RQ value = 1.3 [Baseline and Application Case for resident group]).

Manganese is commonly present in the environment and is an essential element for human health. In this assessment, the primary exposure pathways contributing to the RQ values for the toddler and adult are the consumption of fish, above-ground garden vegetables, root vegetables, berries and Labrador tea (CR #5, Table 4-11). The contribution of these pathways is the same across the Baseline and Application Cases for these life stages. The predicted manganese RQ values are not expected to be associated with adverse health effects.

The predicted exposure to methyl mercury is associated with RQ values greater than 1.0 for the resident group in the multiple pathway assessment. The maximum RQ value of 1.3 for the resident group is not predicted to change from the Baseline Case to Application Case. The Project is not expected to measurably increase methyl mercury-related health risks in the region.

Methyl mercury is the form of mercury that is of greatest concern with respect to accumulation in biological organisms, and subsequent consumption by people (Health Canada 2007). Food intake is the primary route of exposure to mercury compounds in humans, with fish and seafood being the most significant contributors to human exposure (ATSDR 1999). For the resident group, the highest RQ value was predicted for the toddler life stage, where 100% of the estimated daily intake of methyl mercury is attributable to local fish consumption. The methyl mercury concentration (*i.e.*, 95UCLM) in fish used in the HHRA is 0.11 mg/kg wet weight (CR # 5, Appendix B). This concentration is below the subsistence fish consumption guideline of 0.2 mg/kg recommended by Health Canada (2007).

The fish consumption rates used in the HHRA represent rates cited by Health Canada (2007) for subsistence fish consumers for all types of fish. No adjustments for local fish consumption preferences were applied, suggesting that the consumption rates used may be conservative. At present, there is no consumption advisory on fish caught from the Embarras or Mcleod River within the RSA for the Project (Government of Alberta 2011).

Additional factors that may have contributed to the overestimation of the health risks are:

- the estimated daily intakes and associated RQ values are based on the assumption that people rely on locally caught fish as a part of their diet;
- the exposure limit used in this assessment (0.1 µg/kg/day) is based on developmental impairment in children. Health Canada (2007) cites a TDI of 0.2 µg/kg/day for methyl mercury. When compared to the Health Canada TDI, the RQ values for the resident toddler is reduced to 0.7;
- it is important to note that any nutritional benefits associated with eating fish from the RSA were not accounted for in the characterization of the potential health risks; and
- the predicted RQ values for methyl mercury remain consistent across the Baseline and Application Case for the resident group. This suggests that the Project is not expected to increase methyl mercury-related health risks in the region.

Carcinogens

All ICLR values were less than 1.0 (CR #5, Table 4-13), indicating that the Project is associated with negligible incremental cancer risks (*i.e.,* less than 1 in 100,000) for the resident group.

E.5.3.4 Mixture Results

Acute Inhalation Mixture Results

The acute inhalation mixture results are presented in CR #5, Table 4-14 to Table 4-16 for the RSA MPOI, recreational group and resident, respectively. All mixture RQ values are below 1.0 except for the respiratory irritant group and reproductive and developmental toxicants group.

The maximum mixture RQ value for the respiratory irritants group was predicted to be 4.3 in the Application Case. The relative contribution of COPCs to the RQ value is SO_2 (57%), NO_2 (31%), acrolein (6%) and nickel (5%). The RQ value for the respiratory irritants mixture is thought to overstate the actual risk for combined exposure to these COPCs, based on the following rationale:

- the maximum RQ values for acrolein and nickel were less than 1.0 on an individual basis;
- NO_2 and SO_2 are the only COPCs predicted to exceed their exposure limits;
- SO_2 is the primary contributor, comprising 57% of the mixture at the RSA-MPOI;
- the mixture RQ values are unlikely to exceed 1.0 as the SO_2 concentrations used in the mixture calculation are based on 1-hour maximums, and are predicted to exceed their guidelines less than 0.002% of the time and
- NO_2 concentrations are predicted to contribute approximately 31% of the respiratory irritant mixture at the RSA-MPOI. However, the isopleth maps (CR#1) clearly show that the maximum concentrations of NO_2 and SO_2 are not predicted to occur at the same location and are at least 20 km apart.

Based on the low likelihood of NO_2 and SO_2 concentrations exceeding guidelines, the fact that no other mixture components exceed their respective guidelines, and the low likelihood that an individual will be present at either MPOI location at the exact time when maximum concentrations are reached, the predicted acute NO_2 and SO_2 risks are likely overstated and adverse impacts from short-term exposures to the respiratory irritant mixture at the RSA MPOI are not expected.

Chronic Inhalation Mixture Results

The non-carcinogenic inhalation assessment mixture results for the resident group are presented in CR #5, Table 4-17. As people are unlikely to remain for extended periods of time at locations where the MPOI may occur, the MPOI was not included in the chronic mixtures assessment. All chronic inhalation mixture RQ values were less than 1.0, indicating that the risk of additive effects occurring as a result of the combined exposure to COPCs with common chronic toxicological endpoints is low.

Chronic Multiple Exposure Pathway Mixture Results

The chronic multiple pathway mixture results for the resident are presented in CR #5, Table 4-19. The RQ values for the neurotoxicants and reproductive and developmental toxicants mixtures were greater than 1.0 for the resident group. There are no apparent differences between the Baseline and Application Case RQ values for the resident group, indicating that the Project will have a negligible impact on the mixture risks.

The neurotoxicants mixture consists of aluminum, lead, manganese, methyl mercury and selenium. Combined, manganese (54%) and methyl mercury (29%) contribute over 80% of the risk. The RQ values for both manganese and methyl mercury are likely overstated because of the conservative assumptions incorporated into the HHRA. Overall, the potential for adverse neurotoxicological effects is considered to be low.

The reproductive and developmental toxicants mixture consists of aluminum, lead, methyl mercury, nickel and vanadium. Combined methyl mercury (57%) and aluminum (20%) contribute over 75% of the risk. The RQ value for methyl mercury is likely overstated because of conservative assumptions incorporated into the HHRA.

E.5.4 Cumulative Effects Assessment

Typically, a Cumulative Effects Assessment Case (CEA) is evaluated that includes potential health risks associated with existing environmental conditions, existing and approved developments, and future planned developments that have been publicly disclosed during the six months prior to submission of an EIA. However, no planned developments have been publicly disclosed for the area apart from the Project in the RSA. For this reason, a CEA was not assessed in the HHRA.

E.5.5 Mitigation and Monitoring

Monitoring and mitigation has been a part of CVRI operations at the CVM and will be continued as part of this Project. Mitigation programs for key disciplines are provided within the individual consultant reports as appropriate and are summarized as follows:

- air monitoring (Section E.1.5);
- groundwater monitoring (Section E.3.5); and
- surface water monitoring (Section E.11.5).

E.5.6 Summary

The chemical emissions from the Project are not expected to result in adverse health effects in the region. For most of the COPCs, the magnitude of the differences in predicted health risks between the Baseline and Application Case is negligible. In recognition of the influence of duration and pathway of exposure, risk estimates were segregated into:

- acute inhalation;
- chronic inhalation; and
- chronic multiple pathways.

Acute Inhalation Assessment

The potential short-term health risks associated with the Project and other emission sources were evaluated through the comparison of predicted air concentrations for various averaging periods (10-minute, 1-hour, 8-hour or 24-hour) against health-based exposure limits. Overall, there were minimal changes between the Baseline and Application Cases, indicating that the Project emissions are not anticipated to have an impact on human health in the area.

Adverse effects from acute exposures to arsenic are not expected due to the low probability of exceeding the health based guideline, the small area of impact adjacent to the existing CVM and the conservatism incorporated in the derivation of the exposure limit. Adverse effects from exposure to NO_2 and SO_2 are not expected based on the low likelihood of NO_2 and SO_2 concentrations exceeding guidelines and the low likelihood that an individual will be present at the MPOI at the exact time when maximum concentrations are reached.

Chronic Inhalation Assessment

Predicted risks associated with continuous, long-term inhalation of the COPCs were evaluated through the comparison of predicted annual average air concentrations with health-based exposure limits. No exceedances of health-based exposure limits were predicted in the chronic inhalation assessment.

All incremental lifetime cancer risks were predicted to be less than 1.0 in 100,000, indicating that the cancer risks associated with the Project are essentially negligible.

Chronic Multiple Pathway Assessment

The potential long-term health risks associated with exposure to the COPCs via multiple pathways of exposure were evaluated for permanent and seasonal residents in the area. In most instances, potential risks were determined to be negligible. All incremental lifetime cancer risks associated with exposure via multiple pathways of exposure were predicted to be less than 1.0 in 100,000, suggesting that the cancer risks associated with the Project are negligible.

Predicted chronic manganese exposure is associated with an RQ value of 2.5 and 1.3 in the Baseline and Application Case for the toddler and adult resident, respectively. The Project is not expected to measurably increase manganese-related health risks for residents in the region. The predicted exceedance is largely based on conservative assumptions used in the HHRA for surface water concentrations. In addition, adverse effects from manganese exposure are not expected as the estimated intake levels in the HHRA fall within the range of typical Canadian exposure levels, at which adverse effects have not been observed.

Predicted exposure to methyl mercury is associated with RQ values greater than 1.0 for the resident group in the multiple pathway assessment. The maximum RQ value of 1.3 for the resident group is not predicted to change from the Baseline Case to Application Case. The Project is not expected to increase methyl mercury-related health risks in the region. Adverse effects from methyl mercury in fish are not expected because the 95UCLM mercury concentration is below the subsistence fish consumption guideline of 0.2 mg/kg recommended by Health Canada (2007).

E.6 HYDROLOGY

E.6.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of surface hydrology for the proposed Project. The following section is a summary of the Surface Hydrology Assessment that was prepared by Matrix Solutions Inc. and is included as Consultant Report #6 (CR #6). For full details of the assessment, please refer to CR #6.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the surface hydrology component are provided in Section 3.3, and are as follows:

3.3 HYDROLOGY

3.3.1 Baseline Information

[A] Describe and map the surface hydrology. Include flow regimes of streams in the Project Area.

[B] Provide surface flow baseline data, including:

- *a) characteristics of the average stream flow regime including mean monthly and annual flows and run-off depths (water yields), seasonal variation and year-to-year variability for all basins; and*
- *b) estimates of peak flows and low flows for all watercourses.*

3.3.2 Impact Assessment

[A] Discuss changes to watersheds, including surface and near-surface drainage conditions, potential flow impediment, and potential changes in open-water surface areas caused by the Project.

[B] Describe the extent of hydrological changes that will result from disturbances to groundwater and surface water movement:

- *a) include changes to the quantity of surface flow, water levels and channel regime in watercourses (during low, average and peak flows) and water levels in waterbodies;*
- *b) assess the potential impact of any alterations in flow on the hydrology and identify all temporary and permanent alterations, channel realignments, disturbances or surface water withdrawals;*
- *c) discuss both the Project and cumulative effect of these changes on hydrology (e.g., timing, volume, peak and minimum flow rates, river regime and lake levels), including the significance of effects for downstream watercourses; and*
- *d) identify any potential erosion problems in watercourses resulting from the Project.*

[C] Discuss changes in sedimentation patterns in receiving waters resulting from the Project.

[D] Describe impacts on other surface water users resulting from the Project. Identify any potential water use conflicts.

[E] Describe potential downstream impact if surface water is removed.

[F] Discuss the impact of low flow conditions and in-stream flow needs on water supply and water and wastewater management strategies.

[G] Discuss how potential impacts of temporary and permanent roads on wetland hydrology will be minimized and mitigated.

[H] Describe mitigation measures to address impacts during all stages of the Project including:

a) alteration in flow regimes;
b) potential water use conflicts; and
c) increased sediment loadings.

The principal named watercourses crossed by the Project are: Bryan, Hay, Erith, Lendrum and Lund (CR #6, Figure 1). The surface hydrology assessment presents proposed water management plans and addresses the potential impact of the Project on:

- the quantity of surface water flow and stream behaviour during high, average and low flow conditions; and
- sediment concentrations in local and regional streams.

The Project area is located almost entirely within the McLeod River watershed with the southern extent of the Project extending into a tributary of the Pembina River. The regional study area (RSA) primarily focuses on the McLeod River basin upstream of its confluence with the Embarras River and includes the Pembina River basin at the confluence with this unnamed tributary (CR #6, Figure 2). Previous regional hydrologic studies in this region have shown that flow monitoring stations within about a 50 km radius of CVM are hydrologically similar in characteristics and are thus included in the baseline data and study area (CR #6, Figure 2).

The locally affected watersheds within the local study area (LSA) of the proposed Project are as follows (CR #6, Figure 3):

- the Erith River basin and its main tributaries Bacon, Halpenny, Lendrum and Lund creeks;
- the Bryan, Hay and an unnamed creek which join the Embarras River near Robb; and
- the unnamed creek basin draining north into the Pembina River.

For the hydrology assessments the VECs selected include water availability (*i.e.,* flow) and water quality. Water quality is discussed in detail in Section E.11, therefore the discussion of water quality provided in the hydrology assessment focuses on sediment loading in local and regional watercourses.

E.6.2 Baseline Setting

Long term data are required to describe surface hydrology conditions because of the significant natural variability of water flows and sediment concentrations seasonally and from year to year. In the absence of site specific long term data, available long-term regional data from hydrologically similar areas are used and compared with short term site specific data.

This comparison facilitates the generation of long-term flow patterns, high and low flow values and sediment conditions that are applicable to the Project area streams.

The baseline description forms the hydrologic basis for computing flows and conducting water balances for the design of stream crossings, settling ponds and water management facilities. The baseline data consists of local data from the following sources:

- long-term regional flows and data on small to large watersheds;
- historic CVM operations data and experience (primarily sediment and precipitation data and more recent flows); and
- short-term site specific streamflows in the Project areas (longer term baseline and during mine operations data are now being collected on Mercoal and Chance Creeks).

E.6.2.1 Climate

Climatic factors are important for characterizing surface water hydrologic conditions because variability in precipitation, temperature, and evaporation significantly affects basin runoff characteristics and streamflows. The climate in the study area is characterized as continental with short, hot summers and long cold winters. Temperatures typically range from a minimum daily of -35°C, usually occurring in January, to a maximum daily of 30°C occurring in July or August. Regional mean annual temperature data varies over reporting periods from 1914 to 1996 and range from 1.9 °C to 2.2 °C, respectively.

Precipitation has been recorded at Coal Valley Atmospheric Environment Service (AES) Station 3031675 from 1980 to 1986 and at CVM from 1990 to present. The approximate 25 years of combined data at these stations indicates the mean annual precipitation is 618 mm. Annual precipitation has ranged from a high of 1,069 mm in 1980 to a low of 323 mm in 2003. July typically has the highest monthly precipitation at 114 mm with December the lowest at approximately 17 mm. Approximately one third of the annual precipitation falls as snow. Intense summer storms may comprise a significant percentage of the annual precipitation.

A review and analysis of precipitation data from AES regional stations, the station data from operating coal mines and the station at Edson, was conducted in 1998 to review short-duration rainfall intensity frequency distributions. The highest one-day precipitation recorded at CVM was 90.3 mm in June 1980 and the highest recorded in the vicinity was 94.2 mm at Lovett Lookout in 1947. Based on this review, the estimated 100 year, 24 hour maximum storm rainfall for CVM is 115 mm and the 10-year, maximum 24 hour rainfall is 77 mm.

A review of estimates of probable maximum precipitation (the rational upper-limit to precipitation that is physically possible) for this region indicate values of 270 to 300 mm in 24 hours over 300 km² (Verschuren and Wojtiw, 1980) and 608 mm in 24 hours over 20 to 30 km² (Environment Canada 1993). For probable maximum flood calculation purposes this extreme precipitation value may be considered for the Project area with the following conditions: a mid-June event, with above average winter snowpack and delayed melt to May such that the basin is 100% primed (*i.e.,* no losses for depression storage or infiltration).

Estimated monthly and annual lake evaporation and areal evapotranspiration values are based upon an average of reported values for Edson and Jasper climate stations (AENV 1993). The resulting annual values are as follows:

- mean annual lake evaporation – 622 mm; and
- mean annual evapotranspiration – 327 mm.

E.6.2.2 Regional Flow

Water Survey Canada (WSC), Environment Canada and/or AEW has measured streamflows and in some cases sediment concentrations for 13 streams in the region (CR#6, Figure 2). The drainage areas of gauged streams range from Deerlick Creek at 14.0 km² (in the former Tri-Creek Experimental Watershed) to the 2,560 km² McLeod River above Embarras station and the 2,840 km² Pembina River station (CR #6, Table 2).

Minimum, mean and maximum monthly flow patterns expressed in terms of flows (cubic metres per second [m^3/s]) and runoff or flow per unit area (litres per second per square kilometre [L/s/km^2]) for small regional watersheds (the streams in the Tri-Creek Watersheds), medium sized watersheds (Lovett, Erith and Embarras), and large watersheds (McLeod and Pembina) was evaluated (CR #6, Figures 5, 6 and 7). Features of the data and differences to note between the small to large watersheds are as follows:

- the station data shows the significant monthly variability that exists due to precipitation and snowmelt runoff variability;
- the highest maximum monthly flow occurs in June or July at all stations. The highest mean monthly flows tend to be in May and June for the smaller Tri-Creek stations and vary from May to July for the medium to large stations. The highs in May and June reflect steeper well drained basins with quicker response due to snowmelt and rainfall whereas the delayed highs in July may reflect basins with greater storage or more response to the greater rainfall in this month (Erith and Pembina rivers); and
- the lowest flow month is February which, based on the McLeod River station, averages about one-sixth of the October flows.

The regional relationships for low open water flows (7Q10, the 7 day, 1-in-10 year low flow and 1Q10, the 1 day, 1-in-10 year low flow) and maximum instantaneous flows for floods from 1:2 year to 1:100 year return periods (CR #6, Figure 13) can be used to estimate flow ranges for natural, pre-mined condition streams in the Project area, knowing the drainage area of the stream at a specific location. Site specific conditions may warrant variations from these regional hydrologic relationships depending upon the specific basin characteristics and design considerations for water management works. Specific basin characteristics to consider are:

- basin slope;
- basin shape;
- extent of wetland/marsh areas; and
- related soils.

Steep, bare, or poorly vegetated watersheds will result in increased short duration flood peaks with lower relative low flows compared to the regional relations. Site specific monitoring is used as an aid in assessing the variations from the regional stations and relationships.

E.6.2.3 Existing Mined and Reclaimed Area Flow Data

Extensive historical flow monitoring data has been compiled at CVM since operations started in 1978 (CR #6, Figure 14).

Over the current life and approved developments at CVM, over 30 lakes and numerous wetland areas (< 3m maximum depth) will be formed (CR #6, Figures 15A and 15B). Measured flows from a representative sample of the impoundments or sediment control ponds (CR#6, Figure 16), show the typical range of flows at these facilities. The outflows vary in accordance to precipitation with minimal to no flow during dry periods. In many cases the flow variability is dampened by the impoundments and is expected to be greater form natural small watersheds of comparable size. Peak flows are reduced as a result of the pond or pit storage.

E.6.2.4 Robb Trend Flow Data

Streamflow monitoring was conducted at various locations over the 2006 to 2010 period on several streams expected to be affected by mining operations in the Project (CR #6, Figure 14). Hydrographs for the local stations that were monitored in the Project area (CR #6, Figure 17) are similar to those for the regional stations and the CVM station established on Mercoal Creek.

A comparison of spot flow measurements collected at the various streams over the 2006 to 2010 (CR #6, Table 3) period and recorded daily flows on the same day at three regional WSC gauging stations (Embarras River, Lovett River and Wampus Creek) in terms of runoff yield (L/s/km^2) suggests that the streams in the Project area, particularly south of Robb may be wetter and more responsive in the spring and summer with likely lower fall winter baseflows than the regional stations. However, the lower baseflows may be a reflection of the smaller watersheds measured compared to the regional stations. The Embarras and Lovett River stations appear to be most representative of the streams in the Project area.

Seasonal runoff comparisons using local monitored streams with regional streams (CR #6, Table 4 and Figure 18) indicated that runoff conditions in the Project area are expected to be most comparable to the Lovett River and average about 233 mm for the May to October season.

Data indicated the change in runoff observed on Mercoal Creek in 2010 was noticeably lower than Wampus Creek compared to previous years (suggesting a 40% decrease in average flow). This may be due to local climatic variations; however, the magnitude of the difference, compared to the other stations, suggests it reflects the impact of Pit 123 filling and extensive mining activities in the Mercoal basin. Recent measurements in October, 2011 (data not compiled and reported on yet) showed that Mercoal Creek flows were much greater (more than three times) than other streams at this time due to current pit dewatering operations. This shows the significant changes in flows that may occur in small watersheds depending upon mining activities at the time.

E.6.2.5 Sediment Concentrations

Available total suspended sediment (TSS) concentration or sediment concentration data were reviewed and summarized for the region and from existing CVM mine operations. The data show that sediment concentrations can vary by two orders of magnitude for the same flow (CR #6, Figure 19) indicating sediment concentrations are not uniquely related to flow magnitude. Streams can generate high sediment concentrations because of snowmelt, windblown sources, unstable banks and slopes, dirt filled gullies and natural bed material movement that may be independent of flow and variable from stream to stream.

CVRI monitors TSS on a daily to weekly basis from its impoundments and receiving streams upstream and downstream. In 2010 there were fifteen major ponds, five minor ponds and nine creek sites where TSS (and/or turbidity), flow, pH and observation of oil and grease or floating solids was monitored. Sediment concentration compliance limits for the CVM operations (EPEA Approval 11066-01-05) are as follows:

- monthly average maximum - 50 mg/L; and
- daily maximum - 350 mg/L.

Exemptions are allowed for a greater than design storm event for a period of 48 hours following the end of a storm event. The design storm event is based on the 10 year return period precipitation intensity with a duration from 0.5 to 168 hours.

The regional sediment data combined with the historical data collected from mine operations at CVM and an understanding of the impact of mining on sediment concentrations, is considered adequate for assessment purposes. The performance of the runoff and sediment control measures at the existing CVM provide a high degree of confidence that, if appropriate pond sizing and maintenance and operational controls are applied in the proposed mine permit area, the impacts of the proposed Project can be predicted with reasonable accuracy.

E.6.3 Potential Impacts

Elements of the Project that could have an effect on runoff and sediment include:

- cleared land;
- waste rock piles;
- haul roads;
- mine pits and dewatering;
- water impoundments during and after mining;
- water diversions (during mining and restoration); and
- water withdrawals.

Various water management and sediment control measures will be implemented for the Project during operations, reclamation, and closure. These are highlighted in the following sections with further details provided in CR #6, Section 4.4.

E.6.3.1 Project Impacts on Flows and Sediment Load

Land Clearing

Natural watersheds typically generate less direct runoff because of the greater transpiration, interception, and retention in the understory. Forest harvesting and clearing effects include increases in annual water yield, increases in late summer and fall low flows, increases in peak flow, and possibly earlier timing of peak flows.

Results of the extensive studies concluded that on the average, a 20% to 40% increase in the annual water yield, a 1.5 to 3 times increase in the flows due to storm peaks, as well as a 30% to 65% increase in flow during the snowmelt freshet can be expected when 30% to 80% of a watershed is logged. The effect of clearing on hydrology for the Project is not expected to be measurable because the mine will be a narrow strip across the various watersheds and a small percentage of area will be cleared.

Maintaining a 10 m wide buffer along small watercourses can significantly reduce sediment loads (Rex, 2007). Sediment control ponds and buffers are key to limiting sediment loads from Project operations.

Waste Rock Piles

The porous nature of waste rock piles results in increased infiltration compared to natural terrain. Evapotranspiration from reclaimed areas with waste rock piles will be lower but groundwater infiltration will be higher because of the more permeable spoil material conditions. There may be a reduction in net runoff into a creek with negligible change in mean annual runoff and, eventually, an increase in minimum or low flows downstream. Based on commonly applied rainfall-runoff coefficients (from 0.1 to 0.2 for waste rock piles and 0.2 to 0.4 for natural watersheds), peak runoff rates from waste rock piles can be 50% to 33% of the natural area. Sediment loads tend to increase until the waste material is washed and settled then stable drainage paths develop through the rock.

Haul Road Runoff

Haul roads are much less permeable than natural basins with runoff coefficients in the 0.6 to 0.9 range versus the 0.2 to 0.4 range typical for the natural basins in the region. Compared to natural basin runoff haul roads result in higher peak flows and reduced low flows.

Haul roads can be a major source of sediment. Runoff and sediment control is especially dependent upon road maintenance work such as grading, berming, and ditch controls. Containment of haul road runoff is one of the largest ongoing operational efforts required in maintaining clean water.

Three main haulroads (Erith, Halpenny, and Bryan) are aligned to follow natural drainage topography to minimize cut and fill disturbances. Watercourse crossings and culverts will be used to maintain drainage patterns with measures taken to protect the fisheries habitat and fisheries resource.

Mine Pits and Dewatering

Dewatering of the groundwater to facilitate mining increases surface flows. This is usually a minor flow component of the overall surface runoff rate from an area and the magnitude is limited and regulated by pump capacities. Sediment loads can be negligible with sumps separated from active mining and appropriate sized storage backup and controls used.

Mine pits will act as impoundments during high runoff events with water collecting in the pits which are then pumped to settling impoundments. During extreme high runoff events, greater backup and some inundation of the pit will occur depending upon pump capacities. This reduces downstream peak flows as a result of the temporary storage, although the total runoff amount will likely be increased. Earlier snowmelt in the pit areas will also occur. Pits will therefore, increase water yields overall and attenuate or extend the runoff period with peaks moderated. Dewatering operations may be most significant in increasing low base flows as the water is contained and pumped to settling ponds and then gradually released.

Impoundments

Impoundments, such as settling ponds or end pit ponds or lakes, generally reduce downstream peak flows. Increases in low flows can result from a more gradual release of the water stored in the impoundment. Pond evaporation losses may be significant at times but is balanced with direct precipitation on an annual basis. Impoundments can significantly reduce sediment loads.

Settling ponds will be constructed to collect local runoff from haul roads, spoil pile areas, sumps, and pit dewatering operations (Table C.4-1 and Figure C.4-1). Outflows will be pumped to adjacent downstream watercourses or drainage areas.

Twelve end pit lakes are planned (CR #6, Table 13 and Figure 27). Many of the lakes will be restored with shallow connecting channels and adjacent floodplain/wetland areas. Lake filling times following reclamation will be gradual in order to maintain downstream flows. The instream flow needs guidelines (AENV 2011b) are to be applied. Applying this guideline means that only 15% of the inflow can be used to fill the lakes and no inflow can be used for lake filling when the flow is less than the natural Q80 value (*i.e.,* below the flow that is normally exceeded 80% of the time for that time of year). Instream flow monitoring and pump bypasses will need to be established on the lakes during filling. The resulting estimated filling times for each lake are summarized in CR #6, Table 13. During high flow events more than 15% of the flow may be retained in the lakes because of bypass pump limitations.

Water Diversions

Diversions will be sized and designed to convey peak flows. As a result, diversions will not affect the magnitude of downstream flows. Diversion ditches with major side-hill cuts may intercept and re-direct near surface groundwater flows. This effect would be localized to within the sub-watershed. The impact on sediment loads is usually negligible with appropriate erosion control measures.

Staged stream diversions for a number of watercourses, the largest being the Erith River, are required to facilitate mining with each diversion having a specific diversion plan (Table C.4-2 and Figure C.4-1). Channels are to be restored to similar grades and dimensions as existing channels and, where required, incorporate riparian floodplain zones. The diversion design concepts have been used effectively at other channels restored by CVM. CR #6, Table 12 lists the main watercourse diversions that will be required over the duration of the Project along with their approximate length, slope, design flows and timing. Smaller intermittent or ephemeral drainages (drainage areas less than 1 km^2) may have flows temporarily or permanently blocked by waste rock piles or pits. Runoff may be re-directed to adjacent streams or allowed to seep to pits through the waste rock piles.

Water Withdrawals

Water withdrawals reduce flows by a directly measurable amount equal to the diversion. Withdrawals will have no impact on sediment if stable water withdrawal facilities provided. The Project will not require any new or additional withdrawals other than small amounts for dust control which are typically be sourced from settling ponds or constructed retention areas. The existing plant obtains all of its water from existing groundwater sources, the existing tailings facilities, and Coal Creek in the Lovett River basin. The total annual allocation existing active licenses in the McLeod river basin amounts to 0.3% of the mean annual flow in the McLeod River above Embarras (CR #6, Table 8).

E.6.3.2 Impacts in Flow Rates by Watershed

The net impacts of various activities in a basin are highly temporal and site-specific. They depend on the number, size, and location of activity within the watershed. The combined existing CVM and proposed Project mine disturbance areas average 16.5% in the main watershed (CR #6, Figure 3). A summary of the long-term residual effect of surface water flow by watershed, assuming mitigation measures provided in Section E.6.4 are employed, is provided in Table E.6.-1.

Table E.6-1 Surface Water Flow Impact Summary by Watershed

Watershed	Existing Basin Area (km^2)	Existing Mine Footprint (km^2)	Proposed Mine Footprint (km^2)	Existing and Proposed Mine Footprint as a % of Total Basin	Active Mining (Year to Year)	Post Mining Basin Area (km^2)	Impact During Mining[1]			Impact During Lake Filling[3]			Lake Filling Time (Years)	Residual Impact[2]		
							High Flows	Low Flows	Mean Annual Flow	High Flows	Low Flows	Mean Annual Flow		High Flows	Low Flows	Mean Annual Flow
Erith River	74.3	1.18	13.85	20.2%	1-17	80.92	-10%	0 - 5%	±5%	-15%	0%	-15%	7.8	-60%	10%	7%
Bacon Creek	9.7	0.00	1.76	18.1%	3-13	2.91	upper 70% of basin diverted to Erith with lower 2.4 km long channel remaining as is with ~30% of flow									
Halpenny Creek	31.2	0.02	5.83	18.7%	8-26	31.20	-10 - 20%	±20%	10 to 15%	-15%	0%	-15%	3.4	-50%	5%	0%
Embarras River[4]	100.4	4.80	1.12	5.9%	12-26	100.40	-3%	10%	0%	-15%	0%	-15%	n/a	<-1%	<1%	0%
Unnamed Creek to Embarras	9.5	0.00	3.76	39.6%	13-26	7.91	-20%	-16%	-16%	-16%	-16%	-16%	n/a	-16%	-16%	-16%
Hay Creek	7.8	0.00	3.56	45.6%	12-17	8.03	-50%	200%	25%	-15%	0%	-15%	44	-65%	5%	1%
Bryan Creek	24.8	0.00	5.69	23.0%	13-26	26.99	-20%	5%	20%	-15%	0%	-15%	57	-60%	10%	7%
Lendrum Creek	29.2	0.00	6.51	22.3%	11-26	29.49	-20%	5%	20%	-15%	0%	-15%	1.4	-55%	5%	±2%
Lund Creek	57.8	0.00	10.42	18.0%	12-26	66.45	-10%	0 to 5%	25%	-15%	0%	-15%	28	-60%	20%	14%
Tributary to Pembina River	8.6	0.00	1.40	16.2%	17-26	0.15	reduced to near zero flows			98% diverted to Lake 12			n/a	98% diverted to Lake 12		
White Creek	99.6	0.00	0.95	1.0%	15-26	99.02	< -1%	< -1%	< -1%	< -1%	< -1%	< -1%	n/a	< -1%	< -1%	-0.7%
Mitchell Creek	17.6	0.00	1.48	8.4%	12-17	17.24	< -10%	< -1%	-4%	0	0	0	n/a	-2%	-2%	-2%
Pembina River Direct	535	see Fig 3	1.41	0.3%	17-26	526.44	< -2%	< -1%	< -2%	< -2%	< -1%	< -2%	n/a	< -2%	< -1%	< -2%
TOTAL (excluding Pembina)	470.5	6.00	56.34	13.2%		470.71										

1. Estimated maximum magnitude of impact, effects can vary significantly and be reduced depending upon specific mine operations and hydrologic conditions at the time.
2. Magnitude of high / low flow impacts can vary depending upon size /configuration of lake outlet controls that create backup during high flows.
3. Based upon maintaining downstream instream flow needs as per AENV, 2011b guidelines by pumping out of lakes, as required. Percentage reductions in high flows may be greater.
4. Embarrass River numbers are for above Bryan Creek confluence. See text for impacts below Hay and Bryan Creeks.

Erith River

Approximately 20% of the Erith River basin will be disturbed by mining over 17 years. Erith River flows will be regulated by 14 settling ponds (3 ha total area) and in-pit storage and dewatering sumps. Mining activities are expected to reduce high flows by 10% and low flows are expected to remain the same or slightly increase. Annual runoff may have modest variations dependant on mining activities at the time (*e.g.* pit dewatering)

When Lakes 4 and 5 are filling (Figure 27), downstream flows will be maintained by pumping. Pump flows of 20,000 igpm (1.52 m^3/s) will be required in the high flow months of June and July to meet downstream instream flow needs guidelines (AENV 2011b). At times, reductions in high flows will be greater than 15%. Low flows will be maintained at or above the pre-mine natural Q80 (80% exceedance) flow levels.

Mining will intercept the upper portion of the Bacon Creek watershed (5.81 km^2) resulting in a modest increase (8%) in drainage area for 3.5 km of the Erith River. This increase is offset by the regulating effect of the lakes during high flows. Mining activities are not expected to alter the geomorphic characteristics of the Erith River in the reach downstream from the Project.

Following lake filling the long term residual impacts are:

- extensive flood peak attenuation;
- increases in base or low flows of 10% (due to lakes); and
- increase in annual runoff (7%) due to the additional drainage area directed to the Erith River (primarily from Bacon Creek).

Hydrologic routing of 2-year to 100-year flood events results in estimated flood peak reductions by approximately 60%. Lake level rises of up to 1.25 m and a lake storage of over 2 Mm^3 in Lakes 4 and 5 are expected.

The Erith River and Lakes 4 and 5 will be reclaimed with creek inlets extended in large meanders (CR #6, Figure 28). This increases the restored channel lengths, reduces channels slopes (to <10%), and provides for fish use/passage on inlet channels. Similar end pit lake creek inlets will be provided on all fish bearing watercourses.

Changes in downstream channel size is not anticipated as a result of the regulating effect of the lakes and expectation of minimal changes in average annual flow regimes. However, a long-term gradual channel entrenching, with less meandering and steeper channel slope, is predicted with reduced peak flows and reduced sediment load.

Bacon Creek

During mining the upper 5.81 km^2 of Bacon Creek will be diverted into McPherson Pit and then into Lake 4 and the Erith River. The lower 2.4 km long reach of Bacon Creek will be altered significantly with 70% of its basin lost. The percentage flow reduction on the lower Bacon Creek may slightly exceed this 70% due to the higher amount on runoff on the steeper section of the watershed.

Halpenny Creek

During mining Halpenny Creek flows may be altered significantly (±20%) when the temporary water diversions are in place due to the moderately small basin and low flow regimes. Twelve settling ponds (approximately1.8 ha) will regulate flows. Total annual runoff within the basin is expected to increase as the basin's disturbance is 18.7%.

Instream flows can be maintained during lake filling within the limits in CR #6, Table 11 with bypass pumping. Following lake filling high flows will be reduced (up to 50% for extreme events) with low flows expected to be increased in the order of 5% on average.

Embarras Creek

The disturbance footprint within the Embarras River watershed is 1%, therefore, flow/sediment impacts during mining are negligible. Below Robb (where the Hay, Bryan and unnamed creek confluences with the Embarras River) a 3% decrease in high flows, 10% increase in low flows, and negligible change in mean annual flows are expected.

During lake filling, Lakes 1, 2 and 3 are all expected to be filling at the same time over an extended period. The resulting downstream impact on Embarras River flows is a 5% decrease in high and mean annual flows with no impact on low flows.

Following lake filling, the impact on Embarras River flows, downstream of the tributary streams affected, results in a maximum 15% decrease in peak flows and about a 1% increase in low and mean annual flows.

Unnamed Creek to Embarras River

The disturbance footprint in this watershed is 40% (3.76 km^2). Runoff will be directed to Bryan Creek during mining resulting in a 16% reduction in downstream flows. Post mining, runoff from 16.7% (1.59 km^2) of this watershed will be permanently re-directed into the Bryan Creek which will have a proportional residual change in downstream flows.

Hay Creek

Over 45% (3.56 km^2) of the watershed will be disturbed. During mining, the upper portion of the Hay Creek watershed is cut off for about six years. Impoundments will collect watershed runoff which will be released into the lower Hay Creek resulting in controlled high flows and a potentially significant increase in low flows (200%). Mean annual runoff may temporarily increase up to 25% during mining primarily due to pit and groundwater dewatering.

The end pit lake in this watershed will take up to 44 years to fill with downstream flows maintained within the limits in CR #6, Table 11 by using bypass pumping.

Following lake filling, a net increase in mean annual flows of about 1% is expected. The large lake will regulate peak flows and low flows are expected to increase.

Bryan Creek

The middle portion of the Bryan Creek watershed (23%) will be disturbed with diversions provided around/through the active pit areas. Peak flows are expected to be moderated and low flows increased during mining. Mean annual runoff may temporarily increase up to 20% during mining primarily due to road runoff and pit and groundwater dewatering.

Extensive time will be required to fill the two end pit lakes in this watershed with downstream flows maintained within the limits in CR #6, Table 11 using bypass pumping.

Following lake filling, the total watershed area is increased by about 9% (from upper White Creek and the unnamed creek to the northeast) resulting in an estimated 7% increase in mean annual flow from this watershed. The two lakes will regulate peak flows and low flows are expected to increase as estimated in Table E.6.-1.

Lendrum Creek

The middle portion Lendrum Creek watershed (22%) will be disturbed by mine pits, waste rock areas, and watercourse diversions around/through the active mining areas. Peak flows are expected to be moderated and low flows increased during mining. Mean annual runoff may temporarily increase up to 20% during mining due to pit and groundwater dewatering.

The end pit lake in this watershed is estimated to fill in less than two years with downstream flows maintained within the limits in CR #6, Table 11 using bypass pumping.

Following lake filling, the size of the watershed remains relatively unchanged (< 1% increase) and mean annual flows are not expected to change. Peak flows will be regulated and low flows increased as per the estimates in Table E.6-1.

Lund Creek

This is a large watershed with an 18% disturbance area proposed. Higher flows at the downstream end of the Project are expected. Peak flows are expected to be moderated and low flows increased during mining. The estimated mean annual runoff rate is expected to increase up to 25% due to diversion of flows from the Pembina tributary and watershed.

The large end pit lake is expected to take 28 years to fill with downstream flows remaining within the limits in CR #6, Table 11 using bypass pumping.

Following lake filling, the total watershed area is increased by 15% from the Pembina River and its unnamed tributary. Mean annual flows are expected to increase by 14%, peak flows will be regulated, and low flows increased as estimated in Table E.6-1.

Tributary to Pembina River

During mining runoff will progressively be redirected into the Lund Creek watershed with 98% of the watershed permanently re-directed into Lund Creek and Lake 12 when mining is complete.

White Creek

The disturbance footprint comprises less than 1% of this watershed. Following mining, 0.6% (0.58 km²) of the headwaters will be re-directed into the Bryan Creek watershed which decreases flows, by the same amount, in White Creek.

Mitchell Creek

Two percent (0.36 km²) of this watershed will be re-directed into the Hay Creek watershed and Lake. This results in a decrease in flows, by the same amount, in Mitchel Creek. Groundwater drawdown and inflows to Lake 3 may have a small impact on low flows in Mitchell Creek.

Pembina River Direct

During mining, runoff will progressively be re-directed into the Lund Creek watershed. The Pembina River drainage area will be permanently reduced by 1.6% (8.56 km²) as it is directed into Lake 12. Flows in the Pembina River will be reduced by less than 2% at this location. Groundwater drawdown and inflows to Lake 12 may have a small impact on low flows in the Pembina River with flow yields in the upper portions of the watershed being slightly higher.

E.6.3.3 Impact on Sediment Concentrations

CVRIs historical records show that TSS levels from existing mine operations are highly variable and within the range of those measured on the regional watersheds. Runoff from Project operations can be controlled by routing to settling ponds before being released to external watersheds. Precipitation in excess of the design storm event, or unusual short-term sediment generation events, may occur. Design of controlled outflows for this type of event will provide an effective level of sediment control. The Project is expected to have an insignificant effect on sediment loads compared to natural conditions.

Various water management and sediment control measures will be implemented for the Project during operations, reclamation, and closure.

E.6.3.4 Impact on Other Users

There are no existing surface water licenses within the Project area and local watersheds evaluated; therefore, there are no impacts on surface water users in the region.

E.6.3.5 Climate Change Effects

The potential effects of climate change on streamflows considers a range of complex interrelated factors including changes in temperature, changes in precipitation and evaporation, and changes in runoff timing. These factors have been investigated in the literature based on past historical fluctuations and trends to provide a guide. However, these may be masked by changes in land use (forest cover), water management, and abstractions. All of these factors need to be considered when predicting a seasonal expression of flow due to climate change.

In view of climatic variations that can affect the hydrologic cycle, it is prudent to apply precautionary measures in water management practices and design to account for potentially higher and lower flow extremes. Increased icing issues may also occur in reduced early snow cover periods. This emphasizes the need for greater monitoring and maintenance during operations, and possibly reviewing and refining designs where appropriate (e.g. adding a greater degree of conservatism into diversions, crossings and settling ponds by adjusting the rainfall intensity, the return period design or increasing the freeboard). The longer term facilities for the Project may require upgrading or modifications over time; the shorter term (usually less than 10 years) water management facilities may not warrant significant design changes. With appropriate monitoring and maintenance, any hydrologic changes as a result of climate change can be addressed and managed. No specific follow-up programs or adaptive management considerations are proposed at this time.

E.6.4 CUMULATIVE EFFECTS ASSESSMENT

Other activities in the local watersheds that could have a cumulative effect on stream flows and sediment concentrations in the receiving streams are:

- timber harvesting operations;
- road and rail areas;
- petroleum and natural gas activities;
- the Robb area community; and
- recreational uses.

These activities generally increase runoff, peak flows, and sediment loads and possibly reduce low flows. Their cumulative effects on flows are negligible compared to the Project development impacts and they are overlapping, in many cases, with roads and cleared areas. Forest harvesting in most watersheds has over 50% of the areas mapped as having a regenerating closed forest canopy. Therefore, cumulative effects in the various basins are not significantly different than those already identified as a result of the Project activities.

Over the Embarras River basin upstream of Robb the cumulative disturbance area is 16.8% (with 11.2% as existing and future mine areas including Yellowhead Tower and the Project).
The majority of the non-mine disturbance areas are cleared or road/rail areas which all tend to increase average and peak runoff rates. The cumulative impacts on Embarras River flows are estimated to be similar to those previously discussed.

In the larger McLeod and Embarras basins, the effects of the Project and other activities on river flows diminish to near negligible.

With sediment and control measures implemented and maintained at the mines, roads, pipelines and other projects in the basins, the cumulative effects on sediment loading will be insignificant compared to natural variations.

E.6.5 MITIGATION AND MONITORING

E.6.5.1 Mitigation

In order to reduce potential impacts of the Project on surface hydrology CVRI will:

- plan and layout facilities in an effort to minimize drainage diversions and runoff interception (*e.g.,* locate roads along drainage divides and maintain natural vegetated buffers between active mine areas and undisturbed streams);
- direct runoff from active mining areas, spoil piles and roads to settling ponds or retention and clean-out areas for sediment settling treatment;
- design settling ponds according to the latest sizing methodology (1:10 year storm event and safely convey up to the 1;100 year flood event);
- divert runoff from natural undisturbed area around mine activities;
- divert natural streams around or through active mine areas in a controlled manner to assist in maintaining flows by:
  - providing gradual flow diversions with initial flushing/cleaning operations where water flows through new ditches or pits;
  - providing armouring and/or lining of ditches or using culverts or flumes where appropriate to control erosion and limit seepage losses;
  - collecting clean water in in-pit sumps to isolate and keep clear of mine operations;
  - using temporary pumps to direct water around pits where short term bypasses (usually less than 1 year) are required;
  - directing all dirty water to settling facilities and then to the receiving stream once regulatory guidelines have been met; and
  - sizing diversion capacities according to the design life of the diversion, seasonal flows, potential flooding, and fish use and passage.
- design and construct watercourse crossings to meet or exceed the regulatory requirements for approval under the provincial *Water Act* and the federal *Fisheries Act* and *Navigable Waters Protection Act*;
- size watercourse and diversions on fish bearing streams to permit fish passage in accordance with standard guidelines (Alberta Transportation 2001);
- install haul road berms to contain road runoff and direct it to designated runoff control works;
- establish vegetated buffer setbacks of at least 10 m from streams and 30 m from major streams, where possible, to minimize the risk of sediment laden runoff entering the streams;
- incorporate flow and erosion control measures, such as ditch check structures, natural depressions or low areas to create cleanouts (for runoff and sediment retention);
- allow depressions or cleanouts to de-water by a combination of evaporation and exfiltration, wherever possible;
- filter sediments by seepage through natural buffers and constructed materials and possibly through local wetland areas where possible; and
- train personnel to minimize disturbances and use and maintain drainage and sediment controls.

E.6.5.2 Monitoring

In order to monitor the effectiveness of the mitigation measures CVRI will:

- continue monitoring programs already in place at the existing CVM mine (*i.e.,* flow and TSS at settling ponds, regular inspections of all drainage works, and upstream and downstream water quality sampling);
- document the effect of mine operations on long term flow regimes in order to document critical low flow conditions during pit filling periods and define the need for any bypass pumping to maintain in-stream flows;
- establish flow monitoring stations 2-3 years in advance of commencement of Project operations in each watershed;
- conduct periodic runoff and drainage control monitoring (adjust the capacity of or relocate sump systems and drainage works as mining proceeds);
- conduct ongoing monitoring, operations, and maintenance as outlined in the water management plan with periodic reviews and adjustments; and
- monitor adjacent undisturbed areas to ensure surface runoff from disturbed areas does not occur.

E.6.6 SUMMARY OF VECS

With appropriate mitigation and monitoring there will be an insignificant impact on flow and sedimentation within local and regional watercourses. Table E.6-2 summarizes the overall impacts during the operational and abandonment phases for each VEC. Insignificant in terms of flows is less than a 10% change, comparable to the degree of accuracy of flow measurements or published data for small streams. Controlling sediment levels to less than licensing requirements are considered as insignificant for sediment concentrations. Some effects may be either positive or negative due to some uncertainties reflecting the variable conditions that are possible during high, low and average flow periods. However, the assessments are expected to have a high degree of confidence with respect to the magnitude of significance of the impacts.

Table E.6-2 Summary of Impact Significance on Surface Hydrology Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Impact or Effect	Geographical Extent [1]	Duration [2]	Frequency[3]	Reversability[4]	Magnitude [5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
1. Change in Runoff Due to Mine Construction and Operation												
Changes in runoff due to haul roads		Section E.6.5	Application	Local	Long	Seasonal/Periodic	Reversible in the long-term	Moderate	Negative	High	High	Insignificant
			Cumulative	Local	Long	Seasonal/Periodic	Reversible in the long-term	Low - Mod	Negative	High	High	Insignificant
Changes in runoff due to Clearing and Logging		Section E.6.5	Application	Local	Long	Seasonal	Reversible in the long-term	Low – Mod	Negative	High	High	Insignificant
			Cumulative	Local	Long	Continuous/ Seasonal	Reversible in the long-term	Low – Mod	Negative	High	High	Insignificant
Changes in runoff due to operation of Pits & Pit Dewatering		Section E.6.5	Application	Local	Long	Continuous	Reversible in the long-term	Low	Negative	High	High	Insignificant
			Cumulative	Local	Long	Continuous	Reversible in the long-term	Low	Negative	High	High	Insignificant
Changes in runoff due to Temporary Diversions		Section E.6.5	Application	Local	Short	Isolated	Reversible in the short-term	Nil	Neutral	High	High	Insignificant
			Cumulative	Local	Short	Isolated	Reversible in the short-term	Nil	Neutral	High	High	Insignificant
Changes in runoff due to Spoil Piles		Section E.6.5	Application	Local	Long	Seasonal	Reversible in the short-term	Low	Negative & Positive	Moderate	Medium	Insignificant
			Cumulative	Local	Long	Seasonal	Reversible in the short-term	Low	Negative & Positive	Moderate	Medium	Insignificant
2. Change in Runoff After Reclamation and Closure												
Construction of End Pit Lakes and Restored Channels		Section E.6.5	Application	Local	Residual	Continuous	Irreversible	Low-High	Negative & Positive	High	High	Significant
			Cumulative	Local	Residual	Continuous	Irreversible	Low-High	Negative & Positive	High	High	Significant
Changes in runoff due to Reclaimed Spoil Areas		Section E.6.5	Application	Local	Residual	Continuous	Reversible in the long-term	Low – Mod	Negative to Positive	Moderate	High	Insignificant
			Cumulative	Local	Residual	Continuous	Reversible in the long-term	Low - Mod	Negative to Positive	Moderate	High	Insignificant
3. Change in Sediment Concentrations (Water Quality) Due to Mine Construction and Operation												
Impact on sediment concentrations due to Haul Roads		Section E.6.5	Application	Local	Long	Periodic	Reversible in the long-term	Low	Negative	High	High	Insignificant
			Cumulative	Local	Long	Periodic	Reversible in the long-term	Low	Negative	High	High	Insignificant

Table E.6-2 Summary of Impact Significance on Surface Hydrology Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Impact or Effect	Geographical Extent [1]	Duration [2]	Frequency[3]	Reversability[4]	Magnitude [5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
Impact on sediment concentrations due to Clearing and Logging		Section E.6.5	Application	Local	Long	Periodic	Reversible in the long-term	Low	Negative	High	High	Insignificant
			Cumulative	Local	Long	Periodic	Reversible in the long-term	Low	Negative	High	High	Insignificant
Impact on sediment concentrations due to Pit & Pit Dewatering		Section E.6.5	Application	Local	Long	Occasional/Isolated	Reversible in the short-term	Low	Negative	High	Medium	Insignificant
			Cumulative	Local	Long	Occasional/Isolated	Reversible in the short-term	Low	Negative	High	Medium	Insignificant
Impact on sediment concentrations due to Temporary Diversions		Section E.6.5	Application	Local	Short	Isolated	Reversible in the short-term	Nil	Neutral	High	High	Insignificant
			Cumulative	Local	Short	Isolated	Reversible in the short-term	Nil	Neutral	High	High	Insignificant
Impact on sediment concentrations due to Spoil Piles & Rock Drains		Section E.6.5	Application	Local	Long	Seasonal/Periodic	Reversible in the long-term	Low	Negative	Moderate	Medium	Insignificant
			Cumulative	Local	Long	Seasonal/Periodic	Reversible in the long-term	Low	Negative	Moderate	Medium	Insignificant
4. Change in Sediment Concentrations (Water Quality) After Reclamation and Closure												
Impact on sediment concentrations due to End Pit Lakes and Restored Channels		Section E.6.5	Application	Local	Residual	Periodic	Irreversible	Low-Moderate	Positive/Neutral	High	High	Insignificant
			Cumulative	Local	Residual	Periodic	Irreversible	Low-Moderate	Positive /Neutral	High	High	Insignificant
Impact on sediment concentrations due to Reclaimed Spoil Areas		Section E.6.5	Application	Local	Residual	Periodic	Reversible in the short-term	Low	Neutral	Moderate	Low	Insignificant
			Cumulative	Local	Residual	Periodic	Reversible in the short-term	Low	Neutral	Moderate	Low	Insignificant

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant, Significant

E.7 MAMMALIAN CARNIVORES

E.7.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of mammalian carnivores for the proposed Project. The following section is a summary of the Mammalian Carnivore Assessment that was prepared by HAB-TECH Environmental Ltd. and is included as Consultant Report #7 (CR #7). For full details of the assessment, please refer to CR #7.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the mammalian carnivore component are provided in Section 3.7 and Section 3.8, and are as follows:

3.7 WILDLIFE

3.7.1 Baseline Information

[A] Describe and map existing wildlife resources (amphibians, reptiles, birds and terrestrial and aquatic mammals) and their use and potential use of habitats.

[B] Identify key indicator species and discuss the rationale for their selection. Identify composition, distribution, relative abundance, seasonal movements, movement corridors, habitat requirements, key habitat areas, and general life history. Address those species:

- *a) listed as "at Risk, May be at Risk and Sensitive" in The Status of Alberta Species (Alberta Sustainable Resource Development);*
- *b) listed in Schedule 1 of the federal Species at Risk Act; and*
- *c) listed as "at risk" by COSEWIC.*

[C] Describe, quantify and map all existing habitat disturbances (including exploration activities) and identify those habitat disturbances that are related to existing and approved Project operations.

3.7.2 Impact Assessment

[A] Describe Project components and activities that may affect wildlife and wildlife habitat.

[B] Describe and assess the potential impacts of the Project on key indicator species and relate those impacts to wildlife populations and wildlife habitats, addressing:

- *a) how the Project will affect wildlife relative abundance, movement patterns, distribution and recruitment into regional populations for all stages of the Project;*
- *b) how improved or altered access may affect wildlife including potential obstruction of daily and seasonal movements, increased vehicle-wildlife collisions, and increased hunting pressures;*
- *c) how increased habitat fragmentation may affect wildlife considering edge effects, the availability of core habitat, and the influence of linear features and infrastructure on wildlife movements and other population parameters;*
- *d) the spatial and temporal changes to habitat availability and habitat effectiveness (types, quality, quantity, diversity and distribution);*

   e) *potential impacts on wildlife resulting from changes to air and water quality, including both acute and chronic effects to animal health;*
   f) *the resilience and recovery capabilities of wildlife populations and habitats to disturbance; and*
   g) *the potential for the Project Area to be returned to its existing state with respect to wildlife populations and their habitats.*

[C] *Comment on the availability of species for traditional use considering habitat loss, habitat avoidance, vehicle-wildlife collisions, increased non-aboriginal hunting pressure and other Project related impacts on wildlife populations.*

[D] *Provide a strategy and mitigation plan to minimize impacts on wildlife and wildlife habitat for all stages of the Project and to return productive wildlife habitat to the area, considering:*

   a) *consistency of the plan with applicable regional, provincial and federal wildlife habitat objectives and policies;*
   b) *a schedule for the return of habitat capability to areas impacted by the Project;*
   c) *the use of setbacks to protect riparian habitats, interconnectivity of such habitat and the unimpeded movement by wildlife species using that habitat and the use of buffers (e.g. treed buffers) to reduce visual or noise impacts on wildlife;*
   d) *anticipated access controls or other management strategies to protect wildlife during and after Project operations;*
   e) *measures to prevent habituation of wildlife to minimize the potential for human-wildlife encounters and consequent destruction of wildlife, including any staff training program, fencing camps, garbage containment measures or regular follow-up;*
   f) *measures to mitigate habitat fragmentation considering impacts to habitat connectivity and wildlife movements resulting from linear features (e.g., above ground pipelines, roads etc.) and other Project infrastructure and activities; and*
   g) *measures to mitigate mortality risks to wildlife from roads or other hazards related to Project infrastructure.*

3.8 BIODIVERSITY

3.8.1 Baseline Information

[A] *Describe the terrestrial and aquatic biodiversity metrics that will be used to characterize* the existing ecosystems and probable impacts of the Project, and:

   a) *describe the process and rationale used to select biotic and abiotic indicators for biodiversity within selected taxonomic groups;*
   b) *determine the relative abundance of species in each ecosite phase;*
   c) *provide species locations, lists and summaries of observed and estimated species richness and evenness for each ecosite phase;*
   d) *provide a measure of biodiversity on baseline sites that are representative of the proposed reclamation ecosites; and*

e) rank each ecological unit for biodiversity potential. Describe the techniques used in the ranking process.

3.8.2 Impact Assessment

[A] Describe the metrics used to assess the probable impacts of the Project. Discuss the contribution of the Project to any anticipated changes in regional biodiversity and the potential impact to local and regional ecosystems.

[B] Identify and evaluate the extent of potential effects of fragmentation on biodiversity that may result from the Project. Discuss those effects at all relevant scales (from site specific to landscape level).

[C] Discuss the mitigation measures proposed to minimize any anticipated changes in regional biodiversity.

Eighteen species of mammalian carnivore are known to be present or are assumed to exist in the RSA. All were initially considered to be candidates as VECs. Seven of the 18 species are listed as Species of Concern by provincial or federal governments. Listed species include grizzly bear, bobcat, lynx, fisher, long-tailed weasel, wolverine and badger. Five species, grizzly bear, marten, fisher, lynx and wolf, were selected as VECs for the assessment of Project and cumulative impacts on mammalian carnivores. Reasons for eliminating the remaining 13 species as candidates are outlined in CR #7, Table 3.

Three nested study areas were used to assess Project-specific and cumulative impacts on mammalian carnivore VECs (CR #7, Figure 1). These included:

- Disturbance Footprint Area (DFA) (4,277-ha) which is the area within the Mine Permit directly affected by Project development including mines, haul roads, rock dumps, soil piles and ponds;
- Local Study Area (LSA) (10,090 ha) which is the mine permit area and transportation corridor boundaries; and
- Regional Study Area (RSA) (358,731 ha) which is the same as cumulative effects assessment (CEA) study area; based on sub-watersheds/Bear Management Units.

It is anticipated that the lifespan of the Project (including reclamation) will approximately 50 years (operating time: 25 years). Project-specific and cumulative impacts on vegetation and associated wildlife habitat were based on projections including seven scenarios at four time intervals including Project initiation and 10, 25 and 50 years after initiation.

E.7.2 Baseline Conditions

E.7.2.1 Regional Study Area Ecological Description and Supply

The RSA occurs in a transition between the Foothills (84.8%) and Rocky Mountain (15.2%) Natural Regions. Bear Management Units (BMUs) are comprised of various combinations of Natural Regions/Subregions, Ecodistricts and broad vegetation cover. There are ten BMUs found within the RSA (CR #7, Figure 2). The ecological characteristics of each of the ten BMUs in the RSA are described in Table E.7-1.

Table E.7-1 Summary of BMU Characteristics

Characteristic	Beaver Dam	Embarras	Erith	Lambert	Lendrum	Lower Pembina	McLeod	McPherson	Raven	Upper Pembina
Total Area Within RSA (km^2)	384	356.8	263.4	301.3	418.9	294.6	437.8	354.2	364.2	411.6
Proportion of RSA (%)	10.7	9.9	7.3	8.4	11.7	8.2	12.2	9.9	10.2	11.5
Natural Regions										
Rocky Mountain (%)	61.2	0.0	0.0	0.0	0.0	8.2	16.8	5.1	0.0	47.2
Foothills (%)	38.8	99.4	100.0	100.0	100.0	91.8	83.2	94.9	100.0	52.8
Natural Subregions										
Sub-Alpine (%)	53.8	0.0	0.0	0.0	0.0	8.2	0.0	5.1	0.0	45.6
Upper Foothills (%)	38.8	72.6	6.0	30.0	85.7	91.8	83.2	86.5	36.8	52.8
Alpine (%)	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Lower Foothills (%)	0.0	0.0	94.0	70.0	0.0	0.0	0.0	8.4	63.2	0.0
Ecodistrict										
Banff Mountains (%)	59.6	0.0	0.0	0.0	0.0	3.3	13.5	0.0	0.0	36.5
Ram River Foothills (%)	38.8	40.4	0.0	0.0	40.8	37.4	83.2	36.4	0.0	52.8
Luscar Foothills (%)	1.6	0.5	0.0	0.0	0.0	0.0	3.2	0.0	0.0	10.7
Wolf Lake Upland (%)	0.0	32.2	6.0	30.0	44.9	59.3	0.0	55.1	36.8	0.0
Obed Upland (%)	0.0	26.8	94.0	70.0	14.3	0.0	0.0	8.4	63.2	0.0
Dominant Land Cover										
Moderate Young Conifer (%)	65.2	5.0	5.2	0.0	0.0	6.9	3.9	6.0	7.3	49.3
Open Forest Regeneration (%)	10.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	8.0	9.0
Moderate Mature Conifer (%)	0.0	0.0	30.0	15.5	11.3	25.0	14.0	15.6	23.0	10.0
Barren Land (%)	4.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	5.2
Dense Mature Conifer (%)	3.6	15.9	7.4	43.2	8.0	33.8	35.8	12.5	13.7	5.7

Table E.7-1 Summary of BMU Characteristics

Characteristic	Beaver Dam	Embarras	Erith	Lambert	Lendrum	Lower Pembina	McLeod	McPherson	Raven	Upper Pembina
Open Regenerating Shrub (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dense Young Conifer (%)	0.0	0.0	0.0	0.0	6.6	0.0	14.3	6.2	0.0	0.0
Moderate Mature Conifer (%)	4.1	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Treed Wetland (%)	0.	0.0	12.2	8.7	0.0	7.8	0.0	0.0	14.2	0.0
Dense Young Mixedwood (%)	0.0	8.6	7.9	0.0	0.0	0.0	4.1	0.0	0.0	0.0
Moderate Mature Mixedwood (%)	0.0	0.0	0.0	4.8	22.7	0.0	0.0	0.0	0.0	0.0
Moderate Young Deciduous (%)	0.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Moderate Young Mixedwood (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0
Open Regeneration –herbaceous (%)	0.0	0.0	5.4	0.0	0.0	4.4	0.0	0.0	0.0	0.0
Shrubland (%)	6.6	0.0	0.0	0.0	0.0	3.0	5.3	0.0	0.0	0.0
Closed Regenerating –Shrubby (%)	0.0	0.0	0.0	6.6	6.4	0.0	0.0	8.8	0.0	0.0
Open Shrubby Regeneration (%)	0.0	16.8	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0
Moderate Old Growth Mixedwood (%)	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	8.6	0.0
Moderate Old Growth Deciduous (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Upland Grassland (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3
Area of Clearcut and/or Regeneration (km^2)	42.5	79.4	24.2	39.6	91.3	27.7	48.9	62.8	10.9	48.7
Existing Mine Area (km2)	12.2	31.0	-	-	20.3	-	11.2	-	-	81.2
Density of Roads (km/km^2)	0.49	0.85	0.87	0.61	0.88	0.54	0.66	0.95	0.87	0.73
Density of Pipeline (km/km^2)	0.06	0.26	0.26	0.16	0.28	0.23	0.10	0.15	0.26	0.18

E.7.2.2 Local Study Area Ecological Description and Supply

The Project LSA encompasses a total of 100.9 km^2 which accounts for 2.8% of the RSA. The LSA occurs entirely within the Upper Foothills Natural Subregion of the Foothills Natural Region. The higher elevation southwesterly portion of the LSA occurs in the Ram River Foothills Ecodistrict (70.1 km^2) and the lower elevation portions (30.8 km^2) in the Wolf Lake Upland (CR #7, Figure 2). The LSA is dominated by the Lendrum (67.4%) and Embarras (27.4%) BMUs with a minor component overlapping with the Lower Pembina (4.0%) and McPherson (1.2%) BMUs. Dominant vegetation cover types found in the LSA and RSA are listed in Table E.7-2.

Table E.7-2 Dominant Vegetation Cover Types

Vegetation Cover Type	% of LSA	% of RSA
Dense Canopy Mature Conifer Forest	12.3	17.5
Moderate Canopy Mature Conifer Forest	10.4	15.6
Moderate Canopy Young Deciduous Forest	10.0	13.7
Moderate Canopy Mature Mixedwood Forest	9.9	3.8
Open Canopy Regeneration - Herbaceous	9.3	6.4
Moderate Canopy Young Mixedwood Forest	8.6	2.5
Dense Canopy Mature Mixedwood Forest	7.7	0.8
Moderate Canopy Old Growth Deciduous Forest	5.4	1.6
Open Canopy Regeneration - Shrubby	5.1	2.8
Moderate Canopy Young Conifer Forest	4.6	16.5

It is clear from the information in Table E.7-2 that the LSA supports a disproportionate supply of mature mixedwood and old growth deciduous forest cover. When compared to the larger region, the LSA generally has a lesser proportion of coniferous forest and slightly higher amounts of open canopy herbaceous and shrubby vegetation.

E.7.2.3 Linear Features Classification and Mapping

Roads and trails have potential to exert a major negative impact on carnivores through increasing firearm and trapping mortality as well as vehicle collisions (Noss et al.1996; Benn and Herrero 2002). As such, existing linear features and traffic volume estimates were classified and mapped in the RSA.

Linear features were classified as:

- paved road;
- gravel road;
- unimproved road;
- truck trail; and

- pipelines.

Standardized linear access mapping data was obtained from the FRIGBP (2010 Deliverables). A total of 96.5 km of roads and truck trails occur within the 100.9 km^2 LSA. Approximately one-half of roads in the LSA are either one or two lane gravel features with the remaining being truck trails or unimproved roads. Total road density in the LSA is 0.96 km/km^2, which is higher than all 10 BMUs in the Regional Study Area (CR #7, Table 5). Pipeline density in the Project LSA is currently 0.29 km/km^2, which is higher than all but one of the BMUs (Raven) in the RSA (CR #7, Table 5). Existing overall linear feature density in the LSA is very high in a regional context.

E.7.2.4 Winter Tracking Field Studies

Winter tracking transects were completed within the LSA and RSA during the winters of 2007, 2009 and 2011. Resulting winter tracking data was pooled across years and analyzed in two ways: 1) trails per km-day by habitat type; and, 2) mean trails per km-day by land use type (logging, mine reclaim, oil and gas-high density and oil and gas-low density). Data collected within the LSA was summarized and compared to results from other land use scenarios.

Twenty wildlife species or species groups were recorded on transects within the RSA (CR #7, Table 9). These included three ungulates (moose, elk and deer spp.), thirteen carnivore species (weasel spp., least weasel, ermine, long-tailed weasel, marten, fisher, mink, coyote, fox, lynx, cougar, bobcat and wolf), three small mammal species (microtine rodent spp., red-squirrel and varying hare) and one bird (grouse spp.). It was not possible to differentiate mule deer and white-tailed deer tracks and as such they were grouped.

Ungulates

Deer trails were widely distributed across the RSA occurring in twenty-one of 31 (68%) of mapped land cover types within the RSA. Deer trail density was highest in moderate mixed-mature seral forest (16.1 trails/km-day), moderate mixed-young seral forest (7.23), moderate broadleaf-young seral forest (6.8) and moderate broadleaf-old growth forest (6.5) (CR #7, Table 9). Of the 4,349 deer trails observed 96 (2.2%) were observed to be using linear features for travel.

Elk trails were recorded in eighteen of 31 (58%) land cover types sampled. Elk trail densities were highest in open broadleaf-mature seral forest (83.3 trails/km-day), water (frozen lakes/ponds) (5.2), open conifer-young seral forest (5.1) and upland herbaceous (4.4). Of the 952 elk trails observed 47 (4.9%) were using linear features for travel.

Moose trails were recorded in twenty-five of the 31 (81%) mapped land cover types. Moose trail density was highest within open broadleaf-mature seral forest (11.1 trails/km-day), moderate broadleaf forest (5.0), open conifer-young seral forest (2.9) and open mixed-old growth forest (2.2). Of the 395 moose trails observed, 42 (10.6%) used linear features for travel.

Carnivores

Trails of three species of weasel were observed during field surveys: ermine (short-tailed weasel), least weasel, and long-tailed weasel. Ermine trails were the most abundant (n=502) with a density of 1.4 trails/km-day. Twenty-three least weasel trails were recorded for an overall density of 0.06 trails per km-day. Three long-tailed weasel trails were observed. Ermine trails were observed in 21 of 31 (84%) of mapped land cover types. Land cover types with highest ermine trail densities were: open conifer-young seral (5.2 trails/km-day), open mixed-old growth forest/upland herb edges (3.4), barren land (3.02) and treed wetland (2.8) (CR #7, Table 9). Least weasels were detected in 7 land cover types with the most highly used being: open regenerating-shrubby (0.35 trails/km-day), moderate broadleaf-young seral (0.29), barren land (0.15) and shrubs (0.13). No weasel trails were recorded using linear features for travel.

Marten trails were recorded 588 times resulting in 0.57 trails per km-day. Marten trails were recorded in twenty-five of the 31 (81%) land cover types. Marten trail densities were highest within open conifer-mature seral forest (1.68 trails per km-day), moderate broadleaf-old growth forest (1.47), moderate mixed-old growth forest (1.46) and moderate conifer-young seral forest (1.22). Of the 588 marten trails observed, only 3 (0.5%) were using observed using linear features for travel.

A total of 26 fisher trails (0.03 trails per km-day) were observed on tracking transects in the RSA. Fisher trails were recorded within seven of 31 (23%) mapped land cover types. Observations occurred most often within open regenerating-shrubby (0.20 trails per km-day), moderate conifer-mature seral (0.08) and moderate mixed-mature seral (0.07). No fisher trails were recorded along linear features.

Eleven (11) mink trails were recorded within the RSA occurring within open conifer-young seral forest, moderate conifer-young seral forest, dense conifer-mature seral forest and upland herb land cover types. Mink were not observed to use linear features for travel.

A total of 574 coyote trails were observed resulting in a density of 0.55 trails/km-day. Coyote trails were widely distributed being observed in 25 of the 31 (81%) land cover types sampled. Highest densities of coyote trails were observed in: open conifer-young seral forest (5.84 trails/km-day), dense mixed-old growth forest (4.86), closed regenerating-treed (4) and water (frozen lakes/ponds) (2.31). Of the 574 coyote trails observed, 73 (12.7%) were using linear features for travel.

A total of 199 wolf trails were observed on tacking transects in the RSA. Wolf trail density was 0.19 trails per km-day. Wolf trails observed in 14 of 31 (45%) land cover types mapped in the RSA. Wolf trails were recorded most often within open conifer-young seral forest (7.30 trails/km-day), moderate broadleaf-young seral forest(0.97), moderate mixed-young seral (0.78) and dense conifer-mature seral (0.26). Of the 199 wolf trails observed, 25 (12.6%) were using linear features for travel.

Four red fox trails were recorded in barren land, upland herb and dense conifer-mature seral forest. Fox were not observed to use linear features for travel.

A total of 207 lynx trails were recorded on transects yielding a density of 0.20 trails per km-day. Lynx were detected in nineteen of the 31 (61%) land cover types sampled. Lynx trails were most abundant in: closed regenerating-treed (1.09 trails/km-day), moderate mixed-mature seral (0.46), moderate broadleaf-young seral (0.43) and dense conifer-young seral (0.41). Of the 207 lynx trails observed, 8 (3.9%) used linear features for travel.

A total of 25 cougar trails (0.02 trails/km-day) were recorded on transects in the RSA. Cougars occurred within five of the 31 (16%) land cover types sampled. Trails from this species occurred in moderate conifer-mature seral forest (0.06 trails/km-day), dense conifer-mature seral forest (0.06), moderate broadleaf-young seral forest (0.04), moderate mixed-mature seral forest (0.03) and moderate mixed-mature seral forest (0.01). No cougar trails were recorded on linear features.

Only two bobcat trails were recorded on tracking transects, both in mature seral conifer forest. No bobcat trails were recorded on linear features.

Small Mammal Prey and Bird Species

Snowshoe hare trails were the most abundant of all species detected. A total of 27,922 trails were detected resulting for an overall density of 26.8 trails per km-day. Hare trails occurred in 30 of 31 (97%) land cover types sampled in the RSA. Highest snowshoe hare densities occurred in: dense mixed-old growth forest (129.9 trails/km-day), closed regenerating-treed (99.8), dense conifer-young seral forest (96.0), moderate broadleaf-young seral forest (63.3), and closed regenerating-shrubby (60.0) (CR #7, Table 9).

A total of 4,186 red squirrel trails were observed. Overall trail density was 4.0 trails per km-day. Squirrel trails were observed in 27 of the 31 (87%) land cover types sampled. The most productive land cover types for red squirrels were: moderate conifer-old growth forest (11.7 trails per km-day), open conifer-young seral forest (10.2), dense conifer-young seral forest (10.0) and dense mixed-old growth forest (7.6).

A total of 233 grouse (spp.) trails were observed resulting in an overall trail density of 0.22/km-day. Grouse trails were observed in 21 of 31 (68%) land cover types and were most abundant in: dense mixed-old growth forest (1.4 trails per km-day), dense mixed-mature seral forest (0.85), closed regenerating-treed (0.55) and dense conifer-mature seral forest (0.36).

A total of 465 microtine rodent (mice, shrews, voles) trails were recorded on transect. Overall trail density was 0.4 trails per km-day. Microtine rodent trails were detected in 23 of 31 (74%) land cover types. Trails were most abundant in: moderate conifer-old growth forest (0.84 trails per km-day), dense conifer-mature seral forest (0.82), moderate broadleaf-young seral forest (0.75) and dense mixed-old growth forest (0.69).

Comparison of Land Use Classes

Significant differences in mean winter trail densities for coyote, deer and elk were observed between Project transects and transects in other human land use classes (CR #7, Table 11). Mean trails per km-day for coyote were significantly higher for the mine reclaim transects than for Project transects (p=0.003). Mean deer trails per km-day within the LSA (9.69 trails/km-day) were significantly higher than for transects in mine reclaim (0.87 trails/km-day; p = 0.0004) and oil and gas-high density transects (2.34 trails/km-day; p=0.002). Mean trails per km-day for elk were significantly lower for the Project transects (0.16 trails/km-day) than for mine reclaim transects (3.23 trails/km-day; p=0.0002).

Winter trail densities for the mammalian carnivore VECs (marten, fisher, wolf and lynx) did not differ significantly between the LSA and areas with varying land use levels and types in the RSA.

Significant differences in mean winter trail densities for snowshoe hare, coyote, deer and elk were observed between mine reclaim transects and transects in other human land use areas (CR #7,Table 12). Mean trails per km-day for snowshoe hare were significantly lower for the mine reclaim transects (15.6 trails/km-day) than for oil and gas-high density transects (52.6 trails/km-day; p= 0.007). Mean coyote trail density for the mine reclaim transects (1.51 trails/km-day) was observed to be significantly higher than for transects in the all other land use classes. Mean trail densities for coyote for transects within the other human land use classes were: logging 0.37 trails/km-day (p=0.001), oil and gas-high density 0.56 (p=0.006), oil and gas-low density 0.29 (p=0.0001) and the Project 0.45 (p=0.003). Mean trail densities for deer on mine reclaim transects (0.87 trails/km-day) were significantly lower than for transects in oil and gas-low density (5.78 trails/km-day; p=0.04) and the Project areas (9.69 trails/km-day; p=0.0003). Mean elk trail density for mine reclaim transects (3.23 trails/km-day) was significantly higher than for transects in the all other land use classes. Mean trail densities for elk for other human land use classes were: logging 0.08 trails/km-day (p=0.0004), oil and gas-high density 0.005 (p=0.00004), oil and gas-low density 0.79 (p=0.001) and the Project 0.16 (p=0.0001).

E.7.2.5 Multi-species Backtrailing

A total of 30 backtrailing bouts were completed including: coyote (6), wolf (7), lynx (10), and marten (7). A total of 105.1 km of backtrailing was completed including: wolf (39.3-km), lynx (33.4 -km), coyote (19.2-km) and marten (13.2-km) (CR #7, Table 13, Figure 5). Carnivore backtrailing bouts were summarized by activity observations as well as distances travelled through broad land cover type and along linear features.

<u>Coyote</u>

Coyote backtrailing was not conducted in the LSA. The majority of backtrailing for coyote was completed in the vicinity of the existing CVM where trails were most common. Coyotes crossed 21 linear features (1.1/km) and travelled on linear features for 4.7-km or 24% of the total distance backtrailed (CR #7, Table 13). Activity observations included: 7 bed sites (0.04/km), 10 scent posts (0.05) and 3 kill sites (0.02). Coyotes travelled in 15 different land cover types, with the majority of the distance in shrub (31%), upland herb (30%), and barren land (17%) (CR #7, Table 14). Coyotes were commonly observed travelling and hunting in early, mid and late succession vegetation on mine reclaim areas.

<u>Wolf</u>

Wolves were backtrailed seven times for 39.3 km (CR #7, Table 13). Total distance within the LSA was 4.1 km (11%). Wolf trails crossed 31 linear features (0.8/km) and wolves travelled on linear features for over half (21.3 km or 54%) of the total distance backtrailed. Activity observations included: 27 bed sites (0.07/km), 5 scent posts (0.01) and one kill site (0.003). Wolves travelled through 13 different land cover types, but utilized barren land (29%), upland herb (23%), and moderate mixed-mature seral (18%) most often (CR #7, Table 14). The above three habitats supported above average elk trail densities per km day, and moderate mixed-mature seral forest supported the highest deer trail densities per km day. The single kill site (white-tailed deer) was observed in the moderate mixed-mature seral forest cover type.

Lynx

Lynx were backtrailed nine times and for a total distance of 30.7 km (CR #7, Table 13). Total distance backtrailed within the LSA was 18.6 km or 60.6%. Lynx trails crossed 35 linear features (1.1 /km) but no travel or hunting on linear feature were observed. Thirteen bed sites, one kill site and one scent post were observed along back trails. Lynx trails crossed 15 different land cover types with 57% of the total distance backtrailed occurring in three types: Dense conifer-mature seral forest (31%), dense conifer-young seral forest (15%), and closed regenerating treed (11%) (CR #7, Table 14). All three of the above land cover types supported high snowshoe hare trail densities (CR #7, Table 9).

Marten

Marten trails were followed 7 times for a total of 13.2 km (CR #7, Table 13). Of this total, 2.5 km (19%) was sampled in the LSA. Marten trails crossed 14 linear features (1.1 /km) but did not use linear features for travel purposes. Eight bed sites and one kill site were observed along backtrails (CR #7, Table 13). Marten backtrails were recorded in 10 different land cover types. A strong preference for mature forest was evident, with 47% of trails in moderate mixed-mature seral forest and 18% in dense conifer-mature seral forest (CR #7, Table 14).

E.7.2.6 Habitat Suitability Evaluation and Mapping

With reference to regionally pertinent literature, field studies, past regional field studies and knowledge of wildlife-habitat relationships in the Rocky Mountains and Foothills, the suitability of each of the vegetation cover types was assessed for marten, fisher, lynx and wolf (Table E.7-3).

Table E.7-3 Habitat Suitability Ratings for Valued Ecosystems Components by Broad Land Cover Type

Broad Land Cover Type	Marten	Fisher	Lynx	Wolf
Barren Land	VL	VL	VL	VL
Closed Regenerating-Herbaceous	VL	L	L	H
Closed Regenerating-Shrubby	L	L	H	M
Closed Regenerating-Treed	M	M	VH	L
Dense Broadleaf-Mature Seral	L	L	L	M
Dense Broadleaf-Old Growth	L	H	L	H
Dense Broadleaf-Young Seral	L	L	L	H
Dense Conifer-Mature Seral	H	M	M	M
Dense Conifer-Old Growth	VH	VH	VH	M
Dense Conifer-Young Seral	M	L	VH	L
Dense Mixed-Mature Seral	M	M	M	VH

Table E.7-3 Habitat Suitability Ratings for Valued Ecosystems Components by Broad Land Cover Type

Broad Land Cover Type	Marten	Fisher	Lynx	Wolf
Dense Mixed-Old Growth	H	VH	H	H
Dense Mixed-Young Seral	L	L	H	M
Moderate Broadleaf	L	M	L	M
Moderate Broadleaf-Mature Seral	L	M	L	M
Moderate Broadleaf-Old Growth	M	H	L	H
Moderate Broadleaf-Young Seral	L	L	M	H
Moderate Conifer-Mature Seral	VH	M	M	M
Moderate Conifer-Old Growth	VH	VH	M	L
Moderate Conifer-Young Seral	H	L	H	L
Moderate Mixed-Mature Seral	H	M	L	VH
Moderate Mixed-Old Growth	VH	VH	M	H
Moderate Mixed-Young Seral	M	L	H	H
Open Broadleaf-Mature Seral	L	L	L	M
Open Broadleaf-Old Growth	L	H	L	H
Open Broadleaf-Young Seral	L	L	L	M
Open Conifer-Mature Seral	H	M	L	L
Open Conifer-Old Growth	VH	H	H	L
Open Conifer-Young Seral	M	L	M	L
Open Mixed-Mature Seral	L	M	M	L
Open Mixed-Old Growth	M	H	M	M
Open Mixed-Young Seral	L	L	M	M
Open Regenerating-Herbaceous	VL	L	VL	H
Open Regenerating-Shrubby	L	L	L	M
Open Regenerating-Treed	M	L	M	L
Open Wetland	L	L	L	L
Shrubs	L	L	M	H
Treed Wetland	M	M	H	M
Upland Herb	VL	VL	L	H
Water	VL	VL	VL	VL

E.7.2.6 Fur Harvest Returns

Fur harvest return information for the period 1985 to 2001 was obtained from Alberta Sustainable Resource Development for the Registered Fur Management Areas (RFMA) that overlap in whole or in part with the Project RSA. The data was obtained from fur sale records of December 7, 2001 and from affidavit returns for December 7 and 21, 2001 (Bighorn 2007). Data beyond 2001 was not obtained because of Freedom of Information and Privacy Act restrictions. A total of 22 RFMAs overlap in whole or in part with the RSA. CR #7, Figure 6 shows the location of RFMAs in relation to the RSA, BMUs and mine permit boundaries. A summary of the total and average annual number of furbearers harvested per trap line per year is provided in CR #7, Table 16 and 17.

Fur returns for 17 different species were reported. This included red squirrel (13,348), muskrat (3,649), beaver (3,401), marten (1,796), weasel spp. (1,531), coyote (896), wolf (236), lynx (133), mink (128), fisher (50), red fox (47), black bear (18), badger (14), striped-skunk (7), wolverine (6), river otter (4) and raccoon (1). The average numbers of captures per year per trap line for VEC species were: lynx (0.42), marten (5.17), fisher (0.16), and wolf (0.71).

RFMAs 1516, 2619 and 2256 will be directly affected by the proposed development of the Project permit area (CR #7, Figure 6). Over a 16 year period, RFMA 1516 reported an average number of lynx (0.4/year), fisher (0.19), marten (5.4/year) captures and reported below average wolf captures (0/year). Over a 15 year period, RFMA 2256 reported above average marten (8.5/year), and fisher (0.13) captures and below average lynx (0.3/year) and wolf (0.1/year) captures. Over a 17 year period, RFMA 2619 reported below average capture rates for lynx (0.2/year), marten (1.2), fisher (0.12), and wolf (0.6).

Caution must be used when interpreting this data. Capture rates can vary widely and may reflect trapper effort and fur prices as much as it does of animal abundance. Capture rates can also reflect the size of the RFMA.

E.7.2.7 Marten (Martes americana)

Marten is listed provincially as *Secure* (AFWD 2010). It is not listed by COSEWIC (2011) and as such marten populations are considered to be secure at a national level. Martens are a commonly trapped species in the Coal Branch region. Winter tracking inventories in 2007, 2009 and 2011 recorded a total of 588 marten trails for an overall trail density of 0.57 trails per km-day. This trail density is slightly higher than those recorded in previous studies. Bighorn Environmental Design Ltd. (1995) recorded marten track densities of 0.36 tracks per km-day in the existing CVM permit area during the winter of 1991/92. Kansas and Herrero (1999) recorded marten track densities of 0.50 tracks per km-day in the un-mined South Block and West Extension areas in 1998. AGRA (1998) observed marten track densities of 0.47 trails/km-day in the mostly un-mined Drinnan Creek study area approximately 30-km west of the CVM.

Table E.7-4 summarizes the suitability and supply of marten habitat in the RSA by watershed (BMU) and for the entire RSA and LSA. Approximately 626-km^2 (17.5%) of very high and 1374-km^2 (38.3%) of high-quality marten habitat is currently available in the 3587-km2 RSA (CR #7, Figure 7). BMUs with the highest relative percent occurrence of combined high/very high marten habitat are: Beaverdam (73.2%), Lower Pembina (72.5%), Upper Pembina (69.2%) and Lambert (64.6%). The proposed Project footprint does not occur within any of these BMUs.

Table E.7-4 Habitat Suitability and Supply for Marten - Baseline

Bear Management Unit	% Habitat Suitability Class				
	Very Low	Low	Moderate	High	Very High
Beaverdam	16.4	8.2	2.2	69.1	4.2
Embarras	24.3	24.5	11.9	22.4	17.0
Erith	14.2	19.8	17.5	18.2	30.4
Lambert	9.2	14.0	12.2	48.9	15.7
Lendrum	10.8	22.5	24.1	29.5	15.7
Lower Pembina	8.8	8.4	10.3	43.4	29.1
McLeod	9.9	12.5	22.9	40.0	14.6
McPherson	8.1	23.3	22.3	23.9	22.6
Raven	10.1	13.2	28.5	22.8	25.5
Upper Pembina	19.2	7.8	3.8	58.3	10.9
Entire RSA	13.2	15.3	15.7	38.3	17.5
Robb Trend Mine Permit	17.5	14.6	20.2	35.9	11.9

Very high (11.1 km^2) and high (27.2 km^2) suitability marten habitats comprise 11.9% and 35.9% of the LSA respectively (CR #7, Figure 7).

E.7.2.8 Fisher (Martes pennant)

Fisher is listed provincially as Sensitive (AFWD 2010). It is not listed at a national level (COSEWIC 2011). AFWD (2010) reports fisher as being rare to uncommon and that trends in population and distribution are unknown. AFWD also reported that fisher harvest (fur returns) have declined since 1985. Winter tracking inventories recorded a total of 26 trails amounting to a fisher trail density of 0.03 trails per km-day. Fisher trails were detected in a range of vegetation cover types including: open regenerating shrubby (0.20 trails per km/day); moderate conifer forest-mature seral (0.8), moderate mixed forest-mature seral (0.07), treed wetland (0.04), closed regenerating shrubby (0.04), dense mixed forest-young seral (0.02), and, dense conifer forest -mature seral (0.01) (CR #7, Table 9). Fisher trails were not recorded within existing CVM reclaim areas.

Table E.7-5 summarizes the suitability and supply of fisher habitat in the RSA by BMU as well as in the LSA. A relatively low proportion of very high (2.0%) and high (1.7%) suitability fisher habitat is available in the overall RSA (CR #7, Figure 8). BMUs with the highest proportion of combined high/very high fisher habitat are: Raven (11.2%), McPherson (9.7%), Embarras (5.2%) and Lower Pembina (4.1%). Of these BMUs only the Embarras is transected by the proposed Project mine development (CR #7, Figure 8).

Table E.7-5 Habitat Suitability and Supply for Fisher - Baseline

Bear Management Unit	% Habitat Suitability Class				
	Very Low	Low	Moderate	High	Very High
Beaverdam	6.4	83.9	9.6	0.0	0.1
Embarras	7.4	50.4	37.0	4.0	1.2
Erith	8.8	34.2	55.8	0.1	1.0
Lambert	5.2	20.7	73.2	0.2	0.7
Lendrum	5.8	47.0	44.2	1.0	2.1
Lower Pembina	4.4	21.0	70.5	0.0	4.0
McLeod	7.8	37.6	53.9	0.0	0.7
McPherson	6.0	42.4	41.8	2.5	7.2
Raven	5.4	30.2	53.2	8.6	2.6
Upper Pembina	10.2	67.0	21.9	0.1	0.9
Entire RSA	6.8	45.0	44.5	1.7	2.0
Robb Trend Mine Permit	8.4	43.8	42.2	5.3	0.4

The majority of the LSA is comprised of low (43.8%) and moderate (42.2%) fisher habitat suitability (CR #7, Figure 8). Combined very high and high suitability fisher habitats comprise only 5.7% of the LSA. The largest patch of high suitability habitat occurs in Robb West portion of the LSA located immediately north of Highway 47. This area supports late seral deciduous forest conditions.

E.7.2.9 Lynx (Lynx canadensis)

Canada lynx is listed provincially as *Sensitive* (AFWD 2010). This designation reflects concerns that the provincial population has decreased in recent decades perhaps in response to habitat loss and fragmentation. Provincial trapper harvest is governed by a quota. Lynx are listed by COSEWIC (2011) as *Not-at-Risk*.

Lynx are widely distributed but uncommon in the RSA. Winter tracking inventories from 2007 to 2011 recorded a total of 207 lynx trails for an overall density of 0.20 trails per km-day. Previous winter tracking surveys in the Coal Valley region did not record lynx trails. Track surveys carried out in the winters of 1991/92 and 1997/98 by Bighorn Environmental Design Ltd. (1995, 1999) did not find lynx sign in the South Block or the West Extension of the CVM. Track surveys in 1991/92 also failed to record lynx sign at the CVM either (Bighorn 1992). No lynx tracks were observed in the CVM extension area in late November of 1998 (Kansas and Herrero 1999).

The majority of the RSA was rated as medium (40.6%) or high (30.7%) suitability for lynx (Table E.7-6; CR #7, Figure 9). BMUs with the largest proportion of combined high/very high lynx habitat are: Beaverdam (68.4%), Upper Pembina (54.8%), McPherson (38.2%) and

Lendrum (33%). The LSA occurs largely in the Lendrum BMU. Very high suitability habitat for lynx includes closed regenerating forest, dense mature conifer forest, and moderately closed conifer forest. Habitats with high suitability for lynx include open regenerating forest, dense and moderately close mixedwood forest, open coniferous forests and treed wetlands. The Lendrum BMU supports a large amount of regenerating forest, which may explain the large proportion of high/very high suitability lynx habitat.

Table E.7-6 Habitat Suitability and Supply for Lynx - Baseline

Bear Management Unit	% Habitat Suitability Class				
	Very Low	Low	Moderate	High	Very High
Beaverdam	14.0	3.1	14.5	67.6	0.7
Embarras	21.7	10.0	43.2	21.1	4.0
Erith	10.4	16.3	41.9	29.9	1.5
Lambert	7.2	11.0	63.1	16.9	1.7
Lendrum	8.8	28.4	29.8	24.3	8.7
Lower Pembina	7.3	7.8	66.0	16.6	2.3
McLeod	6.6	6.3	56.0	13.9	17.2
McPherson	6.5	15.2	40.1	27.0	11.2
Raven	8.1	18.4	41.8	28.9	2.9
Upper Pembina	14.9	9.5	20.9	54.6	0.1
Entire RSA	10.6	12.6	40.6	5.5	10.6
Robb Trend Mine Permit	15.5	22.2	43.2	16.7	2.4

The LSA supports predominantly moderate (43.2%) and low (22.2%) suitability lynx habitat (Table E.7-6, CR #7, Figure 9). Very high and high suitability lynx habitats comprise 2.4% and 16.7% of the LSA respectively. The largest patch of high suitability lynx habitat occurs in the vicinity of Halpenny Creek (CR #7, Figure 9).

E.7.2.10 Wolf (Canis lupus)

Wolves are listed provincially as *Secure* (AFWD 2010) and nationally as *'Not at Risk'* (COSEWIC 2011). Wolves occur throughout most of the Coal Branch region (Bighorn 1997). winter tracking surveys from 2007 to 2011 recorded a total of 199 wolf trails in the RSA for an overall density of 0.19 trails per km-day. This trail density for wolves is notably higher than the mean density of 0.13 trails/km-day (range = 0.03 to 0.32) for 9 years of similar winter tracking triangle surveys conducted in east-central Alberta (unpublished HAB-TECH files).

Kansas and Charlebois (2008) observed that the levels of use by wolves of reclaimed mines in the Coal Branch area was linked to several interrelated factors including ecoregion representation, the availability of elk as prey and the occurrence of effective travel corridors. Regular wolf use of the CVM area has occurred since the early 1990's. Abundant elk and moose prey have been available in this area since then (see Appendix 1), due largely to the inherent habitat conditions in the Upper Boreal-Cordilleran ecological region. The Lovett River valley floodplain remains as an intact corridor through the CVM. It is currently being used as a travel route by wolves and was likely used in the past.

Highest quality wolf habitat in the RSA is found in mixedwood and broadleaf forests where deer, elk and moose abundance is high. Also rated as highly suitable for wolves were open and closed regenerating stands with an herbaceous understory. Approximately 164.6-km^2 (4.6%) of very high and 681.8-km^2 (19%) of high quality wolf habitat is available in the RSA (CR #7, Figure 10). BMUs with the highest relative percent occurrence of combined high/very high wolf habitat are: Beaverdam (68.4%), Upper Pembina (54.8%), McPherson (38.2%) and Lendrum (33%). The Lendrum BMU will be directly affected by Project development.

Table E.7-7 Habitat Suitability and Supply for Wolf - Baseline

Bear Management Unit	% Habitat Suitability Class				
	Very Low	Low	Moderate	High	Very High
Beaverdam	4.1	66.7	10.2	18.9	0.1
Embarras	4.9	10.5	48.7	34.2	1.7
Erith	5.0	10.2	63.7	16.3	4.8
Lambert	3.3	3.4	76.8	11.0	5.5
Lendrum	3.8	16.4	39.0	21.4	19.4
Lower Pembina	3.0	11.3	70.5	12.5	2.7
McLeod	4.6	21.7	58.7	14.8	0.2
McPherson	4.5	19.0	50.6	20.0	5.9
Raven	3.4	13.7	60.0	21.0	1.9
Upper Pembina	5.9	52.8	21.1	17.5	2.7
Entire RSA	4.3	24.0	48.1	19.0	4.6
Robb Trend Mine Permit	6.4	7.5	31.1	38.7	17.8

The LSA supports a relatively large proportion of high suitability (38.7%) and very high (17.8%) suitability wolf habitat (Table E.7-7, CR #7, Figure 10). The largest patch of very high quality wolf habitat occurs south of the mine permit area and north of the existing CVM on either side of the Halpenny haul road corridor. This large patch is comprised of mixedwood forest which is attractive to deer, moose and elk, all favored prey of wolves.

E.7.2.11 Grizzly Bear (Ursus arctos)

Population Status

Grizzly bear is listed as *Special Concern* nationally by COSEWIC (2011). In Alberta, the grizzly bear is listed as *At Risk* under the *2010 General Status* evaluation and *Threatened* under the *Wildlife Act* (AFWD 2010). Grizzly bears occur throughout the Coal Branch region with decreasing likelihood of occurrence from west to east (Boulanger and Stenhouse 2010). The

RSA for this Project occurs entirely within Bear Management Area (BMA) #3, also known as the Yellowhead Population Unit (Alberta Grizzly Bear Recovery Plan 2008).

Based on review of 13,253 radio-telemetry point locations (CR #7, Figure 12), a total of 33 grizzly bears (18 females and 15 males) frequented the RSA from 1999 to 2006 for at least a portion of their total home range. A number of bears occurred within the RSA for multiple years, an indication of home range fidelity. Of the 18 female bears: one was present for 5 years; four for 4 years; one for 3 years; three for 2 years; and, nine for a single year. Of the 15 male bears: three were present for 4 years; one for 3 years; two for 2 years and nine for a single year.

The BMUs with the greatest number of locations per bear are McLeod, Lambert, Upper Pembina and Lendrum. The Lambert BMU supported the lowest number of individual bears (5) and the lowest proportion of females. These two factors indicate a transient population. BMUs with the highest number of locations per km^2 are McLeod (9.2), Beaverdam (5.2), and Upper Pembina (4.2). BMUs with the lowest density of bear locations per km^2 were Raven (0.9), Erith (1.7), McPherson (2.4), and Embarras (2.4). The regional average was 3.7 locations/km^2. The Project LSA supports a relatively low density of grizzly bear observations (2.6/km^2) but the mine footprint itself supports a relatively high density (4.6/km^2).

Precise understanding of the trends of the grizzly bear population in the RSA is not available. Although adult female survival is high in the Yellowhead region (Boulanger and Stenhouse 2010), a population viability analysis using Yellowhead population and vital rates suggests that the population in the Yellowhead region is in decline (ASRD and ACA 2010). This is consistent with observations by Kansas and Charlebois (2008) who determined that one-third (33.3%) of the radio-collared bears that resided in the CVM Mercoal West/Yellowhead Tower RSA died in a 6-year period and that all but one of these mortalities was human-caused. They concluded that the mortality rate of radio-collared bears in that area from 1999 to 2004 was unsustainable and the population trend of grizzly bears was very likely a decreasing one. Apparent reductions in mortality since 2005 (largely a result of abrogation of hunting) may have reversed this population decline to an unknown level. A DNA hair snag study is currently underway in the Robb-Hinton area to more fully understand population trend in the Yellowhead region.

Habitat Suitability and Supply

Resource selection function (RSF) mapping for grizzly bears was obtained from FRIGBP (2010 Deliverables). This product combines land cover mapping with GPS locations resulting in maps of the seasonal probability of occurrence of grizzly bears. Map grid cells are rated between 1 (lowest) and 10 (highest) in terms of probability of grizzly bear occurrence. CR #7, Figures 15, 16 and 17 illustrate RSF maps for the spring, summer and fall seasons. Average RSF values were calculated for the 10 BMUs in the RSA and for each of three seasons. Average ratings were also calculated for: the RSA as a whole; the Project mine permit area; the Project footprint area; and, the existing CVM permit area (Table E.7-8).

Table E.7-8 Average Seasonal Resource Selection Function Values by Bear Management Unit and Local Study Area

BMU/LSA/RSA	Spring RSF	Summer RSF	Fall RSF
Beaverdam	7.9	7.6	7.7
Embarras	7.0	6.5	6.5
Erith	4.7	4.7	4.7
Lambert	4.7	4.7	4.8
Lendrum	7.4	6.8	6.9
Lower Pembina	7.9	7.3	7.3
McLeod	8.2	7.5	7.4
McPherson	7.9	7.4	7.4
Raven	5.2	4.9	5.0
Upper Pembina	8.1	7.6	7.6
Entire RSA	6.9	6.5	6.9
Robb Trend LSA	7.2	6.8	6.9
Coal Valley Mine Permit	8.4	8.0	8.0

The Project LSA occurs in the Lendrum and Embarras BMUs. These two BMUs support average to low RSF values in a regional context (Table E.7-8). The Project mine permit area had RSF values that were higher than the regional average for spring and summer and the same for fall. The existing CVM permit area had the highest average RSF values for all seasons notwithstanding active mining taking place during the sampling period.

Mortality Risk

The FRIGBP has developed spatial models that map the relative probability of human caused grizzly bear mortality based on landscape variables. The models are based on regression analysis of 297 grizzly bear mortalities in the central Rockies ecosystem, and validated in other parts of Alberta. The primary input variable influencing mortality risk mapping is the distance to open motorized roads. CR #7, Figure 18 illustrates mortality risk mapping for the RSA based on 2010 deliverables from the FRIGBP. Darker tones on the map represent higher levels of mortality risk. Average values for baseline mortality risk were calculated for each BMU and CVM mine permit area (Table E.7-9). Mortality risk ranges from 1 (lowest) to 10 (highest).

Table E.7-9 Average Grizzly Bear Mortality Risk Values

BMU/LSA/RSA	Mortality Risk
Beaverdam	5.2
Embarras	6.5
Erith	7.3
Lambert	6.6
Lendrum	6.8
Lower Pembina	5.6
McLeod	6.3
McPherson	6.7
Raven	7.1
Upper Pembina	5.5
Entire RSA	6.1
Robb Trend LSA	6.9
Coal Valley Mine Permit	6.8

BMUs located in the eastern portion of the RSA supported the highest mortality risk values (Table E.7-9). These included Lendrum, McPherson, and Embarras. These BMUs support the highest density of open motorized linear features.

Habitat States Mapping

2010 deliverables from the FRIGBP include mapping of areas as sources or sinks for bears. Sinks are areas of high quality habitat with very high risk of mortality. Sources are areas where resource availability is high but mortality risk is low (Nielsen et al. 2009). These are calculated by combining RSF and mortality risk outputs. CR #7, Figure 19 provides a map of non-critical habitat, primary and secondary sinks and primary and secondary habitat (sources). Non-critical habitat includes areas where grizzly bear occurrence is rare and habitat is of low quality regardless of mortality risk. Primary and secondary habitats occur primarily along the western portion of the RSA at higher elevations where road densities are lower. The lower elevation eastern portions of the RSA support mainly non-critical and secondary sink habitats. The central portion of the RSA where the Project is proposed is dominated by secondary (34.9%) and primary (31.8%) sink habitats but also supports some primary (2.3%) and secondary (8.6%) source habitat. The reclaimed and active CVM permit area supports mainly primary sink habitat (61.7%) but does have some primary (7.6%) and secondary (8.6%) source habitat.

Use of the Mine Permit Areas by Radio-collared Grizzly Bears

A total of 16 grizzly bears (8F:8M) were located 962 times within the CVM permit area between 1999 and 2005. Seven (7) of these animals spent time in the permit area for more than one year with one bear spending 4 years, two bears for 3 years and four bears for 2 years. Kansas and Charlebois (2008) reported that of the 16 bears recorded within the CVM permit area from 1999 to 2005, 13 bears spent time (170 locations) within the boundaries of the CVM mine footprint – most of this in the reclaimed areas. Two bears –one adult male and one adult female-spent three and four years respectively on the CVM mine footprint. The CVM permit area supports one of the highest number of grizzly bear locations (6.2) per km^2 and was utilized by a large number of different bears relative to its small size. Kansas (2005) and Stevens and Duval (2005) reported a similar attraction of grizzly bears to the reclaimed Gregg River/Luscar mine block.

E.7.3 Potential Impacts

This assessment addresses five potential effects on wildlife habitat and populations including:

- increased mortality;
- habitat alteration;
- sensory disturbance and effective habitat loss;
- barriers to movement and
- habitat fragmentation.

E.7.3.1 Marten

Marten are listed as *Secure* by the Alberta Fish and Wildlife Division (2010). They are the most commonly trapped carnivore in the LSA and RSA and are an economically important species to registered fur trappers. They are a common species regionally and in the vicinity of the Project.

Increased Mortality

Local extirpations of marten can occur as a result of over-trapping (Thompson 1991). Although current trapping levels are unknown it is unlikely that with chronically suppressed fur prices that over-trapping is or will be occurring. Winter tracking surveys from 2007 to 2011 indicate normal to above-normal marten densities throughout the RSA. Trapping access will not improve materially as a result of the development of the proposed Project as no new open roads will be built. In fact, trapping access may deteriorate if the areas are closed to non-mine personnel. The development of the Project is unlikely to cause a material increase in direct marten mortality.

Habitat Alteration

Marten typically prefer mature and old growth conifer dominated forest for both breeding and foraging (Takats et al. 1999). However, viable marten populations can be maintained in early seral and second-growth forests (at reduced densities) where sufficient physical structure is present and when prey populations are high (Poole et al. 2004 and Payer and Harrison 2003; Hearn et al. 2010). There is evidence that marten will use and may even prefer early seral habitats if abundant coarse woody debris, visual cover and prey populations are present (Potvin et al. 1999).

High and very high suitability marten habitat in the RSA was considered to be comprised of moderate to dense canopy mature and old growth conifer forest, open old growth conifer and old growth mixedwood forest (Table E.7-3). At baseline, such habitats comprise 47.8% of the Project mine permit and 39.4% and 45.2% of the Embarras and Lendrum BMUs - the dominant watersheds surrounding the Project mine permit area. These current levels of high suitability late seral forest are within the ranges of 30% to 45% presented by Hearn et al. (2010) and Webb and Boyce (2009). Table E.7-10 shows projected changes in the supply of combined high and very high suitability marten habitat attributable to the Project after immediate construction.

Table E.7-10 Effects of the Project on High/Very High Suitability Marten Habitat Supply at 3 Time Periods

Time Period	Robb Trend LSA**	Embarras BMU	Lendrum BMU
T10 (10 years after Baseline)	-53.6%	-37.3%	-34.6%
T25 (25 years after Baseline)	-82.1%	-54.7%	-46.5%
T50 (50 years after Baseline)	-59.0%	-0.7%	9.4%

** Percentage of supply of High/Very High suitability habitat occurring at T10, T25 or T50

The development footprint of the Project 10 years after the start of mining alters 37.3% of the combined very high/high suitability marten habitat in the Embarras BMU and 34.6% of very high/high suitability marten habitat in the Lendrum BMU. Losses of high/very high marten habitat attributable to the Project amount from 54.7% to 46.5% after 25 years. At 50 years post-construction a minor loss of 0.7% is projected for the Embarras BMU and a gain of 9.4% for the Lendrum BMU. The increases in suitable marten habitat at 50 years is a result of increasing amounts of late seral closed coniferous and mixedwood forest resulting from natural succession

Sensory Disturbance

Marten are not known to be seriously affected by human presence unless excessive trapping and/or extensive forest fragmentation occurs (Buskirk and Ruggiero 1994). Mowat (2006) reported that neither road density nor logging appeared to affect marten habitat selection when variation in ecosystems and stand structure were accounted for. Cablk and Spaulding (2002) observed extensive use of active downhill skiing areas by marten in Colorado. In a detailed review of noise effects on wildlife AMEC (2005) noted that no direct evidence of noise impacts on marten were available. Zielinski et al. (2008) observed that vehicle activity at a level of 0.5 passes per hour did not affect marten occupancy or probability of detection in California. Based on the above it is concluded that marten will possibly avoid some high quality habitat during blasting and coal hauling during active mining, but this will be a short to medium-term effect with limited demographic consequences.

Movement Obstruction

Marten move across the landscape in a manner that optimizes food resources within their home range and minimizes predation risk (Buskirk and Ruggiero 1994; Cushman et a. 2011). Open areas that have no overstory are generally avoided (Spencer et al. 1983, Hargis and McCullogh 1984, Buskirk and Powell 1994; Godbout and Ouellet 2010; Cushman et al. 2011). In stands with sufficient understory, Payer and Harrison (2003) indicate that a regenerating forest becomes suitable for resident marten at 18 m^2/ha basal area with mean tree heights of 9 m. Marten will cross shrubby or sparsely treed stands with less basal area and height than indicated above although minimal height and density thresholds are not fully understood. Marten movements can be enhanced by linking open areas between forest stands with islands of forest cover and coarse woody debris (Soutiere 1979, Steventon and Major 1982). Kansas and Charlebois (2005) observed that riparian strips as narrow as 10 metres were used by marten in a first-pass timber harvest area in the southern Alberta foothills.

Marten movements will be limited on the Project mine site until regenerating forest cover re-establishes, likely sometime between 15 and 30 years post-reclamation. Retention of residual tree islands or riparian buffers at narrow portions of the Project will enhance marten movement in the interim. The movement obstruction effect will not differ significantly however from a clearcut or an intense fire especially if direct placement of soil and slash is conducted and shrubs are planted.

Habitat Fragmentation

Marten are adapted to and can tolerate a degree of habitat fragmentation within their home range. Potvin et al. (1999) suggested that marten will tolerate up to 50% cutover within the landscape but Poole et al. (2004) reported that this tolerance is more likely around 35% of their home ranges. Chapin et al. (1998) showed that marten tolerated a median of 20% regenerating timber clearcuts in their home ranges and maximum values were 40% and 31% for males and females respectively. Bissonette et al. (1989) and Hargis et al. (1999) recommended that the combination of timber harvests and natural openings comprise <25% of landscapes. Hearn et al. (2010) observed that marten persisted in an area with approximately 20% of regenerating forest.

The proposed Project will initially add another 3.2% to 6.9% of recently cleared forest to the Embarras and Lendrum BMUs. This amount of incremental regenerating forest leaves each of the affected BMUs at or slightly below thresholds for habitat fragmentation conducive to marten residence (*i.e.,* from 20% to 50%). Winter tracking surveys from 2007 to 2011 found that marten trail densities in areas with past timber harvest were as high or higher than in areas without timber harvest.

E.7.3.2 Fisher

Fishers are listed as Sensitive by the Alberta Fish and Wildlife Division (2010), and little is known of their ecology in the foothills of Alberta. They are an uncommon species in the RSA with occurrence linked to older mixedwood forests in the lower elevation eastern portions.

Increased Mortality

Anthropogenic death and predation appear to be the most important sources of mortality of fisher (Powell and Zielinski 1994). In un-trapped populations, predation and vehicle collisions are the most common forms of mortality of fisher. The primary sources of potential direct mortality of fisher from the proposed Project are: 1) increased trapping success due to improved access; and 2) motor vehicle collisions. Indirect mortality could result from increased coyote densities and related predation on fisher. Trapping access will not improve materially as a result of the development of the Project areas as no new open roads will be built. In fact, trapping access may deteriorate if the areas are closed to non-mine personnel. Vehicle collisions are likely based on research from other jurisdictions. Low traffic speeds (50 km/hr), limited high quality habitat supply, and inherently low use of linear features by fisher (Devon Canada 2010) will serve to partially mitigate vehicle collisions. Predation by coyotes may occur but effects on fisher populations are likely to be minor based on existing scientific literature.

Habitat Alteration

High and very high suitability fisher habitat in the RSA was considered to be comprised of old growth deciduous, mixedwood and conifer habitats with dense, moderate and open canopies (Table E.7-3). At baseline, such habitats comprise just 5.7% of the Project mine permit (LSA) and 5.2% and 3.1% of the Embarras and Lendrum BMUs - the watersheds surrounding the Project mine permit area. These low proportions reflect the current limited supply of old growth forests in the vicinity of the proposed Project. Table E.7-11 shows projected changes in the supply of combined high and very high suitability fisher habitat attributable to the Project. This was calculated by projecting vegetation cover and habitat supply over time with and without the Project.

Table E.7-11 Effects of the Project on High/Very High Suitability Fisher Habitat Supply at 3 Time Periods

Time Period	Robb Trend LSA**	Embarras BMU	Lendrum BMU
T10 (10 years after Baseline)	91.0%	-4.9%	456.0%
T25 (25 years after Baseline)	-21.1%	97.0%	370.0%
T50 (50 years after Baseline)	5.5%	273.0%	445.0%

** Percentage of supply of High/Very High suitability habitat occurring at T10, T25 or T50

An initial gain of 91% of fisher habitat is projected in the LSA for the first 10 years due to mature mixedwood forests shifting to old growth status (Table E.7-11). Additional land clearing then reduces high/very high suitability fisher habitat to approximately the same as baseline supply in T25 and T50. With reclamation of the Project and natural succession of existing habitats the amount of high/very high suitability fisher habitat at 50 years post construction is estimated to be higher by 5.5% than if mining had not occurred. These projections assume that no timber harvest or fire occurs in the LSA during the 50 years after construction.

Sensory Disturbance

Scientific understanding of fisher response to sensory disturbance is limited (Collister *et al.* 2003). A number of studies have shown that fishers avoid areas with considerable human disturbance. Seglund (1995) found that most fisher (83%) used rest sites that were further than 100 m from human disturbance. Dark (1997) observed that fishers foraged and rested in areas with less human activity. Powell and Zielinski (1994) reported that female fishers abandoned den sites as a result of human disturbance, yet also found that fishers in New England were not overly affected by adjacent human activity and actually denned nearby well-used roads and timber harvest activity. Devon Canada (2010) found that fishers in the boreal forest of northeastern Alberta did not avoid areas within 500 m of high use gravel roads, but did avoid active 3-D seismic development.

Potential sources of sensory disturbance on fisher from the Project are construction, blasting, and hauling of coal to the Plant. These activities have greatest potential to impact fisher in the vicinity of maternal den sites during April to June. Sensory disturbance impacts should be minor in a regional context because relatively little high and very high suitability fisher habitat occurs in the LSA and associated sub-watersheds.

Movement Obstruction

Fishers must find ways of moving between high quality habitat patches following natural or anthropogenic disturbances. Juvenile fishers must also be able to move from their natal range to establish ranges in adjacent areas. Large open areas may limit dispersal and population expansion of fisher (Powell and Zielinski 1994). It is likely that riparian areas are relied upon for movement and dispersal (Aubrey and Houston 1992). Use of unburned riparian strips for movement is likely the way in which fisher have evolved to re-colonize after large boreal fire events.

Similar to marten, fisher movements will be limited on and across the Project until regenerating forest cover re-establishes, likely sometime between 10 and 25 years post-reclamation. Retention of residual tree islands or riparian buffers at narrow portions of the Project will enhance fisher movement in the interim. The movement obstruction effect will not differ significantly however from a clearcut or an intense fire especially if direct placement of soil and slash is conducted and shrubs are planted.

Habitat Fragmentation

In the boreal forest old growth poplar and mixedwood forest habitat that is crucial for fisher maternal denning is inherently distributed in relatively small patches throughout the landscape (CR #7, Figure 8). High quality foraging habitat is more widely distributed and occurs in the form of densely stocked black spruce bogs, densely stocked post-fire pine stands and over-mature, closed canopy forest communities. Open fens and bogs, recent burns, recent clearcuts and early regeneration on mined lands are habitats that are generally avoided by fisher and occur in a variety of shapes and sizes on the landscape over space and time. Open areas are avoided because they make fishers more vulnerable to predation and tend to have deeper snow which is believed to make travel inefficient (Raine 1983, Powell 1993, Krohn *et al.* 1997). Preferred and avoided habitat patches are situated within a matrix of low to moderate quality habitat which are used by fisher for movement and foraging but of themselves could not likely sustain fisher populations over the long-term.

No quantitative analysis of the impact of habitat fragmentation on fisher was undertaken because there is insufficient information to predict fisher response to fragmentation. The proposed Project development will result in similar amounts of suitable fisher habitat over the 50 year life of Project in the context of the LSA. Sub-regional habitat supply will increase markedly because of natural vegetation succession without fire. Movements across the Project will be obstructed for the first 10 to 15 years. The demographic consequences of movement obstruction is unknown but should not be significant based on the fishers adaptation to fire impacts

E.7.3.3 Lynx

Lynx are listed as a Sensitive by the Alberta Fish and Wildlife Division (2010), meaning that it is a species not at risk of extinction or extirpation but that may require special attention to protect it from becoming at risk. Lynx were observed hunting and travelling in reclaimed mine vegetation.

Increased Mortality

Primary sources of lynx mortality are fur trapping, predation, starvation and cannibalism (Mowat et al. 2000). Levels of mortality from fur trapping and predation vary between study areas but are relatively constant in a particular area over medium time frames (10 to 15 years). Lynx populations are reliant on population levels of their main food source – snowshoe hare (Keim et al. 2011). Lynx mortality from starvation and cannibalism within a given population occurs at higher levels during cyclic snowshoe hare lows. Lynx populations fluctuate widely (15 to 20 times) because of a similar magnitude of hare population changes. The main reason for these fluctuations is not mortality per se but variation in recruitment (pregnancy rates and in-utero survival).

Hare population abundance and trapping level can influence survival rates of lynx. Starvation appears to be the most common natural cause of death. Lynx are killed by other predators including cougars, wolverines, wolves, coyotes and other lynx (Mowat et al. 2000, Aubrey et al. 2000). A recent coyote/lynx interaction study by Kolbe et al. (2007) observed that none of the 75 radio collared lynx marked during a 6-year lynx research project were killed by coyotes.

The main potential causes of lynx mortality arising from the Project are: 1) vehicle collisions from coal haul; and, 2) fur harvest. Unlike cougars, lynx are not a big game species in Alberta. Therefore, increased legal hunting pressure due to improved human access will not likely occur. Trapping of lynx is quota-based and recent lynx harvest has not been excessive. Trapping access will not improve materially as a result of the development of the Project. In fact, trapping access may deteriorate if the area is closed to non-mine personnel. Vehicle speeds are reduced on mines to <70 kph further reducing the likelihood of vehicle collisions. Overall, it is predicted that development of the Project is unlikely to cause an increase in direct lynx mortality.

Habitat Alteration

As is the case for most boreal wildlife species lynx have evolved and survived in the face of dynamic and unpredictably changing habitat structure and composition.

Very high suitability habitat for lynx in the RSA includes closed regenerating forest, dense mature conifer forest, and moderately closed conifer forest. Habitats with high suitability for lynx include open regenerating forest, dense and moderately close mixedwood forest, open coniferous forests and treed wetlands. At baseline the Project mine permit area (LSA) currently supports 19.1% of combined high/very high suitability lynx habitat, while the Embarras and Lendrum BMUs have 25.1% and 33.0% respectively.

Table E.7-12 shows projected changes in the supply of combined high and very high suitability lynx habitat in the Project mine permit area from baseline to +10 years, +25 years and +50 years. Projections take into account mine reclamation and natural vegetation succession. Supply changes are shown for the permit area (LSA) and the two BMUs that are most affected by the Project (Embarras and Lendrum).

Table E.7-12 Effects of the Project on High/Very High Suitability Lynx Habitat Supply at 3 Time Periods

Time Period	Robb Trend LSA**	Embarras BMU	Lendrum BMU
T10 (10 years after Baseline)	-8.0%	41.0%	13.0%
T25 (25 years after Baseline)	13.0%	228.0%	59.0%
T50 (50 years after Baseline)	379.0%	288.0%	187.0%

** Percentage of supply of High/Very High suitability habitat occurring at T10, T25 or T50

After the immediate maximum effect of construction, the losses of lynx habitat are predicted to be ameliorated over time by natural aging of existing forests and regeneration of forest on reclaimed lands. An initial loss of 8% of combined high/very high suitability lynx habitat will occur in the LSA after 10 years because of Project construction. Significant increases in the supply of high/very high suitability lynx habitat are projected to occur at T25 (13%) and T50 (379%). These projections assume that no timber harvest or fire occurs during the 50 years post-construction but take into account effective Project reclamation and natural vegetation succession. Succession of early post-seral clearcuts and Project reclamation to young forest with abundant hare populations are the main reasons for projected increases in quality lynx habitat.

Sensory Disturbance

Lynx are generally tolerant of human presence and activity (Staples 1995). They are easily captured by trappers, have little fear of human scent, respond to baits, and are attracted to visual lures (Mowat et al. 2000). Lynx will flee from the immediate presence of humans but this response dwindles somewhat during low hare abundance. Moderate levels of snowmobile activity do not seem to significantly affect lynx distribution or habitat use (Mowat et al. 2000, McKelvey et al. 2000). Lynx will likely temporarily avoid areas within the mine permit adjacent to active mining (blasting and active hauling). This effect will be short-term and will not likely persist beyond the actual period of the effect (*i.e.,* active mining).

Movement Obstruction

Free movement of individual lynx is necessary to access high quality food and security cover resources, provide escape routes from natural and anthropogenic catastrophes, and to promote exchange of genetic materials. All of these factors are important to the long-term persistence of meta-populations. Lynx are effective dispersers and their movement does not appear to be significantly affected by roads, trails, seismic lines, large rivers or lakes. Lynx movements will be limited on the mine site until medium to tall shrub or forest cover re-establishes, likely sometime between 10 and 25 years post-construction. Retention of residual tree islands or riparian buffers at narrow portions of the mine will enhance lynx movement. This effect will not differ significantly however from an intense fire especially if direct placement of soil and slash is conducted.

Habitat Fragmentation

Movement of lynx and food availability (competition from coyotes) are not expected to be affected seriously by proposed mining. Habitat quality is not affected substantively at the sub-regional or regional scale by the Project. Fragmentation related to the Project is thus not expected to affect wolf populations in the region.

E.7.3.4 Wolf

Wolves are a common species in the LSA and RSA. From 1985 to 2001, a total of 14 wolves were trapped within the three RFMAs that overlap the LSA. Wolves are not a listed species at risk in Alberta or nationally.

Increased Mortality

Primary potential sources of human-caused mortality of wolves in the LSA and RSA are fur trapping, hunting, and vehicle mortality. Demographic characteristics (*e.g.,* large litter size) allow grey wolf populations to recover well from numerical lows as compared to other carnivores such as cougars, grizzly bears and wolverines (Weaver et al. 1996). Project-specific mortality of wolves is predicted to be minimal because; hunting and the carrying of firearms is not permitted on the mine permit areas; and, vehicle traffic speeds on the mine and haul roads are limited to less than 70 kph.

Habitat Alteration

Wolf use of landscape is influenced most strongly by ungulate prey availability, snow depths and human use levels. Wolves prefer resting in open natural habitats with an open forest crown (allows light to enter) but with enough cover for protection from wind. These conditions also represent optimum habitat for ungulates such as mule deer and elk. Wolves may use forests altered by logging because these areas provided good deer habitat (important prey source) (Kuzyk et al 2004).

Table E.7-13 shows projected changes in the supply of combined high and very high suitability wolf habitat attributable to the Project at three time periods following Project development. Projections take into account mine reclamation and natural vegetation succession

Table E.7-13 Effects of the Project on High/Very High Suitability Wolf Habitat Supply at 3 Time Periods

Time Period	Robb Trend LSA**	Embarras BMU	Lendrum BMU
T10 (10 years after Baseline)	-56.0%	-50.0%	-39.0%
T25 (25 years after Baseline)	-14.0%	-64.0%	-37.0%
T50 (50 years after Baseline)	-69.0%	-68.0%	-25.0%

** Percentage of supply of High/Very High suitability habitat occurring at T10, T25 or T50

In the LSA high/very high suitability wolf habitat supply drops by 56% from baseline to T10. From T10 to T25 a gain occurs still leaving 14% less high/very high habitat than at baseline. At

T50 high/very high wolf habitat is 69% lower than at baseline. Losses in the Embarras and Lendrum BMUs are of a similar magnitude. Losses in high quality wolf habitat over the 50 year period are attributable to clearing from Project development, as well as natural aging and in-filling of dense stands of forest which offer lesser amounts of herbaceous forage for ungulate prey. These projections assume that no timber harvest or fire occurs during the 50 years post-construction but take into account natural vegetation succession. Losses are of a high magnitude. It is unknown to what extent this level of habitat alteration will affect wolf populations in the region surrounding the Project. Wolves are currently common in the CVM area in spite of 30 years of mining.

Sensory Disturbance

Wolves are not particularly prone to sensory disturbance as evidenced by their regular use of active roads and logging/mining areas.

Movement Obstruction

Grey wolves are wide ranging animals that in general are able to disperse across fragmented landscapes to occupy or reoccupy habitat provided they are not excessively trapped or shot. Wolves routinely travel through reclaimed mine lands in the Coal Branch region including the existing CVM in areas of little or no security cover. Wolves in the region utilize both low and high use roads as travel corridors. Movement obstruction associated with the Project is not a substantive issue affecting wolves in the local or regional area.

Habitat Fragmentation

Movements of wolves are not expected to be affected seriously by proposed mining. Habitat quality is not affected substantively at the sub-regional or regional scale by the Project. Fragmentation related to the Project is thus not expected to affect wolf populations in the region.

E.7.3.5 Grizzly Bear

Grizzly bears are listed as Special Concern nationally by COSEWIC (2011). In Alberta, the grizzly bear is listed as At Risk under the 2010 General Status evaluation and Threatened under the Wildlife Act (AFWD 2010). Grizzly bears are residents in the RSA at low population levels. A considerable amount of empirical research information related to the ecology and response to human land use of this species is available in the region.

Increased Mortality

Direct human-caused mortality, primarily licensed hunting and illegal and self-defence kills, is the factor most responsible for grizzly bear population declines in Alberta and elsewhere in North America (Servheen 1990, Mattson 1993, Alberta Grizzly Bear Recovery Team 2005, ASRD and ACA 2010). McLellan et al. (1999) determined that 77% to 85% of mortalities of radio-collared grizzly bears from 13 different studies were human-caused. Licensed hunting of grizzly bears in Alberta has been suspended since March 2006. Prior to the suspension of the grizzly hunt, licensed hunting accounted for approximately 52% of grizzly bear mortalities in Alberta between 1990 and 2003 (Alberta Grizzly Bear Recovery Team 2005).

Direct mortality of grizzly bears from the proposed Project is unlikely. Neither legal hunting nor firearms will be allowed within the Project mine permit area. There are no records of grizzly bear deaths (radio-collared or otherwise) on mine lands in the last 40+ years of active mining in the Coal Branch (Symbaluk 2008). This lack of mortalities on mine permit lands is likely the result of firearm restrictions and high levels of construction and operation activity dissuading illegal actions. Death of grizzly/brown bears from vehicle collisions normally occurs on high speed roads (>90 kph) (Gunther et al. 1998, Servheen et al. 1998, Clevenger et al. 2002, Kaczensky et al. 2003). Speed limits on CVM coal haul roads are less than 70 kph and will be the same on the Project mine permit area. Sources of domestic garbage at the CVM are contained in appropriate secure containers and transported to the licensed landfill in Hinton as per the Approval conditions. Problem bear actions at mines in the Coal Branch region are of extremely limited occurrence.

Habitat Alteration

Grizzly bears actively select habitats and foods that provide them with the greatest possible net digestible energy (Hamer and Herrero 1983, Pritchard and Robbins 1989). Mining and subsequent reclamation of the existing CVM has significantly changed landscape structure, composition and food production in the permit area for grizzly bears. Mining and reclamation at the CVM has resulted in removal of tree canopies, leading to increases in availability of high energy herbaceous plant material (clover, thistles, legumes) and an increase in ungulates (elk, deer) responding to increased forage and edge habitat. There is strong evidence to suggest that ungulates and plants used for reclamation are sought and used extensively by grizzly bears occurring in the vicinity of the CVM area. Similar findings were observed in the existing Luscar and Gregg River mines (Stevens and Duval 2005; Kansas and Symbaluk 2011). Bears using the reclaimed Luscar and Gregg River mine lands were on average larger than bears in an adjacent un-mined Subalpine and the Gregg/Luscar permit block was considered to be an attractive habitat for grizzly bears and a source for enhanced cub production (Kansas 2005). If similar reclamation measures are used on the Project then impacts on grizzly bears from a habitat alteration perspective will likely be positive within 10 years post-construction.

Sensory Disturbance/Movement Obstruction

Grizzly bears routinely used the mine permit footprint areas of the existing CVM between 1999 and 2005 (CR #7, Figure 11). A total of 16 grizzly bears (960 locations) occurred within the CVM permit area between 1999 and 2005. Eight of these animals spent time in the permit area for more than one year with one bear spending 4 years, two bears for 3 years and five bears for 2 years. The CVM permit area supports one of the highest number of grizzly bear locations (6.2) per km^2 and was utilized by a large number of different bears relative to its small size (CR #7, Section 4.5.4, Table 22). Of the 16 bears and 960 locations recorded within the CVM permit area 13 bears spent time (170 locations) within the boundaries of the mine footprint – most of this in the reclaimed areas (Kansas and Charlebois 2008).

Grizzly bears will likely be displaced from portions of the Project mine footprint and permit area during the active mining period. Displacement will result from construction noise and blasting. At some point shortly after reclamation grizzly bears will be attracted to the herbaceous forage and ungulates on the Project mine footprint as was observed on the Luscar, Gregg River and CVM reclaimed mine areas. The Project mine footprint is narrower than that of the mines which were readily crossed by grizzly bears. The mined lands will not act as a serious barrier to grizzly bears, with the possible exception of during active blasting and hauling.

E.7.4 CUMULATIVE EFFECTS ASSESSMENT

Within the LSA timber harvest, well sites and associated pipelines, and exploration for the mining Project are currently active. No logging is anticipated to occur in the LSA other than salvage of timber on the Project mine footprint. Well sites and pipelines will be relocated to accommodate the Project and further oil and gas production in the Project mine permit areas is not likely. Hunting is not allowed in the LSA. Therefore, cumulative effects were not considered at the scale of the LSA.

In the RSA the primary land uses that may add to and/or interact with Project effects to impact carnivore VECs include:

- timber harvest;
- mountain pine beetle harvest;
- petroleum exploration and development (pipelines, well sites, roads);
- other surface coal mines; and
- hunting and trapping.

The study area delineated for the assessment of cumulative effects on mammalian carnivore VECs is the same as the RSA. The RSA was based on the boundaries of existing BMUs from the Foothills Model Forest Grizzly Bear Project (Stenhouse and Munroe 2002). To assess the cumulative impacts of the project within the RSA, the following time periods were assessed and compared:

- T0 (baseline reflecting past timber harvest, transportation development, petroleum development and mining);
- T10 (Project maximum disturbance);
- T25 (regional maximum disturbance); and
- T50 (Project regional net impact).

The Project has potential to interact with other past, present and future land actions. Two basic kinds of potential interactions between the Project and past, present and planned future land actions include:

- Additive/Compounding Effects - Direct habitat alteration, fragmentation and sensory disturbance resulting from the Project's mine extension activities will add to similar effects from existing land uses in the RSA; and
- Interactive/Synergistic Effects - These are cumulative effects that can arise when the total effect of an interaction between two or more actions is greater than the sum of the effects of the individual actions (Peterson et al. 1987).

An effect was determined to be significant if the Project impacts, when added to effects of other existing and proposed land uses, were likely to exceed the assimilative capacity of a species. A significant cumulative effect is one that has already or would exceed established criteria of scientific effects thresholds associated with potential adverse effects, and as such result in a detectable change in biological, social or economic parameters beyond the range of natural variability.

E.7.4.1 Marten

Fur harvest, and large-scale habitat alteration and fragmentation are the effects most likely to result in marten population decline (CR#7, Table 32). Significant regional cumulative effects on marten populations could arise in two ways:

- Scenario #1. Loss of high quality marten habitat (older conifer forests) from clearcut timber harvest, pine beetle salvage and surface coal mining occurs at or beyond levels that trigger a regional decline in marten populations; and
- Scenario #2. Fur harvest levels increase to a point that is unsustainable in terms of marten populations.

Cumulative effects scenario #1 is not likely to occur for two main reasons. Firstly, several scientific studies conducted in North America have shown that marten will tolerate timber harvest levels of up to 50% in a landscape context and 35% in their home range. Harvest levels in the RSA at baseline average 20% and are at or below the 35% ‘threshold’ for all sub-watersheds (BMUs) in the RSA (CR #7, Section 5.3.1.5). Winter tracking in the RSA from 2007 to 2011 showed that marten trail densities were not reduced in logged areas.

Cumulative effects scenario #2 is also not likely to occur. Firstly marten fur harvest from RFMAs in the RSA is well within average values for the west-central foothills of Alberta. Maximum marten harvest levels in Alberta are established by Alberta Fish and Wildlife and these are sustainable based on the Secure status of this species. Pressures on marten populations from fur harvest are generally low at this point in time. Fur trapping levels declined by approximately 10% between 1977 and 1999 and average pelt values of four important species (lynx, marten, beaver and coyote) declined 70% during that same time period (Poole and Mowat 2001). Increased access associated with industrial development does not necessarily imply more fur harvest. In fact Mullen (2006) noted that active trap lines tended to support less access and fewer oil and gas wells and more old growth forest.

The combined effects of the Project and past, present and future land actions on marten populations are rated as insignificant.

E.7.4.2 Fisher

The greatest threats to regional fisher populations are habitat alteration at maternal denning sites and over-trapping (CR#7, Table 33). Significant cumulative effects on regional fisher populations could arise in two ways:

- Scenario #1. Fur harvest levels increase to a point that is unsustainable and leads to precipitous declines in fisher populations.

- Scenario #2. Loss of high quality maternal denning habitat (*i.e.,* old growth mixedwood forests) from timber harvest or mine reclamation practices that fail to re-establish deciduous trees.

Cumulative effects scenario #1 is unlikely to occur because fisher harvest is very low in the region and subject to quotas. The government can reduce quotas at any time if concerns over regional fisher occurrence or population density arise.

Cumulative effects scenario #2 is also not likely to occur. The supply of high/very high fisher habitat increases steadily over time with increases of 273% and 444% for the Embarras and Lendrum BMUs from baseline to T50 (Table E.7-11).

The combined effects of the Project and past, present and future land actions on fisher populations are rated as insignificant.

E.7.4.3 Lynx

The greatest threats to regional lynx populations are over-trapping, fire suppression and broad-scale effects on populations of their key prey – snowshoe hare (CR# 7, Table 34). Significant cumulative effects on regional lynx populations could arise in two ways:

- Scenario #1. Fur harvest levels increase to a point that is unsustainable and leads to precipitous declines in lynx populations.
- Scenario #2. Loss of high quality snowshoe hare and therefore lynx habitat (*i.e.,* densely stocked early successional conifer and conifer-dominated mixedwood forest) from fire suppression, clearcut timber harvest, pine beetle salvage and/or surface coal mining occurs at or beyond levels that trigger a regional decline in lynx populations.

Cumulative effects scenario #1 is unlikely to occur as Lynx fur harvest is regulated by the Alberta Fish and Wildlife Division through quotas and current (since mid-1980s) levels of lynx harvest in the RSA are low and reflect sustained low fur prices since the early 1980s (Mullen 2006). There is little evidence to conclude that lynx fur harvest will increase significantly in the future, given the inverse relationship between trapper activity and industrial land use levels described by Mullen (2006).

Cumulative effects scenario #2 is unlikely to occur as Lynx are dependent on densely stocked regenerating forests that produce optimum snowshoe hare densities. Planned timber harvest in the RSA will provide an optimal mix of regenerating forest and older forest that lynx need for forage and reproduction (denning). With mitigation surface coal mining will offer the same conditions. Habitat supply projections for lynx (Table E.7-12) predict that supply of high and very high quality lynx habitat will be maintained over time in the RSA in spite of planned timber harvest, beetle salvage and surface coal mining.

Based on the above evidence, the combined effects of the Project and past, present and future land actions on lynx populations are rated as insignificant.

E.7.4.4 Wolf

The greatest threats to regional wolf populations are human-caused mortality caused by legal and illegal hunting, fur harvest, and vehicle collisions (CR#7, Table 35). Wolves could also be affected by significant and large-scale regional declines in ungulate prey availability. Significant cumulative effects on regional wolf populations could arise in the following ways:

- Scenario #1. Road density and associated human use increases to a point ('threshold') where mortality of wolves exceeds the ability of the species to match mortality levels with reproduction.
- Scenario #2. Loss of high quality ungulate and therefore wolf habitat from fire suppression, clearcut timber harvest, pine beetle salvage and/or surface coal mining occurs at or beyond levels that trigger a regional decline in wolf populations.

Mortality of wolves through legal and illegal hunting, fur harvest, and vehicle collisions is influenced strongly by road access and human population density and associated road use levels in an area. Existing open road densities in the RSA (0.73 km/km^2) and in the BMUs that surround the Project area (Embarras - 0.85 km/km^2 and Lendrum - 0.88 km/km^2) are approaching or exceed published thresholds for wolf persistence. Human population densities in the greater Yellowhead County (22,304 km^2) and in the RSA (2,658 km^2) are however considerably lower than those reported by wolf researchers in the northern Great Lakes Region including Minnesota and Wisconsin. Based on the Alberta 2006 census the entire Yellowhead County, which includes two major population centers (Edson and Hinton), has a human population density of 0.5/km^2. The RSA population density is less than half of that of the Yellowhead County. In portions of Minnesota with human population densities of 4.0/km2, Fuller et al. (1992) reported threshold road densities of 0.7 km/km^2. Human population densities are an order of magnitude lower in the RSA than in Fuller et al's Minnesota study area. Given this, it is unlikely that cumulative effects scenario 1 is to occur as it is unlikely that existing road densities exceed thresholds that would lead to unacceptable wolf mortality levels.

Cumulative effects Scenario #2 has some potential to occur as high and very high suitability wolf habitat declines significantly in the RSA from baseline to T50 according to cumulative land use projections and ungulate habitat effectiveness and populations in the RSA are likely to decline over the 50 year period of assessment (Bighorn Environmental 2012). It is unknown to what extent projected decreases in ungulate prey and wolf habitat will impact wolf populations. Wolves have inherently high fecundity and in a region with low human population levels (*i.e.* low mortality risk) are very unlikely to be extirpated in the RSA.

The combined effects of the Project and past, present and future land actions on wolf populations are rated as insignificant.

E.7.4.5 Grizzly Bear

The greatest threat to regional grizzly bear populations is human-caused mortality caused by legal and illegal hunting, self-defence kills by ungulate hunters, and vehicle/train collisions (CR#7, Table 36). Any land use that results in increased access or use of access by individuals carrying firearms is a threat to grizzly bear population persistence. Any roads with vehicle speeds greater than 70 kph also have potential to result in increased grizzly bear mortality.

Significant cumulative effects on regional grizzly bear populations are most likely to express themselves in the following way:

- Scenario 1.Poaching, malicious killing, self-defence kills and vehicle collisions of and with grizzly bears continues to occur at a level in the RSA and greater Yellowhead region wherein mortality rates exceeds reproduction. This would most likely occur as a result of excessive motorized access levels and the ability to carry firearms and drive at high speeds in high quality habitat areas.

The causes and pathways of cumulative effects on grizzly bear mortality are both compounding and synergistic. Increasing open motorized road access is being used by humans leading to increasing probability of contact with grizzly bears. Such contacts are resulting in death of bears as indicated by the high percentage of radio-collared bears being killed. Probability of contact between humans and bears is highest in areas where attractive, high quality habitat overlaps with high road densities and potential for human occurrence (Nielsen et al. 2006). Examples of such areas include regenerating clearcut complexes and riparian vegetation along river valleys (Roever 2007), and surface coal mine permit areas (Stevens and Duval 2005, Kansas 2005). All of these areas support higher than average road densities.

In the case of regional and cumulative grizzly bear mortality, the proposed Project is unlikely to add significantly to regional mortality. This assertion is based on the fact that carrying of firearms in not permitted within any mine permit areas and traffic speed control is practiced. It is further supported by the fact that no grizzly bear mortalities have occurred on mine permit areas in 40+ years in the Coal Branch region (Symbaluk 2008). This does not diminish the seriousness of cumulative effects on grizzly bear mortality in the RSA and broader Yellowhead region.

E.7.5 MITIGATION AND MONITORING

E.7.5.1 Mitigation

In order to reduce potential impacts of the Project on mammalian carnivores CVRI will:

- incorporate select native trees and shrubs such as alder and willow into re-vegetation activities;
- maximize downed woody debris (stumps) through direct placement of top-soil and associated slash and stumps;
- maintain and connect to core areas as many residual forest patches as possible;
- maintain a 30 metre buffer zone of undisturbed natural habitat along well developed riparian corridors, where available;
- plant coniferous trees at higher stem densities (>180 stems per acre);
- continue to maintain hunting and firearm restrictions on the reclaimed areas of the Project including after mining has ceased and until hiding cover on the mines is equivalent to that of natural closed forest cover types.; and
- maintain haul truck and regular vehicle speeds of <70 kph.

E.7.5.2 Monitoring

In order to monitor the effectiveness of mitigation measures CVRI will:

- monitor the effectiveness of measures designed to increase understory cover (downed woody debris, shrubs, tree density) on reclaimed mine lands for marten, fisher and lynx;
- monitor response of marten, fisher lynx to existing and planned mine land reclamation using winter tracking techniques;
- determine if habitats required for fisher maternal denning occur on or immediately adjacent to the Project and assess their levels of use by fisher;
- monitor the effectiveness of establishing and maintaining hiding cover for grizzly bears near Project edges and adjacent to main roads;
- measure and monitor human use levels of linear features during summer, winter and fall (hunting) seasons. Assign this as a primary task of the 'bear warden' position. Use this data to design road closure plans;
- monitor the effectiveness of voluntary and enforced road closures including gating;
- monitor and study specific use of the existing CVM and proposed Project by grizzly bears. Investigate the extent to which existing mines in the region serve as attractive forage sources for grizzlies, and study implications for subregional mortality. Consider non-intrusive methods including DNA hair snagging; and
- continue long-term, multi-species winter monitoring of mammals (carnivores and prey) to regional habitat fragmentation using the tracking data conducted in 2007, 2009 and 2011 as a starting point.

E.7.6 SUMMARY OF VECs

Table E.7-14 summarizes ratings for impact types and VECs. Ratings were based on predicted post-mitigation (residual) conditions and successful implementation of mitigation. An effect was considered to be significant if it was not reversible over the medium to long-term, was of high magnitude and was likely to result in long-term impacts on regional or sub-regional population sustainability of the VEC. Significant impacts were also considered to influence the VEC in a manner far removed from that predicted on the basis of the natural range of variability.

All of the Project-specific impacts on VECs were predicted to be insignificant with respect to regional or sub-regional populations of the VECs considered.

Table E.7-14 Summary of Impact Significance on Mammalian Carnivore Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
1. Marten												
	Increased Mortality	Section E.7.5	Application	Local	Extended	Occasional	Reversible-LT	Low	Negative	High	Medium	Insignificant
			Cumulative	Regional	Extended	Occasional	Reversible-LT	Low	Negative	High	Medium	Insignificant
	Habitat Alteration		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	High	Negative	High	High	Insignificant
	Sensory Disturbance		Application	Regional	Long	Isolated	Reversible-ST	Low	Negative	Moderate	High	Insignificant
			Cumulative	Regional	Extended	Periodic	Reversible-ST	Low	Negative	Moderate	High	Insignificant
	Habitat Fragmentation		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	High	Negative	High	High	Insignificant
	Barriers to Movement		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
2. Fisher												
	Increased Mortality	Section E.7.5	Application	Local	Extended	Occasional	Reversible-LT	Low	Negative	High	Medium	Insignificant
			Cumulative	Regional	Extended	Occasional	Reversible-LT	Low	Negative	High	Medium	Insignificant
	Habitat Alteration		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Low	Negative	High	High	Insignificant
	Sensory Disturbance		Application	Regional	Long	Isolated	Reversible-ST	Moderate	Negative	Low	High	Insignificant
			Cumulative	Regional	Extended	Periodic	Reversible-ST	Low	Negative	Moderate	High	Insignificant
	Habitat Fragmentation		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Negative	Moderate	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Moderate	Negative	Low	High	Insignificant
	Barriers to Movement		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Negative	Moderate	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Moderate	Negative	Moderate	High	Insignificant

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3. Lynx												
	Increased Mortality	Section E.7.5	Application	Local	Extended	Occasional	Reversible-LT	Low	Negative	High	Medium	Insignificant
			Cumulative	Regional	Extended	Occasional	Reversible-LT	Low	Negative	High	Medium	Insignificant
	Habitat Alteration		Application	Local	Extended	Continuous	Reversible-LT	Low	Positive	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Low	Positive	High	High	Insignificant
	Sensory Disturbance		Application	Regional	Long	Isolated	Reversible-ST	Low	Negative	Moderate	High	Insignificant
			Cumulative	Regional	Extended	Periodic	Reversible-ST	Low	Negative	Moderate	High	Insignificant
	Habitat Fragmentation		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Moderate	Positive	High	High	Insignificant
	Barriers to Movement		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
4. Wolf												
	Increased Mortality	Section E.7.5	Application	Local	Extended	Occasional	Reversible-LT	Low	Negative	High	Medium	Insignificant
			Cumulative	Regional	Extended	Occasional	Reversible-LT	Low	Negative	Moderate	High	Insignificant
	Habitat Alteration		Application	Local	Extended	Continuous	Reversible-LT	High	Negative	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	High	Negative	High	High	Insignificant
	Sensory Disturbance		Application	Regional	Long	Isolated	Reversible-ST	Low	Negative	Moderate	High	Insignificant
			Cumulative	Regional	Extended	Periodic	Reversible-ST	Low	Negative	Moderate	High	Insignificant
	Habitat Fragmentation		Application	Local	Extended	Continuous	Reversible-LT	Low	Negative	High	Medium	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Low	Positive	Moderate	Medium	Insignificant
	Barriers to Movement		Application	Local	Extended	Continuous	Reversible-LT	Low	Negative	High	Medium	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Low	Negative	High	Medium	Insignificant

Table E.7-14 Summary of Impact Significance on Mammalian Carnivore Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
5. Grizzly Bear												
	Increased Mortality	Section E.7.5	Application	Local	Extended	Occasional	Reversible-LT	Low	Negative	High	Low	Insignificant
			Cumulative	Regional	Extended	Occasional	Reversible-LT	High	Negative	High	Medium	Significant
	Habitat Alteration		Application	Local	Extended	Continuous	Reversible-LT	Moderate	Positive	High	High	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Moderate	Negative	High	High	Insignificant
	Sensory Disturbance		Application	Regional	Long	Isolated	Reversible-ST	Low	Negative	High	Medium	Insignificant
			Cumulative	Regional	Extended	Periodic	Reversible-ST	Low	Negative	High	Medium	Insignificant
	Habitat Fragmentatio n		Application	Local	Extended	Continuous	Reversible-LT	Low	Negative	High	Low	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Low	Negative	High	Low	Insignificant
	Barriers to Movement		Application	Local	Long	Isolated	Reversible-LT	Low	Negative	High	Medium	Insignificant
			Cumulative	Regional	Extended	Continuous	Reversible-LT	Low	Negative	High	Medium	Insignificant

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant, Significant

E.8 NOISE

E.8.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of noise impacts for the proposed Project. The following section is a summary of the Noise Impact Assessment (NIA) that was prepared by aci Acoustical Consultants Inc. and is included as Consultant Report #8 (CR #8). For full details of the assessment, please refer to CR #8.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the noise component are provided in Section 3.1, and are as follows:

3.1 AIR QUALITY, CLIMATE AND NOISE

3.1.1 Baseline Information

[B] Provide representative baseline noise levels at receptor locations.

3.1.2 Impact Assessment

[C] Summarize the results of the noise assessment conducted for the ERCB and:

a) identify the nearest receptor used in the assessment; and

b) discuss the design, construction and operational factors to be incorporated into the Project to comply with the ERCB's Directive 38: Noise Control.

[D] Describe how air quality and noise impacts resulting from the Project will be mitigated.

The purpose was to generate a computer noise model of the Project under Application Case conditions and compare the resultant sound levels to the Alberta Energy Resources Conservation Board (ERCB) permissible sound level guidelines (Directive 038 on Noise Control, 2007).

The study area for the Project is located south-southwest of Edson, Alberta near the community of Robb (CR #8, Figure 1). Major roads in the area include Highway 47 coming from Edson and Highway 40 coming from Hinton. There is also a Rail line through the community of Robb, towards Edson. The only existing industrial noise sources in the area associated with CVRI are the Plant and existing mining operations at CVM several kilometres away from Robb and the Hanlan Robb Gas Plant, located approximately 11 km east of Robb.

Residential receptors in the area include two trappers cabins (located approximately 8.3 km southeast of the Plant and approximately 8 km northwest of Robb), and the community of Robb. All other trappers' cabins, campsites, *etc.* are more than 1.5 km beyond the Project mine permit boundary and have not been included in the study. This meets with the requirements of ERCB Directive 038.

E.8.2 BASELINE CONDITIONS

Given the relatively large distance between Robb, the current CVRI mining activities, and the Hanlan Gas Plant, which result below detectable noise levels, baseline noise monitoring was not conducted near Robb. This conforms to the requirements of D38.

Directive 038 requires the assessment to include background ambient noise levels in the model. As specified in Directive 038, in most rural areas of Alberta where there is an absence of industrial noise sources the average night-time ambient noise level is approximately 35 dBA. This is known as the average ambient sound level (ASL). For areas greater than 500 m from a heavily traveled road or rail line with a population density between 9 - 160 per quarter section (some of the Robb residents), the ASL is 38 dBA. For areas less than 500 m from a heavily traveled road or rail line with a population density between 9 - 160 per quarter section (the balance of the Robb residents), the ASL is 43 dBA. These ASL values were used as the ambient condition in the modeling with the various Project related noise sources added.

E.8.3 POTENTIAL IMPACTS

E.8.3.1 Noise Sources

The proposed mining operations involve using earth moving equipment (dozer, back hoe, trucks), a drill rig and explosives, and draglines. These operations occur during daytime and nighttime. The equipment and processes occur in different areas at different times throughout the life of the Project. To determine the effect of the Project on the surrounding noise climate, the following three scenarios were modeled to cover the mining activity in different locations:

- Scenario 1 which represents the highest possible noise levels within the community of Robb while the Project is operating at its closest distance to the northwest (CR#8, Figure 2);
- Scenario 2 which represents the highest possible noise levels within the community of Robb while the Project is operating at its closest distance to the southeast (CR#8, Figure 3); and
- Scenario 3 which represents the highest possible noise levels at a distance of 1,500 m from the mine permit boundary for mining activity because the two mining operations will be directly adjacent to each other (CR#8, Figure 4).

E.8.3.2 Permissible Sound Levels

ERCB Directive 038 on Noise Control sets the permissible sound level (PSL) at the receiver location based on population density and relative distances to heavily traveled roads and rails (CR #8, Table 1). In most instances, there is a basic sound level (BSL) of 40 dBA. The Robb residences, however, all have a population density between 9 - 160 dwellings per quarter section of land. For these receptors, the BSL increases to 43 dBA. In addition, many are within 500 m of the rail line which is heavily traveled during the night-time. For these receptors, the BSL increases to 48 dBA. In all cases, the BSL forms the PSL for the night-time while the day-time PSL is 10 dBA higher. Finally, D38 specifies that new facilities must meet a PSL-Night of 40 dBA at 1,500 m from the facility fence-line. The PSLs at a distance of 1,500 m are a L_{eq}Night of 40 dBA and a L_{eq}Day of 50 dBA.

E.8.3.3 Modelling Results

The computer noise modeling was conducted using the CADNA/A (version 4.2.139) software package. The computer noise modeling calculated sound levels in two ways:

- at the two trapper's cabins, the 48 receptors placed within the community of Robb and 61 theoretical receptors located 1,500 m from the mine permit boundary; and

- using a 50 m x 50 m receptor grid pattern within the entire study area and a more detailed 5 m x 5 m grid pattern within the community of Robb.

Scenario 1

The modeled night-time and day-time noise levels are under the PSLs with Project noise combined with the ASL values at all residential and theoretical 1,500 m receptor locations (CR #8, Table 2 and 3).

In addition to the broadband A-weighted (dBA) sound levels, modeling results at the residential and theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels at most locations (CR #8, Table 4 and 5). As specified in D38, if the dBC-dBA sound levels are less than 20 dB, noise is not considered to have a low frequency tonal component. For the locations with dBC-dBA sound levels greater than 20 dB, there are no residents nearby. The noise generated is generally not tonal in nature and is more broadband at the low frequencies. As a result, the possibility of a low frequency noise complaint is low.

Scenario 2

The modeled night-time and day-time noise levels are under the PSLs with Project noise combined with the ASL values at all residential and theoretical 1,500 m receptor locations (CR #8, Table 6 and 7).

In addition to the broadband A-weighted (dBA) sound levels, modeling results at the residential and theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels at most locations (CR #8, Table 8 and 9). As specified in D38, if the dBC-dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. For the locations with dBC-dBA sound levels greater than 20 dB, there are no residents nearby. The noise generated is generally not tonal in nature and is more broadband at the low frequencies. As a result, the possibility of a low frequency noise complaint is low.

Scenario 3

There are no differences between day-time and night-time operations for this scenario, so the noise levels will be the same day or night. The modeled night-time noise levels are under the PSLs with Project noise combined with the ASL values at all residential and theoretical 1,500 m receptor locations (CR #8, Table 10).

In addition to the broadband A-weighted (dBA) sound levels, the modeling results at the residential and theoretical 1,500 m receptor locations indicated C-weighted (dBC) sound levels will be less than 20 dB above the dBA sound levels at most locations (CR #8, Table 11). As specified in D38, if the dBC-dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. For the Robb residential locations with dBC-dBA sound levels greater than 20 dB, the modeled noise levels are very low (below 25 dBA) and will likely be in-audible. For the 1,500 m theoretical receptors with dBC-dBA sound levels greater than 20 dB, there are no residents nearby. The noise generated is generally not tonal in nature and is more broadband at the low frequencies. As a result, the possibility of a low frequency noise complaint is low.

E.8.4 Cumulative Effects Assessment

There are no other industrial noise sources within the study area and current CVM mining activities are a great enough distance from Robb that that noise levels are below detectable noise limits. Therefore, no cumulative effects modeling scenarios have been generated.

E.8.5 Mitigation and Monitoring

E.8.5.1 Mitigation

In order to reduce potential impacts of the Project due to noise CVRI will:

- conduct blasting on weekday afternoons;
- implement the utilization of smaller more localized blasts in order to reduce the amount of explosive used;
- maintain equipment in good working condition; and
- address noise concerns as they are raised by the community of Robb and implement additional mitigation measures as required.

E.8.5.2 Monitoring

In order to assess the effectiveness of mitigation measures CVRI will:

- conduct noise and vibration monitoring once mining begins to come close to Robb.

E.8.6 Summary of VECs

The noise modeling indicated noise levels below the respective PSLs at all of the residential receptors (trappers cabins and Robb residents) and at the theoretical 1,500 m receptors (1,500 m from the Project mine permit boundary). The noise modeling indicated that low frequency tonal noise is not anticipated for most of the receptor locations. There were some exceptions; however, the calculated noise levels for those situations were either well more than 5 dBA below the PSLs or in areas where there are no residents nearby. This results in a minimal possibility of any low frequency tonal noise concerns.

As the Project progresses towards Robb, CVRI will work with Robb residents in conducting noise and vibration monitoring and will implement further mitigation techniques as appropriate.

E.9 SOCIO-ECONOMIC IMPACT ASSESSMENT

E.9.1 Introduction and Terms of Reference

CVRI conducted a socio-economic assessment for the proposed Project. The following section is a summary of the Socio-Economic Impact Assessment (SEIA) that was prepared by Nichols Applied Management and is included as Consultant Report #9 (CR #9). For full details of the assessment, please refer to CR #9.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the socio-economic component are provided in Section 7, and are as follows:

7 SOCIO-ECONOMIC ASSESSMENT

7.1 Baseline Information

[A] Describe the existing socio-economic conditions in the region and in the communities in the region.

[B] Describe factors that may affect existing socio-economic conditions including:

- *a) population changes;*
- *b) CVRI's policies and programs regarding the use of regional and Alberta goods and services;*
- *c) workforce requirements for the Project, including a description of when peak activity periods will occur; and*
- *d) planned accommodations for the workforce for all stages of the Project.*

7.2 Impact Assessment

[A] Describe the socio-economic impacts of construction and operation of the Project, including:

- *a) impacts related to:*
  - *i) housing,*
  - *ii) recreational activities,*
  - *iii) hunting, fishing, trapping and gathering, and*
  - *iv) effects on First Nations and Métis (e.g., traditional land use and social and cultural implications);*
- *b) estimated total Project cost, including a breakdown for engineering and project management, equipment and materials, and labour for both construction and operation stages. Indicate the percentage of expenditures expected to occur in the region, Alberta, Canada outside of Alberta, and outside of Canada;*
- *c) impacts of the Project on the availability of affordable housing and the quality of health care services. Provide a summary of any discussions that have taken place with the local municipalities and the local environmental public health office of Alberta Health Services concerning housing availability and health care services respectively;*
- *d) the impact on local and regional infrastructure and community services, including consideration of municipal "hard services", education/training services, social services, urban and regional recreation services, law enforcement and emergency services; and*
- *e) municipal growth pressures as they relate to the Project and the need for additional Crown land to meet these needs.*

[B] Discuss options for mitigating impacts including:

- *a) CVRI's policies and programs regarding the use of regional and Alberta goods and services;*

b) plans to work with First Nations and Métis communities and groups and other local residents and businesses regarding employment, training needs, and other economic development opportunities arising from the Project;

c) the potential to avoid overlap with other Projects that are reasonably anticipated during all stages of the Project;

d) mitigation plans that will be undertaken to address issues related to the availability of affordable housing and the quality of health care services; and

e) strategies to mitigate socio-economic concerns raised by the local municipality and other stakeholders in the region.

The Project is not a new enterprise but an undertaking that will allow the continuation of an existing venture. Employment is expected to remain roughly constant to current levels, therefore, population and social conditions in the local or regional area are expected to stay fairly static.

A number of measurable parameters are used to assess the effects of the Project on communities in the study area, including:

- workforce;
- spending and employment;
- income;
- land use effects;
- population change, and its related effects on service providers and municipal physical infrastructure; and
- effects specific to local residents.

The parameters used to assess the Project's income and taxation consequences for governments are:

- municipal taxes;
- provincial resource royalty income; and
- federal corporate tax income.

For the purpose of the socio-economic analysis, the RSA includes Yellowhead County and the hamlets within its boundaries (including the Community of Robb), the Town of Edson; and the Town of Hinton.

Recognizing that much of the consultation input focuses on effects felt in close proximity to the CVM, the Local Study Area (LSA) is defined as the Project mine permit area and the Hamlet of Robb.

E.9.2 BASELINE CONDITIONS

E.9.2.1 Economy

The RSA economy is based on forestry, oil and gas and mining industries. The importance of industry to the regional economy is reflected in the composition of its labour force (CR #9, Table 2.1). Over one-quarter of the labour forces of Edson, Hinton and Yellowhead County work in trades, transport and equipment operation. Another 3-5% work directly in forestry, mining or oil and gas, while an additional 5-7% work in processing, manufacturing and utilities. Employment in these sectors is above the provincial average.

The community of Robb has its roots as an early 20th century mining camp, serving coal development in the region. Robb is a population centre linked to nearby industrial activity. The community of Robb's resident workforce is approximately 150. Forty (25%) are employed directly by CVRI, while the remaining 75% predominantly work in the forestry and energy sectors.

E.9.2.2 Population

The latest Federal Census data available indicates an RSA population of 28,584 (Statistics Canada 2011). The RSA population is fairly equally distributed between the Towns of Edson and Hinton and Yellowhead County (CR #9, Table 2.2). Depending on industry activity levels, the RSA can have a sizeable non-permanent population residing in the region. These workforces, present for periods of time, are accommodated primarily in area hotels and motels, and to a lesser extent in camp-based accommodations in Yellowhead County.

As of the 2006 Census (the most recent count available), the population of Robb was 190, remaining essentially unchanged from the 2001 census (StatsCan 2001, 2006). The population base is more stable than the provincial average, with 76% of census respondents indicating living in the same address for the previous 5 years, as opposed to the provincial average of 55%.

E.9.2.3 Housing

The region has a well-developed housing stock, estimated by the 2011 Federal Census at 12,550 dwellings. Compared to the provincial average, the RSA shows slightly higher ownership tenure than the province as a whole (77% versus 74%) and similar level of housing density (number of dwellings as a percentage of population) (StatsCan 2006). The housing stock in the region has increased by 1,230 units, or 11% in that past five years.

Housing in the region is more expensive now than it was in 2006, but prices remain lower than in other communities, like Edmonton (CR #9, Figure 2.1). Apartment rental rates are in line with other communities (CR #9, Table 2.3). The vacancy rate for Edson and Hinton was 10% in 2010, indicating availability of rental accommodation. It is lower than that seen in Grande Prairie (14%), but double that of Edmonton's rate (5%).

As per the 2006 Census, there are 85 private dwellings in Robb, spread out in three clusters within the hamlet boundaries (CR #9, Figure 2.2), of which approximately 95% are owner occupied and 5% are rented. There are a number of dwellings that are treated as vacation properties and occupied on a part-time basis.

E.9.2.4 Public Services

The RSA has a well-developed health and social service infrastructure. The majority of infrastructure and services are located in Edson and Hinton, which also services Yellowhead County residents (CR #9, Table 3.4). In the RSA, health, emergency and social service providers experience the mining sector, including the CVRI CVM, in the following ways:

- it offers stable, well-paying employment which tends to be filled by residents with families who stay long-term in the region, and form an important base as contributing community members;
- it generates some requirements for substance abuse treatment and family counselling, linked to shift demands including night/day changes; shift length and absences from home scene; and differences in days off versus other family members; and
- it creates comparable demand on social and health services as the forestry / wood processing sectors, and less demand than the energy sector, which has more transient and variable employment levels.

Edson and Hinton also have well-developed municipal infrastructure. Both communities are 100 years old, and report challenges regarding aging infrastructure and the current and future maintenance costs. In terms of current and future capacity for growth, the two towns report sufficient water, wastewater and sewage treatment capacity and adequate staffing levels (TOE, TOH, pers. comm., 2011a).

Yellowhead County delivers the following public services in the community of Robb:

- wastewater treatment, connected to residences in the northern half of the hamlet;
- a waste transfer station;
- a community hall and curling rink, constructed in 2007; and
- a fire hall, which is currently being expanded with additional truck bays, personnel and training space.

There is no municipal water system in the community of Robb. For all other services, Edson tends to be the service provider community due to proximity and a paved highway connection. Since the closure of the school in 1997, children have been bussed to Edson schools. Hinton serves as the secondary service community to Robb residents.

E.9.2.5 Land Use Pursuits

The Robb-Cadomin area is a popular destination for backcountry pursuits, including hiking, fishing, hunting and outfitting, ATV and horseback riding. There are a number of campsites in proximity to Robb, including Lovett, Fairfax Lake and Pembina Forks campsites located south and west of Robb on Highway 40 and the McLeod individual and group campsites located on the Robb road to Hinton.

There are a number of trap lines operated in the Robb region, owned and operated by both aboriginal and non-aboriginal persons. There is traditional land use in the region by a number of First Nations and Metis (Section E.12).

E.9.2.6 Current CVM Operation

Operations Employment

The CVM is one of the largest employers in the RSA, with 530 FTE employees working at the mine site. The CVM workforce is comprised of 403 (75%) hourly mine operators, machinists and mechanics and other support functions, and an additional 97 (18%) are management/supervisory, technical and administrative staff. The 530 employee workforce also includes 18 contract positions on-site as well as 34 summer and temporary positions, which together equate to 30 (6%) FTE positions. Mine activity also employs approximately 11 additional FTE positions offering technical, accounting, information technology and administrative support out of CVRI's and Sherritt's corporate office in Edmonton.

Two-thirds (330 or 66%) of the CVM's permanent workforce lives in Edson (CR #9, Table 3.1). An additional 70 (14%) live in Hinton, 40 (8%) live in Robb, and 20 (4%) live elsewhere in Yellowhead County, including the hamlets within its boundaries. In total 460, or 92% of the CVM direct workforce is resident to the RSA. An additional 40 workers (8%) live outside of the RSA. The majority of summer and temporary employees also live within the RSA.

Operations Expenditures

The CVM's current operation expenditures provide a stimulus to the local and provincial economies through wages and salaries paid to employees, the direct purchase of goods and services such as equipment, contract services and professional engineering services. Wage and procurement spending from the CVM circulates in the RSA and beyond, creating additional employment and income with suppliers, and in the general economy.

The CVM's total annual operating budget is in the order of $226 million per year (CR #9, Table 3.2). This represents production costs up to the facility gate. In addition to this, CVRI incurs additional rail, shipping and infrastructure costs required to bring the produced coal to market.

Approximately one-quarter of annual operating expenditures, or $54 million, is estimated to accrue to the RSA. This is overwhelmingly through wages paid to employees and contractors. Based on the residence pattern of employees, of the $53 million in local salaries and wages, an estimated $38 million accrues to Edson, $8 million to Hinton, $4.5 million to Robb, and an additional $2.3 million accrues elsewhere within the RSA.

Just over one-third (39%) of annual operating expenditures, or $88 million, is estimated to accrue elsewhere in the province. These expenditures are split roughly equally across machinery and equipment; tires, fuel and lubrication; and general services and infrastructure needs. Much of these expenditures accrue to the greater Edmonton area. In total, $142 million (63%) of CVM expenditures accrue to Alberta.

A further $23 million (10%) and $61 million (27%) is estimated to accrue to other parts of Canada and other countries, respectively. Approximately $46 million of annual operating spending represents capital expenditures, predominantly for purchases and leases of mining mobile equipment. Rail and port costs, head office expenses and royalty payments are additional to the annual operating expenditures.

Total Employment

In addition to the operations (direct) employment, the CVM's ongoing operation has employment effects on suppliers of goods and services (indirect employment) and employment effects from spending on general goods and services in the economy by employees and suppliers (induced employment). The combined direct, indirect and induced employment effect of CVM activities is estimated to be 1,435 person-years of employment in Alberta. The direct workforce represents full time jobs. The balance of indirect and induced employment equates to a variety of full-time and part-time equivalent positions across a variety of businesses.

Total Income

Operations expenditures constitute income for contractors, suppliers and workers, who in turn, spend part of their income on supplies and services, compounding the income effects of the CVM operation. Table E.9-1 presents the estimated direct, indirect and induced GDP and household income effects to the province of the CVM's operational expenditures, based on published statistics (AFE 2011).

Table E.9-1 Mine Operations Total Income Effects

Expenditure (Annual $millions)	Direct Effects	GDP	Household Income
Mine Operations	226	230	109

Royalties and Taxes

CVRI pays roughly $2.8 million annually in royalties to the Government of Alberta, as the owner of the coal resource at CVM. Royalty payments fluctuate year by year, depending on the particular classifications of land leases being mined and mining volumes achieved.

In 2010 the CVRI paid $500,000 in municipal property and education taxes to Yellowhead County for the CVM operation. This represents roughly 1% of all property and education taxes collected by YellowheadCounty.

In addition to property tax and royalty payments, the mining operation also generates corporate and personal income taxes for the provincial and federal governments.

Community Investment

In 2010, CVRI donated approximately $250,000 in cash and in-kind support to local communities. Examples of initiatives, events and groups supported include:

- in-kind work donated towards construction of the Robb community multiplex, donation of a barbeque and awning to a local recreation group; and
- assistance to the minor hockey association, Kinsmen Club, and Habitat for Humanity.

CRVI is in discussion with Robb residents regarding financial assistance to the outdoor skating rink.

E.9.3 POTENTIAL IMPACTS

The Project maintains the current operations, and represents virtually no effects to the current state of the RSA. Local Project effects include effects of operation on local residents, users of affected lands, and local roadways.

E.9.3.1 Local Resident Effects

The Project will result in active mining in closer proximity to the community of Robb than is the case with existing operations. Normal effects from operations, such as dust, noise and vibrations, are expected to be experienced more acutely by residents during these years. Mining equipment and landscape changes may be visible from some areas of the community.

The landscape disturbance will be obviously visible for a one to two year period after the end of mining activity until replanted grass coverage appears at the beginning of the reclamation process. The Project will not result in the displacement of any residences.

While mining is not scheduled to occur on both sides of the community of Robb concurrently, active mining will be taking place in proximity to the community over a number of years. Planned mitigation measures are expected to decrease, but not eliminate noise, dust, visual and vibration effects experienced by Robb residents in this timeframe.

The effects are expected to be short-term in nature (for the one-to-three year period when mining is in close proximity to either side of Robb). The visual effects will be medium-term, changing over time as reclamation moves from early vegetation planting to tree growth.

E.9.3.2 Property Values

The residual noise, dust, visual, and vibration effects of the Project are expected to have an effect on property values in the community of Robb. The effect will be limited but not negated by the fact that Robb's current population is overwhelmingly linked to industry in the area and that noise, dust, visual, and vibration effects from mining are common occurrences in Robb and environs.

Economic literature of the property value effects linked to industrial activity (*e.g.,* de Vor and de Groot 2009, Boxall et al. 2005) supports the observations above. Studies suggest:

- a negative price effect on property values, of between 5% and 8%, which dissipates as the distance from the industrial site increases; and
- employment creation linked to the industrial activity can temper, or override negative property value effects associated with the Project.

This offsetting effect is explained by the desire of individuals to live within a reasonable commuting distance to their job, thereby increasing demand for local properties. Increased local wages due to project employment may also cause upward pressure on housing prices near a project.

Although the property value effect of the Project is expected to be negative during the period of mining activity close to Robb, actual prices will be influences by other effects as well.

Unmitigated, the Project is expected to have a short term negative effect on property values during the period when active mining takes place is in proximity to the community of Robb. Property prices are not expected to be affected before and after the period of mining near Robb.

E.9.3.3 Local Roadways & Traffic

The Project will result in the relocation of an approximate 6 km section of the Robb Road, owned and operated by West Fraser. The gravel surface high-grade road, open to public use, provides a connection between Hinton and Robb and sees roughly 500 vehicle movements daily. The current mine plan indicates mining of roadway lands will begin in 2028, removing the existing segment of the roadway from use. CVRI will relocate a section of the Robb Road on a roughly parallel alignment to minimize disruptions and ensure safety.

Over the Project timeline, a number of other smaller resource roads will be closed and rerouted due to mining activity. Closure and reopening of local resource roads has been part of the operating procedure for the CVM since its inception. CVRI will continue discussions with other industry users and Yellowhead County officials to determine viable options for minimizing inconveniences and ensuring continued safety for those using the local transportation network.

The mitigation and management measures outlined are expected to minimize any residual effect of the road network.

E.9.4 Cumulative Effects Assessment

Other existing and planned activities in the region include:

- the Vista and Vista South Coal Projects currently proposed by Coalspur Mines Ltd.;
- the existing Obed Mountain Mine operated by CVRI;
- upgrading of the West Fraser Hinton Wood Products wood mill and pulp mill;
- oil and gas activity such as the Suncor Hanlan-Robb gas plant, along with a number of wells in the region and various wells and one gas plant operated by Tourmaline Oil Corp.;
- construction of the Edson Healthcare Centre;
- power distribution projects such as the AltaLink electrical system upgrades and an Alberta Electric System Operator electrical system upgrade;
- the Alberta Transportation Robb Road paving project, near Hinton; and
- the Alberta Transportation paving project of a segment of Highway 40, north of Highway 16, in 2012.

The current picture of cumulative planned activity, based on publicly-available information, suggests an period of increased activity in the region Observations from key community respondents and 2010 well drilling data suggest the energy sector is increasing activity levels above those seen in the post-2008 recession period. Much of the proposed activity is representative of activity typically seen in the region. The new Coalspur Mine, if it proceeds, would represent a substantial uplift in mining activity and related employment and possibly population growth. Closure of the Obed Mountain Mine, if occurred, would serve to dampen but not negate this effect.

E.9.5 MITIGATION AND MONITORING

In order to ensure the local economy and people benefit from the Project, CVRI will continue existing employment and contracting practices. CVRI will continue with the following:

- ongoing inter-industry cooperation with forestry and energy companies building on current working relationships;
- designing the mine plan to avoid active mining on both sides of Robb concurrently and minimizing the duration of development nearest the community;
- continuing the use of dust reduction strategies, such as watering of haul roads;
- using of noise reduction strategies such as lowered night-time activity, use of alternates to equipment horns and alarms;
- continue present monitoring of blasting vibration and noise levels in Robb. Monitoring will also include dust and groundwater supply and quality;
- consideration of inherent advantages of vendors located in or near operating areas when contracting for goods and services;
- continued participation in community involvement initiatives.

E.9.6 SUMMARY

Approval of the Project will ensure the continuation of the following economic impacts:

- the provision of employing 490 RSA residents in well-paying jobs;
- spending an additional $85 million over a six-year period in site preparation and support infrastructure;
- annual mine operations spending amounts to $226 million, of which $54 million is spent in the RSA, primarily in the form of direct wages and salaries;
- the generation of $230 million to provincial GDP and $109 million in provincial household income every year;
- the generation of approximately $2.8 million annually in royalties to the Province of Alberta and municipal tax payments of $500,000; and
- the support of local RSA events and initiatives through community investment funding, donating about $250,000 annually.

The Project represents continued operations of the CVRI CVM, which in its 35 year existence has been an integral part of the RSA. The RSA, and especially the Robb area, has been host to mining for over 100 years.

Whereas the Project ensures the continuation of the CVM until 2038 the absence of the Project will see a reduction of production by 2013 and complete closure soon after. This would mean layoff of the current workforce, except a limited number of positions continuing for additional years of reclamation activity. Over time, the end of operations would result in the loss of 530 direct, permanent and contract jobs. All other effects of the CVM on the region would also cease by 2018. These include the approximately $54 million of annual spending in the RSA; the associated procurement, tax and royalty payments and contribution to GDP to Yellowhead Country, Alberta and elsewhere.

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E.10 SOIL RESOURCES

E.10.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted a soil and terrain assessment for the proposed Project. The following section is a summary of the Soil Resources report that was prepared by CHERNIPESKI Soil Consulting Ltd. and is included as Consultant Report #10 (CR #10). For full details of the assessment, please refer to CR #10.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the soil and terrain component are provided in Section 3.9, and are as follows:

3.9 TERRAIN AND SOILS

3.9.1 Baseline Information

[A] Provide descriptions and maps of the terrain and soils conditions, including:

- *a) surficial geology and topography;*
- *b) soil types and their distribution. Provide an ecological context to the soil resource by supplying a soil survey report and maps to Survey Intensity Level 2 for the Project Area;*
- *c) suitability and availability of soils within the Project Area for reclamation;*
- *d) soils that could be affected by the Project; and*
- *e) descriptions and locations of erosion sensitive soils.*

3.9.2 Impact Assessment

[A] Describe Project activities and other related issues that could affect soil quality (e.g., compaction, contaminants) and:

- *a) indicate the amount (ha) of surface disturbance from mine, overburden disposal, reclamation material stockpiles, infrastructure (e.g., pipelines, power lines, access roads), aggregate and borrow sites, construction camps, waste disposal and other construction and operation activities;*
- *b) describe potential sources of soil contamination;*
- *c) describe the impact of the Project on soil types and reclamation suitability and the approximate volume of soil materials for reclamation. Discuss any constraints or limitations to achieving vegetation/habitat reclamation based on anticipated soil conditions (e.g., compaction, contaminants, salinity, soil moisture, nutrient depletion, erosion, etc.); and*
- *d) discuss the potential for soil erosion during the life of the Project.*

[B] Discuss the potential impact of the Project (including blasting, excavation and tunneling) on slope stability.

[C] Discuss the potential impacts caused by the mulching and storage of woody debris considering, but not limited to vulnerability to fire, degradation of soil quality, increased footprint, etc.

[D] Provide a mitigation plan including:

a) possible measures to minimize surface disturbance including the use of existing clearings for the Project;

b) possible actions to mitigate effects of any constraint or limitation to habitat reclamation such as compaction, contaminants, salinity, soil moisture, erosion, nutrient regime, etc.;

c) possible actions to address impacts to land capability; and

d) any other measures to reduce or eliminate the potential impacts that the Project may have on soil capability and/or quality.

The soil assessment report provides the soil and terrain inventory for Project, an assessment of effects the Project might have on the soil and terrain resources based on the Project development and reclamation plan; and soil conservation and reclamation recommendations to mitigate those effects.

The RSA used for the soil assessment corresponds with the proposed mine permit boundary and the LSA corresponds to the Project footprint (CR #10, Figure 1).

The VEC's were identified as a result of the soil and terrain inventory and input from the public; from governments; and from other Project team members. VECs related to soil resources include:

- the soil resource (including topsoil) and the natural diversity of the soil landscapes;
- land capability for preferred land uses plus future productivity; and
- soil and surficial geologic materials have normal concentrations of trace elements.

E.10.2 Baseline Conditions

The soil inventory methods employed followed current procedures and protocol used in Alberta and described in various manuals and handbooks including the *Canada-Alberta Soil Inventory Project Procedures Manual* (Nikiforuk 1995), the *Canadian System of Soil Classification* (Soil Classification Working Group 1998), the *Soil Survey Handbook* (Expert Committee on Soil Survey 1987), and the *Canada Soil Information System Manual for Describing Soils in the Field* (Expert Committee on Soil Survey 1982).

Soils were investigated at 1350 inspection points (CR#10, Figures 2a to 2f). An additional 328 soil inspections are located in close proximity to the RSA. A baseline of available soil resources to a depth of 1 m of the surface was prepared using soil landscape mapping combined with laboratory analysis of samples collected from 59 soil profiles to characterize soil suitability for re-vegetation.

E.10.2.1 Soil Landscape Models

Mapping was completed at two different scales in response to planning needs. The RSA was mapped at a Survey Intensity Level 2 at a scale of 1:10,000. The LSA was mapped at an operational scale of 1:5,000 using a higher level of survey intensity.

Soil landscape models (Nikiforuk 1995) are the equivalent of "soil map units" (Expert Committee on Soil Survey 1987). The soil landscape models have been stratified and labelled by terrain type to correlate soils and terrain (landform) inventories (CR #10, Section 3). The aerial distribution of terrain types and soil landscapes within the RSA is summarized in Table E.10-1 and shown on CR#10, Figure 3a to 3f.

Table E.10-1 Distribution of Soil Landscape Models in the RSA

Model [1]	Landform	Drainage	Soil Quality Rating[2] by Organic, A, B & C Horizon (thickness in cm)[3]	Area (ha)	Proportion (%)
Fluvial Terrain					
F1	Fluvial: a, b, t	Poor	Organic: Good (0-40) A: Poor (0-20) B: Good (15-43) & Fair (0-50) & Poor (42) C: Good (28-63) & Fair (10-75) & Poor (17)	236.3	1.7
F2	Fluvial: t, v Moraine or Saprolite	Poor	Organic: Good (0-35) A: Poor (0-20) B: Fair (0-32) C: Good (28-63) & Fair (25-100)	78.3	0.6
F3	Fluvial: t, b	Poor	Organic: Good (0-15) A: Poor (0-26) B: Good (20-36) & Fair (0-20) C: Good (50-65) & Fair (92) & Poor (56-100)	42.2	0.3
F4	Fluvial: v, t	Poor	Organic: - A: Poor (0-6) B: Good (0-15) C: Good (90) & Poor (81)	7.3	0.1
F5	Fluvial: v, b, t	Imperfect to Well	Organic: - A: Fair (0-22) B: Fair (0-53) C: Fair (35-97) & Poor (83)	130	1.0
F6	Fluvial: v, b, t	Well	Organic: - A: Fair (0-22) B: Fair (0-39) C: Fair (35-97) & Poor (83)	115.5	0.9
Subtotal				**609.6**	**4.6**
Glaciofluvial Terrain					
G1	Glaciofluvial: v, b Moraine or Glaciolacustrine	Well to Moderately well	Organic: - A: Poor (2-24) B: Fair (12-46) C: Fair (30-75) & Poor (44)	136.2	1.0
G5	Glaciofluvial: v, b Moraine	Imperfect	Organic: - A: Poor (25) B: Fair (15) C: Fair (55)	7.8	0.1
G6	Glaciofluvial: v Moraine	Poor	Organic: Good (18) A: Poor (3) B: Fair (18) C: Fair (61)	12.3	0.1
Subtotal				**156.3**	**1.2**

Table E.10-1 Distribution of Soil Landscape Models in the RSA

Model [1]	Landform	Drainage	Soil Quality Rating[2] by Organic, A, B & C Horizon (thickness in cm)[3]	Area (ha)	Proportion (%)
Glaciolacustrine Terrain					
L1	Glaciolacustrine: v-b Moraine: b, u	Moderately well	Organic: - A: Poor (5-30) B: Fair (20-54) & Poor (28-55) C: Fair (20-63) & Poor (30-50)	1513.4	11.2
L2	Glaciolacustrine: v-b Moraine: b	Well to Moderately well	Organic: - A: Poor (3-20) B: Fair (20-30) C: Fair (50-74)	47.6	0.4
L3	Glaciolacustrine: v Softrock	Moderately well	Organic: A: Poor (19-25) B: Fair (34-46) C: Good (30) & Fair (20)	6.7	0.0
L4	Glaciolacustrine: v Bedrock	Moderately well	Organic: - A: Poor (10-13) B: Fair (29-40) C: Fair (15-38)	15.4	0.1
L5	Glaciolacustrine: v, b Moraine b, u	Imperfect	Organic: - A: Poor (3-49) B: Fair (13-42) & Poor (24-56) C: Fair (30-76) & Poor (25-60)	3758.3	27.7
L6	Glaciolacustrine: v, b Moriane: b, I, u	Poor	Organic: Good (0-40) A: Poor (0-30) B: Good (21-30) & Fair(0-49) & Poor(20-30) C: Good(35-60) & Fair(20-63) &Poor(30-80)	192.4	1.4
Subtotal				**5533.8**	**40.8**
Moraine Terrain					
M1	Moraine: b, i, r, u	Moderately well	Organic: - A: Fair (5-35) B: Fair (10-46) & Poor (22-34) C: Good (45-60) & Fair (25-65) & Poor (50)	3435.2	25.4
M2	Moraine: v Saprolite or Bedrock	Moderately well	Organic: - A: Fair (10-29) & Poor (2-23) B: Fair (15-42) C: Good (14) & Fair (0-65) & Poor (23-58)	795	5.9
M3	Moraine: b, i, r	Well	Organic: - A: Fair (0-23) & Poor (14) B: Fair (17-63) C: Fair (22-70)	343.1	2.5
M4	Moraine: v Saprolite or Bedrock	Well	Organic: - A: Poor (0-32) B: Fair (14-35) C: fair (0-65)	532.1	3.9
M5	Moraine: b, v Softrock	Imperfect	Organic: - A: Poor (0-33) B: Fair (18-47) & Poor (41) C: Good (30-53) & Fair (30-63)	274.1	2.0

Table E.10-1 Distribution of Soil Landscape Models in the RSA					
Model (1)	**Landform**	**Drainage**	**Soil Quality Rating(2) by Organic, A, B & C Horizon (thickness in cm)(3)**	**Area (ha)**	**Proportion (%)**
M6	Moraine: b, i	Poor	Organic: Good (0-40) A: Fair (0-30) B: Fair (0-47) C: Good (60-95) & Fair (15-95) & Poor (90)	107.5	0.8
Subtotal				**5487**	**40.5**
Organic Terrain					
O1	Organic: blanket	Very poor	Organic: Good (100) A: - B: - C: -	468	3.5
O2	Organic: v-b Fluvial, Glaciolacustrine or Moraine	Very poor	Organic: Good (45-100) A: - B: - C: Fair (6-55) & Poor (5-50)	352.6	2.6
O4	Organic: b	Very poor	Organic: Good (100) A: - B: - C: -	202.1	1.5
Subtotal				**1022.7**	**7.6**
Saprolite Terrain					
S1	Saprolite: v Bedrock: r	Well	Organc: - A: Poor (0-6) B: Fair (19) & Poor (46) C: Poor (0-44)	135	1.0
S2	Saprolite: b, r, i	Moderately well	Organic: - A: Poor (6-16) B: Fair (14-29) C: Fair (67) & Poor (50-65)	23.1	0.2
S3	Saprolite: v, b Bedrock: i, r	Well	Organic: - A: Poor (5-40) B: Fair (0-30) C: Fair (30-62) & Poor (24)	120.7	0.9
S4	Saprolite: b, i, r	Moderately well	Organic: - A: Poor (0-17) B: Fair (15-50) C: fair (46-65)	35	0.3
S5	Saprolite: r	Moderately well to Imperfect	Organic: - A: Poor (8-21) B: Fair (21-36) & Poor (16) C: Fair (42-60) & Poor (36-55)	104.2	0.8
Subtotal				**418**	**3.2**
Other					
BD	Beaver Dam	-	Not Rated	0.6	0.0
DL	Disturbed Land	-	Not Rated	18.6	0.1

Table E.10-1 Distribution of Soil Landscape Models in the RSA

Model [1]	Landform	Drainage	Soil Quality Rating[2] by Organic, A, B & C Horizon (thickness in cm)[3]	Area (ha)	Proportion (%)
GP	Gravel Pit	-	Not Rated	2.5	0.0
OW	Open Water	-	Not Rated	2.7	0.0
PT	Pit (open mine)	-	Not Rated	5.7	0.0
RB1	Rough Broken 1		Not Rated	4.2	0.0
RB2	Rough Broken 2	-	Not Rated	85.3	0.6
RD	Road	-	Not Rated	176.7	1.3
SP	Spoil	-	Not Rated	14	0.1
WS	Well Site	-	Not Rated	11	0.1
Subtotal				**321.3**	**2.2**
Total				**13548.7**	**100**

(1) Soil model characteristics are described in CR #10, Table 1.
(2) Ratings for East Slope root zone material (after ASAC, 1987)
(3) Depth of soil rating is based on investigation to 100 cm.

Soils on Fluvial Terrain

Fluvial sediments generally consist of silts, sands and gravel with a minor fraction of clay. They have been deposited by moving water and are therefore well to moderately well-sorted and stratified (Soil Classification Working Group 1998). Landforms are typically stream channels and floodplains with moderately fine to coarse textured, Gleysolic soils, subject to periodic flooding. Landforms also include terraces with Regosolic, Brunisolic and Luvisolic soils.

Soils on Glaciofluvial Terrain

Glaciofluvial sediments are typically low in clay content, being sandy and even silty, and are well sorted and stratified. They were deposited by moving water and have accumulated from suspension in fresh standing water, or have accumulated at lake margins through wave action (Soil Classification Working Group 1998). Landforms vary from veneers and blankets overlying glaciolacustrine or till and are typically undulating to rolling.

The soils are typically (Orthic or Eluviated) Eutric Brunisols on moderately well to well drained slope positions. Gleyed Luvisolic soils occupy imperfectly drained slope positions while poorly drained areas have Gleysolic soils.

Soils on Glaciolacustrine Terrain

Glaciolacustrine sediments are typically high in clay content, but may also be silty or sandy, and are well sorted and stratified. They were deposited on lakebeds from suspension in fresh standing water, or have accumulated at lake margins through wave action (Soil Classification Working Group 1998). Landforms vary from veneers and blankets to undulating, rolling, ridged and inclined. Glaciolacustrine landforms are largely controlled by the underlying till and bedrock topography.

The soils are typically (Brunisolic or Orthic) Gray Luvisols and (Orthic or Eluviated) Eutric Brunisols on moderately well to well drained slope positions. Gleyed Luvisolic soils occupy imperfectly drained slope positions while poorly drained areas have Gleysolic soils.

<u>Soils on Morainal Terrain</u>

Morainal deposits are generally non-stratified, being composed of a heterogeneous mixture of particle sizes (sand, silt and clay) that has been transported and deposited by glacier movement with little modification (Soil Classification Working Group 1998). Within the valleys, thick blanket deposits usually have undulating to rolling landforms. Some ridges are also composed of thick morainal deposits while veneers overlying saprolite and bedrock material with ridged and inclined landforms are more common.

The soils are typically (Brunisolic or Orthic) Gray Luvisols and (Orthic or Eluviated) Eutric Brunisols on moderately well to well drained slope positions. Gleyed Luvisolic soils occupy imperfectly drained slope positions while poorly drained areas have Gleysolic soils.

<u>Soils on Organic Terrain</u>

Organic materials are peat deposits composed of sphagnum and forest peat typical of bogs, and sedge peat typical of fens. Sphagnum and forest peat typically has a high fibre content and are quite acidic, being isolated from nutrient-rich ground water. Sedge peat typically has a lower fibre content and is near neutral through close association with mineral rich ground water (Soil Classification Working Group 1998). Typical organic landforms are veneer and blankets overlying glacial material. Organic soils in the area are Mesisols and Humisols (and a few Fibrisols) occurring as bogs, fens or transitions between fens and bogs.

<u>Soils on Saprolite Terrain</u>

Saprolite materials are soft, weathered sandstone and mudstone deposits that usually have a high proportion of residual silts and clays (Soil Classification Working Group 1998). These materials are sometimes referred to as residual (adjective) or residuum (noun). The rock has weathered in a coherent state, with very little movement. Typical landforms are ridge crests and steep escarpments associated with more resistant sandstones, and valleys associated with softer shales and mudstones.

Soils on saprolite terrain are mostly Eutric Brunisols and Brunisolic Gray Luvisols developed on medium to fine textured sediments. Coarse textured saprolite material is also present; having Eutric Brunisol or Brunisolic Gray Luvisolic soils. These soils can also be lithic (shallow bedrock) and have high coarse fragment content.

E.10.2.3 Soil Suitability

Current environmental regulations require that disturbed land be returned to equivalent land capability. To meet this requirement, foothills coal mines salvage and replace surface soil on disturbed areas. Site conditions and soil samples collected during the soil survey are used to identify suitable sources of reclamation material as a guide to material handling during salvage.

The suitability of baseline soil materials are rated according to criteria set by the Alberta Soils Advisory Committee for evaluating the suitability of root zone material in the Eastern Slopes

Region (CR #10, Table 3). Ratings are divided into three categories of suitability (Good, Fair and Poor) and one category indicating that the soil material is unsuitable as a rooting medium.

Soil suitability ratings are based on soil inspection data and on laboratory results of sampled soils. Table E.10-1 summarizes the baseline soil types together with quality and depth of soil horizon material available for salvage and reclamation in the LSA. Table E.10-1 shows that baseline (undisturbed/pre-mine) soil conditions have natural limitations for reclamation suitability. The distribution of soil quality and depth by horizon is illustrated in CR #10, Figure 4a to f.

E.10.2.4 Evaluation of Soil Erosion Potential

Soil erosion hazard is the rate and amount of soil loss, by water and/or wind, which may be expected in an area following unmitigated removal of the protective vegetation cover. The rate of erosion depends on several factors:

- the amount, intensity, and seasonal distribution of rainfall or snowmelt;
- the steepness and length of slopes;
- the absence or presence of channels of concentration;
- the type of vegetation cover; and
- the nature of the soil.

Infiltration capacity and structure stability are two important soil characteristics influencing erosion by water. Particle size, durability of surface clods, rock fragments, organic matter and lime content are important soil characteristics influencing erosion by wind.

The soil landscape units encountered have been rated for potential erosion hazard by water and wind and are summarized in Table E.10-2 and shown on CR#10, Figures 5 and 6. Ratings were determined using the modified universal soil loss equation according to Tajek et al (1985). According to Coote and Pettapiece (1989) the risk of soil erosion by wind is generally negligible in the LSA; exposed ridges, however, can be windswept and actively eroded by wind and water.

Table E.10-2 Potential for Soil Erosion by Water and Wind

Soil Landscape Model	Erodability (K value)	Topography Class	Slope Factor (LS value)	Potential Soil Erosion Class	
				Water	Wind
G1	0.053	3 4 5 6 >6	0.75 2.5 5 13	Slight Slight Moderate High Severe	Moderate
G5	0.063	5	5	Moderate	Low
G6	0.020	5 6	5 13	Slight Moderate	Low
L1 + L3 + L4	0.072	3 4 5 >5	0.75 2.5 5 13	Slight Slight to Moderate Moderate to High Severe	High

Table E.10-2 Potential for Soil Erosion by Water and Wind

Soil Landscape Model	Erodability (K value)	Topography Class	Slope Factor (LS value)	Potential Soil Erosion Class	
				Water	Wind
L2 + L5	0.053	3 4 5 6 >6	0.75 2.5 5 13	Slight Slight Moderate High Severe	L2 = Moderate L5 = Low
L6	0.020	3 4 5 6	0.75 2.5 5 13	Slight Slight Slight Moderate	Low
M1 + M2	0.072	3 4 5 6 >6	0.75 2.5 5 13	Slight Slight to Moderate Moderate – High High Severe	High
M3+M4+M5	0.053	3 4 5 6 >6	0.75 2.5 5 13	Slight Slight Moderate High Severe	M3&M4 = Mod M5 = Low
M6	0.020	3 4 5 6	0.75 2.5 5 13	Slight Slight Slight Moderate	Low
O1 + O2 + O4	-	-	-	Not Rated	Not Rated
S1 + S2	0.053	6 >6	13	High Severe	Moderate
S3 + S4	0.063	5 6 >6	5 13	Moderate Severe Severe	Moderate
S5	0.072	4 5 6 >6	2.5 5 13	Slight to Moderate Moderate – High High Severe	High

Assumptions for erosion by water: slope length = 150 metres and soil cover factor = 0.05 (an over-estimation).
Additional Notes:

Fluvial landscapes can accumulate sediments and are categorized as having a High potential for soil erosion by water.
Fluvial landscapes are categorized as having a Low potential for soil erson by wind.
Rough Broken landscapes are categorized as having a Severe potential for soil erosion by water.
Rough Broken landscapes are categorized as having a Moderate potential for soil erosion by wind.

E.10.2.5 Overburden Assessment

Overburden is considered in this assessment to include all geologic material below the surface soil profile and above the coal seam being mined. A truck and shovel operation or a dragline is used to remove the overburden (soft or blasted, shattered bedrock). After the overburden material is excavated from above, between, and below the coal seams, it is termed “spoil”. The spoil is hauled to a disposal site where it is end-dumped resulting in a sorting by size (larger rocks roll further down slope) or dumped by the dragline which also results in sorting by size. Spoil materials derived from different bedrock layers are mixed in a dump or backfill as a result of the excavation, dumping and recontouring activities. Surface soils are usually more suitable as a post-mine rootzone material than the spoil materials and therefore soils are salvaged and later spread as a coversoil over re-contoured spoil as part of soil reclamation.

A total of 128 overburden samples (mostly bedrock) from fourteen test holes (CR #10, Figure 8) were collected by CVM and analysed for texture, carbonate content, detailed salinity and metals (CR #10, Table 8). The samples submitted represent the various geologic units that will form the spoil such as sandstone, siltstone, shale, mudstone, bentonitic clays and interbedded units. Spoil that forms the deep rootzone of the reclaimed land's minesoils will usually be a mixture of bedrock units. Previous evaluations of CVM spoil and minesoil characteristics have been reported by Knapik (1984), Knapik and Rosentreter (1999), Knapik and Chernipeski (1999), McGrath (2001), Chernipeski (2005), Arregoces and Leskiw (2007) and Chernipeski (2008).

It is important to recognize the effects of climate, site factors, minesoil construction practice, re-vegetation management, and animal and human use in addition to spoil effects on minesoil quality in a reclaimed landscape. Possible effects of overburden characteristics cannot be viewed in isolation.

Soil reaction (measured as pH of a soil-water paste) serves as an indicator of chemical conditions that influence nutrient availability, soil organism activity, and spoil weathering. The pH of bedrock cores from the Project study area range from 6.0 to 10.3 and more than 50% of samples are rated as Poor quality to Unsuitable. The material tends to be strongly alkaline in nature. However, experience at CVM shows the pH of spoil materials decreases quickly with weathering and the pH of minesoil subsoil layers (reclaimed spoil) is typically in the 6 to 7.5 range. A high pH subsoil material in a minesoil profile is not considered to be a serious detriment to establishing and maintaining grass vegetation.

The lime content of soil influences properties such as pH and availability of nutrients. The lime content of the Project overburden ranges from 0.8 to 22 percent. After mixing during removal and dumping, mean lime content of newly mined, surface spoil will be approximately 1 to 5 percent (Fair quality), which will not be a severe limitation for plant growth. Exposed spoil will weather when leached by rain (weak carbonic acid) and, therefore, reduce the lime content in the near-surface spoil. The result will be minesoils with neutral to weakly calcareous subsoil.

Salinity is typically not a problem in the Coal Valley area due to the non-marine nature of the geology. The EC of bedrock samples from the Project ranges from 0.5 to 5.7 dS/ (Good to Fair quality) with a mean EC of 1.2 dS/m indicating Good quality. Salinity is not a limiting factor for suitability of the Project spoil as a rooting medium.

In the LSA, the SAR of Val d'Or overburden is generally less than 2 (Good quality) except for occasional samples in the range of 4.1 to 6.6 (Fair quality) and two samples of 8.0 and 8.7 (Poor quality). The non-sodic overburden samples were generally collected within 12 to 49 m of the surface. Mynheer overburden is known to be sodic and occurs at depth within the LSA where SAR values greater than 12 (Unsuitable quality) is typical. Mynheer overburden is expected to produce spoil having a high SAR. SAR of exposed spoil at the CVM is known to be reduced quickly (few years) with weathering. Minesoils with a high SAR in the subsoil/rootzone will support grass vegetation but are limiting for trees and shrubs. Any efforts to keep sodic spoil material buried in a dump or pit will reduce adverse effects on vegetation. Another part of the CVM management practice is to sample surface spoil prior to coversoil placement to identify potential sodic spoil and to plan for an effective reclamation practice.

Water content at saturation of overburden samples from the Project ranged from 11 to 152 percent. Results show that unconsolidated surface material and bedrock associated with the Val d'Or seam has water content at saturation of less than 60% indicating Good to Fair quality. Overburden associated with the Mynheer seam has a wide range of water content at saturation, including all values greater than 80% (Poor quality). In general, test results indicate that water content at saturation is slightly lower in sandstone overburden and slightly higher in siltstone and shale overburden.

Rock and coarse fragment content can limit the suitability of spoil as a rooting medium. The degree of limitation is often variable, and is related to handling history as well as lithology of the overburden. The resistant sandstone beds of the Saunders Group will produce the most persistent rock and coarse fragments while the softer sandstones, siltstones and shales will produce mostly fines. No limitations from rock or coarse fragment content were encountered at the CVM (Knapik and Rosentreter 1999). No limitations from rock or coarse fragment content are expected at the Project as mining will occur in the same geologic material.

Due to the high occurrence of sandstone within the Val d'Or overburden, the most likely result will be a coarse textured spoil – predicted to be sandy loam to loamy sand. Siltstone and mudstone associated with the Mynheer overburden is predicted to have a finer textured spoil. At the existing CVM, when sandstone and mudstone are broken up, spoil was found to be medium to moderately coarse textured (Knapik and Rosentreter 1999).

Baseline concentrations of 15 trace elements were reported and compared to background levels for crustal abundance, Alberta tills and agricultural land, and to guidelines provided by CCME and AEW (CR #10, Table 9). In the Project overburden, the mean concentration of all trace elements studied is in the typical range for agricultural soils, crustal values and Alberta tills, including guidelines provided by CCME and AEW. A few maximum values exceed normally reported ranges.

Part of the CVM operating approval terms and conditions from AEW is that, prior to surface soil replacement, 1.0 m of suitable overburden be achieved on at least 85% of the area based on a 1 hectare area. Suitable overburden means overburden, spoil, or regolith which has an EC less than 5 dS/m, a SAR less than 8, and a pH less than or equal to 8.0. In effect, AEW has ordered that essentially Good and Fair quality overburden is to become part of the minesoil rootzone. Overburden associated with the Mynheer seam is not suitable for use within 1 m of the surface prior to replacement of salvaged soil because of high SAR and pH.

E.10.3 POTENTIAL IMPACTS

The soil resource is a VEC, and it should not be degraded in quality, buried or wasted. There is potential for loss of this resource as a result of surface mining and related activities. The soil resource can be lost or degraded in several ways:

- disturbance of natural soil profile and landscape;

- burial of soil;
- mixing of soil;
- erosion;
- loss of diversity; and
- loss of land capability.

E.10.3.1 Effect by Disturbance

During the mining phase there is complete disruption of the natural soil profiles and soil landscapes. The complete disruption to the soil lasts for approximately five to ten years (short-term). Mitigation and protection of the soil resource in a surface mine operation is achieved by minimizing disturbance, and salvage of surface soil and construction of post-mining terrain.

Salvaged soil will be used as coversoil to build new soils (minesoils). Minesoil profiles and minesoil landscapes will be built to satisfy the soil-function requirements of planned vegetation habitats, which are located to suit geomorphic landscape positions and land use needs. The structure of minesoil landscapes will be designed to be similar to pre-mine soil landscapes by having wet and dry soils, soils with concave and convex surfaces, grassland soils, and forest soils. The minesoil landscapes will also be designed to be compatible with the biophysical reclamation units within the mine area.

The minesoil profiles will have different structure from pre-mine soils, and this difference will lessen over time. The main differences are:

- changes in soil horizons (layering) and in properties of horizons;
- changes in spatial distribution and diversity of soils in the three dimensional landscape; and
- an initial increase in upland soils suitable for grassland vegetation.

While minesoil profiles and landscapes will not have the exact same structure as pre-mine soils they can be expected to function adequately and very similarly to the existing reclaimed soils at the CVM (Knapik and Rosentreter 1999). As soil development processes work over time the initial minesoil profiles will change in response to organic additions, to leaching by rainwater, to soil animal activity, and to other inputs. The initial minesoil profiles, with grassland soil characteristics, may continue as grassland soils or will develop into forest soils or wetland soils depending on site location and re-vegetation treatments.

The impacts on soil resources due to disturbance will be insignificant after mitigation.

E.10.3.2 Effect by Burial of Soil

Areas where the soils are too wet or the slopes are too steep to allow salvage of surface soil will not have soils salvaged. This lost volume of soil will be mitigated by salvaging to greater than minimum depths in places where soil quality is suitable. The net adverse effect on volume or quality of soil stockpiled for reclamation is expected to be insignificant.

E.10.3.3 Effect by Mixing Soils

Soils will be salvaged in a one lift operation which results in mixing of soil horizons. Soils from different soil landscapes are subject to mixing in the stockpile and further mixing occurs during placement. The result is a blended surface soil material which is placed as coversoil on levelled (or shaped) spoil.

The forest soils typical of the mine disturbance area do not exhibit a strong decrease in quality with depth. Salvaging some or most of the B horizon with the duff and Ae/Bm horizon will have a neutral or positive effect on soil quality. Prescribed salvage depths will avoid soil layers that are detrimental to surface soil quality.

Impacts due to mixing of the soil are insignificant.

E.10.3.4 Effect by Erosion of Minesoils

Erosion of placed coversoil material can occur until the soil surface is stabilized with vegetation cover. Several effective mitigation procedures that can be employed are:

- shaping of the post-mine geomorphic landscape to reduce slope steepness and slope length;
- building terraced, rolling, ridged, and hummocky surface forms to reduce overland flow rates and distance;
- placement of coversoil on concave land surfaces and leaving a rough loose soil surface to reduce the erosion potential to a low risk level; and
- establish a fast-growing grassy cover in the first growing season to limit the time the soil surface is exposed.

With the use of appropriate and available technology there is low risk for accelerated erosion of coversoil. The net loss of soil resources through erosion is insignificant.

E.10.3.5 Effect by Loss of Diversity

The planned reclamation approach (Section F) will provide for considerable landscape and ecological diversity. Shaping the minescape to have several surface forms and building different minesoil profiles in appropriate landscape positions will provide diversity at the landscape level. Using soil profile building techniques that leave rough soil surfaces with variable soil thickness will provide diversity at the profile level. Vegetation management will influence site diversity and encourage diversity of soil development conditions. The reclamation plan is intended to provide for ecological diversity; the post reclamation landscape will not have large homogeneous areas. Inclusion of lowlands for development into wetlands and water bodies in the post-mining landscape will increase landscape diversity.

E.10.3.6 Loss of Land Capability

The post-mine landscape, minesoils, and vegetation are designed to meet stated end land use goals which are based on the integrated resource management plan (Section F). Based on experiences at the existing CVM there will be changes in land capability at specific locations, but overall, will be similar to pre-mine capability. The post-reclamation landscape will have a variety of slopes and aspects and a variety of ridges, benches and valleys – similar to the pre-mine landscape. A number of lakes/ponds are planned, each with a littoral zone (<3m water) to operate as a wetland. Conversion of a terrestrial landscape to one containing lakes is a residual effect that is not reversible with time. The effect is also cumulative as lakes are being added to the landscape at the existing CVM. However, adding lakes to the landscape enhances diversity and is an acceptable and positive land use change at the CVM.

Land use capability of a surface mine area is lost during active mining. Minesoil landscapes (surface form) and minesoil profile (soil layer thickness) are developed immediately. Early pioneering attributes can be developed over 1 to 3 years (grass cover, tree seedlings) and early succession attributes take 5 to 20 years or longer to develop (nutrient cycling, native plant invasion, wildlife hiding cover, forest stands). The environmental effect of achieving equivalent capability is local and of short to extended duration. Ecological processes will reverse the effects with time.

E.10.4 Cumulative Effects Assessment

No other projects have been announced within the RSA therefore a cumulative effects assessment was not conducted.

E.10.5 Mitigation and Monitoring

E.10.5.1 Mitigation

In order to reduce potential impacts of the Project on soil resources CVRI will:

- plan to minimize overall disturbance;
- utilize direct placement of surface soil whenever practical;
- salvage suitable coversoil where possible;
- salvage to greater than minimum depths in places where soil quality is suitable;
- plan to provide rough surfaces with topographical diversity in order to promote ecological diversity and minimize large homogeneous areas;
- design post-mine landscapes, minesoils and vegetation with consideration of end land use goals;
- take steps to reduce erosion such as building terraced, rolling, ridged, and hummocky surface forms (reducing overland flow rates and distance) to reduce erosion potential;
- implement sampling of surface spoil prior to coversoil placement to identify potential sodic spoil;
- not use sodic overburden associated with the Mynheer coal seam within 1 m of the surface prior to replacement of salvaged soil;
- plan to create a variety of landscapes and soil types;
- leave a rough but loose soil surface to reduce erosion potential to a low risk level;
- leave soil surfaces with variable soil thickness, where possible, to provide diversity at the profile level; and
- implement further erosion control measures once coversoil has been replaced.

E.10.5.2 Monitoring

In order to assess the effectiveness of mitigation measures CVRI will:

- implement sampling of areas recontoured with overburden salvaged from areas over the Mynheer coal seam to determine presence of sodic spoil material; and
- monitor reclaimed areas for erosion.

E.10.6 SUMMARY OF VECS

Surface mining will completely disrupt the natural terrain and natural soil landscapes and will be mitigated by reclamation (Section F). Reclamation is the creation of new terrain (minescapes) and new soil landscapes (minesoil landscapes) followed by re-vegetation.

A summary of potential environmental effects, planned mitigation, residual effects and significance is presented in Table E.10-3.

Table E.10-3 Summary of Impact Significance on Soil & Terrain Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
SOILS												
Disruption of natural soil landscapes		Soil salvage and reclamation of soil landscapes	Project	local 5,729 ha	short	continuous	reversible (long term)	high	negative	high	high	insignificant
			Residual	local 5,729 ha	residual	continuous	reversible (long term)	low	neutral	high	high	insignificant
			Cumulative	local 5,729 ha	residual	continuous	reversible (long term)	low	neutral	high	high	insignificant
Loss of non-salvageable soil		Salvage best quality soil	Project	local 5,729 ha	short	isolated	irreversible	low	negative	high	high	insignificant
			Residual	No residual effects noted								insignificant
			Cumulative	No cumulative effects noted								insignificant
Change in soil quality by mixing during salvage			Project	local 5,729 ha	short	periodic	reversible (long term)	low	neutral	high	high	insignificant
			Residual	local 5,729 ha	residual	continuous	reversible (long term)	low	neutral	high	high	insignificant
			Cumulative	No cumulative effects noted								insignificant
Accelerated erosion of minesoils causes loss of soil resource		Design and construct for erosion control	Project	local 5,729 ha	short	isolated	reversible (long term)	low	neutral	high	high	insignificant
			Residual	local 5,729 ha	residual	isolated	reversible (long term)	low	neutral	high	high	insignificant
			Cumulative	No cumulative effects noted								insignificant
Loss of soil landscape diversity		Build minesoil diversity	Project	local 5,729 ha	extended	continuous	reversible (long term)	low	neutral	high	high	insignificant
			Residual	No residual effects noted								insignificant
			Cumulative	No cumulative effects noted								insignificant

Table E.10-3 Summary of Impact Significance on Soil & Terrain Valued Environmental Components

VEC Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
LAND CAPABILITY											
Loss of land capability and future production	Reclaim to meet land use goals	Project	local 5,729 ha	short	continuous	reversible	moderate	negative	high	high	insignificant
		Residual	local 5,729 ha	extended	continuous	reversible	moderate	neutral	high	high	insignificant
		Cumulative	local 5,729 ha	extended	continuous	reversible	moderate	neutral	high	high	insignificant
Delay in returning capability and diversity	Successional reclamation	Project	local 5,729	short	continuous	reversible	moderate	negative	high	high	insignificant
		Residual	local 5,729 ha	extended	isolated	reversible	moderate	neutral	high	high	insignificant
		Cumulative	No cumulative effects noted								insignificant
Climate change causes increased moisture deficits	None required	Project	No project effects noted								insignificant
OVERBURDEN CHARACTERISTICS											
Increased trace element concentrations	Not adverse effects – no mitigation required	Project	No project effects noted								insignificant

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant, Significant

E.11 SURFACE WATER QUALITY

E.11.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of surface water quality for the proposed Project. The following section is a summary of the Surface Water Quality Impact Assessment that was prepared by Hatfield Consultants and is included as Consultant Report #11 (CR #11). For full details of the assessment, please refer to CR #11.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the surface water quality component are provided in Section 3.4, and are as follows:

3.4 SURFACE WATER QUALITY

3.4.1 Baseline Information

[A] Describe the baseline water quality of watercourses and waterbodies. Discuss the effects of seasonal variations, flow and other factors on water quality.

3.4.2 Impact Assessment

[A] Identify Project components that may influence or impact surface water quality.

[B] Describe the potential impacts of the Project on surface water quality:

- *a) discuss any changes in water quality resulting from the Project including impacts on drinking water quality;*
- *b) discuss the significance of any impacts on water quality and implications to aquatic resources (e.g., biota, biodiversity and habitat);*
- *c) discuss seasonal variation and potential impacts on surface water quality; and*
- *d) discuss the effect of changes in surface runoff or groundwater discharge on water quality in surface waterbodies.*

[C] Describe proposed mitigation measures to maintain surface water quality at all stages of the Project.

Surface water quality is the VEC considered in this assessment. Surface water quality issues to be considered in the assessment were obtained from results of the public consultation program (Section G), information obtained from the Traditional Environmental Knowledge (TEK) and Traditional Land Use (TLU) study (Section E.12), scope of previous assessments at CVM, and a review of the Project mine plans (Section C). Issues to considered include:

- soil erosion, sediments entering streams via surface runoff, increased sedimentation of surface waters;
- leaching of nitrates into surface waters;
- discharges of water from impoundments to natural watercourses; and
- effects on end-pit lakes on surface water quality.

The Local Study Area (LSA) for the Project is defined by the small drainages that begin within or run through the Project permit boundary (CR# 11, Figure 2) including summarized as follows:

- Bryan Creek, an unnamed creek draining into the Embarrass River near Robb, Hay Creek, Mitchell Creek, Bacon Creek, Lendrum Creek, and an unnamed creek draining into the Pembina River at the time this assessment was prepared were not downstream of existing mines; and
- Jackson Creek, Erith River, Halpenny Creek, Lund Creek, and Lendrum Creek are downstream of existing mines.

The Regional Study Area (RSA) for the Project is defined by the LSA plus the following watercourses (CR# 11, Figure 2):

- Embarras River from its confluence with Jackson Creek downstream to its confluence with the Erith River;
- Erith River from its confluence with Lund Creek to its confluence with the Embarras River; and
- Pembina River beginning at its confluence with the unnamed creek draining into the Pembina River at the southeastern end of the Project permit boundary to approximately 10 km downstream.

E.11.2 Baseline Conditions

CVRI has measured surface water quality in numerous watercourses throughout the LSA and RSA under various surface water sampling field programs in the Coal Valley area. In order to augment this data an additional field program was undertaken for the Project. A summary of the surface water quality data used for characterizing baseline surface water quality conditions in the LSA and RSA is provided in CR# 11, Table 5.

E.11.2.1 Surface Water Quality in the RSA

Surface water quality in the RSA is generally good (CR# 11, Table 10). Dissolved organic carbon concentrations were measured and range from 2 to 12 mg/L. The concentration of TSS in the RSA was usually measured to be below 10 mg/L, but some high concentrations of TSS (approximately 200 mg/L) were observed in the fall season of 2009. Watercourses in the RSA are alkaline (pH from 7.6 to 8.8) and have concentrations of TDS that are similar to that in the LSA (20 mg/L to 322 mg/L). Water in the RSA is moderately hard to very hard. The summer trophic status of watercourses in the RSA is classified as oligotrophic to mesotrophic.

Many water quality variables are below their detection limits, with concentrations of 33% of the 6,042 combinations of measured water quality variables, seasons, and sampling locations being below detection limits (CR# 11, Table 10). The proportion of combinations of measured water quality variables, seasons, and sampling were below detection limits ranged from 30% in spring to 35% in winter and fall.

Concentrations of 7.7% of all water quality variables, for which there are surface water quality guidelines (*i.e.,* all combinations of measured water quality variables with guidelines, seasons, and sampling locations), exceeded surface water quality guidelines (CR# 11, Table 10). The highest and lowest frequencies of guideline exceedance occur in the summer season (8.7%) and winter season (3.7%), respectively (CR# 11, Table 11). Seventeen of the 50 surface water quality variables in watercourses that are downstream of existing mines were measured to have at least one guideline exceedance in the Baseline Case dataset (CR# 11, Table 9).

The frequency of guidelines exceedances for total and dissolved metals is 5% (CR#11, Table 11). Total aluminum, total iron, and total chromium concentrations account for 49% of all guideline exceedances in the Baseline, with lower frequencies of guideline exceedance for total phosphorus, total and dissolved cadmium, total and dissolved copper, and dissolved lead (CR# 11, Table 11).

E.11.2.2 Watercourses in the LSA Not Downstream of Existing Mines

Surface water quality in the watercourses of the LSA that are not downstream of existing mines is characterized by concentrations of dissolved organic carbon (ranging from 2 to 17 mg/L) and concentrations of TSS (ranging from below the detection limit to 263 mg/L) with an annual median concentration that is also below detection limits (CR# 11, Table 6). Watercourses in the LSA are alkaline (pH from 7.5 to 8.5) and have TDS levels ranging from 64 to 320 mg/L. The ionic characteristics of these surface waters are dominated by bicarbonate, calcium, and sodium. Water is moderately hard to hard, and summer trophic status of watercourses in the LSA is oligotrophic.

Many surface water quality variables in the baseline dataset are below detection limits in many parts of the LSA, with concentrations of 33% of all combinations of measured water quality variables, seasons, and sampling locations being below detection limits (CR# 11, Table 6). There is little seasonal variability in the frequency with which concentrations of water quality variables are below detection limits; the proportion ranged from 36% in winter to 28% in the spring.

Concentrations of 4.2% of all combinations of measured water quality variables with guidelines, seasons, and sampling locations are above guideline values (CR # 11, Table 7). Total aluminum, and total iron concentrations account for approximately 65% of all metal guideline exceedances, with lower frequencies of guideline exceedances for total copper, chromium, cadmium, dissolved iron, and dissolved aluminum. For water quality variables that are not metals total phosphorus, phenols, and sulphide account for most of the guideline exceedances.

Fifteen of the 50 surface water quality variables were measured to have at least one guideline exceedance. The highest frequency of guideline exceedance occurred in the spring season and the lowest in the winter season (8.9% and 1.4%, respectively). The frequency with which surface water quality guidelines for total and dissolved metals are exceeded is 2.7% of all measured cases.

E.11.2.3 Watercourses in the LSA Downstream of Existing Mines

Surface water quality of watercourses in the LSA downstream of existing mines is similar to water quality of watercourses that are not downstream of existing mines (CR #11, Table 8).

Surface waters are alkaline (pH ranging from 7.5 to 8.5) and have levels of total suspended solids ranging from a concentration that is below the detection limit of 3.0 mg/L to 544 mg/L, with an annual median of 4.5 mg/L. Surface waters are dominated by bicarbonate, calcium, and sodium, with concentrations of dissolved organic carbon that range from 2 to 14 mg/L and have a summer trophic status ranging from oligotrophic to mesotrophic.

The frequency with which the concentration of surface water quality variables are below detection limits are similar (29% of 3,335 combinations of measured water quality variables, seasons, and sampling locations, CR # 11, Table 8) to watercourses in the LSA that are not downstream of existing mines.

Concentrations of 6% of measured water quality variables with guidelines are above those guideline values in watercourses in the LSA that are downstream of existing mines (CR# 11, Table 9). Total aluminum, and total iron concentrations account for approximately 33% of all metal guideline exceedances, with lower frequencies of guideline exceedances for total copper, chromium, mercury, cadmium, silver, as well as dissolved copper (CR# 11, Table 9). Total phosphorus, phenols and sulphide account for all of the guideline exceedances for water quality variables that are not metals. The highest and lowest frequencies of guideline exceedance occur in the spring season (12%) and winter season (0%), respectively. Sixteen of the 50 surface water quality variables were measured to have at least one guideline exceedance.

The frequency with which surface water quality guidelines for total and dissolved metals are exceeded is 4% of all measured cases. Total aluminum, and total iron concentrations account for approximately 45% of all metal guideline exceedances, with lower frequencies of guideline exceedance for total copper, and total chromium (CR# 11, Table 9).

E.11.3 Potential Impacts

Issues considered in the assessment of potential impacts to surface water quality include:

- soil erosion, sediments entering streams via surface runoff, increased sedimentation of surface waters;
- leaching of nitrates into surface waters;
- discharges of water from impoundments to natural watercourses; and
- effects on end-pit lakes on surface water quality.

E.11.3.1 Effects of Mine Construction Activities

During the construction phase of the Project activities such as tree clearing; constructing access roads, diversions, and settling ponds; area disturbances for waste and soil piles; clearing and site disturbance; and constructing drainage controls, cleanouts/retention areas have the potential to impact water quality. With implementation of the mitigation measures summarized in Section E.11.5 and described in detail in the Reclamation Plan (Section F), potential impacts of the construction phases are predicted to be insignificant in the LSA for the following reasons:

- impacts from construction activities which have been identified as potentially adverse are mitigable using standard engineering and environmental design applications;
- short-term impacts on surface water quality during culvert crossing installation are inevitable, temporary and localized;

- potential adverse effects associated with sedimentation will be localized and will be confined to the immediate and downstream areas of the construction activities;
- potential effects on water quality associated with sediment input will be temporary and will occur mainly during the period of construction and until bank slopes are stabilized; and
- construction of haul roads, mine dewatering systems and overburden dumps will follow mining plans and schedules. These activities will be carried out sequentially, at intervals, before the development of new areas.

Because the potential effects of construction activities on surface water quality in the LSA are assessed as insignificant the potential effects on surface water quality in the RSA are also assessed as insignificant.

E.11.3.2 Effects of Using Nitrogen-Based Explosives

Explosives containing ammonium nitrate will be used during the mine operations. The use of explosives is required to breakup of the overburden material. Broken rock and unconsolidated material will be deposited in piles, or be used to backfill previously mined areas. These rock piles and backfilled areas are potential sources of leaching of nitrates into surface waters.

While increases in concentration of nitrogen compounds downstream of active mines has been documented in a number of cases, elevated concentrations have often been below surface water quality guidelines (CR #11, Section 4.2.1.3). A review of nitrate and ammonia concentrations in surface waters used in this assessment (CR #11, Table 6 to Table 9 and Appendix A2) found that:

- most of the measured concentrations of ammonia were below the detection limit in both watercourses downstream of existing mines (100% of measured ammonia concentrations were below detection limits) and watercourses not downstream of existing mines (97% of measured ammonia concentrations were below detection limits);
- many of the measured concentrations of nitrate were below the detection limit in both watercourses downstream of existing mines (80% of measured nitrate concentrations were below detection limits) and watercourses not downstream of existing mines (40% of measured nitrate concentrations were below detection limits); and
- there was no significant difference in the concentration of nitrates in watercourses downstream of existing mines compared with the concentration of nitrates in watercourses not downstream of existing mines.

The residual effects (after mitigation) of the Project on surface water quality due to increases in nitrogen caused by the use of explosives containing ammonium nitrate are assessed as insignificant in the LSA. Because the potential effects of using nitrogen-based explosives on surface water quality in the LSA are assessed as insignificant the potential effects on surface water quality in the RSA are also assessed as insignificant.

E.11.3.3 Discharge from Impoundments to Natural Watercourses

Water collection and impoundment structures will be used to attenuate the impacts of the mining activities on the local watercourses, including increased sediment loads and deposition of those sediments. The water from these impoundments will be released into local streams which will eventually enter the Embarras and Pembina Rivers and smaller tributaries.

A water quality model was developed to simulate the effects of impoundment discharges into receiving waters for seven watercourses in the LSA (CR #11, Appendix A3). The model was developed from empirical data gathered as part of baseline conditions (CR# 11, Section 3 and CR# 6), as well as from data reported by the CVM in its annual approvals reports from 2001 to 2010. Surface water quality conditions are predicted for the Bryan, Hay, Lendrum, Halpenny, Bacon, and Lund Creeks and the Embarras and Erith Rivers (CR# 11, Figure 2).

The model scenarios contain a number of conservative assumptions about the number of impoundments operating at any given time, water quality of impoundment discharges, streamflows in the receiving watercourses, and statistical power available for assessing impoundment effects (CR# 11, Section 4.3.1.3). Using this set of assumptions a total of 314 (98%) out of 322 cases (*i.e.,* combinations of water quality variable (46) and LSA drainage (7)) have either: a predicted concentration for the Project that is less than the concentration in the baseline; or a predicted mean concentration for the Project that is less than the guideline value. Eight out of 322 cases have both a predicted concentration for the Project that is greater than the concentration in the baseline; and a predicted mean concentration for the Project that is greater than the guideline value. All eight cases are total aluminum and total iron and occur in four watercourses (Bryan, Hay, Lendrum, and Lund Creeks). For these eight cases the probability that an effects monitoring program will be able to detect statistically-significant increases:

- in concentrations of total aluminum or total iron in these four watercourses is assessed at less than 1%; and
- in the frequency with which concentrations of these two water quality variables exceed their water quality guidelines during the operation of impoundments is assessed at less than 1% for total iron in all four watercourses and from 2% to 7% for total aluminum, depending on the watercourse.

In the Coal Valley area, the relationships between TSS concentrations and concentrations of total aluminum and total iron are such that concentrations of both these water quality variables are above their guideline values at low TSS levels (Hatfield 2008). This suggests that it may be difficult to manage concentrations of water quality variables such as total aluminum and total iron in impoundments through the management of TSS levels.

There will be changes in surface water quality; however, there are expected to be relatively few instances of detectable increases in the concentration of water quality variables as a result of impoundment discharges and even fewer instances of detectable increases in concentration coupled with concentrations being above surface water quality guidelines. Effects of the Project's operation of impoundments on surface water quality, with mitigation, are insignificant in the LSA

In the RSA surface water quality conditions are predicted for the Embarras River at its confluence with the Erith River and Erith River at its confluence with the Embarras River. Using the same set of conservative assumptions as used for the LSA, a total of 88 (96%) out of 92 cases (*i.e.,* combinations of water quality variable (46) and RSA drainage (2)) have either a predicted concentration for the Project that is less than the concentration in the baseline; or a predicted mean concentration for the Project that is less than the guideline value. Four (4%) out of 92 cases have both a predicted concentration for the Project that is greater than the concentration in the baseline; and a predicted mean concentration for the Project that is greater than the guideline value. All four cases are total aluminum and total iron. For these four cases the probability that an effects monitoring program will be able to detect statistically-significant increases:

- in concentrations of total aluminum or total iron in the Embarras River at its confluence with the Erith River and the Erith River at its confluence with the Embarras River is assessed at less than 1%; and
- in the frequency with which concentrations of these two water quality variables exceed their water quality guidelines during the operation of impoundments is assessed at less than 1% for total iron in all four watercourses and from 2% to 7% for total aluminum, depending on the watercourse.

There will be changes in surface water quality with the Project; however, there are expected to be relatively few instances of detectable increases in the concentration of water quality variables as a result of impoundment discharges and even fewer instances detectable increases in concentration coupled with concentrations being above surface water quality guidelines. Effects of the Project on surface water quality, after mitigation, for operation of impoundments are insignificant in the RSA.

E.11.3.4 Effect of End Pit Lake Characteristics on Water Quality

Analyses presented in End-Pit Lake Working Group (2004) suggest that the design, construction, and management of end-pit lakes influence their viability. Twelve end-pit lakes/ponds will be constructed as part of the reclamation landscape for the Project (Table C.4-4). The effects of these end-pit lakes on the surface water quality have been assessed. Information used in the impact analysis is derived from three sets of studies conducted on CVM end-pit lakes:

- studies conducted on Lovett, Silkstone, and Stirling (Pit 24) lakes (Agbeti 1998, Mackay 1999) in the 1990s;
- studies conducted on Lovett, Silkstone, and Stirling (Pit 24) lakes plus Pit 35 and Pit 45 lakes (Hatfield 2008) in 2006; and
- a detailed study of surface water quality conditions in nine existing CVM end-pit lakes and one natural lake existing (Appendix 8).

Results of these studies indicate that there may be fewer constraints of water quality to the ecological viability of end-pit lakes in the Coal Valley area than those described in End-Pit Lake Working Group (2004):

- the concentration of a number of water quality variables, such as nutrients and major ions, are higher in end-pit lakes than in natural lakes. These higher concentrations are not at levels that would affect the ecological viability of the end-pit lakes (CR# 11, Table 16);
- there have been relatively few instances of measured water quality variables, including metals, exceeding provincial or federal water quality guidelines (CR# 11, Table 16);

- incidence of water quality guideline exceedance is not measurably greater in end-pit lakes than in natural lakes in the Coal Valley area (CR# 11, Table 16); and
- the trophic status of end-pit lakes is similar to that of natural lakes in the Coal Valley area.

The exception to this is dissolved oxygen. Study results indicate there are portions of end-pit lakes in all seasons sampled with concentrations of dissolved oxygen that are below provincial guidelines for the protection of aquatic life (CR# 11, Figure 3). The same is true of the natural lake (Fairfax Lake). The depth patterns of dissolved oxygen in the lakes that were studied are related to processes of lake stratification and turnover.

The following conclusions may be made regarding the results of the impact analysis of water quality in end-pit lakes:

- all of the end-pit lakes proposed for the Project will likely have groundwater as their major source of water;
- some of the end-pit lakes will be meromictic, others will be holomictic, and others will likely exhibit partial mixes;
- the specific turnover pattern of any particular end-pit lake cannot be predicted, although the likelihood that an end-pit lake will be holomictic will be greater with similar salinity of (any) surface and groundwater inflows and shallower end-pit lake depth;
- the concentration of a number of water quality variables, such as nutrients and major ions, are predicted to be higher in the end-pit lakes than in natural lakes, but these higher concentrations are not at levels that would affect the ecological viability of the end-pit lakes;
- there are predicted to be relatively few instances of measured water quality metals exceeding provincial or federal water quality guidelines in the end pit lakes; and
- patterns of dissolved oxygen concentration with depth and changes in these patterns are predicted to be the major water quality variable influencing amount of suitable aquatic habitat available for aquatic life in the end-pit lakes proposed for the Project.

It is worth noting that, while lake turnover is generally considered an important ecological process in most productive lakes (Hutchinson 1938, Effler and Perkins 1987 and Wetzel 2001) it is not a necessary process governing the ability of a lake to sustain healthy fish populations (Effler and Perkins 1987, Trimbee and Prepas 1988).

Effects of the Project on surface water quality in the end-pit lakes (after mitigation) as a result of their design, construction, and management are assessed as insignificant:

E.11.4 Cumulative Effects Assessment

Because the potential effects of the Project on surface water quality in the LSA and RSA are assessed as Insignificant for the Application Case, potential effects of the Project on surface water quality are also assessed as Insignificant for the Planned Development Case for both the LSA and RSA.

E.11.5 MITIGATION AND MONITORING

E.11.4.1 Mitigation

In order to reduce potential impacts of the Project on water quality CVRI will:

- plan to divert clean water around areas to be disturbed;
- minimize the time interval between clearing/grubbing and subsequent earthworks, particularly at or in the vicinity of watercourses or in areas susceptible to erosion;
- install surface runoff collection and treatment systems in an effort to control groundwater seepage from road cuts and surface runoff from disturbed areas. Surface runoff will be directed to settling impoundments for removal of settleable solids;
- utilize slope grading and stabilization techniques to control erosion including: ditching above the cutslope to channel surface runoff away from the cutslope, leaving buffer (vegetation) strips between the construction site and a watercourse, placing large rock rip rap to stabilize slopes;
- utilize temporary measures to control erosion before a vegetation cover is re-established, including: diversion ditches, drainage control, check dams, sediment ponds, sumps and mulches;
- plan to undertake progressive reclamation to reduce the amount of disturbed area at any given time;
- whenever possible, carry out construction activities in close proximity to watercourses during periods of relatively low surface runoff and maintain a 30 m buffer (vegetation) strip between construction sites and watercourses except at stream crossings and diversions;
- design and construct all stream crossings in compliance with the Alberta *Code of Practice for Watercourse Crossings* and associated guidelines;
- where necessary, utilize interim erosion/sediment control measures until long-term protection can be effectively implemented;
- implement the use of explosives with less slurry to reduce the amount of nitrogen compounds released;
- minimize water contact with explosives by undertaking water control activities (dewatering of pit areas, use of diversion ditches and interceptor ditches) for drier conditions for mining and blasting operations; and
- design water management to direct mine-affected water to settling impoundments for treatment prior to discharge of surface waters and discharge from impoundments in accordance with conditions in the EPEA approval.

E.11.4.2 Monitoring

In order to monitor the effectiveness of mitigation measures CVRI will:

- monitor impoundments as required in the EPEA approval; and
- monitor surface water quality in natural watercourses, both upstream and downstream of Project activities as required in the EPEA approval.

E.11.6 SUMMARY OF VECS

CVM has been in operation for over 30 years. During this time CVRI has successfully developed and operated surface water management systems. With mitigation, monitoring and adaptive management the Project will have an insignificant impact on watercourses in the LSA and RSA. A summary of the environmental assessment is included in Table E.11-1.

Table E.11-1 Summary of Impact Significance on Surface Water Quality Valued Environmental Components

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution (Direction)[6]	Confidence Rating[7]	Probability of Occurrence[8]	Impact Rating[9]
1. Surface Water Quality												
	Changes in Surface Water Quality from Construction Activities	Section E.11.5	Application	Local	Short	Isolated	Reversible, Short-term	Low	Negative	High	High	Insignificant
				Regional	Short	Isolated	Reversible, Short-term	Low	Negative	High	High	Insignificant
			Planned Development	Local	Short	Isolated	Reversible, Short-term	Low	Negative	High	High	Insignificant
				Regional	Short	Isolated	Reversible, Short-term	Low	Negative	High	High	Insignificant
	Changes in Surface Water Quality from use of Nitrogen-Based Explosives	Section E.11.5	Application	Local	Long	Periodic	Reversible, Long-term	Low	Negative	High	High	Insignificant
				Regional	Long	Periodic	Reversible, Long-term	Low	Negative	High	High	Insignificant
			Planned Development	Local	Long	Periodic	Reversible, Long-term	Low	Negative	High	High	Insignificant
				Regional	Long	Periodic	Reversible, Long-term	Low	Negative	High	High	Insignificant
	Changes in Surface Water Quality from Operation of Project Impoundments	Section E.11.5	Application	Local	Extended	Occasional	Reversible, Long-term	Low	Negative	High	High	Insignificant
				Regional	Extended	Occasional	Reversible, Long-term	Low	Negative	High	High	Insignificant
			Planned Development	Local	Extended	Occasional	Reversible, Long-term	Low	Negative	High	High	Insignificant
				Regional	Extended	Occasional	Reversible, Long-term	Low	Negative	High	High	Insignificant
	Water Quality of End-Pit Lakes	Section E.11.5	Application	Local	Residual	Continuous	Irreversible	Low	Neutral	High	High	Insignificant

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant, Significant

E.12 TRADITIONAL ECOLOGICAL KNOWLEDGE AND LAND USE

E.12.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted an assessment of traditional ecological knowledge and land use for the proposed Project. The following section is a summary of the Traditional Ecological Knowledge and Traditional Land Use (TEK/TLU) assessment that was prepared by Lifeways of Canada Limited and is included as Consultant Report #12 (CR #12). For full details of the assessment, please refer to CR #12.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the traditional use component are provided in Section 5, and are as follows:

5 TRADITIONAL ECOLOGICAL KNOWLEDGE AND LAND USE

[A] Provide:

- *a) a map and description of traditional use areas including fishing, hunting, trapping, nutritional or medicinal plant harvesting, and cultural use by affected Aboriginal peoples (if the aboriginal community or group is willing to have these locations disclosed);*
- *b) a map of cabin sites, spiritual sites, graves and other traditional use sites considered historic resources under the Historical Resources Act (if the aboriginal community or group is willing to have these locations disclosed), as well as traditional trails and resource activity patterns; and*
- *c) a discussion of:*
  - *i) access to traditional lands in the Project Area during all stages of the Project,*
  - *ii) the vegetation and wildlife used for traditional, food, ceremonial, medicinal and other purposes, and*
  - *iii) aboriginal views on land reclamation.*

[B] Determine the impact of the Project on traditional uses and culture and identify possible

People of Aboriginal heritage and their ancestors have used the Foothills area of Alberta for the last 10,000 years. Under Treaty with the Government of Canada, the First Nations' uses were enshrined as the right to collect, hunt, fish, and trap for food on Crown land, as well as other traditional uses such as ceremonies and burials.

As part of CVRI's ongoing consultation program Aboriginal community representatives have been kept up-to-date on mine development activities and toured current mine operations and of potential extension areas. Aboriginal communities involved in CVRI's consultation process include Alexis First Nation, Jim O'Chiese and the Foothills Ojibway Society (FOS), and the Nakcowinewak Nation of Canada (NNC). The Paul First Nation, Sunchild First Nation, O'Chiese First Nations, Mountain Cree (Smallboy) Camp, Aseniwuche Winewak Nation (AWN), and the Métis Nation of Alberta (MNA) have more recently been involved with consultation activities with CVRI.

E.12.2 SCOPE OF THE ASSESSMENT

As part of the EIA process for the proposed Project, communities are encouraged to undertake Traditional Use Studies (TUS) of the Project area to help gauge the effect of the development on members of the Aboriginal community. Consultation and studies for the Project are in accordance with the *Government of Alberta's First Nations Consultation Guidelines on Land Management and Resource Development*. The Project's consultation program also incorporated directives from the Canadian Environmental Assessment Agency (CEAA) or other Federal government agencies.

A number of Aboriginal communities have used the Coal Valley area historically and traditionally. Many of these groups have strong social and blood ties with one another. The potentially affected Aboriginal groups included in this process were established using previous consultation efforts as the precedent. The Project is located in the Treaty 6 area. Consultations are not limited to Treaty First Nations groups as the area has been used by several non-Treaty Aboriginal groups in the region.

CVRI provided capacity funding to Aboriginal groups with rights and traditional uses in the area in order for effective consultation and TUS to occur. Project consultation and TUS were initiated in July 2006 with information about three proposed mine extensions (Yellowhead Tower, Mercoal West, and this Project) being sent to each potentially affected group. This process was re-initiated in February 2011 specifically for the Project along with more recent changes and additions to the Project area. On February 23, 2011 CEAA mailed early notification letters to potentially affected First Nations and Métis groups noting that the Project was subject to a Provincial environmental assessment and consideration under CEAA and participation by the Major Project Management Office (MPMO).

Consultations and TUS were initiated with several Treaty 6 First Nations including the Alexis Nakota Sioux Nation, Paul First Nation, O'Chiese First Nation, and Sunchild First Nation. The Mountain Cree Camp, officially members of the Ermineskin Cree Tribe, and the Métis Nation of Alberta Zone IV have also been consulted. In addition, several societies representing non-treaty Aboriginal groups in the area are being consulted, including the Foothills Ojibway Society, Nakcowinewak Nation of Canada, and Aseniwuche Winewak Nation (AWN).

E.12.3 CONCERNS RAISED

CVRI is engaged with consultation regarding the Project with the potentially affected Aboriginal groups. Consultation with each group is tailored to the needs of the group depending on development of their own consultation and traditional use programs and level of interest in the area. Communications involve mailouts, meetings, tours, and traditional field studies.

AWN has indicated no concern with the proposed Project. TUS for the Project have been completed for the Alexis First Nation, Mountain Cree Camp, Nakcowinewak Nation, O'Chiese First Nation, and Sunchild First Nation. The Foothills Ojibway Society and Paul First Nation are in the process of completing field studies for Project. All groups that have undertaken field studies, with the exception of the Mountain Cree Camp, have done so exclusively using their own traditional use programs or external consultants. They will communicate or share the sensitive data as they feel appropriate with CVRI, SAAB, or ACCS. Discussions regarding First

Nations concerns with the development and possible mitigation strategies are on-going, and will be finalized on a group-by-group basis after the Project application submission date.

The Aboriginal groups have inspected the Project area and identified resources used by their people. Table E.12-1 provides a list of plant and fungi species or classes observed by Aboriginal groups in the Project area that they use for a variety of medicinal or mundane purposes. A total of 84 species or classes of plant/fungi that are important to Aboriginal groups have been identified in the Project area. As a generic statement, all Aboriginal groups consulted are concerned that CVRI take steps to ensure that native plant species are included in reclamation plans rather than solely agronomic species as have been often utilized in the past.

Table E.12-1 Plants and Fungi in the Robb Trend Area Important to Aboriginal People

Common Name	Latin Name
Alpine Bistort	Polygonum viviparum
Alpine Sweet Vetch	Hedysarum alpinum
Alsike Clover	Trifolium hydridum
Arrow-leafed Coltsfoot	Petasites sagittatus
Balsam fir	Abies balsamea
Bearberry (Kinnikinnik)	Arctostaphylos uva-ursi
Black Spruce	Picea mariana
Bog Birch	Betula glandulosa
Bog Cranberry	Vaccinium uliginosum
Bracted Honeysuckle	Lonicera involucrate
Bunchberry	Cornus canadensis
Canada Buffaloberry	Shepherdia canadensis
Clematis	Clematis verticellaris
Common Blueberry	Vaccinium myrtilloides
Common Harebell	Campanula rotundifolia
Common Plantain	Platago major
Common Sage	Salvia offcinalis
Common Yarrow	Achillea millefolium
Cow Parnsip	Heracleum lanatum
Devils Club	Oplopanax horidus
Dewberry	Rubus pubescens
Diamond Willow	Salix sp.
Diamond Willow fungus	Haploporus odorus
Dock	Rumex crispus

Table E.12-1 Plants and Fungi in the Robb Trend Area Important to Aboriginal People

Common Name	Latin Name
Dwarf Blueberry	Vaccinium caespitosum
False Solomon's seal	Smilacina stellata and S. racemosa
Field Horsetail	Equisetum arvense
Fireweed	Epilobium angustifolium
Fog Mint	Mentha arvenis
Gooseberry	Ribes oxyacanthoides
Green Alder	Alnus crispa
Green Wintergreen	Pyrola virens
Ground Juniper	Juniper communis
Huckleberry	Vaccinium spp.
Indian Moccasin (Lady Slipper)	Cypripedium pubescens
Indian Paint Brush	Castilleja miniata
Labrador Tea	Ledum groenlandicum
Lady Fen	Athyrium filix-femina
Larch (Tamarack)	Larix laricina
Lingonberry	Vaccinium vitis-idaea
Lodgepole Pine	Pinus contorta
Low-bush Cranberry	Viburnum edule
Mooseberry	Viburnum nudicaulis
Moss fungus	Unknowm
Old Man's Beard lichen	Usnea hirta
Old Man's Whiskers	Guem triflorum
Ox-eye Daisy	Chrysanthemum leucanthemum
Pine	Pinus spp.
Pink-bracted Common Wintergreen	Pyrola asarifolia
Prickly Rose (Wild Rose)	Rosa acicularis
Prince's-Pine	Chimaphila umbellata
Puffballs	Lycoperdom spp.
Rat Root	Acorus calamus
Red and White Baneberry	Actaea rubra
Red Currant	Ribes triste
Red Elderberry	Sambucus racemosa

Table E.12-1 Plants and Fungi in the Robb Trend Area Important to Aboriginal People

Common Name	Latin Name
Red Willow	Alnus crispa
Saskatoonberry	Amelanchier alnifolia
Seneca Snakeroot	Polygala Seneca
Small-bog Cranberry	Oxycoccus microcarpus
Sow Thistle	Sonchus sp.
Spiked Clubmoss	Lycopodium annotinum
Spiny Wood Fern	Dryopteris carthusiana
Stair-Step Moss	Hylocomium splendens
Stinging or Common Nettle	Urtica gracilis
Swamp Horse-tail	Equisetum fluvitile
Sweet Sicily	Osmorhiza brevistylis
Tall Bush Blueberry	Vaccinium membranaceum
Tobacco Root	Valeriana edulis
Tree fungus	Piptoporus betulinus
Twinflower	Linnaea borealis
Twisted stalk; liverberry	Streptopus amplexifolius
Venus's Slipper	Calypso bulbosa
Water Parsnip	Sium suave
Western Mountain Ash	Sorbus scopulina
Western Wood Lily	Lilium philadelphicum
White (Paper) Birch	Betula papyrifera
White Poplar (Aspen)	Populus tremuloides
White Spruce	Picea glauca
Willow	Salix spp.
Wild Chives	Allium schoenoprasum
Wild Raspberry	Rubus idaeus
Wild Sarsaparilla	Aralia nudicaulis
Wild Strawberry	Fragaria virginiana

Most Aboriginal groups focused their traditional studies on the presence of important plants in the area. Discussion of concerns regarding animal species tended to occur in generic terms, and were typically about hunting and trapping practices. Table E.12-2 presents a list of animals that Aboriginal groups have identified as a concern in the region.

Table E.12-2 Animals in the Robb Trend Area Important to Aboriginal People	
Common Name	**Latin Name**
Grizzly Bear	Ursus arctos horribilis
Black Bear	Ursus americanus
Moose	Alces alces
Elk	Cervus canadensis
Deer	Odocoileus spp.
Beaver	Castor canadensis
Rabbit	Sylvilagus sp., Lepus spp.
Wolverine	Gulo gulo
Fox	Vulpes spp.
Ducks	Various
Geese	Various
Fish	Various
Squirrels	Sciurus spp.
Caribou	Rangifer tarandus
Wolf	Canis lupus spp.
Mink	Neovison vison
Fisher	Martes pennant
Lynx	Lynx canadensis
Eagle	Aquila chrysaetos, Haliaeetus leucocephalus
Common Loon	Gavia immer
Bighorn sheep	Ovis canadensis
Coyotes	Canis latrans

During discussions, open houses, and fieldwork with Aboriginal groups several items of concern have been raised about the proposed Project and developments. Many of these mirror general environmental impact concerns raised by other stakeholders and the general public. A summary follows:

Water Quality – Water Quality is the most commonly raised issue for Aboriginal people. Their concern is how the CVRI will keep the water clean and expressed scepticism that it could be accomplished. Concerns include surface water and groundwater. One issue raised is how groundwater flow will affect others on the margins of the Project area. As water is often seen as one of the four major elements of life, it is critical to the well-being of all animal and plant life in the region. Water quality has been discussed in detail in Section E.3 and E.11 and CR#3 and CR#11.

Moose Licks/Salt Licks/Springs – The availability of moose or salt licks was raised as a concern as some of these will be removed during Project development. These are important to the wildlife in the region and location of the lick are important places for hunters to look for game. Wildlife has been discussed in detail in Section E.14.

Displacement of Wildlife – Many Aboriginal people use or have used this area for hunting, particularly for moose, deer, and elk. Many mentioned that portions of the Project area are great moose habitat and expressed concerns about impact of the Project on game populations (particularly moose). Moose are culturally important as the most preferred game. Furbearers commonly trapped are of general concern although no Aboriginal person cited ownership of a trapline to be affected. Concern about the overall wildlife displacement impact was voiced. Wildlife has been discussed in detail in Section E.14.

Bears – A number of Aboriginal people also mentioned the importance of bears. Although not frequently hunted, bears are powerful and an important animal often viewed as four-legged men. Mammalian wildlife is discussed in detail in Section E.7.

Health of Wild Game – Aboriginal people have noted that with increased development in the area, particularly from oil and gas, comes an increase in visibly diseased game animals. Sometimes the animals are inedible once killed and skinned as if tainted or poisoned. They attribute poor health of these animals to nearby developments and its effects on the environment. They questioned whether tissue sampling occurs in the area to help study animal health. Wildlife has been discussed in detail in Section E.14.

Avoidance of Important Locales – Aboriginal groups have or will identify to CVRI the locations of known burials, ceremonial sites, and camping locations within the proposed Project areas and region. Discussions are underway on avoidance or mitigation strategies on a case-by-case basis. Historical resources in the area have been discussed in detail in Section E.4 and land use issues are discussed in Section E.16.

Impact to Medicinal and Food Plants – One of the most common concerns among Aboriginal elders was the impact to medicinal and food plants in the Project area (refer to Table E.12-1 and E.12-2; CR #12, Appendix B). A number of these plants are "rare" or "rare elsewhere", whereas others are more common. Often these plants cannot be transplanted due to specific conditions required. Transplanting may, in some cases, impact the potency or efficacy of the medicines. CVRI was asked to use traditional knowledge and native plant species in the reclamation process. The vegetation resource has been discussed in detail in Section E.13.

Future Extension – One individual expressed concern about the potential extension of the Project to the southeast on the opposite side of the Pembina River. Active traplines are located to the east. One individual expressed concern that the CVM could potentially expand to the Genesee area because of the extent of the coal seams. Future development has been discussed in detail in Section C.2 and C.3.

Exporting Coal/Transporting Coal – Several individuals expressed concern that the coal was being exported to foreign lands. At one Open House, an individual inquired about coal trains and exposure to coal dust along rail lines. The coal markets are discussed in Section A.1.

Clear-Cutting and Noise Pollution - It was noted that the forested area, wildlife, and medicinal plants would be impacted by the clear-cutting and mining operations in the area. Concern was also expressed over the displacement of animals by noise pollution.

Reclamation - The use of native species and traditional knowledge during reclamation is important. Questions were raised about the expected length of time required for regrowth of mushrooms, tree fungus, trees, and plants. Questions of what the landscape would look like after reclamation and if prior reclamation studies had been completed were also raised. Several people mentioned that animals are attracted to reclaimed areas and expressed concerns about the effect of this on game populations and hunting rights.

Employment Opportunities – Many people expressed interest in job opportunities for Aboriginal peoples. Concerns were voiced about past discrimination and the requirement for a high school diploma to obtain employment with some industries. Several elders thought the need for a diploma would encourage youth to finish school but frequently this was viewed as a barrier to older Aboriginal individuals. The need for further training or certificates for certain positions was raised. Desire for the incorporation of Aboriginal youth into positions such as environmental monitors or to assist in reclamation was expressed.

Contracting Opportunities – Several Aboriginal groups enquired about contracting opportunities for Aboriginally-owned companies or affiliated corporations.

Agreements - A number of consulted Aboriginal groups have expressed interest in solidifying their relationship with CVRI through long-term memoranda of understanding or similar written agreements.

E.12.4 Mitigation and Monitoring

E.12.4.1 Mitigation

In order to reduce potential impacts of the Project on TLU CVRI will:

- continue consultations with the Aboriginal groups as information is brought forward regarding specific impacts to traditional use areas;
- continue to update SREM Aboriginal Affairs Branch (SAAB) on the progress of consultation with potentially affected Aboriginal groups;
- continue negotiations with Aboriginal groups, on a case by case basis, for avoidance of ceremonial areas, specific plant species, graves, and other areas; and
- undertake further discussions with Aboriginal groups on specific impacts and mitigation measures following the submission of final reports on traditional use studies.

E.12.4.2 Monitoring

CVRI will undertake the following monitoring measures:

- complete longer-term monitoring on the impact to medicinal and other plants and for general environmental monitoring; and
- continue to consult with the Aboriginal communities regarding future development plans.

E.12.5 SUMMARY OF VECS

CVRI has provided capacity funding and other support to a number of Aboriginal groups that have used the Coal Valley area in the past and present. Capacity funding was used to complete TUS and TEK studies of the proposed Project. TUS results indicate Aboriginals in the area continue to use the region for hunting, collection of medicinal and food plants, camping, and ceremonial pursuits. Some Aboriginal groups have indicated that the Project will impact specific areas they use but through appropriate measures the impact to resources and areas important to them can be mitigated or avoided.

The TUSs undertaken for the Project have collected and safeguarded important cultural information for several Aboriginal groups. These studies not only provide information important to the assessment of environmental impacts but help in the transmission of cultural knowledge from elders to the young people. It also resulted in an important and positive extension of CVRI's relationship with the Aboriginal peoples and their inclusion in the approval process for developments in the region. Field studies for several Aboriginal groups are still awaiting completion and further discussion. Consultations with the Aboriginal groups will be ongoing as information is brought forward regarding specific impacts to traditional use areas.

E.13 VEGETATION, WETLANDS AND RARE PLANTS

E.13.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI conducted a vegetation and wetlands assessment for the proposed Project. The following section is a summary of the Vegetation and Wetlands Resource Assessment that was prepared by Millennium EMS Solutions Ltd. and is included as Consultant Report #13 (CR #13). For full details of the assessment, please refer to CR #13.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the vegetation and wetlands component are provided in Section 3.6, and are as follows:

3.6 VEGETATION

3.6.1 Baseline Information

[A] Describe and map vegetation communities for each ecosite phase.

[B] Describe and map wetlands and discuss their distribution and relative abundance.

[C] Identify, verify and map the relative abundance of species of rare plants and the ecosite phases where they are found.

[D] Discuss the potential of each ecosite phase to support rare plant species, plants for traditional, medicinal and cultural purposes, old growth forests and communities of limited distribution. Consider their importance for local and regional habitat, sustained forest growth, rare plant habitat and the hydrologic regime.

[E] Describe the regional relevance of landscape units that are identified as rare.

[F] Provide Timber Productivity Ratings for both the Project Area and the Local Study Area, including identification of productive forested, non-productive forested and non-forested lands.

3.6.2 Impact Assessment

[A] Identify the amount of vegetation and wetlands to be disturbed for all stages of the Project.

[B] Discuss any potential impacts the Project may have on rare plants or endangered species.

[C] Discuss temporary (include timeframe) and permanent changes to vegetation and wetland communities.

[D] Describe the regional impact of any ecosite phase to be removed.

[E] Discuss from an ecological perspective, the expected timelines for establishment and recovery of vegetative communities and the expected differences in the resulting vegetative community structures.

[F] Provide a predicted Ecological Land Classification map that shows the reclaimed vegetation.

[G] Discuss the impact of any loss of wetlands, including how the loss will affect land use.

[H] Provide a mitigation strategy that will minimize Project impacts addressing:

a) mitigation of the adverse effects of site clearing on rare plants, plant communities and plants for traditional, medicinal and cultural purposes. Identify any setbacks proposed around environmentally-sensitive areas such as surface waterbodies, riparian areas and wetlands; and

b) measures and techniques that will be used to minimize the impact of loss of wetlands on land use.

[I] Discuss weeds and non-native invasive species and describe how these species will be assessed and controlled prior to and during operation and reclamation.

[J] Discuss at multiple spatial scales, the predicted changes to upland, riparian and wetland habitats resulting from increased fragmentation.

VECs were selected based on specific requirements outlined in the final terms of reference (AENV, 2011); regulatory requirements and guidelines; and issues raised by stakeholders through the consultation process. The importance and rationale for selection of each VEC are included in CR#13, Section 3.5.1. Project VECs are:

- terrestrial vegetation;
- forest resources;
- wetlands;
- old growth forests;
- non-native and noxious plant species;
- traditionally used vegetation species;
- fragmentation; and
- biodiversity.

The LSA used for the vegetation and wetlands assessment encompasses the proposed mine permit boundary and the RSA extends from Hinton in the northwest past Edson to near Sang Lake in the northeast, down almost to the Blackstone Lookout in the southwest, to near Medicine Lake in the southeast (CR #13, Figure 1-1).

E.13.2 BASELINE CONDITIONS

E.13.2.8 Land Classification

Ecological landscape classification (ELC) cover classes for the RSA were derived from raster satellite data from the Foothills Research Institute (FRI 2009). This was further refined by adding crown closure, percent conifer, stand origin, and regeneration to the land cover dataset. The percent canopy closure dataset was then re-classified into four classes (zero, greater than 0 to less than 30%, 30% to 70%, and greater than 70%), following which conifer, mixed, broadleaf, and regenerating forest stands were differentiated further. ELC classes in the RSA are listed in Table E.13-1 and shown ion CR # 13, Figure 4-8.

Table E.13-1 Ecological Landscape Cover Classes in the RSA

ELC Class	Area (ha)	Proportion (%)
Barren land	14,012.5	3.9
Closed regenerating forest	17,216.6	4.8
Open regenerating forest	34,002.1	9.5
Dense broadleaf	1,142.7	0.3
Moderate broadleaf	11,281.9	3.1
Open broadleaf	80.2	0.02
Dense mixedwood	12,164.1	3.4
Moderate mixedwood	26,221.7	7.3
Open mixedwood	369.8	0.1
Dense conifer	78,581.9	21.9
Moderate conifer	116,837.9	32.6
Open conifer	1,430.0	0.4
Shrubs	12,172.6	3.4
Upland herbaceous	9,017.5	2.5
Total Upland:	334,531.5	93.3
Open wetland	3,852.5	1.1
Treed wetland	19,302.7	5.4
Total Wetland:	23,155.2	6.5
Water	1,044.3	0.3
Total	358,731.0	100.0

E.13.2.2 Ecological Land Classification

The majority of the RSA is situated within the Upper Foothills Natural Subregion (UF) of Alberta, with a small portion occupying the Lower Foothills Natural Subregion (LF). Vegetation within the UF is limited in diversity due to the short and cool growing season, which consequently favors the growth of extensive closed canopy coniferous forests (Natural Regions Committee 2006).

In total, 574 vegetation species were documented during field surveys within the LSA. Of these, 345 were vascular and included 9 trees, 62 shrubs, 193 forbs and 81 graminoids, and 229 were non-vascular and included 134 bryophytes and 95 lichens. The complete listing of the flora identified and documented for the LSA is presented in CR#13, Appendix 3.

The LSA was mapped utilizing the Beckingham et al. (1996) ecological land classification system which incorporates vegetation, soil, site, and productivity information. Table E.13-2 shows the extent of each ecosite phase within the total LSA. A map of the ecosite phases within the LSA is included in CR# 13, Figures 4-1.

Table E.13-2 Baseline Ecosite Phases in the LSA and Project Footprint

Ecosite Phase	LSA		Project Footprint	
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)
Upper Foothills				
b1 - bearberry/lichen Pl	38.6	0.4	16.1	0.2
c1 - hairy wild rye Pl	97.7	1.0	38.9	0.4
c2 - hairy wild rye Aw	132.9	1.3	46.2	0.5
c3 - hairy wild rye Aw-Sw-Pl	372.8	3.7	187	1.9
c4 – hairy wild rye white spruce	25.5	0.3	3.2	0.0
d1 - Labrador tea-mesic Pl-Sb	1,339.50	13.3	671.7	6.7
e1 - tall bilberry/arnica Pl	1,941.90	19.2	904	9.0
e2 - tall bilberry/arnica Aw-Sw-Pl	1,345.70	13.3	553.6	5.5
e3 - tall bilberry/arnica Sw	260.7	2.6	167.8	1.7
e4 - tall bilberry/arnica Fa	15	0.1	15	0.1
f1 - bracted honeysuckle Pl	184.6	1.8	151	1.5
f2 –bracted honeysuckle Pb	251.6	2.5	191.5	1.9
f3 - bracted honeysuckle Pb-Sw-Pl	102.5	1.0	46.3	0.5
f4 - bracted honeysuckle Sw	149.1	1.5	104.3	1.0
f6 - bracted honeysuckle willow	13.9	0.1	1.3	0.0
g1 - shrubby meadow	39.6	0.4	22	0.2
g2 – forb meadow	0.3	0.0		0.0
h1 - Labrador tea-subhygric Sb-Pl	331.3	3.3	224.4	2.2

Table E.13-2 Baseline Ecosite Phases in the LSA and Project Footprint

Ecosite Phase	LSA		Project Footprint	
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)
i1 - Labrador tea/horsetail Sb-Sw	196.7	1.9	130.1	1.3
j1 - horsetail Sw	99.5	1.0	46.9	0.5
k1 - treed bog	95.2	0.9	66.5	0.7
l1 - treed poor fen	195.2	1.9	167.2	1.7
l2 - shrubby poor fen	26.5	0.3	9.8	0.1
m1 - treed rich fen	73.5	0.7	68.3	0.7
m2 - shrubby rich fen	13.2	0.1	10.5	0.1
m3 - graminoid rich fen	27.8	0.3	11.1	0.1
Disturbed	325.2	3.2	171.3	1.7
Subtotal (UF)	**7,696.0**	**76.2**	**4,026.0**	**39.9**
Lower Foothills				
c1 - hairy wild rye Pl	8.7	0.1	8.7	0.1
c2 - hairy wild rye Aw	54	0.5	42.3	0.4
c3 - hairy wild rye Aw-Sw-Pl	18.8	0.2	8.3	0.1
d1 - Labrador tea-mesic Pl-Sb	203.9	2.0	162.1	1.6
e1 - low-bush cranberry Pl	315.5	3.1	161	1.6
e2 - low-bush cranberry Aw	623.2	6.2	416.8	4.1
e3 - low-bush cranberry Aw-Sw-Pl	166.3	1.6	122.7	1.2
e4 - low-bush cranberry Sw	53.4	0.5	15	0.1
f1 - bracted honeysuckle Pl	19.3	0.2	11.1	0.1
f2 - bracted honeysuckle Aw-Pb	160.9	1.6	140.7	1.4
f3 - bracted honeysuckle Pb-Sw-Pl	83.8	0.8	60	0.6
f4 - bracted honeysuckle Sw	17.8	0.2	16.8	0.2
f6 - bracted honeysuckle willow		0.0		0.0
g1 - shrubby meadow	19.1	0.2	17	0.2
g2 – forb meadow	10	0.1	9.3	0.1
h1 - Labrador tea-subhygric Sb-Pl	180.6	1.8	133.8	1.3
i1 – horsetail balsam poplar-aspen	49.7	0.5	40	0.4
i3 - horsetail Sw	0.8	0.0	5.4	0.1
j1 - Labrador tea/horsetail Sb-Sw	56.2	0.6	46.8	0.5
k1 - treed bog	77.7	0.8	68.6	0.7
k2 – shrubby bog	2.8	0.0	2.8	0.0

Table E.13-2 Baseline Ecosite Phases in the LSA and Project Footprint				
Ecosite Phase	**LSA**		**Project Footprint**	
	Area (ha)	**Proportion (%)**	**Area (ha)**	**Proportion (%)**
l1 - treed poor fen	127	1.3	104.9	1.0
l2 - shrubby poor fen	3	0.0		0.0
l3 – horsetail white spruce	7.8	0.1		0.0
m1 - treed rich fen	16.7	0.2	10.9	0.1
m2 - shrubby rich fen	3.4	0.0	3.1	0.0
m3 - graminoid rich fen	9.2	0.1	9.2	0.1
n1 – marsh	6.2	0.1	6.2	0.1
Disturbed	101.9	1	79.3	0.8
Subtotal (LF)	**2397.7**	**23.7**	**1702.8**	**16.9**
Total	**10,093.7**	**100.0**	**5,728.8**	**56.8**

E.13.2.3 Wetlands

Wetland sampling was incorporated into the detailed vegetation and wetlands survey. Wetlands within the LSA are classified using the Canadian Wetland Classification System (National Wetlands Working Group 1997), the Alberta Wetland Inventory Classification Standards (AWIS) (Halsey et al. 2004) (CR #13, Table 3.6), and the appropriate field guide to ecosites of Alberta (Beckingham et al 1996; Beckingham and Archibald 1996). The distribution of wetlands in the LSA is listed in Table E.13-3 and shown on CR #13, Figure 4-3.

Table E.13-3 Wetland Area and Distribution in the LSA and Project Footprint				
Wetland Type	**LSA**		**Project Footprint**	
	Area (ha)	**Proportion (%)**	**Area (ha)**	**Proportion (%)**
BTNN - Wooded bogs without internal lawns, patterning or permafrost	175.6	1.7	137.9	1.4
FONG - Open graminoid fens without patterning or permafrost	44.7	0.4	25.6	0.2
FONS - Open shrubby fens without patterning or permafrost	88.2	0.9	57.0	0.6
FTNN - Wooded fens without internal lawns, patterning or permafrost	403.1	4.0	337.0	3.3
MONG - Marsh	6.2	0.1	6.2	0.1
STNN - Wooded swamp without internal lawns, patterning or permafrost	15.4	0.2	0.3	0.0
WONN - Open water	1.7	0.0	1.2	0.0
Total Wetland Area	734.9	7.3	565.2	5.6

A floating fen was encountered during the vegetation and wetland survey, and was identified as a unique feature in the LSA as these fens are relatively uncommon throughout the Alberta foothills. Floating fens occur adjacent to ponds or lakes and are underlain by water or a mixture of water and peat (CR # 13, Figure 4-4). The floating fen observed within the LSA is a rich graminoid fen (UF-m3, FONG).

E.13.2.4 Biodiversity and Fragmentation

Biodiversity is a measure of the health of an ecosystem and defines the degree of variation among living organisms within an ecosystem (Environment Canada 1995). A key influence on biodiversity is the effects of fragmentation. Increased ecosystem fragmentation may result in a wide range of threats to biodiversity, such as an increase in invasive and non-native species, reduction or restriction of wildlife movement, reduction of genetic diversity and population viability, loss of resilience, alteration of natural disturbance patterns, and interruption of succession. Fragmentation and biodiversity are inversely co-dependent in that as fragmentation of natural landscapes increases, biodiversity decreases.

Biodiversity exists at several scales or levels, including genetic (species) community, and landscape-level. For the purpose of this assessment, biodiversity is measured at the species level, community level and landscape level. Species level biodiversity describes the diversity of vegetation at the genetic level and is a major contributor to the sustainability of an ecosystem. Community diversity involves species composition (number and abundance of species), the structure of the community (presence of different layers of vegetation), its functioning (overall health) and the physical characteristics of the site. Biodiversity at a landscape level refers to the assemblage of plant communities in relation to one another in a mosaic of patches, corridors, and matrices.

The biodiversity indicators that were used to characterize baseline biodiversity and assess the effects of the Project on biodiversity in the LSA and the RSA are listed in CR #13, Table 3.7.

Species Level Biodiversity

Species level biodiversity was measured in terms of species richness, diversity, and evenness (CR #13, Table 4.11). In total, 574 vegetation species were documented during field surveys within the LSA. Of these, 345 were vascular and included 9 trees, 62 shrubs, 193 forbs and 81 graminoids, and 229 were non-vascular and included 134 bryophytes and 95 lichens. The highest mean species richness and diversity was found in ecosite phase LF-e3 (mean=45.7 and 4.5, respectively). The lowest mean species richness value was observed in UF-e4 tall bilberry/arnica Fa (mean=12.0), and the lowest Shannon diversity was found in LF-m3 graminoid rich fen (1.9).

When only vascular species diversity measures were considered, the analysis demonstrated that the highest vascular plant diversity index was in the f2 ecosite phase while the highest heterogeneity (evenness) was found in ecosite phases e3, c3, and l1. The lowest values for vascular species diversity were found in ecosite phase m3 (graminoid rich fen). The low value for evenness in the rich graminoid fen reflects the habitat specificity of plants that grow in rich fen communities where often colonies of one species may dominate resulting in lowered heterogeneity.

Community Level Biodiversity

Unlike the species level assessment that focuses on species within each ecosite phase, the community level assessment focused on number of ecosite phases within the LSA and the biodiversity potential of each ecosite phase. Biodiversity potential describes the potential of each ecosite phase or community to support a variety of self-sustaining plant and animal populations. It incorporates the structure and composition of each ecosite phase as well as the rarity of the ecosite phase at a landscape level.

A ranking metric was used to determine the biodiversity potential of each ecosite phase in the LSA (CR #13, Section 3.4.2). Ecosite phases were ranked as very low, low, moderate high and very high. All disturbed and anthropogenic classes were not ranked for biodiversity. Table E.13-4 shows the total area of all ecosite phases combined for each of the five biodiversity classes.

Table E.13-4 Area and Percent of Biodiversity Potential in the LSA and Project Footprint

Rank	Ecosite Phases	LSA		Project Footprint	
		Area (ha)	Proportion (%)	Area (ha)	Proportion (%)
Very High	f4, i1	413.2	4.1	121.1	1.2
High	c3, f2, f3, g1, g2, h1, j1, k1, m1	1,990.0	19.7	1,519.8	15.1
Moderate	b1, c1, c2, c4, d1, e1, e2, e4, f1, f6, i3, k2, l1, l2, l3, m2, m3	6,830.1	67.7	3,831.3	38.0
Low	e3, n1	433.2	4.3	6.2	0.1
Very Low	None	0	0	0	0.0
Not ranked	Existing disturbance, NMS, NWL, NWR,	427.0	4.2	0	0.0
Total		**10,093.6**	**100**	**5478.3**	**54.3**

Landscape Level Biodiversity

The number and type of ecosite phases in the LSA and land cover classes in the RSA as well as the level of habitat fragmentation were used to determine biodiversity at the landscape level.

Twenty five UF ecosite phases and twenty seven LF ecosite phases, three water classes (lakes, rivers and sandbars) and two anthropogenic cover classes were mapped within the LSA. Thirteen ecosite phases, sandy areas and open water classes were of limited distribution (less than 1%) in the LSA. Most of the LSA contains large tracts of forests stands that are older than 100 years old. A portion of these stands that form part of the Hinton Wood Products FMA are slated to be harvested prior to mining.

Ecosite phases in the LSA were described using the following fragmentation metrics:

- total area of the patch in the LSA, number of patches;
- mean patch area;

- total edge (perimeter) of each ecosite phase; and
- perimeter to area ratio.

The total patch area in the LSA is 10,093.6 ha. The largest patches are lodgepole pine tall bilberry/arnica (e1 ecosite phase) community in the UF natural subregion, trembling aspen-white spruce and lodgepole pine dominated tall bilberry arnica (e3 ecosite phase) in the UF natural subregion and lodgepole pine and black spruce dominated Labrador tea (d1 ecosite phase) community (CR #13, Table 4.15). The lowest total patch area were found in white spruce dominated horsetail (i3 ecosite phase) in the LF and shrubby bog (k2) community with total area of 0.8 and 2.8 ha respectively. These ecosite phases are limited in distribution in the LSA.

The total number of patches of ecosite phases in the LSA is 874 of which 814 are naturally vegetated patches. Ecosite phase d1 has the largest number of patches while ecosite phase g2 and k2 have only one patch in the LSA. The relatively small number of patches in the LSA is a reflection of the low level of landscape fragmentation at baseline. Mean patch size varies from 0.2 ha for the i3 ecosite phase to 31.9 ha for the balsam poplar dominated bracted honeysuckle (f2 ecosite phase) in the UF.

Total edge or perimeter length is a function of the amount of border between different patches and is related to the average patch size. The largest perimeter length in the LSA is the e1 ecosite phase (largest patch area) while the lowest perimeter length is found in the i3 ecosite phase.

Perimeter to area ratio gives a description of the shape of a community with linear patches having higher perimeter to area ratios than nonlinear landscape units. The patch type with the highest perimeter to area ratios in the LSA are f2, g1, and i3 ecosite phases. These communities often have elongated shapes that follow areas of low topography such as riparian margins. Linear anthropogenic features such as pipelines (CIP), roads, and highways (AIH) as well as rivers and streams had high perimeter to area ratios. Shannon's diversity index is 2.83 and the evenness index is 0.75.

The total patch area in the RSA is 358,732.2 ha, with the largest patches being moderate conifer and natural open regenerating cover classes (CR #13, Table 4.20). The lowest total patch area for natural cover classes was found in the open broadleaf community and the disturbed treed wetland cover class. Both these communities are limited in distribution in the RSA.

The total number of patches of land cover classes in the RSA is 30,280 of which 29,219 are naturally vegetated patches. The open regenerating natural cover class has the largest number of patches while the disturbed open conifer and the disturbed wetland class each had only 2 and 3 patches, respectively. Mean patch size varies from 0.7 ha for disturbed treed wetlands to 47.8 ha for the disturbed barren land cover class. The largest perimeter length is the natural open regenerating land cover class while the smallest perimeter length is found in the disturbed treed wetlands.

Shannon' diversity in the RSA is 2.14 while Shannon's evenness index is 0.64. Relative to the LSA, the low values reflect the smaller number of patch types in the RSA compared to the LSA.

E.13.2.5 Rare Plants

A rare plant is defined by the Alberta Native Plant Council (ANPC) as "any native vascular or non-vascular (mosses, hornworts, liverworts) plant that, because of its biological characteristics or for some other reason, exists in low numbers or in very restricted areas in Alberta" (ANPC 2000a). This definition also applies to lichens and fungi. A rare plant community is any native plant community that is uncommon, of limited extent, or locally significant.

The ranking of a plant species or community as rare within this study follows ACIMS's definition; that is, all S1, S2, and some S3 species are on the tracking and watch lists, and are considered rare. A combined rank (*e.g.,* S1/S2) is given for species whose status is uncertain; with the first rank indicating the rarity status given current documentation, and the second rank indicating the rarity status that will most likely be assigned after all historical data and likely habitats have been checked.

Forty-six vegetation species documented during field surveys in the LSA are on the ACIMS Alberta Rare Plant Tracking and Watch Lists (Table E.13-5). Of these, 20 are vascular plants (with 38 occurrences), 18 are bryophytes (with 40 occurrences), and 7 are lichens (with 9 occurrences). Additionally, one occurrence each of Chrysospenium iowense (golden saxifrage), the crust lichen Lecidea leprarioides, and Conocephalum conicum (snake liverwort) were observed within 500 m outside the LSA boundary (CR # 13, Figure 4-6).

Table E.13-5 Documented Rare Plant Occurrences in the LSA

Species	Plant Community Type	Occurrences		Alberta Rank	Adjacent Jurisdictions Rank		Global Rank	ASRD 2010 Status
		LSA	PF		B.C.	Sask.		
Vascular Plants								
Botrychium crenulatum – scalloped moonwort	UF-d1.2	1	1	S1	S2S3	-	G3	May Be At Risk
Botrychium michiganense – Michigan grape fern	UF-d1.2	1	1	SU	S2S3	S1	G1	Undetermined
Botrychium spathulatum – spoonleaf moonwort	Road right of way	1	1	S2	S1	-	G3	May be at risk
Carex capitata – capitate sedge[1]	UF-l2.1	1	1	S3	S4	S5?	G5	Sensitive
Carex heleonastes - Hudson Bay sedge	UF-k1.1	1	1	S2	S2S3	S2	G4	Sensitive
Carex lacustris - lakeshore sedge	UF-m1.1	1	1	S2	-	-	G5	May Be At Risk
Carex platylepis - broad-scaled sedge	UF-j1.1	1	1	S1S2	-	SNR	G4?	No Status
Carex vesicaria - blister sedge	UF-m3.1	1	1	S1	S4	SU	G5	Undetermined
Chrysosplenium iowense - golden saxifrage	UF-i1.1, LF-n1.1, UF-m2.2	3	3	S3?	S2S3	S1?	G3?	Sensitive
Coptis trifolia – goldthread[1]	UF-c1.2, UF-d1.2, LF-e1.1, LF-j1.1	4	2	S3	S4	S5	G5	Secure
Drosera linearis - slender-leaved sundew[1]	LF-m3.1, UF-m2.1	2	2	S3	S1	S1	G4	Sensitive
Epilobium leptocarpum - willowherb	UF-m2.1	1	1	S1	S2S3	-	G5	May Be At Risk
Luzula rufescens - reddish wood-rush	LF-c3.1	1	1	S1	S2S3	-	G5	Sensitive
Phegopteris connectilis - northern beech fern	UF-f4.3	1	1	S2	S3S4	S2	G5	May Be At Risk
Salix commutata - changeable willow	UF-e2.4	1	1	S2	S4	-	G5	Sensitive
Sparganium fluctuans - bur-reed	UF-m3.1, LF-m3.1	3	3	S1	S2S3	S2	G5	May Be At Risk

Table E.13-5 Documented Rare Plant Occurrences in the LSA

Species	Plant Community Type	Occurrences		Alberta Rank	Adjacent Jurisdictions Rank		Global Rank	ASRD 2010 Status
		LSA	PF		B.C.	Sask.		
Sparganium hyperboreum - northern bur-reed	UF-m2.1	1	1	S1	-	-	G5	Sensitive
Ranunculus occidentalis var.brevistylis – western buttercup[1]	UF-j1.1	1	1	S3	SNR	-	G5T5	Secure
Ranunculus uncinatus – hairy buttercup[1]	UF-d1.2, UF-e3.1, LF-e3.2, UF-f1.1, LF-f2.2, UF-f3.1, UF-f4.3, UF-j1.1, UF-e1.1	10	10	S3	S5	-	G5	Sensitive
Trisetum cernuum - nodding trisetum	UF-l2.1	2	2	S2	S5	-	G5	May Be At Risk
Bryophytes								
Anastrophyllum helleranum - liverwort	UF-c1.2, 2UF-f4.3, UF-h1.3, UF-i1.2, UF-e1.4	5	5	S2	-	-	G5	No Status
Aulacomnium acuminatum – acutetip aluacomnium moss	UF-l2.1	1	1	S1	S1S3	-	G3?	Sensitive
Barbilophozia attenuata - liverwort	UF-f4.3	1	1	S1	-	-	G5	No Status
Blasia pusilla - liverwort	UF-i1.1, LF-h1.1	2	2	S1	-	-	G5	No Status
Conocephalum conicum - snake liverwort	UF-f3.1, UF-f4.3, UF-i1.1, UF-j1.1, UF-l1.1 (2), LF-g1.1, LF-i1.1, LF-g1.2	9	9	S2	-	-	G5	No Status
Drepanocladus brevifolius - brown moss	UF-m1.1	1	1	SU	-	-	GNRQ	Sensitive
Herzogiella turfacea – liverwort[1]	UF-d1.3	1	0	S3	S2	SNR	G4G5	Undetermined
Hypnum pallescens - stump pigtail moss	UF-m3.1	1	1	S2	S3S4	SNR	G5	Secure
Lophozia capitata - liverwort	UF-f4.3	1	1	S1	-	-	G4	No Status
Lophozia collaris - liverwort	LF-h1.1, LF-j1.1	2	2	S1	-	-	G5	No Status
Lophozia incisa - liverwort	UF-i1.2	1	1	S2	-	-	G5	No Status

Table E.13-5 Documented Rare Plant Occurrences in the LSA

Species	Plant Community Type	Occurrences		Alberta Rank	Adjacent Jurisdictions Rank		Global Rank	ASRD 2010 Status
		LSA	PF		B.C.	Sask.		
Lophozia longidens - liverwort	UF-f3.2, LF-e2.3	2	0	S1	-	-	G5	No Status
Lophozia obtusa - liverwort	UF-d1.2, UF-e2.1,UF-f4.3, UF-g1.1	4	4	S1	-	-	G4G5	No Status
Pohlia crudoides - moss	UF-l2.1, LF-m1.1, LF-n1.1	3	3	S1	S2S3	-	G2G4	May Be At Risk
Scapania glaucocephala - liverwort	UF-e1.4	1	1	S2	SNR	-	G4G5	No Status
Splachnum luteum - yellow collar moss	UF-e1.3, UF-i1.1	2	2	S3	S2S3	S3?	G3	Sensitive
Splachnum rubrum - red collar moss	UF-e1.3, UF-i1.1	2	2	S3	S1S3	S3?	G3	Sensitive
Tritomaria scitula - liverwort	UF-i1.1	1	1	S2S3	-	-	G4	No Status
Lichens								
Cladonia acuminata – cladonia lichen	LF-e1.1	1	1	S1?	S3S5	-	G5?	No Status
Cladina stygia - (black-based) reindeer lichen	UF-l1.1	1	1	S1	-	SNR	G5	Secure
Cladonia squamosa – cladonia lichen	UF-e1.4	1	1	S2	-	S5	G5	May Be At Risk
Cladonia symphycarpia – cladonia lichen	UF-e1.1	1	1	S2	-	-	G3G5	May Be At Risk
Hypogymnia metaphysodes – lichen	UF-e1.4, UF-i1.1, LF-f3.1	3	3	S2	-	-	G3G5	Secure
Peltigera polydactyla – many fruited pelt lichen	LF-g1.1	1	1	S1S2	-	-	G5?	May Be At Risk
Rhizocarpon chioneum – lichen	LF-e3.4	1	1	S2S3	-	-	G3G4	No Status

E.13.2.6 Traditional Use

Aboriginal consultation meetings, field visits conducted by CVRI with First Nations and Aboriginal representatives resulted in the identification of a list of vegetation species which are valued by the First Nation groups for their uses (Table E.12-1).

The results of baseline (existing) field surveys identified 88 TEK vegetation species which occur in the LSA (CR # 13, Appendix 5). None of the TEK vegetation species are on Alberta's 2011 Tracking and Watch List. Of the TEK vegetation species documented during field surveys, 8 are used for critical medicinal purposes, 20 are used for food and 60 are used for other uses.

TEK vegetation have a very high potential to occur in ecosite phase d1, e2, e3 and i1 and a high potential to occur in c3, e1 and j1 in the Foothills Natural Sub-regions (CR # 13, Table 4.7).

E.13.2.7 Non- Native and Invasive Species

The baseline field surveys identified 16 non-native and invasive species within the LSA with a total of 105 occurrences (CR # 13, Appendix 4). Of these, five are regulated noxious species with 29 occurrences (Government of Alberta 2010) and 11 are non-regulated species which are considered agronomic invasive species (ANPC 2010). The non-native and invasive species are:

- noxious weeds: Chrysanthemum leucanthemum, Cirsium arvense, Linaria vulgaris, Ranunculus acris, and Sonchus arvensis; and
- agronomic invasive species: Festuca rubra, Glyceria grandis, Medicago sativa, Melilotis alba, Melilotis officionale, Phalaris arundinacea, Phleum pratense, Poa pratensis, Trifolium hybridum, Trifolium pratense, and Trifolium repens.

E.13.2.8 Old Growth Forest

The definition of what constitutes an old growth forest varies and is contingent upon the reference used. The age-based definition proposed by Schneider (2002) was chosen for the purpose of this report because the age-based definitions can be easily applied using AVI data. Consequently, old growth forest here is defined according to tree species, using the following criteria:

- white spruce, black spruce, and tamarack forests are 140 years or older;
- pine forests and mixed pine-spruce/tamarack forests are 120 years or older; and
- deciduous and mixed coniferous-deciduous forests are 100 years or older.

Mixed stands are defined as those with less than 80% cover of the dominant tree species, and more than 20% of the tree type that would otherwise denote younger old growth criteria. For example, a stand with 60% black spruce, 20% tamarack, and 20% birch would be considered old growth at 140 years or older, but one with 50% black spruce, 20% tamarack, and 30% birch would be considered old growth at 100 years or older. Stand origin data from the AVI data for the LSA were used to determine the stand ages, and have been rounded to the nearest decade.

Approximately 6,156.7 ha, or 61% of the LSA is old growth forest. The results of the old growth analyses for the LSA are summarized in Table E.13-6 and the old growth distribution within the LSA is presented in CR # 13, Figure 4-2.

Table E.13-6 Old Growth Forest in the LSA and Project Footprint

ELC Composition	LSA		Project Footprint	
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)
Black Spruce Mixedwood	97.1	1.0	87.8	0.9
Black Spruce Pure	151.6	1.5	151.6	1.5
Fir Mixedwood	6.4	0.1	6.4	0.1
Pine Mixedwood	920.1	9.1	877.9	8.7
Pine Pure	2,127.7	21.1	2,127.7	21.1
White Spruce Mixedwood	211.2	2.1	209.7	2.1
White Spruce Pure	141.9	1.4	141.9	1.4
Larch Mixedwood	14.1	0.1	14.1	0.1
Larch Pure	6.2	0.1	6.2	0.1
Aspen Pure	2,173.5	21.5	1,175.0	11.6
Aspen Mixedwood	306.9	3.0	272.2	2.7
Total	6,156.7	61.0	5,070.4	50.2

E.13.2.9 Forestry Resources

As part of the baseline vegetation resource assessment, forestry resources were also surveyed. The specific objectives were to:

- determine the type and volume of timber as per the Alberta Vegetation Inventory (AVI); and
- determine the amount of merchantable and non-merchantable timber within the LSA (using AVI data).

The total area of forested land was determined using the polygon area given by the AVI data. Forested areas (both productive and unproductive) represent 67.3% of the LSA. Productive forested land represents 65.5% of the LSA and non-productive forested land represents 1.8% (CR # 13, Table 4.2). Non-forested land occupies the remainder of the LSA (32.7%) and is a combination of anthropogenic features, lakes and rivers, and areas with shrubby or graminoid vegetation.

The total volume of timber in the LSA is 1,163,537 m^3, of that, 1,158,474 m^3 is classified as productive timber (CR #13, Table 4.3).

E.13.3 Potential Impacts

The overall potential Project effects to vegetation and wetlands are related to removing natural vegetation and disturbing soils within the Project Footprint area. Removing native vegetation will impact vegetation and wetlands directly through the removal of biomass and reduction of plant communities and indirectly through changes to hydrology, soils, topography, biodiversity, and habitat fragmentation.

E.13.3.1 Ecosite Phases

The Project Footprint is predicted to cover 5,728 ha. This represents the removal of 56.8% of ecosite phases (Table E.13-2) from the LSA. Construction and operation of the Project will result in the removal of all natural vegetation and wetlands within the Project footprint.

Potential effects to vegetation as a result of the Project will be mitigated through the reclamation and revegetation activities. These will be aimed at the establishment of equivalent ecosites within the Project area. Ecosite is defined by the site conditions (moisture and nutrient regimes) relative to the regional climate. Over time, reclaimed and revegetated sites are expected to resemble pre-disturbance ecosites.

Initially, a reclaimed and revegetated ecosite will have a different understory species composition and structure compared to naturally occurring ones. Areas will first be dominated by annual graminoid and legume species from a seed mix applied. With time, planted trees, shrubs and forbs are expected to exert an influence on the understory conditions. As a canopy closes, the composition of native species will increase and the structure will become more complex. Reclaimed and revegetated areas are expected to then resemble pre-disturbance ecosites.

The residual Project effect is insignificant following the implementation of mitigation and monitoring measures outlined in Section E.13.5.

E.13.3.2 Wetlands

The area of wetlands that will be removed from the Project Footprint is 565.2 ha which incorporates 76.9% of the LSA wetlands (Table E.13-3). Wetlands which are limited in distribution in the LSA that will be removed total (90.3 ha) which encompasses 16% of the Project Footprint wetlands or 12.29% of the LSA wetlands.

One floating fen will be removed by the Project Footprint. Floating fens are unique for the Foothills Natural Sub-regions; consequently, this ecological feature has contributed to the final significance rating for the Project.

Organic soil wetlands (peatlands) represent an important wetland type in the Project Footprint as these wetland types are difficult to reclaim and slow to recover following disturbance. Mitigation measures, including maintenance of the integrity of the hydrologic regime (drainage patterns) of wetlands; and, minimization of the Project Footprint where wetlands occur are recommended. During construction, peat and topsoil materials from wetlands, will be salvaged and stored for replacement during reclamation. If these mitigation measures are implemented, the effect of the reduction of peatland area, as a result of the Project is expected to be insignificant over time.

E.13.3.3 Rare plants

Construction and operation of the Project will result in the removal of all of the rare plant species listed as in the Project Footprint in Table E.13-5 except for Herzogiella turfacea (liverwort) and Lophozia longidens (liverwort) which were not within the Project Footprint.

Construction and operation of the Project is expected to result in the removal of the rare plant community. The bog willow / marsh cinquefoil (Salix pedicellaris / Potentilla palustris) rich fen community documented is currently tracked by the Alberta Conservation Information Management System and is ranked as S2?

Construction and operation of the Project will result in the removal of 1,454.6 ha of area which encompasses 14.30% of ecosite phases within the LSA with high and very high rare plant potential. High rare plant potential occurs within f1, f2, f3, f4, f6, g1 and g2 which are ecosite phases which typically have a greater diversity of vascular vegetation; while very high rare plant potential occurs within i1 and j1 where a greater diversity of non-vascular vegetation typically occurs.

Vegetation species ranking, in Alberta, is largely determined by the number of times a species is detected in the province. Low profile and hard to identify species are more likely to be listed as rare (Alberta Biodiversity Monitoring Institute (ABMI) 2007). As well, it is difficult to determine if some species are in fact rare, if they are at the edge of their natural range and only appear to be rare, or if they are taxonomically uncertain and have been misidentified or described as subspecies.

Avoidance of rare plant vegetation species ranked between S1 and S3 is the best option; nonetheless, where avoidance is not an option, site and species specific mitigation is the next best option. Mitigation recommendations for this Project have taken into account species specific provincial and global ranking. Specifically, vascular plants with a provincial ranking of between S1 and S3 and with a global ranking of less than G4 are assigned mitigation measures of transplanting to a suitable plant community, and aiding in the dispersal of propagules.

Non-vascular lichen and bryophyte species often have specific and microclimate requirements and/or symbiotic relationships; consequently, transplanting is not a viable option. Accordingly, no mitigation is recommended for the non-vascular species other than reporting these observations to ACIMS for updating of the tracking lists; and minimizing disturbance where practical in areas of potentially suitable habitat for rare plants and rare plant communities. No additional mitigation for lichen species is recommended.

Mitigation measures within the Project Footprint at Project closure, for areas with high and very high rare plant potential, should focus on the re-establishment of ecosite capability which includes high and very high rare plant potential. In time, as these reclaimed and revegetated plant communities begin to function like mature ecosite phases, it is expected that the potential for these sites to support rare plants will return. The re-occurrence of natural disturbances, particularly fire, would enhance restoration of natural composition, structure and functioning, including enhanced rare plant potential.

With implementation of the mitigation measures outlined in Section E.13.5, the residual Project effect is insignificant.

E.13.3.4 Old Growth Forests

The total amount of old growth forest in the LSA is 6,156.7 ha (Table E.13-6) which encompasses 61% of the LSA area. The Project will result in the removal of 5,070.4 ha of old growth forest which encompasses 50.2% of the LSA. The old growth in the Project Footprint is comprised mostly (21.1%) of pure pine which covers 2,127.7 ha and 2,173.5 ha (21.5%) of pure aspen.

The amount of old growth and ecosite phases with the potential to support old growth forests that are to be removed from the Project Footprint is considerable; nonetheless, it is anticipated that the mitigation measures outlined in Section E.13.5 will result in the return of old growth forests over time.

The Project significance rating is insignificant following the implementation of mitigation and monitoring measures outlined in Section E.13.5.

E.13.3.5 Forestry Resources

The Project Footprint will remove 1,083,496 m^3 or 82.2% of the timber volume from the LSA as a result of construction of the Project (CR #13, Table 5.7). Alpine fir is the species with the least amount of volume which will be removed from the Project Footprint and totals 1,457.7 m^3 which is 99.8% of all alpine fir in the LSA. Lodgepole pine is the species with the greatest volume removed and totals 530,442.5 m^3 which encompasses 82% of the total volume of lodgepole pine in the LSA. Trembling aspen is second greatest volume removed, by species and totals 396,170.2 m^3.

E.13.3.6 Non-native and Invasive Species

Sixteen non-native and invasive vegetation species (including noxious species) were noted in the LSA (CR # 13, Appendix 4).

E.13.3.7 Traditional Use Plants

TEK vegetation has a very high potential to occur in ecosite phases d1, e2, e3 and i1 and a high potential to occur in c3, e1 and j1 in the Foothills Natural Sub-regions (CR # 13, Table 5.13). In total 2,264.9 ha of ecosite phases with very high potential to support TEK vegetation will be removed by the Project Footprint, this area encompasses 22.4% of the very high potential area in the LSA. As well, in total 1,354.1 ha of ecosite phases with high potential to support TEK vegetation will be removed by the Project Footprint, high potential area encompasses 13.4% of the high potential area in the LSA. Fifty-four percent (5,467.0 ha) of areas which support TEK vegetation will be removed from the LSA by the Project Footprint.

The distribution of ecosite phases which support TEK vegetation will be accessible in both the RSA following removal of ecosite phases by the Project Footprint in the LSA. With the implementation of mitigation measures the Project is expected to have a limited spatial effect, and a moderate temporal effect. Potential Project effects are related to the attenuation of available TEK vegetation (vegetation used for medicinal, food and other uses) as a result of the removal of ecosite phases within the LSA.

The Project significance rating is insignificant, contingent upon following the implementation of mitigation and monitoring measures outlined in Section E.13.5.

E.13.3.8 Biodiversity

Species Diversity

Construction and operation of the Project will result in the removal of all vegetation from the Project Footprint resulting in reduced species level biodiversity in the LSA. After closure, species richness is expected to be lower than naturally developing ecosites. The current reclamation practice is to seed annual grass and legume species to stabilize reconstructed soils and to minimize sedimentation. Since these species are quick to establish and form a dense turf layer, native species ingress and regeneration will be initially limited due to competition. Native species cover and subsequently biodiversity will increase over time.

Measures taken to mitigate for the reduction in area of terrestrial vegetation, wetlands, old growth forests, and non-native and invasive species will effectively mitigate for potential Project effects on species level biodiversity.

Community and Landscape Diversity

Construction and operation will result in the removal of 100 % of e4 in the UF subregion, k2 (shrubby bog) and n1 ecosite phases from the Project Footprint area. Construction and operation of the Project will result in the removal of 1.2 % (121.1 ha) of ecosite phases with very high biodiversity potential rating, 15.1 % of ecosite phases with high biodiversity potential rating, 38% (3831.3 ha) of ecosite phases with moderate biodiversity potential rating and 0.1 % of the n1 (marsh) ecosite phase that has low biodiversity potential (Table E.13-4) from the LSA.

Effects on Habitat Fragmentation

Within the LSA, ecosite phases with the highest level of fragmentation effect, as a consequence of the Project (application scenario), are f3, l1 (increase in mean patch size and reduction in number of patches); d1, g1, and m2 (increase in the number of patches). When there are increases in the numbers of patches, decreases in patch size, and decreases in the mean perimeter length, fragmentation increases and biodiversity decreases.

Within the RSA, broad cover classes were used to assess the effect of the Project on biodiversity. While the Project occupies just 1.6% (5728 ha) of the RSA, most of the RSA has large tracts of land with forest stands in various stages of maturity following timber harvesting, natural disturbances such as fire and other human directed disturbances. Although effects of the Project may be negligible relative to the size of the RSA, some cover classes will be affected as a result of the Project (CR # 13, Table 5.18 to 5.21). At the landscape level, Shannon diversity index and Shannon's evenness index did not show a net change between baseline and closure. This implies that though area may have been lost from some of the natural cover classes, the overall heterogeneity of the landscape did not change as a result of the Project because other patch types, albeit disturbed types are created on the landscape. Over time, these areas will develop into mature forest stands with high biodiversity potential.

E.13.4 Cumulative Effects Assessment

The planned development case (Cumulative Effects Assessment) was used to assess the effect of the Project in combination with other future projects in the region. Only the RSA is assessed for the effect of the Project in combination with other existing and future projects in the region. Therefore only broad cover classes (ELC classes) were used for the planned development case.

Within the RSA it was necessary to incorporate several activities along with the Project. In the RSA the following disturbances were included in the cumulative effects assessment:

- logging;
- mountain pine beetle;
- pipelines;
- wellsites;
- mines;
- roads; and
- climate change.

Although fire is another disturbance that occurs in the area, it is not predicable enough to make projections with any degree of certainty.

In order to assess the vegetation effects of the Project, as well as other existing, planned, and approved projects and activities within the RSA it was necessary to model into the future. Modeling was carried out by modifying the FRI mapping to reflect the predicted state of the vegetation and wetlands conditions at 10, 25 and 50 years into the future. Four scenarios were considered:

- T0 – Baseline case (Year 0), without Project;
- T10 – Maximum disturbance case (at approximately 10 years into the future) within the RSA for Coal Valley – Robb Trend Project;
- T25 – Disturbance case (at approximately 25 years into the future) within the RSA for Coal Valley – Robb Trend Project; and,
- T50 – Regional closure case (at approximately 50 years into the future) within the RSA.

At 10 years (T10), the largest change related to the Project, the existing CVM disturbance, and other industrial disturbances such as oil and gas exploration and forest harvesting within the RSA is a decrease in natural moderate conifer (-28,105 ha), natural dense conifer (-13,637 ha) and natural moderate mixed (-6,944 ha) (CR # 13, Table 5.3) while at the same time there are increases in natural open regenerating (37,552 ha), natural closed regenerating (14,367 ha) and disturbed open regenerating (3,306 ha).

At 25 years (T25), natural moderate conifer is still decreasing from the Baseline case (-56,980 ha) as is natural moderate mixed (-11,021 ha); while natural closed regenerating and natural open regenerating are increasing nearly equitably (48,278 ha and 19,360 ha respectively). These changes in ELC represent additional forest harvesting as mining progresses, although, the increases in natural open and closed regenerating are keeping pace, to some degree, with clearing at this 25 year stage.

After 50 years (T50), the amount of change related to the Project, the existing CVM disturbance, and other industrial disturbances such as oil and gas exploration and forest harvesting within the RSA has levelled off and forests are establishing. The introduction of man-made lakes to the landscape is a higher effect of the Project given the creation of approximately 722 ha of water bodies. The greatest change in area is expected to be the decrease in natural open regenerating

(-33,029 ha) and the increase in natural dense conifer (+34,387 ha) which is a reflection of continued reclamation and re-vegetation of mined areas and planted forests (CR # 13, Figure 5-3).

Habitat fragmentation will increase with the addition of the Project in combination with other existing and approved future projects in the RSA. Specifically the number of patches will increase while the mean area of individual patches will decrease. Because most of the RSA is dominated by forest stands slated for timber harvesting, natural succession will progressively increase in areas that are mapped as natural open regenerating at baseline. Overall, the number of patches of natural dense conifer, natural closed regenerating and natural moderate conifer cover classes will increase as previously harvested stands mature.

Although the responses of species populations to changes in habitat area and fragmentation are uncertain (and these responses are likely to vary among species), it is expected that the populations of most species will recover to near-baseline levels where reclaimed habitat is structurally and compositionally similar to that existing at baseline.

E.13.5 Mitigation and Monitoring

E.13.5.1 Mitigation

In order to reduce potential impacts of the Project on vegetation and wetlands resources CVRI will:

- implement a re-vegetation program which aims at the establishment of ecosite equivalent to the pre-disturbed landscape;
- implement a re-vegetation program which aims at the re-establishment of ecosites which are regionally limited in distribution;
- design to preserve adjacent habitat by minimizing the area required for construction and operation of the Project;
- seed stockpiled topsoil with suitable species mix to ensure long term stability of the soil piles, which reduces erosion and the potential for weed establishment;
- use coarse woody debris, when available, to amend soils to provide mycorrhizal and microbial inoculum;
- implement the use of tree, shrub, forb and graminoid vegetation species native to ecosites;
- implement the use of tree, shrub, forb and graminoid vegetation species to provide structure to ecosites with the goal of enhancing biodiversity;
- design the division of wetlands by roads to reduce the effect of water flow to wetlands outside of the Project;
- implement the use of short-lived agronomics on sites with a higher degree of disturbance, to provide soil stability and prevent soil erosion;
- work with Aboriginal groups to design and implement re-vegetation programs that target and support TEK vegetation;
- for areas with high and very high rare plant potential, will focus on the re-establishment of ecosite capability which includes high and very high rare plant potential;

- transplant rare plants found within the Project where possible that have a provincial ranking of S1-S3 and global rank of less than G4;
- plan to salvage all merchantable timber; and
- continue the weed control program currently in place at the CVM.

E.13.5.2 Monitoring

In order to assess the effectiveness of the mitigation measures CVRI will:

- assess the composition, structure, ecological succession and biodiversity targets of reclaimed sites;
- monitor timber harvesting activities;
- monitor revegetation efforts by performing survival, growth and health assessments;
- conduct a rare plant survey on any new development areas not included in this assessment;
- monitor and maintain drainage control structures in relation to wetlands adjacent to the Project;
- monitor re-establishment in reclaimed wetlands;
- conduct regeneration surveys on reclaimed lands and assess whether stocking densities and performance expectations are being met;
- conduct regular site inspections to identify invasive species; and
- complete post reclamation studies, similar to those completed on existing CVM reclaimed sites, to assess reclamation and allow for adaptive management.

E.13.6 Summary of VECs

Environmental effects on vegetation and wetland resources were assessed after accounting for relevant mitigation measures. Mitigation and monitoring methods and approaches towards re-establishing pre-development land capability are planned for all stages of the Project to minimize and, where possible, prevent Project effects. These methods will be implemented in conjunction with the Project Reclamation Plan (Section F), and priority effort will be given to the VECs. Table E.13-8 summarizes the impacts to Vegetation, Wetlands and Rare plants.

Table E.13-8 Summary of Impacts on Vegetation and Wetlands Valued Environmental Components

VEC	Nature of Potential Effect	Mitigation / Protection Plan	Type of Effect	Geographical Extent of Effect[1]	Duration of Effect[2]	Frequency of Effect[3]	Ability for Recovery from Effect[4]	Magnitude of Effect[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Effect Occurrence[8]	Significance[9]
1. Terrestrial Vegetation/Plant Communities (Ecosite Phases)												
	Reduction in Plant Community Types & Area	Section E.13.5	Application	Local	Extended	Continuous	Reversible Long Term	High	Neutral	Moderate	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	High	Neutral	Moderate	High	Insignificant
2. Rare Plants, Rare Plant Communities and Rare Plant Potential												
	Removal of Rare Species, Communities & Potential	Section E.13.5	Application	Local	Extended	Continuous	Reversible Long Term	Moderate	Neutral	Low	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Moderate	Neutral	Low	High	Insignificant
3. Wetlands												
	Reduction in Types & Area	Section E.13.5	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Low	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Low	High	Insignificant
4. Old Growth Forests												
	Removal of Old Growth Forests	Section E.13.5	Application	Local	Extended	Isolated	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Isolated	Reversible Long Term	Low	Neutral	High	High	Insignificant
5. Non-native and invasive species												
	Spread of Invasive & Non-native Species	Section E.13.5	Application	Local	Extended	Periodic	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Periodic	Reversible Long Term	Low	Neutral	High	High	Insignificant
6. Traditionally Used Plants												
	Removed from Footprint	Section E.13.5	Application	Local	Extended	Continuous	Reversible Long Term	Moderate	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Moderate	Neutral	High	High	Insignificant

Table E.13-8 Summary of Impacts on Vegetation and Wetlands Valued Environmental Components

VEC	Nature of Potential Effect	Mitigation / Protection Plan	Type of Effect	Geographical Extent of Effect[1]	Duration of Effect[2]	Frequency of Effect[3]	Ability for Recovery from Effect[4]	Magnitude of Effect[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Effect Occurrence[8]	Significance[9]
7. Biodiversity												
	Reduction in Genetic-Species Diversity	Section E.13.5	Application	Local	Extended	Continuous	Reversible Long Term	Low	Negative	Moderate	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant
	Reduction of Community Diversity	Section E.13.5	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
	Reduction of Landscape Diversity	Section E.13.5	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant

(1) Local, Regional, Provincial, National, Global
(2) Short, Long, Extended, Residual
(3) Continuous, Isolated, Periodic, Occasional (Accidental, Seasonal)
(4) Reversible in short term, Reversible in long term, Irreversible – rare
(5) Nil, Low, Moderate, High
(6) Neutral, Positive, Negative
(7) Low, Moderate, High
(8) Low, Medium, High
(9) Insignificant, Significant

E.14 WILDLIFE

E.14.1 INTRODUCTION AND TERMS OF REFERENCE

CVRI retained Bighorn Wildlife Technologies Ltd. to conduct a Wildlife Assessment for the proposed Project. The following is a summary of the Wildlife Assessment included as Consultant Report #14 (CR# 14). This section has been prepared to discuss the wildlife impacts for the Project.

The specific requirements for wildlife are provided in Section 3.7 and 3.8 of the ToR and are as follows:

CVM shall describe existing wildlife resources (amphibians, reptiles, birds and terrestrial and aquatic mammals), and their use of habitats in the Study Area(s). Document the anticipated changes to wildlife in the Study Area(s). Specifically:

3.7.1 Baseline Information

[A] Describe and map existing wildlife resources (amphibians, reptiles, birds and terrestrial and aquatic mammals) and their use and potential use of habitats.

[B] Identify key indicator species and discuss the rationale for their selection. Identify composition, distribution, relative abundance, seasonal movements, movement corridors, habitat requirements, key habitat areas, and general life history. Address those species:

a) listed as "at Risk, May be at Risk and Sensitive" in The Status of Alberta Species (Alberta Sustainable Resource Development);

b) listed in Schedule 1 of the federal Species at Risk Act; and

c) listed as "at risk" by COSEWIC.

[C] Describe, quantify and map all existing habitat disturbances (including exploration activities) and identify those habitat disturbances that are related to existing and approved Project operations.

3.7.2 Impact Assessment

[A] Describe Project components and activities that may affect wildlife and wildlife habitat.

[B] Describe and assess the potential impacts of the Project on key indicator species and relate those impacts to wildlife populations and wildlife habitats, addressing:

a) how the Project will affect wildlife relative abundance, movement patterns, distribution and recruitment into regional populations for all stages of the Project;

b) how improved or altered access may affect wildlife including potential obstruction of daily and seasonal movements, increased vehicle-wildlife collisions, and increased hunting pressures;

c) how increased habitat fragmentation may affect wildlife considering edge effects, the availability of core habitat, and the influence of linear features and infrastructure on wildlife movements and other population parameters;

- d) *the spatial and temporal changes to habitat availability and habitat effectiveness (types, quality, quantity, diversity and distribution);*
- e) *potential impacts on wildlife resulting from changes to air and water quality, including both acute and chronic effects to animal health;*
- f) *the resilience and recovery capabilities of wildlife populations and habitats to disturbance; and*
- g) *the potential for the Project Area to be returned to its existing state with respect to wildlife populations and their habitats.*

[C] Comment on the availability of species for traditional use considering habitat loss, habitat avoidance, vehicle-wildlife collisions, increased non-aboriginal hunting pressure and other Project related impacts on wildlife populations.

[D] Provide a strategy and mitigation plan to minimize impacts on wildlife and wildlife habitat for all stages of the Project and to return productive wildlife habitat to the area, considering:

- a) *consistency of the plan with applicable regional, provincial and federal wildlife habitat objectives and policies;*
- b) *a schedule for the return of habitat capability to areas impacted by the Project;*
- c) *the use of setbacks to protect riparian habitats, interconnectivity of such habitat and the unimpeded movement by wildlife species using that habitat and the use of buffers (e.g. treed buffers) to reduce visual or noise impacts on wildlife;*
- d) *anticipated access controls or other management strategies to protect wildlife during and after Project operations;*
- e) *measures to prevent habituation of wildlife to minimize the potential for human-wildlife encounters and consequent destruction of wildlife, including any staff training program, fencing camps, garbage containment measures or regular follow-up;*
- f) *measures to mitigate habitat fragmentation considering impacts to habitat connectivity and wildlife movements resulting from linear features (e.g., above ground pipelines, roads etc.) and other Project infrastructure and activities; and*
- g) *measures to mitigate mortality risks to wildlife from roads or other hazards related to Project infrastructure.*

3.8 BIODIVERSITY

3.8.1 Baseline Information

[A] Describe the terrestrial and aquatic biodiversity metrics that will be used to characterize the existing ecosystems and probable impacts of the Project, and:

- a) *describe the process and rationale used to select biotic and abiotic indicators for biodiversity within selected taxonomic groups;*
- b) *determine the relative abundance of species in each ecosite phase;*
- c) *provide species locations, lists and summaries of observed and estimated species richness and evenness for each ecosite phase;*

d) provide a measure of biodiversity on baseline sites that are representative of the proposed reclamation ecosites; and

e) rank each ecological unit for biodiversity potential. Describe the techniques used in the ranking process.

3.8.2 Impact Assessment

[A] Describe the metrics used to assess the probable impacts of the Project. Discuss the contribution of the Project to any anticipated changes in regional biodiversity and the potential impact to local and regional ecosystems.

[B] Identify and evaluate the extent of potential effects of fragmentation on biodiversity that may result from the Project. Discuss those effects at all relevant scales (from site specific to landscape level).

[C] Discuss the mitigation measures proposed to minimize any anticipated changes in regional biodiversity.

The specific tasks established for this component of the wildlife assessment were:

- identify relative abundance, concentration areas, distribution patterns, and habitat associations of ungulates by means of winter aerial surveys, snow track-counts, and a spring pellet-browse survey;
- identify small mammal, avian and amphibian presence, relative abundance and habitat association by means of snow track-counts, trapping small mammals, owl surveys, spring bird survey, breeding bird survey, migration survey, and amphibian survey;
- compile a list of vertebrate species (excluding fishes) and identify their status as per the Committee on Endangered Wildlife in Canada (COSEWIC), the Canadian Endangered Species Conservation Council (CESCC 2006) and the General Status of Alberta Wild Species (ASRD 2005);
- prepare a habitat map to identify the quantity and quality of habitat present in the Project Development Areas;
- update wildlife use of the existing CVM by means of aerial survey, systematic monthly ground surveys, spring pellet-group counts, breeding bird survey and amphibian survey;
- identify Valued Environmental Components for assessing the potential impact of the proposed development on ungulates, small mammals, birds and amphibians;
- discuss biodiversity at the LSA and RSA scale;
- review Traditional Use Studies (TUS) prepared for CVRI from a wildlife perspective;
- discuss climate change with respect to changes in the Boreal-Cordilleran ecoregion that may affect wildlife; and
- evaluate the potential impacts of the Project within a temporal and spatial perspective that incorporates existing and future demands by other users and developments by conducting a quantitative cumulative effects assessment for elk.

The study areas are included in Figure D.2.3-1 and D.2.3-2 and CR# 14, Figure 1.1. The local study area (LSA) includes the proposed mine permit area. The regional study area (RSA) is comprised of seven Bear Management Units (BMUs) defined by the Foothills Model Forest

Grizzly Bear project (Stenhouse and Munroe 2002). The units are: McPherson, McLeod, Embarras, Lendrum, Beaverdam, Upper Pembina and Lower Pembina

E.14.2 BASELINE SETTING

E.14.2.1 Habitat

Forty habitat types were identified for the LSA (Table E.14-1, CR #14, Figure 4.1). Habitats were derived from ecosite phase coverage provided by Millennium EMS Solutions Ltd. (Millennium).

Five habitat types dominated the Project (58%) and they are: Lodgepole Pine / TB (13.7%); Lodgepole Pine-Black Spruce / LT (12.9%); Mixed Wood / TB (11.8%); Coniferous Cutblock (10.7%); and Mixed Wood Cutblock (8.9%).

Coniferous forests represented the majority of habitat types (40.5%) of the Project, while deciduous forests comprised of mixed wood or trembling aspen represented 26.5%. Bogs and fens of various composition covered 7% of the area. Willow Upland (0.9%), Willow-Birch Meadow (1%), Forb Meadows (0.06%) and Herbaceous Grasslands (1%) were present. Mixed Wood and Coniferous Cutblocks represented about 20 % of the Project. Non vegetated areas comprised 3% of the area. Small amounts of cattail marsh and open water were present.

Approximately 5,728 ha of wildlife habitat or about 57% of the Project mine permit area will be disturbed. Most of the disturbance in the Project (48% or 2,096.5 ha) will occur in four habitats: Lodgepole Pine / TB (16.8%); Lodgepole Pine-Black Spruce / LT (13.5%); Mixed Wood / TB (10.4%); and Black Spruce–Lodgepole Pine / LT (7%). Ten percent of the mining disturbance (494.8) ha will occur in coniferous and deciduous cutblock habitat.

Table E.14-1 Amount (ha) and Composition of Habitat and Disturbance by the Robb Trend Project.

ID	Habitat Name	RT LSA (ha)	% of RT	RT disturbed (ha)	% of RT disturbed	% of Habitat Disturbed
H1	Bearberry Grassland	0.00	0.00	0.00	0.00	0.00
H2	Lodgepole Pine / Bearberry	25.52	0.25	5.75	0.13	22.5
H3	Lodgepole Pine / Hairy Wild Rye	179.52	1.78	90.92	2.07	50.6
H4	Trembling Aspen / Hairy Wild Rye	71.68	0.71	30.35	0.69	42.3
H5	Mixed Wood / Hairy Wild Rye	397.27	3.95	165.84	3.77	41.7
H6	White Spruce / Hairy Wild Rye	29.94	0.30	7.92	0.18	26.5
H7	Lodgepole Pine - Black Spruce / Labrador Tea	1302.97	12.95	592.82	13.47	45.5
H8	Lodgepole Pine / Tall Bilberry	1374.76	13.67	737.55	16.76	53.6
H9	Lodgepole Pine / Tall Bilberry – Burn	27.60	0.27	27.95	0.64	100.0
H10	Mixed Wood / Tall Bilberry	1187.46	11.80	458.27	10.41	38.6
H11	Subalpine Fir / Tall Billberry	6.43	0.06	6.43	0.15	100.0
H12	Trembling Aspen / Lowbush Cranberry	444.12	4.41	176.21	4.00	39.7
H13	Mixed Wood / Lowbush Cranberry	121.98	1.21	97.55	2.22	80.0

Table E.14-1 Amount (ha) and Composition of Habitat and Disturbance by the Robb Trend Project.

ID	Habitat Name	RT LSA (ha)	% of RT	RT disturbed (ha)	% of RT disturbed	% of Habitat Disturbed
H14	Lodgepole Pine / Bracted Honeysuckle	355.82	3.54	124.75	2.84	35.1
H15	Mixed Wood / Bracted Honeysuckle	262.83	2.61	83.05	1.89	31.6
H16	White Spruce / Bracted Honeysuckle	157.50	1.57	127.15	2.89	80.7
H17	Alpine Fir / Bracted Honeysuckle	0.00	0.00	0.00	0.00	0.00
H18	Willow Upland	89.93	0.89	3.27	0.07	3.6
H19	Willow-Birch Meadow	97.50	0.97	42.75	0.97	43.9
H20	Forb Meadow	6.05	0.06	6.05	0.14	100.0
H21	Black Spruce - Lodgepole Pine / Labrador Tea	364.40	3.62	307.87	7.00	84.5
H22	Black & White Spruce / Labrador Tea	187.37	1.86	118.72	2.70	63.4
H23	Deciduous / Horsetail	137.96	1.37	111.241	2.53	80.6
H24	Mixed Wood / Horsetail	0.00	0.00	0.00	0.00	0.00
H25	White Spruce / Horsetail	0.84	0.01	0.00	0.00	0.00
H26	Treed Bog	184.86	1.84	110.37	2.51	59.7
H27	Shrubby Bog	2.82	0.03	2.82	0.06	100.0
H28	Treed Poor Fen	361.38	3.59	192.84	4.38	53.4
H29	Shrubby Poor Fen	26.18	0.26	14.23	0.32	54.4
H30	Graminoid Poor Fen	6.53	0.06	4.11	0.09	62.8
H31	Treed Rich Fen	87.06	0.87	73.05	1.66	83.9
H32	Shrubby Rich Fen	6.96	0.07	0.34	0.01	4.9
H33	Graminoid Rich Fen	43.15	0.43	17.18	0.39	39.8
H34	Cattail Marsh	6.15	0.06	6.15	0.14	100.0
H35	Herbaceous Grassland - mostly agronomics	98.65	0.98	42.60	0.97	43.2
H36	Mixed Wood Cutblock	899.96	8.95	233.47	5.31	25.9
H37	Coniferous Cutblock	1076.36	10.70	261.31	5.94	24.3
H38	Non Vegetated RoW, Gravel, Mines, Sand etc	310.99	3.09	118.03	2.68	38.0
H39	Shallow Open Water	2.97	0.03	1.38	0.03	46.5
H40	River	8.68	0.09	0.00	0.00	0.00
H41	Pine / Lowbush Cranberry	0.00	0.00	0.00	0.00	0.00
H42	White Spruce / Lowbush Cranberry	21.34	0.21	0.00	0.00	0.00

Table E.14-1 Amount (ha) and Composition of Habitat and Disturbance by the Robb Trend Project.

ID	Habitat Name	RT LSA (ha)	% of RT	RT disturbed (ha)	% of RT disturbed	% of Habitat Disturbed
H43	Deciduous / Bracted Honeysuckle 49.34 ha	49.34	0.49	0.00	0.00	0.00
H44	White Spruce / Tall Bilberry 42.21 ha	42.21	0.42	0.00	0.00	0.00

E.14.2.2 Ungulates

The Project ungulate aerial survey indicated that white-tailed deer were the most abundant ungulate (382) observed during the winter air survey, followed by elk (187), moose (145), and mule deer (87) (Table E.14-2). Relative abundance in 2008 as expressed by density (uncorrected for visibility bias) was: white-tailed deer (0.38/km^2), elk (0.19/km^2), moose (0.15/km^2), and mule deer (0.09/km^2).

Three wolf packs of 8, 2 and 2, one cougar and one coyote were also observed during the 2008 survey. As well, a Northern Goshawk, Barred Owl, Common Ravens, one unidentified raptor and one Gray Jay were also observed.

Table E.14-2 Number of ungulates observed during the Robb Trend air survey (composite December 22- 24, 2008 and January 10, 2011).

Species	Cow	Calf	Bull	U/C	Total	Bull :100 Cow :Calf
Elk	138	27	22	0	187	16:100:20
Moose	99	23	19	4	145	19:100:23
Mule Deer	54	14	19	0	87	35:100:26
White-tailed Deer	241	94	35	12	382	15:100:39
Deer sp.				2	2	

To evaluate differences in population numbers in the Coal Valley area, the area of the recent air surveys conducted in 2007 and 2008 was adjusted to the same area flown during the 1996 and 1997 air surveys (Table E.14-3).

Table E.14-3 Comparison of Ungulates Observed During Four Ungulate Air Surveys Flown in the Robb Trend Area During the Winters of 1996-97, 2007 and 2008. The 2007 and 2008 Surveys are Adjusted to the Same Area Flown in 1996/97.

Date	Elk	Moose	Mule Deer	White-tailed Deer	Deer sp.	Total
November 21, 1996	184	88	39	2	4	317
January 12, 1997	77	71	7	5	1	161
January 11 &12, 2007	133	17	4	76	0	230
December 22-24, 2008	183	10	60	176	0	429

Elk

One hundred and eighty-seven elk (22 bulls, 138 cows, 27 calves) were observed during the Project 2008 aerial survey for a bull:100cow:calf ratio of 16:100:20. Even though elk numbers in the northern east slopes have increased since 1987, particularly for the Hinton-Cadomin area (Murphy and Kneteman 2011), it appears that the elk of the Lovett Ridge complex are not increasing. Several reasons for this may include: increased access on the northeast side of the Lovett Ridge allowing for increasing legal and illegal harvest, continuing predation and static habitat.

A harmonic mean analysis of elk distribution during the Project survey indicated that 98% of elk observations were made in two areas on the CVM comprising 24% of the total elk distribution (CR #14, Figure 5.1). The area occupied by elk on the Lovett ridge has been reduced since surveys were first flown for CVRI's CVM in 1996. The core area occupied by elk in 2011 (57 km²) is slightly larger than the core area identified during the 2007 air survey (30.2 km²) but much reduced from the core area occupied during the 1996/97 survey (190.9 km²).

Evidence of overwinter elk use as measured by pellet-group counts was found in 16 of 26 habitats sampled in the Project LSA at a moderate overall level of use. Elk showed highest preference for Trembling Aspen/HWR (69 pg/ha), White Spruce/LC (14 pg/ha)/ha, Mixed Wood/LC (58 pg/ha), Deciduous/BH (10 pg/ha), Willow Upland 18 pg/ha), Mixed Wood/BH (50 pg/ha), and Trembling Aspen/LC (33 pg/ha) habitats (CR #14, Table 5.6). These 7 habitats occur in the Project but comprise a small amount of total area (<8.6%).

Moose

There were 145 moose (19 bulls, 99 cows, 23 calves, and four unclassified) observed during the Project air survey. The bull:100cow:calf ratio was 19:100:23. Moose numbers have declined on the Lovett Ridge in the area containing the CVM including the South Block expansion between 1996 and 2008. Ficht and Smith (2004) cited increased road access that enhances regulated and unregulated hunting opportunities, an over estimate of the population for several years resulting in too high bull harvest goals, and a more accurate survey in 2004 over 1996 as reasons for the decline between 1994 and 2004.

Moose were distributed throughout the Project between the Pembina River and the McLeod River in three areas of concentration. Sixty percent of moose observations in the survey area were made in these three areas which comprise 42% of the total moose distribution (Table 5.3, Figure 5.2). The centre of activity for moose in the survey area occurred in the CVM South Block.

Moose showed highest preference for Shrubby Rich fen, Willow Upland, White Spruce/TB, Mixed Wood/LC, and Deciduous/H. Moderate preference was made for Mixed Wood/BH, Treed bog, and Deciduous/BH. Low preference was made for Lodgepole Pine/HWR, Mixed Wood/HWR, and Lodgepole Pine/BH.

Mule Deer

Eighty-seven mule deer were observed on the December 22 to 24, 2008 and January 10, 2011 air survey (19 buck, 54 cows, and 14 calves). The buck:100doe:fawn ratio was 35:100:26. This is the highest number of mule deer observed since surveys were flown for CVRI's CVM in 1996.

Mule deer exhibited a bimodal distribution associated with the CVM (CR #14, Figure 5.3) where 93% of observations occurred. The core area of use was concentrated on new reclaimed habitat in the CVM South Block and Mercoal East. The harmonic centre was located in the CVM South Block. Only one observation of two mule deer was made in the Project LSA.

A strong association exists between mule deer distribution and rugged, steep-sloping terrain. Mule deer prefer steep topography, partially treed lands associated with valley slopes and bottom-lands, south-facing slopes, tree-line subalpine, and montane environments (Neitfeld et al. 1984). Deer showed highest preference for Mixed Wood/BH, Deciduous/BH and Mixed Wood/LC habitats. Deer showed moderate preference for Lodgepole Pine/HWR, Trembling Aspen/HWR, Lodgepole Pine/BH, Willow Upland, and White Spruce/TB.

White-tailed Deer

Three hundred and eighty-two white-tailed deer were observed during the December 22 to 24, 2008 and January 10, 2011 air survey (35 bulls, 241 cows, 94 calves, and 12 unclassified). White-tailed deer have steadily increased in numbers since surveys were begun for CVRI's CVM in 1996.

White-tailed Deer were strongly associated (65% of observations in 29% of the total distribution area) with the Lovett Ridge southwest of Robb in the headwaters of the Embarras River, Bacon Creek, Halpenny Creek and Lendrum Creek west of Corser's Road (CR #14, Figure 5.4). The centre of activity occurred on Halpenny East. Most observations on the CVM were associated with the headwaters of Halpenny Creek.

White-tailed deer are generally associated with valley bottom habitat. This may explain why white-tailed deer are found on the north side of the Lovett Ridge complex where streams and associated riparian habitat are found throughout the area.

E.14.2.3 Small Mammals

Shrews and Cricetid Rodents

Seven species of small mammals and 330 individuals were caught in the Project in 2004 during 3,816 trap-nights. Capture success was 8.6% and the corrected catch effort was 10.16 animals per 100 trap-nights.

The southern red-backed vole was the most abundant (4.19 /100 TN) small mammal captured in the Project (Table E.14-4). It was most abundant in Black Spruce-Pine / LT habitat but was also found in high numbers in Pine-Black Spruce / LT and Aspen / LC habitats.

Table E.14-4 Corrected Catch Effort (CE=#/100 trap nights) of Small Mammals per Habitat, Robb Trend, 2007 and 2008

	H7	H19	H26	H12	H36	H28	H29	H10	H23	H5	H37	H31	H21	H35	Total
	Pine-Blk Spruce/ LT	**Willow-Birch Meadow**	**Treed Bog**	**Aspen/ LC**	**Deciduous Cutblock**	**Treed Poor Fen**	**Shrubby Poor Fen**	**Mixed Wood/ TB**	**Deciduous/ H**	**Mixed Wood/ HWR**	**Coniferous Cutblock**	**Treed Rich Fen**	**Blk Spruce-Pine/ LT**	**Grass-land**	
Masked Shrew	2.56	2.46	0.71	10.63	2.62	2.05		2.39	2.64	3.17	0.8	2.01	0.78	1.95	2.25
Arctic Shrew	3.84		1.77		7.86			0.75			1.1	0.67	1.56		1.08
Dusky Shrew		0.35		1.93			0.65	0.13		1.41					0.28
Deer Mouse				1.93				2.39	1.32	0.71	0.4			1.30	0.86
S. Red-backed Vole	10.66		8.13	10.63	3.49	2.74		3.01		0.35	8.7		16.41		4.19
Meadow Vole								0.75				0.67	0.78		0.25
W. Jumping Mouse	0.43	5.27		5.80	11.35			0.63						0.65	1.26
Total	17.48	8.08	10.60	30.92	25.33	4.79	0.65	10.04	3.96	5.64	10.9	3.36	19.53	3.90	10.16

Capture effort in the Project (10.16/100TN) was the second highest of all small mammal inventories conducted in the region since 1992. Capture effort on the CVM Yellowhead Tower mine area (15.48/100TN) in 2006 was higher than other small mammal inventories, while capture effort on CVM Mercoal West mine area in 2004 was the lowest (1.43/100TN). Catch effort on the CVM (1992), South Block, West Extension and Mercoal East ranged between 4.44 and 6.09/100 TN (Table E.14-5). All species captured on the Project LSA occurred within their expected range in Alberta (Smith 1993).

Table E.14-5 Corrected Catch Effort (# / 100 TN) of Small Mammal Species from the Robb Trend Regional Study Area, 1992- 2010.

	Coal Valley 1992	West Extension 1996, 1997	South Block 1996, 1997	Mercoal East 2001, 2002	Mercoal West 2004	Yellowhead Tower 2006	Robb Trend 2007-2010
# of Trap Nights	1908	1431	1431	3816	1908	1908	3816
# of Traplines	12	9	9	24	12	12	24
#/100TN (CE)	4.85	6.09	4.44	4.98	1.43	15.48	10.16
Masked Shrew	-	0.53	0.66	0.57	0.39	2.56	2.25
Dusky Shrew	0.11	0.08	-	0.03	0.17	1.16	0.28
Arctic Shrew	0.83	1.2	0.36	0.33	0.11	2.01	1.08
Deer Mouse	1.05	-	-	-	-	0.18	0.86
SRB Vole	0.61	2.18	2.26	1.77	0.33	5.24	4.19
Meadow Vole	2.21	1.57	1.09	2.26	0.22	3.96	0.25
N Bog Lemming	-	-	-	-	0.06	-	-
WJ Mouse	0.06	0.45	0.07	-	0.17	0.24	1.26
Total Species	6	6	6	5	7	7	7

SRB Vole=Southern Red-backed Vole N Bog Lemming=Northern Bog Lemming WJ Mouse=Western Jumping Mouse

Bats

Thirteen hours of bat surveys were conducted throughout the Project LSA in late July and early August, 2008, 2009 and 2010. Myotis species were the most common bat in the Project (8.9 passes/hour and 2.8 buzzes per hour). Hoary / Silver-haired bats were reasonably common while the Big Brown Bat was the least common.

Hares, Squirrels, Muskrats and Porcupine

The snowshoe hare is found throughout the province except for the grassland region. It occurs in the Foothills where it is widespread but may undergo local periodical fluctuations. The Snowshoe Hare was present throughout the Project LSA.

The red squirrel is widespread throughout the Boreal-Cordilleran region (Smith 1993) and is probably the best known tree squirrel in the region. The red squirrel and characteristic middens were observed in many different habitats that throughout the Project.

The LSA occurs within the range of the northern flying squirrel (Smith 1993). This species occurs in coniferous and mixed wood forests. It is likely that the northern flying squirrel occurs throughout the Project.

The Least Chipmunk is widespread in the Foothills Natural Region (Smith 1993) but may have a local distribution. Least Chipmunks were recorded in the Project LSA May 11 and 12, 2007 in habitats associated with the forest edge.

The muskrat is a semi-aquatic rodent and is widespread throughout the region wherever there is long-standing or permanent water, *i.e.*, sloughs, lakes, marshes, streams (Smith 1993). Muskrats were incidentally on the Project in the pond north of HWY 47 at the Robb corner. Muskrats are found on the CVM.

American beaver are found throughout the province wherever there is suitable water (sloughs, rivers, creeks and lakes) and trees within easy access. Active and abandoned beaver dams were present throughout the northern part of the Project. Beavers have been recorded on ponds and various water bodies on the CVM.

Porcupines are found throughout the province but never in large numbers. Porcupines were observed on the Lovett Ridge in the CVM West Extension and in the South Block (Bighorn 1999:68).

E.14.2.4 Avifauna

Breeding Birds

Bird survey activities in the Project between 2007 and 2010 resulted in the identification of 120 species and 3,982 bird observations. Observations were made during the breeding bird survey (2,347 birds); winter resident survey (445 birds); owl survey (15 birds); and incidentally (1,175 birds). The White-throated Sparrow, Yellow-rumped Warbler, Pine Siskin, Lincoln's Sparrow, and Swainson's Thrush were the most abundant species (>20 pairs per km^2) identified during the Project breeding bird surveys (Table E.14-6). These five species represented 6% of the 83 species and 987 birds or 42% of the individuals identified during these surveys.

Nine species composed of 633 birds or 27% of individuals counted were relatively abundant (8-19 pairs/km^2). They were: Warbling Vireo, Dark-eyed Junco, Chipping Sparrow, Red-breasted Nuthatch, Yellow-bellied Sapsucker, Ruby-crowned kinglet, American Robin, Gray Jay, and Alder Flycatcher.

Table E.14-6 Relative Abundance of Bird Species Located on the Robb Trend During Breeding Bird Surveys Conducted June through early July, 2007 to 2010.

Species	% Occurrence	Total Birds	Pairs/km^2	Diversity (BSD)
White-throated Sparrow	61.54	297	45.47	0.262
Yellow-rumped Warbler	65.87	229	35.06	0.227
Pine Siskin	33.65	186	28.48	0.201
Lincoln's Sparrow	32.69	141	21.59	0.169
Swainson's Thrush	43.75	134	20.52	0.163
Warbling Vireo	32.21	95	14.55	0.130
Dark-eyed Junco	29.81	85	13.01	0.120
Chipping Sparrow	28.37	74	11.33	0.109
Red-breasted Nuthatch	26.44	70	10.72	0.105
Yellow-bellied Sapsucker	28.37	67	10.26	0.102
Ruby-crowned Kinglet	27.88	65	9.95	0.099
American Robin	26.92	65	9.95	0.099
Gray Jay	27.40	60	9.19	0.094
Alder Flycatcher	16.35	52	7.96	0.084
Wilson's Warbler	16.35	47	7.20	0.078
White-winged Crossbill	5.29	44	6.74	0.075
Wilson's Snipe	15.38	40	6.12	0.069
Golden-crowned Kinglet	13.94	38	5.82	0.067
Orange-crowned Warbler	15.87	38	5.82	0.067
Tennessee Warbler	12.98	32	4.90	0.059
Hermit Thrush	12.98	30	4.59	0.056
Yellow-bellied Flycatcher	11.54	29	4.44	0.054
Mourning Warbler	8.17	26	3.98	0.050
Brown-headed Cowbird	8.65	25	3.83	0.048
Least Flycatcher	7.69	23	3.52	0.045
Varied Thrush	8.65	23	3.52	0.045
Common Yellowthroat	5.77	23	3.52	0.045
Cedar Waxwing	5.29	19	2.91	0.039
Swamp Sparrow	3.85	19	2.91	0.039
Black-capped Chickadee	7.69	18	2.76	0.037
Clay-colored Sparrow	4.33	17	2.60	0.036
Solitary Sandpiper	6.73	16	2.45	0.034
Northern Flicker	6.25	15	2.30	0.032
Common Raven	5.29	13	1.99	0.029
Western Wood-Pewee	5.29	12	1.84	0.027
Rose-breasted Grosbeak	4.33	11	1.68	0.025
Tree Swallow	1.92	10	1.53	0.023
Western Tanager	3.37	10	1.53	0.023
American Redstart	2.88	9	1.38	0.021

Table E.14-6 Relative Abundance of Bird Species Located on the Robb Trend During Breeding Bird Surveys Conducted June through early July, 2007 to 2010.

Species	% Occurrence	Total Birds	Pairs/km^2	Diversity (BSD)
Hairy Woodpecker	3.37	8	1.22	0.019
Dusky Flycatcher	3.37	8	1.22	0.019
Red-eyed Vireo	2.88	7	1.07	0.017
Ovenbird	2.88	7	1.07	0.017
Spotted Sandpiper	2.40	6	0.92	0.015
Olive-sided Flycatcher	2.88	6	0.92	0.015
Barn Swallow	1.44	6	0.92	0.015
Boreal Chickadee	2.88	6	0.92	0.015
Brown Creeper	2.88	6	0.92	0.015
Red-winged Blackbird	0.96	6	0.92	0.015
Red Crossbill	1.44	6	0.92	0.015
Ruffed Grouse	2.40	5	0.77	0.013
Amer. Three-toed Woodpecker	2.40	5	0.77	0.013
Yellow Warbler	1.92	5	0.77	0.013
Blue-headed Vireo	1.44	4	0.61	0.011
Winter Wren	1.92	4	0.61	0.011
Townsend's Solitaire	1.92	4	0.61	0.011
Northern Waterthrush	1.92	4	0.61	0.011
Lesser Scaup	0.48	3	0.46	0.009
Greater Yellowlegs	0.96	3	0.46	0.009
Bufflehead	0.96	2	0.31	0.006
Barrow's Goldeneye	0.48	2	0.31	0.006
Red-tailed Hawk	0.48	2	0.31	0.006
Downy Woodpecker	0.96	2	0.31	0.006
American Crow	0.96	2	0.31	0.006
Song Sparrow	0.96	2	0.31	0.006
Purple Finch	0.48	2	0.31	0.006
Mallard	0.48	1	0.15	0.003
Green-winged Teal	0.48	1	0.15	0.003
Ring-necked Duck	0.48	1	0.15	0.003
Common Goldeneye	0.48	1	0.15	0.003
Common Merganser	0.48	1	0.15	0.003
Spruce Grouse	0.48	1	0.15	0.003
Common Loon	0.48	1	0.15	0.003
Sora	0.48	1	0.15	0.003
Killdeer	0.48	1	0.15	0.003
Great Gray Owl	0.48	1	0.15	0.003
Black-backed Woodpecker	0.48	1	0.15	0.003
Pileated Woodpecker	0.48	1	0.15	0.003

Table E.14-6 Relative Abundance of Bird Species Located on the Robb Trend During Breeding Bird Surveys Conducted June through early July, 2007 to 2010.				
Species	**% Occurrence**	**Total Birds**	**Pairs/km^2**	**Diversity (BSD)**
Pacific-slope Flycatcher	0.48	1	0.15	0.003
House Wren	0.48	1	0.15	0.003
Black-throated Green Warbler	0.48	1	0.15	0.003
Le Conte's Sparrow	0.48	1	0.15	0.003
Pine Grosbeak	0.48	1	0.15	0.003
83 species	208 plots	2347	359.35	3.467

Woodpeckers establish and maintain territories earlier than most early migrating passerines; winter bird surveys carried out in the late winter / early spring period are useful for detecting their presence. The Project winter bird surveys recorded 445 birds and 46 species. Six woodpecker species were recorded as well as 27 early migrants and 13 permanent residents (Table E.14-7).

Table E.14-7 Winter Bird Survey Results, Robb Trend, 2007 – 2009.						
		Species	**% Occurrence**	**Total Birds**	**Pairs/km2**	**BSD**
10	YBSA	Yellow-bellied Sapsucker	24	49	16.1	0.243
38	DEJU	Dark-eyed Junco	25	38	12.5	0.210
28	AMRO	American Robin	25	35	11.5	0.200
32	YRWA	Yellow-rumped Warbler	22	35	11.5	0.200
25	RCKI	Ruby-crowned Kinglet	22	24	7.9	0.157
24	GCKI	Golden-crowned Kinglet	14	22	7.2	0.149
34	LISP	Lincoln's Sparrow	8	22	7.2	0.149
4	RUGR	Ruffed Grouse	20	21	6.9	0.144
37	WTSP	White-throated Sparrow	12	19	6.2	0.135
19	BCCH	Black-capped Chickadee	9	16	5.3	0.120
22	RBNU	Red-breasted Nuthatch	13	16	5.3	0.120
44	WWCR	White-winged Crossbill	3	13	4.3	0.103
9	WISN	Wilson's Snipe	7	11	3.6	0.091
16	GRAJ	Gray Jay	7	10	3.3	0.085
31	OCWA	Orange-crowned Warbler	5	10	3.3	0.085
2	TUSW	Tundra Swan	1	8	2.6	0.072
11	ATWO	American Three-toed Woodpecker	6	8	2.6	0.072
14	NOFL	Norhern Flicker	8	8	2.6	0.072
29	VATH	Varied Thrush	7	7	2.3	0.065
39	RWBL	Red-winged Blackbird	2	7	2.3	0.065
1	CAGO	Canada Goose	2	5	1.6	0.050
7	GRYE	Greater Yellowlegs	3	5	1.6	0.050
20	BOCH	Boreal Chickadee	4	5	1.6	0.050

Table E.14-7 Winter Bird Survey Results, Robb Trend, 2007 – 2009.

		Species	% Occurrence	Total Birds	Pairs/km2	BSD
21	BRCR	Brown Creeper	3	5	1.6	0.050
26	TOSO	Townsend's Solitaire	4	4	1.3	0.042
35	SOSP	Song Sparrow	3	4	1.3	0.042
46	PISI	Pine Siskin	4	4	1.3	0.042
12	DOWO	Downy Woodpecker	3	3	1.0	0.034
13	HAWO	Hairy Woodpecker	3	3	1.0	0.034
33	CHSP	Chipping Sparrow	3	3	1.0	0.034
36	SWSP	Swamp Sparrow	2	3	1.0	0.034
40	BHCO	Brown-headed Cowbird	1	3	1.0	0.034
41	PUFI	Purple Finch	2	3	1.0	0.034
3	MALL	Mallard	1	2	0.7	0.024
8	SOSA	Solitary Sandpiper	2	2	0.7	0.024
17	CORA	Common Raven	2	2	0.7	0.024
5	NOHA	Northern Harrier	1	1	0.3	0.014
6	KILL	Killdeer	1	1	0.3	0.014
15	PIWO	Pileated Woodpecker	1	1	0.3	0.014
18	TRES	Tree Swallow	1	1	0.3	0.014
23	WIWR	Winter Wren	1	1	0.3	0.014
27	HETH	Hermit Thrush	1	1	0.3	0.014
30	BOWA	Bohemian Waxwing	1	1	0.3	0.014
42	EVGR	Evening Grosbeak	1	1	0.3	0.014
43	PIGR	Pine Grosbeak	1	1	0.3	0.014
45	CORE	Common Redpoll	1	1	0.3	0.014
		46 species	100	445	146.1	3.279

Bird species diversity in the Project is relatively high (BSD=3.467) compared to the CVM Yellowhead Tower (BSD=3.111), CVM (BSD = 2.914) and CVM Mercoal West (BSD=2.792). Diversity of the Project is enhanced by variable topographic relief, diverse upland and wetland habitats, the presence of mature mixed wood forest, subalpine fir forest, and riparian habitat associated with the Embarras River, Bryan Creek, Hay Creek, Erith River and its numerous tributaries. Table E.14-8 lists the habitats that had the highest relative abundance and bird species diversity in the Project.

Table E.14-8 Relative Abundance (pairs/km2) and Bird Species Diversity (BSD) of Habitats Sampled on the Robb Trend, 2007-2010.

Habitat	Habitat Description	No. Plots	No. Species	No. Birds	pairs/km2	BSD
H12	Trembling Aspen / Lowbush Cranberry	13	37	157	384.6	3.273
H19	Willow-Birch Meadow	7	31	107	486.8	3.126
H10	Mixed Wood / Tall Bilberry	22	42	246	356.1	3.073
H15	Mixed Wood / Bracted Honeysuckle	11	33	111	321.4	3.014
H28	Treed Poor Fen	11	30	126	364.8	3.003

Table E.14-8 Relative Abundance (pairs/km2) and Bird Species Diversity (BSD) of Habitats Sampled on the Robb Trend, 2007-2010.

Habitat	Habitat Description	No. Plots	No. Species	No. Birds	pairs/km2	BSD
H43	Deciduous / Bracted Honeysuckle	10	29	119	379.0	2.988
H5	Mixed Wood / Hairy Wild Rye	5	25	51	324.8	2.950
H36	Mixed Wood Cutblock	13	34	199	487.5	2.923
H39	Shallow Open Water	2	21	31	493.6	2.891
H27	Shrubby Bog	1	20	27	859.9	2.885
H3	Lodgepole Pine / Hairy Wild Rye	5	23	54	343.9	2.852
H25	White Spruce / Horsetail	4	22	54	429.9	2.846
H13	Mixed Wood / Lowbush Cranberry	4	20	49	390.1	2.824
H21	Black Spruce – Lodgepole Pine / Labrador Tea	9	23	59	208.8	2.752
H41	Lodgepole Pine / Lowbush Cranberry	6	23	65	345.0	2.749
H44	White Spruce / Tall Bilberry	3	19	36	382.2	2.739
H8	Lodgepole Pine / Tall Bilberry	12	24	79	209.7	2.736
H26	Treed Bog	7	26	116	527.8	2.729
H7	Lodgepole Pine – Black Spruce / Labrador Tea	18	25	143	253.0	2.702
H37	Coniferous Cutblock	20	32	303	482.5	2.688
H22	Black & White Spruce / Labrador Tea	5	18	39	248.4	2.671
H31	Treed Rich Fen	5	16	47	299.4	2.570
H42	White Spruce / Lowbush Cranberry	1	12	15	345.0	2.396
H4	Trembling Aspen / Hairy Wild Rye	3	12	26	276.0	2.395
H14	Lodgepole Pine / Lowbush Cranberry	3	11	17	2.6	2.282
H24	Mixed Wood Horsetail	1	10	14	445.9	2.206
H16	White Spruce / Bracted Honeysuckle	3	11	29	307.9	2.133
H30	Graminoid Poor Fen	2	8	14	222.9	2.008
H11	Subalpine Fir / Tall Bilberry	1	6	8	11.6	1.667
H33	Graminoid Rich Fen	1	5	6	191.1	1.561
All		208	83	2347	359.4	3.467

Raptors

Two groups of raptors are present in the Project. The diurnal raptors are represented by true hawks, falcons, eagles and soaring hawks and are active during daylight hours. Nocturnal raptors are represented by owls which are primarily active at night. Both raptor groups employ different strategies for acquiring prey and represent second level carnivores in the food web.

The Red-tailed Hawk, American Kestrel, and Broad-winged Hawk were identified as summer residents; breeding evidence was confirmed by the presence of a nest site for these species. The Osprey, Bald Eagle, Northern Harrier, and Sharp-shinned Hawk, were designated as summer visitants with the potential of breeding in the Project in appropriate habitat. The Golden Eagle which occurs further west and breeds in the Front Ranges was observed as a fall migrant in the Project. It is potentially a seasonal visitor to the LSA either accidentally, the result of weather patterns or when foraging for food. The Rough-legged Hawk was designated as a migrant, using the Project area either as a travel corridor or for resting /feeding. Repeated observations of the Northern Goshawk throughout all seasons indicated that this bird is a permanent resident of the Project area, probably breeding.

Four nocturnal owl species, the Boreal Owl, Northern Saw-whet Owl, Barred Owl, and the Great Gray Owl were identified in the Project during nocturnal owl surveys conducted in March and April, 2006 and 2007. The Boreal Owl was the most abundant, occurring 8 times on the 79 (13%) stations surveyed. Three Northern Saw-whet Owls and three Barred Owls were detected during the survey while a single Great Gray Owl was identified on one survey station.

E.14.2.5 Amphibians

Wood frogs were identified at 48 different sites in the Project during the 2006-2010 study (CR #14, Figure 8.1). Calling individuals were detected as early as April 24, 2006; egg masses were observed June 5, 2008 and tadpoles July 4 and 10, 2008. Wood frogs were observed in roadside ditches, roadside puddles, beaver ponds, riparian areas, tamarack fens, riparian willow habitat, birch-willow meadows, wet cutlines in lodgepole pine forest, and aspen cutblock.

The western toad was found on 17 sites during the Project study (CR #14, Figure 8.1) Tadpoles were observed as early as June 3 and as late as July 10. Adults were observed throughout the summer from June 4 to August 31. Observations were made in diverse habitats including: roadside ditches, various sized beaver ponds, birch-willow meadows, aspen cutblock, tall willow on north-facing slopes, and Lodgepole Pine / Labrador Tea forest.

The Boreal Chorus Frog was identified at nine different locations in the Project, 2006-2010 (CR #14, Figure 8.1). These frogs were heard vocalizing as early as April 26 and as late as July 13. They were found in roadside ponds, wetlands, and beaver ponds of various sizes. The boreal chorus frog may spend the non-breeding period in damp marshy or wooded areas and overwinter in relatively dry sites.

E.14.2.6 Biodiversity

Biodiversity is discussed throughout the report (CR #14). The number of species occurring in the RSA, Project LSA, and the reclaimed CVM are:

- All Areas = 244 species (5 ungulates, 28 small mammals, 207 birds, 4 amphibians)
- RSA = 227 species (5 ungulates, 28 small mammals, 191 birds, 4 amphibians)
- CVM = 165 species (5 ungulates, 12 small mammals, 145 birds, 3 amphibians)
- Project LSA = 143 species (4 ungulates, 15 small mammals, 121 birds, 3 amphibians)

Species occurrence in the RSA provides a context for the results of wildlife inventories conducted on the Project LSA.

Range maps found in Russell and Bauer (1993) indicate that four amphibians (long-toed salamander, western toad, wood frog, and boreal chorus frog) are present in the RSA. The long-toed salamander predominately occurs north of the McLeod River in the McPherson BMU (L. Wilkinson, FWMIS pers. comm. July 9, 2007). It is not expected to occur in the LSA.

Range maps in the Atlas of Breeding Birds in Alberta (Semenchuk 1992, FAN 2007) identified 191 bird species as breeding, probably breeding, possibly breeding or observed in the RSA. An additional 16 bird species were identified in the RSA from this study and previous work completed for the CVM expansions for a total of 207 bird species in the RSA.

A number of bird species (39) that occur in the RSA were not present on the LSA or CVM. These species are: Double–crested Cormorant, Wood Duck, Northern Pintail, Canvasback, Redhead, Harlequin Duck, Ruddy Duck, White-tailed Ptarmigan, Dusky Grouse, Gyrfalcon, Eared Grebe, Prairie Falcon, Franklin's Gull, Bonaparte's Gull, California Gull, Black Tern, Common Tern, Rock Pigeon, Mourning Dove, Common Nighthawk, Black Swift, Ruby-throated Hummingbird, Calliope Hummingbird, Hammond's Flycatcher, Eastern Phoebe, Loggerhead Shrike, Cassin's Vireo, Steller's Jay, Clark's Nutcracker, Black-billed Magpie, Bank Swallow, Mountain Chickadee, Palm Warbler, Blackpoll Warbler, Black-and-White Warbler, Golden-crowned Sparrow, Yellow-headed Blackbird, Baltimore Oriole and House Sparrow.

Range maps in Smith (1993) identified five ungulates and 28 small mammals as possibly occurring in the RSA (CR #14, Table 9.1). A number of species occurred at the western or northern edge of the RSA boundary and are not expected to occur in the Project LSA. These species include: pika, golden-mantled ground squirrel and long-tailed vole. The bighorn sheep has been observed as an accidental visitant to the CVM.

Three species of amphibians (western toad, wood frog and boreal chorus frog), 121 bird species, four ungulates and 15 small mammals were confirmed present in the Project LSA. It is likely the Little Brown Myotis, Northern Myotis and Northern Flying Squirrel area also present in the Project LSA. The Tundra Swan was observed in migration over the LSA but no records exist elsewhere in the RSA for this bird (CR #14, Table 9.1, Appendix III).

E.14.3 Potential Impacts

Industrial impacts on wildlife can be classed as direct or indirect. Direct impacts involve mortality by increased vehicular collisions and mortality by increased legal and illegal hunting through provision of new access. Indirect impacts include disturbance and habitat loss due to construction and operating phases. Indirect impacts can be divided into three categories, habitat change, creation of barriers, and harassment resulting in habitat alienation or death.

E.14.3.1 Ungulates

Direct Mortality

Haul trucks to be used have a maximum speed of 60 km/h. Potential direct mortality through vehicle collisions is not expected to be a problem as haul roads are typically wide (approx. 30m) and provide a good field of view for operators and wildlife. Truck travel is slower (areas of 30 km/h and areas of 60 km/h) than highway speeds. Haul truck operators at the CVM are experienced drivers. All mine vehicles using the haulroad are radio-equipped. It is standard operating practice for operators to advise other operators if a road hazard is encountered including wildlife on the road.

Loss of Winter Habitat

No elk were observed in the LSA during the 2008 air survey but elk pellets were found during the spring pellet-group counts indicating some level of overwinter use. Elk displayed preference for 7 habitat types comprising 8.6% of the area of the LSA (CR #14, Table 5.4, Section 5.2.2). Of these 7 habitats 451 ha will be disturbed. This is 4.7% of the total area of the LSA.

The reclamation plan for the LSA will initially increase the amount of upland grassland habitat. Currently only a very small proportion of the pre-disturbance LSA is comprised of upland grassland (0.98%). These grasslands are represented largely by reclaimed herbaceous meadows associated with right-of-ways. It is expected that elk and deer will respond positively to the early stages of upland reclaimed and re-vegetated areas on the LSA particularly in the Robb West, Main and Central zones where there is extensive mixed wood and deciduous habitat adjacent the disturbance area.

The Project will disturb 1.9% of moose winter range core area in the LSA (CR #14, Table 12.1). Disturbance will affect 48% of 11 habitats preferred by moose (CR #14, Table 5.4, Section 5.4.3). Habitats preferred by moose comprise a small portion of the LSA (6.8%) but may provide a necessary resource for moose in winter as use is disproportionate to availability.

No winter habitat for mule deer will be disturbed by the Project (CR #14, Table 12.1) however mule deer range is considerably reduced since air surveys were first flown in the CVM area in 1996. The Project will disturb 2.8% of winter range for white-tailed deer and 6.2% of winter range core area (CR #14, Table 12.1).

Disturbance will affect 37% of eight habitats preferred by deer in the LSA (CR #14, Table 5.4, Section 5.5.3). Deer are expected to respond positively to the early stages of upland reclaimed and re-vegetated areas on the LSA particularly in the Robb West, Main and Central zones.

Disruption of Movement Patterns

Ungulates will be temporarily displaced by active mining as they are unable to cross a pit disturbance. This displacement will be restricted to local use as there are no indications of long distance or major seasonal migrations in the LSA.

Displacement

Ungulates and other wildlife respond positively to predictable human activity by a process of habituation which allows the animal to gradually accept new experiences in the absence of negative feedback. Elk, moose, mule deer, white-tailed deer and other wildlife on the CVM make use of the reclaimed landscapes in the presence of active mining. It can be expected that animals local to the LSA area will respond in the same positive manner as at the CVM. However, once mining and reclamation is completed, wildlife will be exposed to random human activity. Ungulates and other wildlife that had become accustomed to using these areas as a refuge will alter their use of the reclaimed sites at this time if human activity is frequent, unpredictable and unplanned.

E.14.3.2 Small Mammals

The impact of mining development will involve direct mortality through clearing and loss of habitat during mine development and changed composition in small mammal communities in the early stages of reclamation.

The density of small mammals in reclaimed grasslands has been shown to be similar to undisturbed habitats (Hingtgen and Clark 1984). After initial grassland establishment, the number of small mammal species is expected to be similar to those on undisturbed similar habitats, although a greater proportion of deer mice can be expected to occur in the early succession reclamation.

Other forest dependent small mammals (red squirrel, snowshoe hare) will be expected to use the regenerated forest and its understorey once it becomes established. Understorey development is a necessary component of snowshoe hare habitat. Muskrat and beaver have been observed using the reclaimed lakes on the CVM (Bighorn 1995:24).

E.14.3.3 Breeding Birds

The breeding bird assessment includes potential impacts to perching birds, waterfowl, cranes, rails, and allies, shorebirds, gulls, auks, fowl-like birds and woodpeckers.

Habitat Loss

Loss of habitat and the subsequent temporary displacement/loss of birds are a consequence of mining activities. Habitats supporting the highest diversity of birds in the LSA are:

- Trembling Aspen / LC (BSD = 3.273)
- Willow-Birch Meadow (BSD = 3.126)
- Mixed Wood / TB (BSD = 3.073)
- Mixed Wood / BH (BSD = 3.014)
- Treed Poor Fen (BSD = 3.003)

These habitats comprise 2,354 ha or 9.5% of the LSA. Mining will disturb 953 ha of these habitats. Habitats supporting high diversity of birds comprise 6,275 ha or 62.3% of the LSA. Mining will disturb 2,794 ha of these habitats. Habitats supporting moderate diversity of birds comprise 613 ha or 6.1% of the LSA. Mining will disturb 286 ha of these habitats. Habitats with the lowest bird species diversity comprise 49.6 ha or 0.5% of the LSA. Mining will disturb 24 ha of these habitats.

Mining and reclamation activities will shift the community composition of birds. Bird species associated with grasslands, waterbodies and forest edge communities will predominate the initial reclaimed landscape. The high diversity of the reclaimed habitats on the CVM (BSD = 3.170; Bighorn 1999) is partly a result of species response to:

- reclaimed lakes and ponds on the CVM;
- upland early succession grassland reclamation;
- riparian/reclaimed edge and forest/reclaimed edge habitats; and

- birds associated with undisturbed forest.

Cavity nesting birds will not nest in reclaimed habitat until toward the end of the life span of the seral forest community. Cavity nesting birds have been found nesting in trees adjacent to riparian/reclamation habitat in the Lovett Lake area of the CVM (Bighorn 1995:85). Woodpeckers and other cavity nesters require forests with structural components such as standing dead and decaying trees, stem rot-infected trees, large live trees, hardwoods, and stumps. Conservation of these ecosystem components requires the integration of wildlife habitat requirements with timber harvesting, pest management and reclamation activities.

Direct Mortality

Most breeding birds are active from May to the end of July in the LSA; clearing in these three months would invariably destroy nests and young birds.

E.14.3.4 Raptors

Loss of Habitat

Habitat loss or alteration results in direct impacts to raptors by removal of cover, perch sites, nest sites and loss or alteration of prey sources. Clearing of vegetation will result in direct losses of both nesting and foraging habitat for raptors using the immediate area. Not all raptors will be affected in the same way by vegetation clearing. While certain species like the cavity nesters, *e.g.,* Boreal Owl, may be affected by forest clearing, others such as the Great Gray Owl will benefit as they hunt along the edges of forest margins. Hawks and eagles will generally benefit from clearing a continuous forest because they need the open spaces for hunting and migration. Open areas have the potential of creating thermal updrafts important for migrating soarers. Red-tailed Hawks and Rough-legged Hawks have been observed during migration in modest numbers over the CVM; Golden Eagles have also been observed during migration. The presence of healthy small mammal communities in the CVM reclamation provide good foraging habitat for species like the Northern Harrier which are commonly observed hunting over the reclaimed grasslands.

Direct Mortality

Raptors that hunt or scavenge dead rodents or ungulates along roads or railways may be killed by moving vehicles. Potential direct mortality through vehicle collisions is not expected to be a problem in the LSA as haul roads are typically wide, and truck travel is slower than highway speeds.

Because of their size, behaviour, and habit of perching or nesting on power poles, some raptor species are particularly prone to electrocution, *i.e.,* Golden Eagles, Osprey, Great Horned Owls, Red-tailed Hawks, and Rough-legged Hawks. Forested areas generally have fewer reported raptor electrocutions than parklands, shrublands and grasslands.

There has been no indication that electrocution of raptors has been a problem on the existing CVM. The Project LSA is located in a forested environment. These two factors and the use of raptor safe specifications on distribution lines will minimize potential of raptor electrocution in the LSA.

Displacement

Mining is not expected to interrupt the raptor migration over the Yellowhead Fire Tower but removal of forested habitat early in the mining process will eliminate trees and foraging habitat for raptors that may occasionally stop to hunt and rest in the LSA. It is expected that once reclamation is initiated, the small mammals typically associated with early succession grasslands will provide a food source for raptors during migration especially for Northern Harrier, Rough-legged Hawk and Red-tailed Hawk in the fall and perhaps eagles in the spring.

E.14.3.5 Amphibians

Three species of amphibians were identified in the LSA. Wood frogs and western toads are found throughout the LSA where small ponds associated with riparian and wetland areas are found. Boreal chorus frogs are associated with ponds and wetlands. Direct loss of habitat by mining will initially occur as some riparian and wetland areas will be disturbed. Pit development may obstruct seasonal movement of amphibians until reclamation is established.

E.14.4 Cumulative Effects Assessment

In an effort to put the impacts of the Project into a temporal and spatial perspective with existing and future demands by other users and developments, a cumulative effects assessment (CEA) was carried out for elk, moose and terrestrial avifauna in the Project RSA.

Modeling was carried out for the following time frames 10, 25 and 50 years into the future (Section E.13.4.1). Seven scenarios were developed:

- time 0 year Baseline Year (Year 0) without Project;
- time 10 years Maximum disturbance case for the Project (approximately 10 years) with the Project (T10a) and without the Project (T10b);
- time 25 Years Maximum disturbance within the RSA from all activities (approximately 25 years), with the Project (T25a) and without the Project (T25b); and
- time 50 Years Regional closure case (50 years), with the Project (T50a) and without the Project (T50b).

To assess the impact of the project within the RSA, the following scenarios were compared:

- time 10 years T10a versus T10b (project maximum disturbance);
- time 25 years T25a vs. T25b (regional maximum disturbance); and
- time 50 Years T50a vs. T50b (project regional net impact).

The cumulative effects assessment is based on a land class map (LC 17) developed by Millennium (November 14, 2011). Codes and a description of the 17 land classes are listed in Table E.14-9. A more detailed description of the 17 RSA land classes is found in Appendix 2, (Millennium 2011c). The LC17 map is comprised of 114,057 polygons (358,725 ha).

Table E.14-9 Land Cover Codes and Classes for the Regional Study Area at Baseline T0 (Millennium 2011c) and HSI Values for Elk (Buckmaster et al. 1999) and Moose (Romito et al. 1999).

Code	Land Cover Descriptions	Area (ha)	Elk HSI	Moose HSI
1	open conifer (< 30% crown closure)	1,430	0.08	0.4
2	moderate conifer (30% - 70% crown closure)	116,848	0.04	0.4
3	dense conifer (> 70% crown closure)	78,600	0.01	0.2
4	open broadleaf (< 30% crown closure)	80	0.8	0.3
5	moderate broadleaf (30% - 70% crown closure)	11,274	0.4	0.5
6	dense broadleaf (> 70% crown closure)	1,143	0.1	0.4
7	open mixed (< 30% crown closure)	370	0.4	0.5
8	moderate mixed (30% to 70% crown closure)	26,217	0.2	1
9	dense mixed (> 70% crown closure)	12,153	0.05	0.5
10	open regenerating forest (< 30% crown closure)	34,006	0.08	0.4
11	closed regenerating forest (>30% crown closure)	17,216	0.02	0.4
12	upland herbaceous	9,021	1	0.2
13	Shrubs	12,172	0.6	1
14	open wetland	3,854	0.05	0.2
15	treed wetland	19,285	0.08	1
16	Water	1,085	-	-
17	barren land	13,973	-	-

Development features in the RSA were identified (*e.g.,* pipelines, wellsites, roads) and the 17 land classes were modified to predict changing conditions caused by mining, forest harvesting, mountain pine beetle, and climate change, for 10, 25 and 50 years.

E.14.4.1 Cumulative Effects Assessment for Elk

A winter foraging Habitat Suitability Index (HSI) Model developed by the Foothills Model Forest (Version 5) was used to predict the suitability of habitat for elk (Buckmaster et al. 1999) in the RSA for baseline, 10, 25 and 50 years. The model is used to predict potential changes in elk habitat area. The model produces HSI values for critical winter food habitat and is applicable to the Foothills Model Forest in west-central Alberta.

The 17 land classes were assigned an HSI value based on:

- Elk winter foraging model (Buckmaster et al. 1999).
- LC17 RSA descriptions and winter use levels measured by elk pellet-groups/ha throughout the RSA.

The outcomes of the HSI analysis for elk for the seven scenarios are shown in Table E.14.10. Year T0 baseline (CR #14, Figure 13.1) shows an HSI value of 0.217 for elk for the entire RSA. Without the Project development, this value decreases in Year 10 to 0.195 and continues to decrease in Year 25 to 0.185, and to 0.178 in Year 50 (CR #14, Figures 13.2, 13.4 and 13.6). With the Project development, the baseline Year 0 value of 0.217 decreases to 0.189 in Year 10, remains similar (0.187) in Year 25 and decreases to 0.168 in Year 50 (CR #14, Figures 13.3, 13.5, and 13.7).

Table E.14-10 Predicted Changes to Elk Habitat Suitability from Year 0 (baseline) through Years 10, 25 and 50 - Without the Robb Trend Project and - With the Robb Trend Project.

	Elk HSI Without the Project	Percent change from Year 0 (%)	Elk HSI With the Project	Percent change from Year 0 (%)	% Difference between Without and With the Project
Year 0	0.217		0.217		
Year 10	0.196	-9.8	0.189	-12.9	-3.6
Year 25	0.185	-14.7	0.187	-13.8	1.1
Year 50	0.178	-17.9	0.169	-22.3	-5.6

These results suggest that a regional scale impact is changing the elk habitat suitability of which the Project development is a small component (5.6% by Year 50). At Year 25, the Project development actually makes a small positive contribution to elk habitat suitability (1.1%) as well as effectiveness (85.5% in the RSA and 89.3% in the RSA with Project). To examine these trends further, the change in vegetation Land Cover types were examined. The amounts of all mixed wood and broadleaf cover types decrease from Year 0 through to Year 50. Moderate broadleaf, moderate mixed and dense mixed cover types show the largest declines (-36%, -44% and -53% respectively). At year 25, the Project provides a 22% increase in the upland herb cover type over Year 0. This cover type is common in early succession reclaimed areas and is classified as a having a high elk HSI value (1). By Year 50, upland herb and shrub cover types also show a decline of -31% and -3% respectively. Conifer types on the other hand show a mixed result. Open and moderate conifer cover types show a -19% and-23% decrease by Year 50 while dense conifer increases by 65% and closed regenerating by 213%. Open regenerating forest disappears off the landscape (decreases by -100%). Note that conifer dominated land cover types are given lower elk HSI rating (0.01 - 0.08) than mixed wood (0.05 - 0.4) and broadleaf (0.1 - 0.8) cover types. The decline in the mixed wood and broadleaf cover types contributes to the decrease in elk habitat suitability over time.

The impacts of the Project development on elk are insignificant provided mitigation is implemented including reclamation appropriate for elk, and future monitoring.

E.14.4.2 Cumulative Effects Assessment for Moose

A winter habitat HSI model developed by the Foothills Model Forest (Version 5) was used to predict the suitability of habitat for moose (Romito et al. 1999) at a landscape scale for baseline, 10, 25 and 50 years. The model is used to predict potential changes in moose habitat area and carrying capacity.

The 17 land classes were assigned a moose HSI value based on:

- Moose winter habitat model (Romito et al. 1999).
- LC17 RSA descriptions and winter use levels measured by elk pellet-groups/ha throughout the RSA.

At baseline T0, moose habitat suitability is much higher (HSI =0.413; CR #14, Figure 13.8) in the RSA than elk habitat suitability (HSI = 0.217; CR #14, Figure 13.1). Large areas of moderately rated moose habitat exist over most of the RSA while elk habitat is concentrated to local areas of relatively high quality habitat. In addition, the differences between the without Project and with Project were smaller for moose than for elk. The greatest difference for moose (-3.9 %) between without and with Project was observed in year 10 (CR #14, Figures 13.9 and 13.10) while years 25 and 50 had almost identical differences (-2.3% and -2.8% respectively; Table E.14-11, CR #14, Figures 13.11, 13.12, 13.13 and 13.14).

Table E.14-11 Predicted Changes to Moose Habitat Suitability from Year 0 (Baseline), through Years 10, 25 and 50, without the Robb Trend Project and with the Robb Trend Project.

	Moose HSI Without Project	Percent change from Year 0	Moose HSI With Project	Percent change from Year 0	% difference between Without Project and With Project
Year 0	0.413		0.413		
Year 10	0.414	0.3	0.398	-3.7	-3.9
Year 25	0.388	-6.1	0.379	-8.2	-2.3
Year 50	0.367	-11.2	0.356	-13.6	-2.8

Overall, moose habitat effectiveness at Year 50 is 86.3% of that at Year 0 without the Project and 85.4% with the Project. This overall decline suggests that a regional level impact is occurring and that the additional impact of the Project is small. Large amounts of moderate quality moose habitat is available throughout the RSA for moose thereby moderating the effect of habitat change caused by mining. High quality moose habitat on the Project and other areas associated with mixed wood of the Lovett Ridge will be reclaimed with a closed forest regeneration forest of lesser habitat quality (CR #14, Figures 13.13 and 13.14).

The impact of the Project development is not significant after mitigation.

E.14.4.3 Avifauna

Breeding birds and raptors are recognized as VECs for the Project impact assessment. The impact assessment concluded that mining activities would shift bird community composition for an extended period of time but that grassland and wetland habitat created by reclamation would result in similar biodiversity once these habitats were established. A complete list of bird species that occur in the RSA and their national and provincial status is found in CR #14, Table 9.1.

Twenty-six bird species in the Project or Local Study Area (LSA) are identified as "Sensitive" by ASRD (2011) and one species is identified as "May Be At Risk" (CR #14, Table 13.7). One of these 26 species, the Black-throated Green Warbler, is listed under the Alberta Wildlife Act as "Threatened". These 27 species are identified to discuss potential cumulative effects of the Project on birds at the regional scale in the RSA (CR #14, Table 13.7). Three of these 27 species are on the federal COSEWIC list: Olive-sided Flycatcher, Barn Swallow and Rusty Blackbird. The Olive–sided Flycatcher appears on the SARA list as Threatened, Schedule 1 and the Rusty Blackbird as Special Concern, Schedule 1. The Barn Swallow has no schedule, No Status under SARA.

Green-winged Teal

Green-winged Teal are unlike most dabblers in North America in that they prefer the wooded ponds and streams of the deciduous parklands and boreal areas.

The Green-winged Teal is an uncommon summer resident in the Project area. It was observed on one plot during the Project breeding bird survey. It was observed 10 more times during other work in the Project; five of these observations were on the pond near the Hwy 47 turnoff to Robb. Green-winged Teal have been observed on lakes in the CVM. Wetland development associated with the Project should provide habitat for this species. Millennium (2011c:91) indicates that the Project should result in a net increase of water of 869.6 ha by Year 50.

Lesser Scaup

The Lesser Scaup prefers permanent and semi-permanent wetlands with tall, dense herbaceous vegetation nearby for nest cover. The rating of the Lesser Scaup in Alberta moved from Secure in 2000 to Sensitive in 2005. Surveys show a long-term decline in populations within Alberta and surrounding jurisdictions.

The Lesser Scaup was observed on one plot during the Project breeding bird survey for a total of 3 birds; relative abundance was 0.46 pairs/km2. It was observed another 18 times at different locations throughout the Project study area and is considered an uncommon summer visitant. On the CVM it is identified as probable breeding. Wetland development associated with the Project should provide breeding habitat for this species. Millennium (2011c:91) indicates that the Project should result in a net increase of water of 869.6 ha by Year 50.

Great Blue Heron

This species is found in every Natural Region in Alberta but is not common in the northern part of the province. Nests are usually built in trees and tend to be close to wetland foraging areas. Because this species tends to be gregarious, its distribution across the province is fairly patchy.

The Great Blue Heron was observed once in May 2009 on the highway 47 pond in the Project study area. It is a very uncommon migrant in the Project. It has been observed on the CVM. Water developments associated with the Project will provide stopover habitat for this bird.

Millennium (2011c:91) indicates that the Project should result in a net increase of water of 869.6 ha by Year 50.

Osprey

The Osprey is found in every Natural Region across the province. Ospreys are fish specialists and consequently their breeding areas are always associated with water bodies such as lakes and rivers. The distribution of this species reflects its need for living near water.

The Osprey was observed one time on the beaver pond off the Lund Creek road on July 10, 2008. It is a very uncommon summer visitant in the Project and has been observed on the CVM. Lake development associated with the Project should provide a fishery suitable for Osprey. Millennium (2011c:91) indicates that the Project should result in a net increase of water of 869.6 ha by Year 50.

Bald Eagle

It breeds in all natural regions of Alberta. Nests are placed in tall trees, near large lakes or rivers with an adequate fish supply. ASRD (2011) describes the Bald Eagle population as "A species once at risk throughout much of its North American range, but now recovering; low density in Alberta. Nests vulnerable to human disturbance, and as such, require protection".

The Bald Eagle is an uncommon migrant in the Project. Five observations of Bald Eagles were made on the Robb Trend; all were during fall migration on September 27, 29, 2008 and October 14, 2005. Five soaring Bald Eagles were sighted during the Yellowhead Fire Tower hawk watch 2006, 2007 and 2009. All birds were moving in a southerly direction indicating they were migrants and not resident birds. Bald Eagles are not nesting in the Project LSA. The Project may cause visitants and migrants to distribute themselves differently on the permit area during active mining but it is expected that they will continue to move through the RSA as well as the LSA.

Northern Harrier

The Northern Harrier nests throughout Alberta (Salt and Salt 1976). Harriers occur in open alluvial meadows and wetlands in the montane, lower subalpine and upper subalpine ecoregions. They nest on the ground among shrubs, grasses and forbs in either wet or dry areas. Harriers hunt over grasslands and shrub meadows. During migration, they occur in high creeks and valleys of the front ranges (Holroyd and Van Tighem 1983).

It is an uncommon migrant in the Project; four observations of Northern Harrier were observed in the Project during spring (April 17, 2007, May 5, 2009, May 20, 2008) and fall migration (August 29, 2007). It is possible that these birds may occasionally forage in the grassy and fen areas of the LSA. Nests are located on the ground in open areas that are usually near wetlands or marshy meadows. Harriers have been confirmed breeding in these habitats on the CVM (Bighorn 1995, 1999). The Northern Harrier is commonly observed hunting on the Luscar and Gregg River Mines during migration where small mammals exist in high density in reclaimed grasslands (MacCallum 2003). Millennium (2011c:90) indicated that shrub vegetation in the Project will initially show a net increase in the years T10 and 25 but by T50 there will be a decrease of 290.3 ha. Upland herbaceous communities will be reduced by 2061.4 ha by year 50, from current availability, reducing foraging areas for these birds.

Northern Goshawk

Northern Goshawk nest in areas of mature deciduous and deciduous-dominated mixed wood stands, in mid-to lower slope positions (Schaffer 1997). Goshawks forage in stands with high structural and tree species diversity (Schaffer et al. 1999). This species is most prevalent in the Foothills Natural Region but, with the exception of the Grassland and Parkland Natural Region's, is found elsewhere in Alberta where suitable nesting structures occur in mixed wood forests with high canopy closure (FAN 2007).

ASRD (2011) notes that: *"Logging, industrial development, and human encroachment on nesting habitat may reduce populations in the boreal forest. Maintenance of mature forest breeding habitat needs to be incorporated into forest planning on both public and private lands".*

Eight observations of Northern Goshawk were made in the Project through multiple years and seasons; suggesting that this bird is a permanent resident. It is considered uncommon and probable breeding in the Project. One observation of a Northern Goshawk was made September 27, 2009 from the Yellowhead Fire Tower. This may have been a resident bird as it approached from the northeast, landed and proceeded through the forest. Millennium (2011c:90) indicated that there will be a decrease in the amount of dense broadleaf of -287.9 ha in the Project by year 50. Reclamation to establish a variety of vegetation communities including mixed wood forest and understorey diversity will provide habitat for the Northern Goshawk as well as a variety of wildlife species.

Broad-winged Hawk

Broad-winged Hawks breed in the Boreal Forest but can be present in any natural region where a mature to old growth mixed wood forest may occur. They often are undetected during breeding because of their shy and quiet disposition during the nesting period.

ASRD (2011) describes the Broad-winged Hawk as: *"May be experiencing major population declines as breeding habitat disappears. [It] requires large stands of mature to old-growth forest in the parkland and southern boreal forest. Careful woodlot management [is] essential to maintain breeding habitat".*

Two Broad-winged Hawks were observed overhead at the Yellowhead Fire Tower on September 21, 2006. One Broad-winged Hawk was observed at the entrance to the old Bryan Mine on Robb West, May 21, 2008 and another southeast of Robb June 2, 2008. Two Broad-winged Hawks were observed May 13 and 15, 2009 in mature mixed wood habitat southeast of Robb and at the same location on June 10 and 11 a Broad-winged Hawk was defending a nest site from two Blue Jays. Millennium (2011) indicated that there will be a decrease of 5,937.1 ha in the amount of dense mixed wood in the Project by year 50, thus reducing the availability of nesting habitat for the Broad-winged Hawk in the Robb area.

Golden Eagle

In Alberta, the Golden Eagle nests locally in the lower reaches of the southern river systems and in the Rocky Mountain region (Semenchuk 1992:89). During the breeding season, Golden Eagles occur in open and semi-open habitat in the Alpine and Subalpine Natural Regions. They nest on cliff faces with generally southerly exposure (Holroyd and Van Tighem 1983). In summer they hunt mainly along semi-open mountain slopes, avalanche paths and alpine meadows. During migration and winter they concentrate in low valleys.

ASRD (2011) indicates: *"Most recent estimate suggests 100-250 breeding pairs in Alberta. Disturbance from human related activities is greatest threat. Because of its low population and dispersal over a large area, nest site inventory and protection are necessary".*

Eight Golden Eagles (0.22 birds/hour) were observed during the Yellowhead Tower hawk watch 2006-2009 and one was observed on Robb West, November 3, 2006. Golden Eagles do not nest on the LSA. It is a very uncommon migrant / summer visitant in the Project. The Project may cause visitants and migrants to distribute themselves differently on the permit area during active mining but it is expected that they will continue to move through the RSA as well as the LSA.

American Kestrel

Alberta's most abundant falcon, the American Kestrel is found is every Natural Region across the province. The American Kestrel requires open habitats such as grasslands, areas where forests have burned for hunting. It is attracted to human-modified habitats, pastures and parkland, and near areas of human activity, including heavily developed urban areas (Smallwood and Bird 2002). It is an obligate cavity nester that relies on the cavities created by woodpeckers and fungal decay.

One American Kestrel is a very uncommon summer resident in the Project; one was observed May 20, 2008 on Robb West. One was observed during the 2009-2009 Yellowhead Fire Tower hawk watch September 26, 2009 (0.03 birds/hour). The American Kestrel is a fairly common migrant and summer visitant to the reclaimed Luscar and Gregg River mines located south of Hinton (MacCallum 2003). Kestrels have been observed hunting over reclaimed areas on the CVM during breeding season (Bighorn 1995).

Millennium (2011c:90) indicated upland herbaceous communities will be reduced by 2061.4 ha by year 50, from current availability, reducing foraging areas for these birds.

Sora

The Sora is the best known of the three Alberta rails. The preferred habitat of this species is a mix of shallow and moderately deep water with emergent vegetation present. Grassland, Parkland Natural Region wetlands, as well as valley wetlands found in the Rocky Mountain Natural Region satisfy Sora requirements because these wetlands tend to be shallow. However, Boreal Forest and Foothills Natural Region wetlands would not be suitable because these wetlands are deep (FAN 2007).

The Sora's provincial status is Sensitive. ASRD (2011) indicates that *"Large (>50%) declines have occurred in Alberta and all surrounding jurisdictions since 1994. Species threatened by loss of wetland habitat"*.

The Sora was observed on one plot during the Robb Trend breeding bird survey; relative abundance was 2 pairs/km^2. It is a very uncommon summer resident. Millennium (2011c:91) indicates that the Project should result in a net increase of water of 869.6 ha by Year 50 thus potentially providing habitat for this species.

Sandhill Crane

The Sandhill Crane nests on the ground in wet forest areas usually near small ponds or marshes. Sandhill Cranes are usually seen in pairs, are solitary nesters, and are widely distributed across their range. In Alberta they were recorded during the breeding season in the Boreal Forest and Foothills Natural Region's and less frequently in the Rocky Mountain NR (FAN 2007:198).

The Sandhill Crane is described in ASRD (2005) as *"sparsely distributed through boreal and foothill bogs and marshes. It is vulnerable to wetland loss and sensitive to human disturbance. Land use planning needs to incorporate the maintenance of breeding habitat"*.

Tracks of one Sandhill Crane were observed on a road at the east end of Robb Trend May 9, 2009 during migration; they do not breed in the LSA. It is a very uncommon migrant.

Upland Sandpiper

This unusual shorebird was observed one time on May 21, 2008 in the Project. This species is an obligate grassland species, spends most of its life away from water. It exhibits distinctive grassland adaptations: cryptic coloration, ground-nesting, well-defined diversionary displays, flight song, and relatively short incubation and nestling periods. It spends as little as 4 months on its main breeding grounds, where it typically requires 3 different but nearby habitats; during courting, it needs perches and low vegetation for visibility; during nesting, higher vegetation to hide its nest; and during supervision of young, lower vegetation. It spends up to 8 months on its wintering grounds in South America (FAN 2007).

It's occurrence on the Project is considered accidental.

Northern Pygmy-Owl

Northern Pygmy-Owls show preference for older, structurally diverse mixed wood habitats with line-of-sight enhanced by increased edge and terrain roughness (Piroecky and Prescott 2004). This secondary cavity nester prefers to select trees with an existing cavity.

ARSD (2005) states: *"local populations are present in boreal forest, foothills and Rocky Mountains. Forest management plans need to ensure breeding habitat is maintained"*.

A single Northern Pygmy-Owl was observed at the Yellowhead fire tower, October 14, 2007. One individual was observed May 18, 2010 in Robb West. This species is a very uncommon summer resident in the Project. Millennium (2011c:90) indicated that there will be a constant reduction of the amount of moderate broadleaf and the amount of dense mixed wood in the LSA through the years 10, 25 and 50. Reclamation to establish a variety of vegetation communities including mixed wood forest and understorey diversity will provide habitat for the Northern Pygmy-Owl as well as a variety of wildlife species. Retention of live deciduous trees during forest harvest will provide perching sites for Northern Pygmy-Owls and increase structural diversity of the replacement stand.

Barred Owl

Barred owls inhabit mature to old mixed wood and deciduous stands with large, tall canopy trees and numerous dead or dying trees with cavities or tops broken off (Olsen et al. 1999). Owls will select large balsam poplars with cavities, or broken off trees for nesting sites.

ASRD (2010) describes this species as: *"Likely fewer than 2000 breeding birds in the province. This interior forest species requires larger blocks of mature dense woodland. Forest fragmentation [is] detrimental. Forest management plans need to ensure breeding habitat retained."*

The Barred Owl was observed on the night April 30, 2007 in the Robb Trend study area. It is a very uncommon, resident in the Project. Millennium (2011c:90) indicated that there will be constant reduction in the amount of dense mixed wood and the amount of dense broadleaf in the Project through the years 10, 25 and 50. Reclamation to establish a variety of vegetation communities including mixed wood forest and understorey diversity will provide habitat for the Barrd Owl as well as a variety of wildlife species. Retention of wildlife trees during forest harvesting and other best practices can maintain habitat suitability for the Barred Owl in harvested areas.

Great Gray Owl

The Great Gray Owl is found in a diverse mix of treed muskeg and mature forest close to open areas. It breeds and winters in forested areas across Canada. It will nest in mature deciduous forests and mature coniferous forest with broken off trees. They prey on mice, voles, shrews, bog lemmings, small birds and other animals.

ASRD (2005) indicates that the Great Gray Owl is: *"A naturally scarce species, widely distributed in foothill and boreal habitats. Requires stands of mature forest for nesting, thus is vulnerable to harvest."*

The Great Gray Owl is an uncommon permanent resident in the Project. Millennium (2011c:90) indicated that there will be a constant reduction in the amount of dense broadleaf in the Project through to Year 50. However after an initial decrease in dense conifer in the Project area, there will be an increase of 44,090 ha by year 50. By year 50, the reclaimed upland forested areas will increasingly come to resemble and function like mature deciduous and coniferous ecosites. Reclamation to establish a variety of forest vegetation will benefit the Great Gray Owl and other wildlife. Patch retention and other best practices can maintain habitat suitability for the Great Gray Owl in harvested areas.

Black-backed Woodpecker

Black-backed Woodpeckers occupy all types of dense coniferous forests. They exhibit a high preference for fire-kill trees shortly after a burn where they may remain for several years (Murphy and Lehnhausen 1998). The Black-backed Woodpecker tends to increase in abundance in burnt areas whereas in unburnt areas surrounding these burns the species remains relatively rare (Niemi 1978). This species will also use forests that have been disturbed by insects, disease and wind damage. Beetle larvae that hatch and develop within trees are the main food consumed by the Black-backed Woodpecker. Nest cavities are excavated in mature trees that are within, or adjacent to, disturbed forest habitat. Nest sites are selected in live and dead trees of various species. Nest tree dbh ranges between 27-40 cm, height 21.7-32.7 m, and nest cavity height from 5-12 m (Bull et al. 1986, Hoffman 1997, Caton 1996). Despite occurring in four Natural Regions, this species in mainly found in the Boreal Forest Natural Region (FAN 2007).

The Black-backed Woodpecker was observed on one plot during the Robb Trend breeding bird survey; relative abundance was 0.2 pair/km^2. It was not observed during the Robb Trend winter bird survey. It is a very uncommon permanent resident in the Project. Millenium (2011c:88) indicates that after 50 years there will be an increase in natural dense conifer (+34,387 ha).

Pileated Woodpecker

In Alberta the Pileated Woodpecker is found mainly in the mature mixed wood, deciduous or coniferous forest of Boreal Forest, Foothills, Parklands and Rocky Mountain Natural Regions (FAN 2007). This species prefers larger diameter deciduous trees for nesting and prefers carpenter ants found in large substrates either dead or damaged. Habitat selection is flexible at territory and stand scales (Bonar 2001). Its distribution may be limited to the availability of large diameter trees (>25 cm dbh) which it uses for nesting and roosting. Pileated Woodpeckers occur in naturally low numbers.

The Pileated Woodpecker is a permanent resident of the Project that occurs in low densities. This large woodpecker was observed only once on plot during the Project breeding bird survey; relative abundance was 0.2 pairs/km^2. It is listed as sensitive in Alberta.

Millennium (2011c:90) indicated that there will be a constant reduction in the amount of dense broadleaf and dense mixed wood in the Project through the years 10, 25 and 50. Reclamation to establish a variety of vegetation communities including mixed wood forest and understorey diversity will provide habitat for the Pileated Woodpecker as well as a variety of wildlife species. Best Management Practices such as wildlife tree retention, leaving dead wood on the forest floor from the pre-harvest stand, as well as new silviculture techniques, *i.e.,* retention system, partial cut, are all techniques that mitigate the impact of forest harvesting on species like the Pileated Woodpecker.

Olive-sided Flycatcher

The Olive-sided Flycatcher breeds along forest edges and openings, including burns, natural edges of bogs, marshes and open water, semi-open forest, and harvested forest with some structure retained. It breeds in semi-open coniferous and mixed wood forests with considerable height diversity or an open canopy that are often associated with riparian habitat. Tall, prominent trees and snags, which serve as singing and foraging perches, and unobstructed air space for foraging are common features of all nesting habitats (Altman and Sallabanks 2000). The Olive-sided Flycatcher winters in Central and South America. It departs early in the fall and arrives late in the spring.

The Olive-sided Flycatcher was observed on 6 different plots during the Project breeding bird survey for a total of 6 birds; relative abundance was 0.9 pairs/km2. It is an uncommon summer resident in the Project. Millennium (2011c:90) indicated that there will be a decrease in the amount of open conifer as well as a decrease in the amount of moderate conifer in the Project through the years 10, 25 and 50. Forest harvest practices that retain snags and live trees (potential nest trees) help provide suitable habitat for the Olive-sided Flycatcher.

Reasons for the declines in Olive-sided Flycatcher populations are unclear. Population decline is occurring throughout its breeding range despite different forest management practices. One hypothesis suggests that loss or alteration of habitat on wintering grounds is largely responsible (Altman and Sallabanks 2000).

Western Wood Peewee

This species, primarily found at the edge of forested regions of the province is widespread but never abundant in Alberta. The Western Wood-Pewee prefers open mixed, deciduous or coniferous forests often at the forest edge adjacent water bodies, streams, wetlands or clearings. Its generalized foraging behaviour and nest site selection reflect its common occurrence. It is found most commonly in the Foothills, Rocky Mountain and Grassland Natural Regions (FAN 2007).

The Western Wood-Pewee is a fairly common summer resident in the Project where 12 birds were recorded on 11 different plots during the breeding bird survey. Lake and wetland development associated with the Project should provide suitable habitat for this species especially if diverse forest communities are established adjacent to the water edge. Millennium (2011c:91) indicates that the Project should result in a net increase of water of 869.6 ha by Year 50.

Least Flycatcher

The Least Flycatcher winters in the Neotropics, arrives in Alberta in May, and is gone in September. Sightings outside this period, which corresponds to the availability of flying insects, are either misidentifications or individuals that have failed to migrate and will likely perish. The Least Flycatcher is commonly seen in all forested habitats, with the Parkland and Boreal Forest Natural Regions being the regions of highest concentration. Least Flycatchers are common urban birds, too, because they find parks, golf courses and even mature backyards to their liking (FAN 2007).

The Least Flycatcher was observed on 16 different plots during the Robb Trend breeding bird survey for a total of 23 birds or relative abundance of 3.5 pairs/km2. It is a fairly common summer resident in the Project. Reclamation to establish a variety of vegetation communities including mixed wood forest and understorey diversity will provide habitat for the Least Flycatcher as well as a variety of wildlife species

Barn Swallow

This species is often found associated with human activity, and near open areas which are used for foraging. Ancestral breeding habitat presumably was in mountainous areas and seacoasts that provided caves and rock crevices for nesting. The Barn Swallow has almost completely converted to breeding under the eaves of or inside artificial structures (Brown and Bomberger-Brown 1999).

The Barn Swallow is described in ASRD (2010) as "a common species that is declining in Alberta and all surrounding jurisdictions".

The Barn Swallow was observed on 3 different plots during the Project breeding bird survey for a total of 6 birds. This species had a relative abundance of 0.9 pairs/km2. It was also spotted five more times from June 5 to July 5, 2008. It is an uncommon summer resident in the Project. Shrublands and open upland herb vegetation will decrease in the Project area however an increase in water may provide foraging habitat for these birds. Opportunities to leave small cliffs may provide nesting habitat for the Barn Swallow (as well as the Cliff Swallow) if there are crevices in the cliff.

Brown Creeper

In Alberta the Brown Creeper breeds in the Boreal Forest, Foothills, and Rocky Mountain NRs where it favours late succession stages of coniferous spruce-fir forests (rarely pine) with an abundance of dead and dying trees which are used for nesting and foraging (Banks et al 1999). Brown Creepers are opportunistic and colonize recently disturbed areas, e.g., after fire where large amounts of dead and dying trees occur. This species tends to quiet and inconspicuous.

ASRD (2010) states the Brown Creeper is: "A mature forest-dependent species that is vulnerable to forest fragmentation, and certain forest management practices".

The Brown Creeper was observed on six different plots during the Robb Trend breeding bird survey for a total of six birds. The relative abundance was 0.9 pairs/km2. This species of bird was also observed in April, May and June from 2007 to 2008. The Brown Creeper is a fairly common summer resident in the Project. Millennium (2011c:90) indicated that there will be an increase in the amount of dense coniferous in the RSA through the years 10, 25 and 50. By year 50, the reclaimed upland forested areas will increasingly come to resemble and function like mature coniferous ecosites. Reclamation to establish a variety of forest vegetation will benefit the Brown Creeper and other wildlife. Best Management Practices such as wildlife tree retention, and silviculture techniques, *i.e.*, retention system, are techniques that mitigate the impact of forest harvesting on species like the Brown Creeper.

Black-throated Green Warbler

This bird breeds in a variety of forested habitats including coniferous, deciduous, and mixed wood habitats preferring extensive unfragmented stretches of mature coniferous forests. A single Black-throated Green Warbler was detected June 22, 2010 on Robb West.

ASRD (2010) states that there are: *"Over 10,000 individuals [Black-throated Green Warblers] in the province. [It is] designated a "Species of Special Concern" in Alberta. Habitat loss and* *fragmentation resulting from industrial development threaten this old-growth dependent species".*

The Black-throated Green Warbler was observed on plot once during the breeding bird survey in Robb West. It is a very uncommon summer resident in the Project. Millennium (2011c:90) indicated that there will be an increase in the amount of dense coniferous in the RSA through the years 10, 25 and 50. By year 50, the reclaimed upland forested areas will increasingly come to resemble and function like mature coniferous ecosites. Reclamation to establish a variety of forest vegetation will benefit this species and other wildlife.

Common Yellowthroat

This species has the ability to breed in a variety of habitats but prefers to nest in damp or wet areas that have high densities of low vegetation such as shrubby wetlands, and early succession forests often the result of forest fires or tree harvesting.

ASRD (2010) describes this species as *"a common, widespread species with a declining population in Alberta and surrounding jurisdictions. Threats to habitat identified".*

The Common Yellowthroat was observed on 12 different plots during the Robb Trend breeding bird survey for a total of 23 birds. This species had a relative abundance of 3.5 pairs/km^2. It is a fairly common summer resident. Wetland development associated with the Project should provide breeding habitat for this species. Millennium (2011c:91) indicates that the Project should result in a net increase of water of 869.6 ha by Year 50.

Western Tanager

The Western Tanager can be found in all Natural Regions of the province for at least part of the year. A neotropical migrant from wintering grounds in Mexico and central America, this tanager spends only about a third of the year (May-August) in Alberta. A species of older mixedwood forests in Alberta, the Western Tanager is observed most frequently in the Rocky Mountain and Foothills Natural Regions (FAN 2007).

The Western Tanager was observed on 7 different plots during the Robb Trend breeding bird survey for a total of 10 birds. This species had a relative abundance of 1.5 pairs/km^2. It is a fairly common summer resident on the Project.

Rusty Blackbird

The Rusty Blackbird nests in the boreal forest and favours the shores of wetlands such as slow-moving streams, peat bogs, marshes, swamps, beaver ponds and pasture edges. In wooded areas, the Rusty Blackbird only rarely enters the forest interior. COSEWIC indicates that "*More than 70% of the breeding range of the species is in Canada's boreal forest. The species has experienced a severe decline that appears to be ongoing, albeit at a slower rate. There is no evidence to suggest that this trend will be reversed. Known threats occur primarily on the winter range, and include habitat conversion and blackbird control programs in the United States".*

One Rusty Blackbird was observed feeding in a roadside ditch near the Erith River in the Project during migration on April 7, 2007. It is a very uncommon migrant in the Project area.

E.14.5 Mitigation and Monitoring

E.14.5.1 Mitigation

The following measures are recommended to mitigate the potential impacts of the Project on wildlife:

- undertake reclamation activities that specifically enhance wildlife use of the reclaimed area. Specifically provide diverse vegetation communities and complex arrangements of vegetation and landscape features;
- maintain as much undisturbed habitat as possible during mining will help to enhance the wildlife diversity of the reclaimed sites;
- avoid disturbing wetland habitats as much as possible particularly during haul road placement;
- where possible vegetation clearing should be planned for outside of the May to July breeding season;
- if raptor nests are found during operations, mitigation measures will be developed to address the specific situation;
- continue with the existing CVM wildlife management;
- remove carrion from haul roads to reduce raptor mortality;
- use of raptor-safe power line configurations for distribution lines to minimize chances of raptor electrocution;
- focus reclamation on establishing ecosystem function and initiating soil microbial activity. Wherever possible, direct haul placement techniques will be used;
- reclamation seed mix will be composed of several species of grasses and several species of legumes to provide foraging diversity for small mammals, ungulates, and selected bird species. Reclamation activities will initially establish a cover vegetation of grasses and legumes to prevent erosion and initiate soil development. Trees and shrubs will additionally be planted at the appropriate time;
- planting of willow, and other deciduous shrubs in selected areas to provide additional hiding cover and browsing opportunities for ungulates;
- plan upland grasslands for south-facing aspects so that winter forage opportunities are created for elk and deer;
- plant a variety of deciduous, mixed wood and coniferous forest types would establish forest complexity for ungulates and other wildlife;
- mimic the natural disturbance regime where possible. This includes designing complexity into the landscape by establishing forests with structural diversity and variety in vegetation communities and topography and reclaiming wetlands to include islands, irregular shoreline features, and a variety of aquatic and upland vegetation will promote nesting by waterfowl;
- identify opportunities to develop a number of ponds with shallow edges (<1 m) and emergent vegetation suitable for amphibian breeding and waterfowl nesting;
- vegetate soil stockpiles and waste areas with a grass/legume-forb mix to maintain wildlife use in the disturbance zone and reduce erosion potential;

- reduce line of site and promote movement of wildlife across reclaimed areas by using variable contouring of dump slopes;
- break continuous pit disturbances at intervals by "land bridges" or by variable slope angles as is currently done on the CVM; and
- establish where possible specialized habitat features such as snags, rock outcrops, cliffs and mineral licks.

E.14.5.2 Monitoring

CVM will monitor:

- human use of reclaimed areas and if determined necessary, develop an access management plan;
- timber removal by the FMA holder so that mining and forest harvesting can be coordinated so they do not result in simultaneous removal of mature tree cover and the creation of overly large open disturbances; and
- the response of ungulates to reclamation of the Project and other CVM projects.

E.14.6 Summary of VECs

Table E.14-12 provides a summary of the net impacts of the Project on wildlife after mitigation measures have been implemented. The assessment assumes the following vegetation response (adapted from GDC 2007, Section 5.2.1.1):

- grassland vegetation will take five years to establish after initial disturbance;
- trees are typically planted 2-4 years after the initial seed mix. After 8 years (for pine) or 14 years (for spruce) trees will be 2 m high and begin to provide hiding cover for ungulates, *i.e.,* 10-18 years after initial seeding. It is assumed that shrubs will be established at the same time as trees;
- most areas planted to trees will have crown closure by 25 years after initial seeding, average tree height will be >5 m, understorey vegetation will change to respond to altered light regime and native species adapted to understorey conditions will begin to ingress and dominate;
- wetlands will re-establish; and
- forest stands will begin to resemble ecosites with an understorey of hairy wild rye and labrador tea / feather moss at 50 years. More open areas including less densely planted forests and areas left as meadows will have higher cover and diversity of plant species and native graminoids will increasingly dominate open areas.

A variety of wildlife use on undisturbed and reclaimed habitat associated with coal leases during and after the mining phase has been documented. Wildlife have colonized new habitat created by reclamation of coal mines (MacCallum 2003). Activity associated with mining is predictable and focused. Animals are not subject to random and varied human disturbance within the MSL. These conditions allow animals to colonize the reclaimed landscape. The MSL associated with the CVM has provided a secure environment for wildlife and is instrumental in maintaining regional ungulate populations especially in the Critical Wildlife Habitat associated with the

Lovett Ridge. Initial displacement of the existing wildlife community on the Project LSA by active mining will be followed relatively quickly by colonization of wildlife species appropriate to the stage of succession reached by the regenerated plant community. Because the development is relatively narrow and small in area, species representative of the initially undisturbed habitats are expected to continue to be represented in the final landscape. Designing complexity into the landscape (lakes, ponds, wetlands, variety in vegetation communities and topography) will support wildlife diversity.

Given that appropriate habitats are established and movement opportunities are designed into the Project disturbance, wildlife are expected to adjust to the initial displacement and disturbance by colonizing newly available habitat and incorporating it into their daily and seasonal activities. Species composition on the reclaimed LSA will be similar, but changed, in response to the addition of lakes, ponds and other habitat features into the final landscape. Species composition of the wildlife communities will change over time in response to vegetation development and maturation.

The residual impact ratings assume:

- human recreation and access is managed to provide security for wildlife especially in the vicinity of the Lovett Ridge;
- diverse habitat types are established;
- structural complexity is established in reclaimed forest types;
- deciduous shrubs are incorporated into the reclaimed landscape; and
- industrial development in the region is coordinated and promotes best management practices that ensure long term viable wildlife populations.

Table E.14-12 Determination of the Significance of Potential Effects of the Proposed Project on Wildlife Resources (Ungulates, Small Mammals, Breeding Birds, Raptors, and Amphibians).

VEC	Nature of Potential Impact	Mitigation/ Protection Plan	Type of Effect	Criteria for Determining Significance						Significance	Project Contribution	Confidence Rating
				Extent	Duration	Frequency	Recovery	Magnitude	Probability			
UNGULATES (Moose, Deer, Elk)												
Elk	Loss of Foraging Habitat	Minimize Loss (2) Reclamation (1, 9,10,12,17,18)	Project	Local	Grassland Development (Extended) Shrub Development (Long) Forest Development (Long)	Continuous	Reversible in Short-Term	Moderate	High	Significant	Positive	High
	Loss of Forest Cover	Minimize Loss (2) Reclamation (9,10)	Residual	Local		Continuous	Reversible in Long-Term	Low	High	Insignificant	Neutral	High
Moose	Loss of Foraging Habitat	Minimize Loss (2) Reclamation (1, 7, 8, 10, 11, 16)	Project	Local	Shrub Development (Long)	Continuous	Reversible Long-Term	Low	High	Insignificant	Neutral	Moderate
	Loss of Forest Cover	Minimize Loss (2) Reclamation (1, 7, 8, 11,)	Residual	Local	Forest Development (Long)	Continuous	Reversible in Long-Term	Low	High	Insignificant	Neutral	High
Deer	Loss of Foraging Habitat	Minimize Loss (2) Reclamation (1, 7, 8, 9,10,11,12,16)	Project	Local	Grassland Development (Extended) Shrub Development (Long) Forest Development (Long)	Continuous	Reversible in Short-Term	Moderate	High	Significant	Positive	High
	Loss of Forest Cover	Minimize Loss (2) Reclamation (9,10)	Residual	Local		Continuous	Reversible in Long-Term	Low	High	Insignificant	Neutral	High

Table E.14-12 Determination of the Significance of Potential Effects of the Proposed Project on Wildlife Resources (Ungulates, Small Mammals, Breeding Birds, Raptors, and Amphibians).

VEC	Nature of Potential Impact	Mitigation/ Protection Plan	Type of Effect	Criteria for Determining Significance						Significance	Project Contribution	Confidence Rating
				Extent	Duration	Frequency	Recovery	Magnitude	Probability			
Elk Moose Deer	Disruption of Movement Patterns	Minimize Loss (2) Reclamation (15) Management (18)	Project Project	Local Local	Short Short	Continuous Continuous	Reversible in Short-Term Reversible in Short-Term	Low Moderate	High High	Insignificant Insignificant	Neutral Neutral	High Moderate
Elk Moose Deer	Displacement	Management (17,18)	Project	Regional	Long	Continuous	Reversible in Long-Term	Moderate	Medium	Insignificant	Neutral	Moderate
Elk Moose Deer	Direct Mortality	Training (5)	Project	Local	Short	Continuous	Irreversible	Low	High	Insignificant	Neutral	High
SMALL MAMMALS												
	Loss of Habitat	Minimize Loss (2) Reclamation (1,7,8, 9, 10, 11, 15,16)	Project	Local	Grassland Development (Extended) Shrub Development (Long) Forest Development (Long)	Continuous Continuous	Reversible in Short-Term Reversible in Long-Term	Low Low	High High	Insignificant Insignificant	Neutral Neutral	High Moderate

Table E.14-12 Determination of the Significance of Potential Effects of the Proposed Project on Wildlife Resources (Ungulates, Small Mammals, Breeding Birds, Raptors, and Amphibians).

VEC	Nature of Potential Impact	Mitigation/ Protection Plan	Type of Effect	Criteria for Determining Significance						Significance	Project Contribution	Confidence Rating
				Extent	Duration	Frequency	Recovery	Magnitude	Probability			
BREEDING BIRDS and RAPTORS												
	Loss of Habitat	Minimize Loss (2) Reclamation (1, 7, 8, 9, 10, 11, 12, 13, 16) Management (18)	Project and Residual Project	Local Local	Grassland Development (Extended) Shrub Development (Long) Forest Development (Long) Short	Continuous Continuous Continuous	Reversible in Short-Term Reversible in Long-Term Reversible in Short-Term	Low Low Low	High High High	Insignificant Insignificant Insignificant	Neutral Neutral Neutral	High Moderate High
	Direct Mortality	Timing & Training (3, 4, 6)	Project	Local	Short	Continuous	Irreversible	Low	High	Insignificant	Neutral	High
	Displacement	Minimize Loss (2) Reclamation (1, 7, 8, 9, 10, 11, 12, 13, 16) Management (18)	Project and Residual Project	Local Local	Grassland Development (Extended) Shrub Development (Long) Forest Development (Long) Short	Continuous Continuous Continuous	Reversible in Short-Term Reversible in Long-Term Reversible in Short-Term	Low Low Low	High High High	Insignificant Insignificant Insignificant	Neutral Neutral Neutral	High Moderate High
AMPHIBIANS												
	Loss of Habitat	Minimize Loss (2) Reclamation (1, 13)	Project	Local	Short	Continuous	Reversible in Short-Term	Low	High	Insignificant	Neutral	High

E.15 GREENHOUSE GAS AND CLIMATE CHANGE

E.15.1 INTRODUCTION AND TERMS OF REFERENCE

Greenhouse Gases (GHG) absorb heat radiated by the earth and subsequently warm the atmosphere, leading to what is commonly known as the greenhouse effect. Common GHGs include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). This section has been prepared to discuss the GHGs and climate change potential for the Project.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the GHG and climate change components are provided in Section 2.7 and 3.1, and are as follows:

2.7 AIR EMISSIONS MANAGEMENT

[A] Identify the type, volume and source of air emissions for the proposed Project:

d) describe the annual and total greenhouse gas emissions during all stages of the project. Identify the primary sources and provide examples of calculations; and

e) describe CVRI's overall greenhouse gas management plans.

3.1 AIR QUALITY, CLIMATE AND NOISE

3.1.2 Impact Assessment

[B] Identify stages or elements of the Project that are sensitive to changes or variability in climate parameters, including frequency and severity of extreme weather events. Discuss what impacts the change to climate parameters may have on elements of the Project that are sensitive to climate parameters.

E.15.2 GREENHOUSE GAS

E.15.2.1 Project GHG Emissions

Project Case 1, as defined in Section E.1, was chosen for the air assessment as mining will be at full production and Robb West operations are nearest to Robb. To ensure the assessment was conservative it was assumed that daily raw coal production from Robb West was almost twice the annual average (maximum 29,400 t/day compared to 15,100 t/day) and that daily raw coal production from Robb East was almost four times higher (maximum 22,200 t/day compare to 5,500 t/day).

There are three sources of GHG emissions for Project Case 1:

- fugitive emissions of coal-bed methane;
- combustion of clean coal in the coal dryer; and
- diesel combustion in the mine fleet and haul vehicles.

Greenhouse gas emissions are expressed in carbon dioxide equivalents (CO2e). Fugitive methane emissions from surface coal mining were estimated using emission factors provided by the Intergovernmental Panel on Climate Change (IPCC 2006). Table E.15-1 summarizes fugitive emissions of methane from the mine.

Table E.15-1 Fugitive Coal Bed Methane Emissions

	Robb West	Robb East	TOTAL (Project Case 1) (Year 2034)
CH4 Emission Factor (t CH4/kt coal)	0.87	0.87	-
Coal Production (t/yr)	5,500,000	2,000,000	7,500,000
Methane Emissions (t/yr)	4,785	1,740	6,525
GHG Emissions (t CO2e/yr)	100,485	36,540	137,025

GHG emission estimates for diesel combustion and for the coal dryer are based on the amount of fuel consumed and Environmental Canada emission factors. A summary of direct annual GHG emissions for Project Case 1 from both fugitive and combustion sources are shown in Table E.15-2. The total equivalent CO_2 emissions from Project operations were estimated to be 357 kt/yr. According to Environment Canada (2011b), total national GHG emissions were 690 Mt in 2009 and Alberta's share was 33.8% or 233 Mt. Therefore, direct GHG emissions from Project operations in 2034 will be approximately 0.15% of 2009 Alberta GHG emissions and 0.05% of national emissions.

Table E.15-2 Total Annual Direct GHG Emissions (for Year 2034)

Source	Annual GHG Emissions (kt CO_2e/yr)
Fugitive Methane	137
Coal Dryer	126
Diesel Combustion	94
Total Project Case 1	357

Construction phase GHG emissions were estimated by pro-rating the GHG emissions from the operations phase based on the ratio of material moved in the construction phase to the material moved in the operational phase. Maximum construction emissions are expected to occur during the construction of the Halpenny and Erith haul roads which will be constructed concurrently. The amount of material moved during the construction phase is estimated to be 7.7 Mt. The maximum annual amount of material moved during the operations phase is estimated to be 51.2 Mt, which is predicted to occur in 2034. The total GHG emissions during the initial construction phase are approximately 15% (7.7 Mt ÷ 51.2 Mt) of the GHG emissions in 2034, which is 54 kt CO2e/year.

GHG emissions during the reclamation phase are assumed to be equal to construction phase emissions.

E.15.2.2 Greenhouse Gas Management Strategy

CVRI will develop a GHG Management plan that will incorporate a process of continuous improvement throughout the life of the Project and will contain elements that are consistent with the Province of Alberta's GHG emissions reduction plan, *Albertans and Climate Changes; Taking Action, (2002)* and the *Climate Change and Emissions Management Act (2007)*.

The Alberta Action Plan focuses on improving energy efficiency, enhancing the use of technology to control industrial emissions, seeking out new environmentally friendly sources of energy and better emissions management. The plan outlines nine key areas that the Province is focusing on with respect to climate change:

1) Negotiate agreements with key sectors.
2) Emissions trading.
3) Put the Alberta government "house" in order.
4) Help Albertans conserve energy.
5) Support technology.
6) Carbon management.
7) Renewable/alternative energy sources.
8) Biological sinks.
9) Adapting to climate change.

CVRI's Project GHG management plan will include the following approaches:

- optimization of energy efficiency during Project design and operations;
- best practices will be the standard for all phases of the Project;
- equipment purchasing decisions will be made with consideration of continuous improvement principles, energy efficiency, appropriate equipment sizing, and improving technology (particularly, mine fleet emissions and combustion technologies);
- rigorous equipment maintenance and replacement procedures;
- training programs for operations personnel with a focus on reviewing plant energy use trends and identifying opportunities for improvement;
- implementation of a GHG monitoring and reporting program to measure and compare against the GHG management plan and to identify gaps and opportunities for further improvement;
- establishment of continuous improvement targets for the reduction of GHG emissions as part of the business planning cycle;
- trading of GHG offsets, if necessary; and
- contributing to the Climate Change and Emissions Management Fund, if necessary.

CVRI's GHG Management Plan will support five actions of the Alberta Strategy, as outlined below:

1) **Negotiate Agreements with Key Sectors** - CVRI participated in the stakeholder consultation regarding the development of a Specified Gas Emitters Regulation in Alberta and will actively engage in future consultations and negotiations with the Province and the federal government.
2) **Emissions Trading**- CVRI Project GHG Management Plan supports the development of offset trading systems and the Climate Change and Emissions Management Fund. If necessary, and cost effective, CVRI will use offsets or contribute to the Fund to manage GHG emissions.
3) **Help Albertans Conserve Energy** - The availability of a local coal source will result in reduced fuel consumption and transportation costs.
4) **Support Technology** - The CVRI GHG Management Plan supports the development of cleaner technology and commits to participating in ongoing research and development where appropriate.
5) **Adapting to Climate Change** - CVRI will work with stakeholders to understand climate change impacts and will take part in national and regional research initiatives where appropriate.

E.15.3 CLIMATE CHANGE

Air quality is strongly dependent on specific weather variables and could be sensitive to climate change. Generally, the future climate is expected to be more stagnant due to a weaker global circulation and the currently decreasing frequency of mid-latitude cyclones. The observed correlation between surface ozone and temperature in polluted regions points to a detrimental effect of warming. Climate change alone will increase summertime surface ozone in regions with manmade emissions (Jacob and Winner, 2009). At the same time, increased water vapour in the future climate is expected to decrease the ozone background, so these two parameters have opposite sensitivities to climate change.

The effect of climate change on particulate is more complicated and uncertain. Precipitation frequency is an important factor in mitigation, but wildfires fuelled by climate change could become an increasingly important particulate source.

Increased volatilization of soil mercury and possibly deposited PAHs could occur, as soil mercury is mainly bound to organic matter. Future warming at boreal latitudes could release large amounts of soil organic matter to the atmosphere as CO_2 through increased respiration and forest fire frequency (Jacob and Winner, 2009).

E.15.3.1 Projected Climate Change

Climate change may affect construction, operation, decommissioning, and reclamation stages of the Project. The effect of global warming on climate variables in Alberta have been assessed by the Prairie Adaptation Research Collaborative (PARC) using IPCC (IPCC 2001) growth scenarios and various international GCMs (Barrow and Yu, 2005).

The climate change assessment for the Project included the following elements:

- determine projections for climate parameters during the Project lifetime;

- identify potential effects of climate change on Project stages; and
- identify implications that climate change may have on the Project.

The existing and projected changes to the selected climate parameters are provided for the region near the Project. The selected parameters are:

- average annual temperature;
- annual precipitation;
- degree days; and
- moisture index (an increase indicates additional moisture stress).

Predicted changes in the 2050s for these parameters near the expected end of the Project lifetime are listed in Table E.15-3.

Table E.15-3 Projected Climate Parameters near Grande Prairie[a] Based on the Median Change Scenario of the Alberta Climate Model (Barrow and Yu, 2005)

Parameter	Baseline Value (1961 – 1990)	Median Prediction, 2050s	Change (%) Baseline to Median
Mean Annual Temperature (K)	274.6	276.7	0.8
Annual Precipitation (mm)	471	506	7
Degree Days > 5°C	1280	1925	50
Annual Moisture Index	2.7	3.9	44

(a) Grande Prairie, farther north than Edmonton, was chosen to reflect effects of higher elevation at the Project

E.15.3.2 Sensitivity to Climate Change

Construction on the Project is largely limited to new haul road corridors in stages through the Project life, as the Plant is already operational. Extreme weather conditions may affect fugitive dust emissions and the frequency of windblown dust. However, the impact is expected to be low and would occur either prior to the beginning of operations (for Robb West and Robb East) or during operations for Robb Main. Any increases in dust can be readily managed with appropriate dust control. Therefore, the impact of climate change on construction is expected to be insignificant.

Increases in the frequency of extreme temperature will result in an increased frequency of high ozone concentrations, as a result of the increase in temperature/radiation and possibly through increases in biogenic emissions of precursors.

Increased precipitation may reduce fugitive dust from many aspects of operations. At the same time, increases in annual moisture index and degree days likely more than offset the increased precipitation, causing additional drying. Mitigation by road watering could adapt to changes as they occur. $PM_{2.5}$ emissions, which arise largely from combustion, are not expected to change as much as those of coarser particulate.

For the decommissioning phase of the Project, climate change may impact reclamation and re-vegetation activities, potentially increasing fugitive dust emissions as evidenced by increases in the annual moisture index and degree days in the 2050s. These impacts are anticipated to be low and can be readily managed with appropriate dust control.

Overall, the change in climate will have low to no impact on air quality associated with the Project as potential increases in fugitive dust can be managed through adaptive road watering practices.

E.16 LAND AND RESOURCE USE

This section provides an overview of land and resource use policies, management plans and leases pertaining to the land and resource use in the Project area. In addition, it describes unique sites, special features and recreation facilities in the area as well as existing commercial and recreational land and resource use activities.

Alberta Environment issued the final ToR for the Project on August 4, 2011. The specific requirements for the land and resource use component are provided in Section 3.10, and are as follows:

3.10 LAND USE

3.10.1 Baseline Information:

[A] Describe and map the current land uses in the study area, including all Crown land and Crown Reservations (Holding Reservation, Protective Notation, and Consultative Notation).

[B] Indicate where Crown Land dispositions will be needed for roads or other infrastructure for the Project.

[C] Identify and map unique sites or special features in the local and regional study areas such as Parks and Protected Areas, Heritage Rivers, Historic Sites, Environmentally Significant Areas, culturally significant sites and other designations (World Heritage Sites, Ramsar Sites, Internationally Important Bird Areas, etc).

[D] Describe and map land clearing activities, showing the timing of the activities.

[E] Describe the status of timber harvesting arrangements, including species and timing.

3.10.2 Impact Assessment

[A] Identify the potential impact of the Project on land uses, including:

a) impacts to unique sites or special features;

b) impacts caused by changes in public access arising from linear development, including secondary effects related to increased hunter, angler and other recreational access, decreased access to traditional use sites and facilitated predator movement;

c) potential impacts to aggregate reserves that may be located on land under CVRI's control;

d) the impact of development and reclamation on commercial forest harvesting and fire management in the study Area;

e) the amount of commercial and non-commercial forest land base that will be disturbed by the Project, including the Timber Productivity Ratings for the Project area. Compare the pre-disturbance and reclaimed percentages and distribution of all forested communities in the Project Area;

f) how the Project impacts Annual Allowable Cuts and quotas within the Forest Management Agreement area;

g) the potential impact on existing land uses of anticipated changes (type and extent) to the pre-disturbance topography, elevation and drainage pattern within the Project Area; and

h) impacts of the Project on public access, regional recreational activities, aboriginal land use and other land uses during and after development activities.

[B] Discuss possible mitigation strategies to address impacts on land use including:

a) access management during and after Project operations;

b) the process for addressing the needs of other land users in both the local and regional study areas; and

c) how potentially-affected aggregate reserves will be salvaged and stockpiled with input provided by Alberta Sustainable Resource Development.

E.16.1 Land and Resource Use Policies

E.16.1.1 Coal Development Policy

A Coal Development Policy for Alberta was adopted in 1976 with the purpose of guiding the exploration and development of coal resources throughout the province. Under this policy, exploration and development of coal deposits are permitted only under strict control to ensure environmental protection and satisfactory reclamation of any disturbed land.

The policy includes a land classification system that considers environmental sensitivity, alternate land uses, potential coal resources and infrastructure. Provincial lands fall into one of four categories with respect to coal exploration and development. Department of Energy and Natural Resources 1976 describes the four categories as follows:

Category 1: In which no exploration or commercial development will be permitted (*e.g.* National and Provincial Parks, Wilderness and Natural Areas, Heritage Sites and other environmentally sensitive areas).

Category 2: In which limited exploration is desirable and may be permitted under strict control but in which commercial development by surface mining will not normally be considered at the present time (*i.e.* areas of high environmental sensitivity, where preferred land use has yet to be determined or where infrastructure is lacking). Underground mining or in-situ operations may be permitted in areas within this category where the surface effects of the operation are deemed to be environmentally acceptable.

Category 3: In which exploration is desirable and may be permitted under appropriate control but in which development by surface or underground mining or in-situ operations will be approved subject to proper assurances respecting protection of the environment and reclamation of disturbed lands and as the provision of needed infrastructure is determined to be in the public interest (*i.e.* northern forested region, Class 1 and 2 agricultural land and settled areas).

Category 4: In which exploration may be permitted under appropriate control and in which surface or underground mining or in-situ operations may be considered subject to proper assurances respecting protection of the environment and reclamation of disturbed lands. This category covers the parts of the Province not included in the other three categories.

The Project area is within Category 4 (Figure E.16-1), which allows "development permitted under normal approval procedures" and is described as an area (Department of Energy and Natural Resources, 1976) "in which surface or underground mining or in-situ operations may be considered subject to proper assurances respecting protection of the environment and reclamation of disturbed lands".

E.16.1.2 Eastern Slopes Policy

The Eastern Slopes of Alberta's Rocky Mountains covers an area of approximately 90,000 km² that contains a wealth of renewable and non-renewable resources - most of which are located on or beneath Crown lands (AENR 1984). Increasing pressure for resource and land use in this area created conflicts in land allocation and increasing concerns regarding environmental protection of this important watershed region. These concerns demonstrated the need for an integrated land use policy and a comprehensive plan for management and development.

In 1970, the Alberta Government responded to these identified needs with two planning studies in the Eastern Slopes - the Foothills Resource Allocation Study and the Hinton-Yellowhead Regional Land Use Study. These studies started a comprehensive planning process designed to identify optimum resource uses for land units based on an evaluation of resource capability, present land use economics and demand. In 1973, the Environmental Conservation Authority conducted public hearings and a public opinion survey regarding land use and resource development in the Eastern Slopes in order to identify the views and concerns of Alberta residents. Public feedback received during this consultation process identified watershed protection and public recreation as priority items as well as the need for an integrated resource policy and land use planning in the area.

In response to these needs and concerns, the Eastern Slopes Interdepartmental Planning Committee was established in 1975 to make recommendations on an integrated resource planning approach for management of the Eastern Slopes. The Government of Alberta used these recommendations to prepare "A Policy for Resource Management of the Eastern Slopes" (Eastern Slopes Policy) in 1977 (revised in 1984). The policy uses a regional land use zoning system to designate land use areas for varying degrees of protection, resource management and development. The overriding principle of all zones is to protect the valuable water resources of the Eastern Slopes, and to provide for public land and resource use in a manner consistent with principles of conservation and environmental protection.

As stated above, the Eastern Slopes Policy refers to three broad land use zones which designate large areas of land for varying degrees of protection, multiple use management, or resource development. Within the broad zones, eight detailed land use zones outline a range of permitted activities that are consistent with the priorities and management objectives of the zone. The eight land use zones are:

Protection	1. Prime Protection 2. Critical Wildlife
Resource Management	3. Special Use 4. General Recreation 5. Multiple Use 6. Agriculture
Development	7. Industrial 8. Facility

In 1990, the Eastern Slopes Policy was replaced by the Coal Branch Sub-Regional Integrated Resource Plan (IRP) and is no longer used to guide land and resource use decisions in this geographic region.

E.16.1.3 Coal Branch Sub-Regional Integrated Resource Plan

The Coal Branch Sub-Regional Integrated Resource Plan (1990) presents the Government of Alberta's resource management policy for public lands within this region of the Eastern Slopes. This Plan has replaced the Eastern Slopes Policy established in 1977. It is intended to be a guide for resource managers, industry and the public with responsibilities or interests in the area, rather than a regulatory mechanism. The plan has no legal status and is subject to revisions or review at the discretion of the Minister of Forestry, Lands and Wildlife.

The plan supersedes the zoning configuration set down in the Eastern Slopes Policy. As a result, the zones have been refined and the regional zoning and the table of compatible activities found in the Eastern Slopes Policy no longer apply in the Coal Branch planning area.

The Coal Branch planning area has been divided into eight smaller resource management areas (RMAs) but the broad resource management objectives of the Eastern Slopes Policy and the Coal Branch Integrated Resource Plan (IRP) apply to each of the RMAs. The eight RMAs are:

- Yellowhead Corridor
- Edson South-Pembina
- Robb Highlands
- Cardinal-Brazeau
- McLeod
- Brule Lake
- Mountain Park-Folding Mountain
- Nikanassin

The proposed Project area lies within the Robb Highlands RMA (Figure E.16-2). The management intent for the Robb Highlands RMA is to provide for a range of multiple use activities while recognizing the area's resource values. In addition, the importance of watershed protection, fisheries, wildlife, extensive recreation and historical resources must also be recognized in this area.

The objectives for the Robb Highlands RMA are (Alberta Forestry, Lands and Wildlife, 1990):

- to ensure opportunities for exploration and development of coal, petroleum and natural gas;
- to ensure that allocated timber resources are managed to provide ongoing sustainable yields;
- to ensure that existing and future resource developments do not result in unacceptable changes in water quality and quantity;
- to maintain an optimum sustained supply of deciduous and coniferous timber production;
- to increase elk and mule deer populations while maintaining or increasing moose densities;
- to retain productive recreational fisheries at Fairfax Lake and manage Mackenzie Creek as a naturally producing fishery;
- to maintain existing levels of authorized horse grazing and ensure good rangeland condition is maintained;
- to maintain the hamlet boundaries of Robb and maintain Mercoal as a seasonal residency and short-term leasehold area;
- to maintain recreational capability of specific areas and river corridors identified as having potential for present or future use or development;
- to preserve historic sites and preserve historic resources for future generations;
- to provide and maintain auto-access camping, day use and water access as well as trails and staging facilities for equestrian use, hiking, snowmobiles and off highway vehicles; and
- to maintain Highways 47 and 40 as safe transportation corridors for industrial and recreational users while managing visual landscape qualities and recognizing potential for industrial and historical interpretative opportunities along these corridors.

In summary, the RMAs objectives recognize the significant resources in the area including coal, natural gas, timber, wildlife and fisheries, rangeland as well as the importance of watershed protection, outdoor recreation, historical resources and safe road access.

There are three zoning levels that have been determined through the IRP for the Project development area (Figure E.16-3):

- Zone 2 (Critical Wildlife) – To protect specific fish and wildlife populations by protecting aquatic and terrestrial habitat crucial to the maintenance of those populations;
- Zone 5 (Multiple Use) – To provide for the management and development of the full range of available resources, while meeting long-term objectives for watershed management and environmental protection; and
- Zone 8 (Facility) – To recognize existing or approved settlement and commercial development areas.

Coal mining is considered compatible within the Zone 5 areas. Mining is also permitted under certain circumstance with appropriate conditions and controls within Zone 2.

E.16.1.4 Other Land and Resource Use Policies

Fish and Wildlife have developed guidelines and referral maps (Wildlife Referral Zones) for industrial activities within the Rocky Mountain, Edson and Whitecourt Forest areas. Such guidelines and referral maps are to be utilized by land management agencies for applying conditions to land use activities.

Certain portions of the Project areas have been identified as Class C (Figure E.16-4). This zone corresponds to the IRP Zone 2 described above.

The "Class C – Key Wildlife and Watercourse" zone as a combination of critical wildlife habitat from both uplands and major watercourse valleys (ASRD 2005). The intent of this zone is to:

- protect regionally-significant wildlife movement corridors;
- protect areas with rich habitat diversity and regionally-significant habitat types;
- protect critical hiding and thermal cover for ungulates; and
- protect the complex structure and processes of riparian areas.

To achieve the above goals, guidelines for industrial activities in this zone aim to (in order of priority) prevent loss and fragmentation of habitat; prevent long-term all-weather vehicle access; prevent sensory disturbance during periods of thermal or nutritional stress on wildlife; and prevent the development of barriers to wildlife corridors (*e.g.,* stream crossings) (ASRD 2005).

E.16.2 INDUSTRIAL DEVELOPMENT

Over the last several years industrial development in the region has increased significantly. In addition to coal mining there is oil and gas development, forestry, aggregate operations, and public roadways, and utilities. The following section outlines the existing surface and subsurface dispositions that overlap with the proposed Project mine permit boundaries (Abacus 2012).

E.16.2.1 Coal

CVRI holds Mine Permit No. C2005-6E issued by the Energy Resource Conservation Board for development of the CVM. CVRI is requesting an extension to this permit area in order to develop the Project areas.

A detailed listing of all the coal leases found within the Project area is provided in Table B.6-1 and shown on Figure B.6-1. Some leases are held directly by CVRI and others are held by companies within a royalty arrangement to CVRI. There are also several coal leases held by others.

There are also a number of surface dispositions in the Project area related to coal development. These surface dispositions are held by CVRI and are listed in Table E.16-1 and shown on Figure E.16-6.

Table E.16-1 Coal Mining Surface Dispositions		
Disposition	**Disposition Holder**	**Location**
LOC 101779	Coal Valley Resources Inc.	NE-32-46-18-W5M NW-33-46-18-W5M
LOC 101778	Coal Valley Resources Inc.	NE-14-48-20-W5M
LOC 100159	Coal Valley Resources Inc.	NW-12-49-21-W5M
LOC 101784	Coal Valley Resources Inc.	NE-30-49-21-W5M
LOC 10785	Coal Valley Resources Inc.	NW-30-49-21-W5M
LOC 101780	Coal Valley Resources Inc.	NW-34-47-19-W5M
LOC 100159	Coal Valley Resources Inc.	NE, SE-33-47-19-W5M NW-34-47-19-W5M

E.16.2.2 Oil and Gas

There is extensive oil and gas activity in the Project area. Petroleum and Natural Gas Licences and Leases have been issued by Alberta Energy throughout the Project area. The dispositions are listed in Table E.16-2 and shown on Figure E.16-7.

Table E.16-2 Petroleum & Natural Gas Leases and Licences		
Disposition	**Disposition Holder**	**Location**
Licences		
0555507010516	Antelope Land Services	LSD 16-31-48-20-W5M
0555511040276	Coales Bay Resources	LSD 7, 8, 11, 13, 14, NE-22-46-18-W5M LSD 10, 15,SE;SW;NW-27-46-18-W5M LSD 1, 8, 14, NE-28-46-18-W5M LSD 9, 10, 15; NW;SW;SE-33-46-18-W5M LSD 4-3-46-18-W5M LSD 4 ,5-3-47-18-W5M
0555504050810	Husky Oil Operations Limited	LSD 4- 3-48-19-W5M
0131307020395	Mancal Coal Inc.	LSD 1-36-49-22-W5M
0060695110470	Manitok Energy Inc.	LSD 1, 7, 8, 11, 13, 14, NE-7-47-18-W5M LSD 4-19-47-18-W5M LSD 1;7; 8; 11; 13; 14; NE-13-47-18-W5M
0060696050691	Manitok Energy Inc.	LSD 16-32-47-19-W5M LSD 6; NW; NE; SE-33-47-19-W5M LSD 1; 7; 8; 11; 13; 14; NE-23-47-19-W5M
0060697050967	Manitok Energy Inc. (50%) Persta Resources Inc. (50%)	LSD 11; 12; 13; SE; SW-4-48-19-W5M LSD 6; NW; NE; SE-48-19-W5M
0555507010515	Meridian Land Services	LSD 2; 12; SW-24-48-20-W5M LSD 1; 2; 12; SW-18-48-19-W5M LSD 3; 5; 6; NW; NE; SE-13-48-20-W5M
0555507010517	Meridian Land Services	LSD 4; 5; 14; NE-16-49-21-W5M LSD 15; 16-19-49-21-W5M LSD 3; 5; 6; NW; NE; SE-30-49-21-W5M
0060608090142	Persta Resources Inc.	LSD 1; 2; 7; NW; SW-26-47-19-W5M
0555507010513	Persta Resources Inc.	LSD 1; 7; 8; 11; 13; 14; NE-27-47-19-W5M

Table E.16-2 Petroleum & Natural Gas Leases and Licences

Disposition	Disposition Holder	Location
0060607060326	Ranger Land Services	LSD 12; 13-21-48-20-W5M
0060607060327	Persta Resources Inc.	LSD 9; 14; 15; 16-22-48-20-W5M
0060607060328	Persta Resources Inc.	Section 27; 32-48-20-W5M LSD 5; 6; NW; NE; SE-6-49-20-W5M
0060607060332	Persta Resources Inc.	Section 33-48-20-W5M
0555508030753	Persta Resources Inc.	LSD 16-32-47-19-W5M
0060608090143	Persta Resources Inc.	NW; SW; SE-34-47-19-W5M
0555508030754	Persta Resources Inc.	NW; NE; SW-6-48-19-W5M
0555507010514	Persta Resources Inc.	Section 7-48-19-W5M LSD 1; 8; 9; 16-1-48-20-W5M NE; SE-12-48-20-W5M
0060607060329	Persta Resources Inc.	LSD 4; 5; 8; NW; NE-28-48-20-W5M
0050510120380	Rockford Land Ltd.	LSD 3; 4; 7-49-20-W5M
0555511040277	Ranger Land Services	LSD 7, 8, 11, 13, 14, NE-22-46-18-W5M LSD 10, 15,SE;SW;NW-27-46-18-W5M LSD 1, 8, 14, NE-28-46-18-W5M LSD 9, 10, 15; NW;SW;SE-33-46-18-W5M LSD 4-34-46-18-W5M LSD 4 ,5-3-47-18-W5M
0060607060330	Ranger Land Services	LSD 6; 11; 14; NE; SE-29-48-20-W5M
0060600010375	Sabre Energy Ltd.	LSD 2; 3; 6; 7; 8; 11; 14; NE-4-49-21-W5M
0545409100552	Scott Land & Lease Ltd.	LSD 2; 12; SW-26-48-20-W5M LSD 2; 7; 11; 12; 13; SW-34-48-20-W5M LSD 2; 3; 4-4-49-20-W5M LSD 12; SW; SE-5-49-20-W5M
0555508070373	Scott Land & Lease Ltd.	LSD 1; 2; 7; 11; 12; SW-8-48-19-W5M SW; SE-31-49-21-W5M LSD 4-32-49-21-W5M
0555506050797	Scott Land & Lease Ltd.	LSD 10; NW; SW; SE-12-49-21-W5M
0555506050798	Scott Lease & Land Ltd.	LSD 5; 6; NW-15-49-21-W5M
0555506050798	Scott Land & Lease Ltd.	LSD 1; 2-14-49-21-W5M LSD 11; 13; 14; NE; SE-20-49-21-W5M LSD 9; 10; 15; NW;SW-21-49-21-W5M LSD 3; 4; 5-22-49-21-W5M LSD 9; 10; NW; SW; SE-29-49-21-W5M LSD 1-36-49-22-W5M
0555508040368	Scott Land & Lease Ltd.	LSD 9; 16- 25-49-22-W5M
0555511110504	Standard Land Company	NW; SW; SE-34-47-19-W5M LSD 4-35-47-19-W5M
0555505060329	Suncor Energy Inc.	LSD 2; 3; 6; 7; 8; 11; 14; NE-4-49-21-W5M LSD 1; 7; 8; NE-11-49-21-W5M LSD 3; 5; 6; 11; 12; 13; SE-9-49-21-W5M LSD 11; 13; 14; NE-1-49-21-W5M LSD 5; 12; 13-3-49-21-W5M
0555505060330	Windfall Resources	LSD 1; 7; 8; NE-17-49-21-W5M
0555511100258	Windfall Resources	LSD 9;10; 15; NW; SW; SE-23-48-20-W5M LSD 9; 15; 16-14-48-20-W5M
0060697050966	Manitok Energy Inc. (50%) Persta Resources Inc. (50%)	NW; SW; NE-6-48-19-W5M

Table E.16-2 Petroleum & Natural Gas Leases and Licences

Disposition	Disposition Holder	Location
0555598010117	Suncor Energy Inc. (50%) Husky Oil Operations Limited (50%)	LSD 3; 5; 6; 11; 12; 13; SE-9-49-21-W5M
0555598080082	Shell Canada Limited (50%) Tourmaline Oil Corp. (50%)	LSD 3; 4; 5-28-49-21-W5M
0060603060624	Suncor Energy Inc.(50%) Husky Oil Operations Ltd. (50%)	LSD 1; 7; 8; NE-11-49-21-W5M
0060697070615	Suncor Energy Inc. (50%) Petrus Resources Ltd. (25%) Manitok Energy Inc. (25%)	LSD 11; 13-14; NE-49-21-W5M LSD 5; 12; 13-3-49-21-W5M
0555594020081	Suncor Energy Inc. (50%) Manitok Energy Inc. (25%) Petrus Resources Ltd. (25%)	LSD 9; 16- 25-49-22-W5M
0060697120362	Suncor Energy Energy Inc. (50%) Manitok Energy Inc. (25%) Petrus Resources Ltd. (25%)	LSD 1; 7; 8-NE-49-21-W5M
	Suncor Energy Inc. (50%) Husky Oil Operations Limited (50%)	LSD 11; 13; 14; NE-1-49-21-W5M
0060607060331	Supernova Resources Ltd. (20%) Stone Petroleums Ltd. (80%)	Section 32-48-20-W5M
Leases		
001 122027	Tourmaline Oil Corp. (20%) Husky Oil Operations Limitd (22%) Enerplus Corporation (26%) Suncor Energy Inc. (32%)	LSD 2; 7; 12; SW-17-48-20-W5M
001 122028	Tourmaline Oil Corp. (20%) Husky Oil Operations Limited (22%) Enerplus Corporation 26%) Suncor Energy Inc. (32%)	LSD 2; 7; 12; SW-17-48-20-W5M NE-18-48-20-W5M LSD 3; 6; 9; 10; SE-19-48-20-W5M LSD 4; 5; 6; 7; 8; 11; 12; 14; NE-20-48-20-W5M
001 26297	Tourmaline Oil Corp.(17%) Enerplus Corporation (19%) Suncor Energy Inc. (29%) Husky Oil Operations Ltd. (35%)	LSD 16-8-49-21-W5M
001 26296	Tourmaline Oil Corp. (17%) Enerplus Corporation (19%) Suncor Energy Inc. (29) Husky Oil Operations Limited (35%)	LSD 3; 5; 6; 11; 12; 13; SE-9-49-21-W5M
001 36082	Tourmaline Oil Corp. (20%) Enerplus Corporation (26%) Suncor Energy Inc. (22%) Husky Oil Operations Limited (32%)	LSD 10; 15-8-48-20-W5M

Alberta Sustainable Resource Development has issued a number of surface dispositions to support oil and gas activity in the area covered by the Project. The surface dispositions, disposition holders, and location of the dispositions are listed in Table E.16-3 and shown on

Figure E.16-6. The following companies hold the dispositions; ConocoPhillips Canada Resources Corp. (ConocoPhillips), Harvest Operations Corp. (Harvest Operations), Husky Oil Operations Limited (Husky Oil), Manitok Energy Inc. (Manitok Energy), Persta Resources Inc. (Persta Resources),) Richards Oil and Gas Limited (Richards Oil & Gas), Sabre Energy Ltd. (Sabre Energy, Suncor Energy Inc. (Suncor Energy) Tourmaline Oil Corp. (Tormaline Oil), Yellow Gas Co-op Ltd. (Yellowhead Gas),

Table E.16-3 Surface Dispositions in Support of Oil and Gas Activity

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
LOC 940711	ConocoPhillips	NW; NE-6-48-19-W5M SW-7-48-19-W5M SE-12-48-20-W5M	Access Road
LOC 961489	ConocoPhillips	SW; SE-33-47-19-W5M	Access Road
LOC 040439	Harvest Operations	NW-27-46-18-W5M SW-34-46-18-W5M	Access Road
LOC 081798	Husky Oil	NE-8-48-19-W5M	Access Road
LOC 111041	Husky Oil	NE-8-48-19-W5M	Access Road
LOC 910755	Manitok Energy	SW-35-47-19-W5M SE-34-47-19-W5M	Access Road
LOC 920698	Manitok Energy	SW-34-47-19-W5M SW; SE-5-48-19-W5M NW; SW, SE-4-48-19-W5M	Access Road
LOC 930271	Manitok Energy	SE-23-47-19-W5M SW, SE-33-47-19-W5M NW: SE-27-47-19-W5M SW-5-48-19-W5M	Access Road
LOC 930954	Manitok Energy	NW-3-49-21-W5M	Access Road
LOC 941322	Manitok Energy	SW-3-48-19-W5M SE-4-48-19-18-W5M	Access Road
LOC 961070	Manitok Energy	NW-9-49-21-W5M SW-16-49-21-W5M NE; SE-17-49-21 W5M	Access Road
LOC 961071	Manitok Energy	SE-17-49-21 W5M	Access Road
LOC 981301	Manitok Energy	NE-25-49-22-W5M	Access Road
LOC 981318	Manitok Energy	NE-19-49-21 W5M	Access Road
LOC 090317	Persta Resources	SW-5-48-19-W5M	Access Road
LOC 100238	Perstra Resources	SW-6-48-19-W5M SE-1-48-20-W5M	Access Road
LOC 090317	Persta Resources	SW-5-48-19-W5M	Access Road
LOC 111792	Pestra Resources	SW-23-48-20-W5M	Access Road
LOC 000994	Sabre Energy	SW-3-49-21-W5M SE-4-49-21-W5M	Access Road
LOC 000160	Suncor Energy	SW-19-48-20-W5M	Access Road
LOC 5204	Suncor Energy	NE-8-48-20-W5M SW-17-48-20-W5M	Access Road

Table E.16-3 Surface Dispositions in Support of Oil and Gas Activity

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
LOC 820762	Suncor Energy	NE-12-49-21-W5M	Environment
LOC 940945	Suncor Energy	NW-22-46-18-W5M NE; SW-27-46-18-W5M SE-34-46-18-W5M	Access Road
LOC 951205	Suncor Energy	NE-8-49-21-W5M NW; NE-9-49-21-W5M	Access Road
LOC 961070	Suncor Energy	SW-16-49-21W5M	Access Road
LOC 970548	Suncor Energy	NE-8-48-20-W5M	Access Road
LOC 971461	Suncor Energy	SW-16-49-21W5M NW-9-49-21-W5M	Access Road
LOC 100413	Tourmaline Oil	NW-15-49-21-W5M SW-22-49-21 W5M	Access Road
LOC 100631	Tourmaline Oil	NW-1-49-21-W5M	Access Road
LOC 110794	Tourmaline Oil	SW-22-49-21 W5M	Access Road
LOC 111741	Tourmaline Oil	SW-4-49-20-W5M	Access Road
LOC 100931	Tourmaline Oil	NW-1-49-21-W5M	Access Road
MLL 090099	Tourmaline Oil	SW-32-49-21-W5M	Industrial
MSL 941016	Conoco Phillips	SE-12-48-20-W5M	Wellsite
MSL 961967	Conoco Phillips	SE-33-47-19-W5M	Wellsite
MSL 040660	Harvest Operations	SW-34-46-18-W5M	Wellsite
MSL 910846	Manitok Energy	SE-23-47-19-W5M	Wellsite
MSL 931537	Manitok Energy	NW-3-49-21-W5M	Wellsite
MSL 930805	Manitok Energy	NE-32-47-19-W5M	Wellsite
MSL 981772	Manitok Energy	NE-19-49-21 W5M	Wellsite
MSL 111901	Perstra Resources	SW-6-48-19-W5M	Battery Site
MSL 111966	Persta Resources	SW-23-48-20-W5M	Access Road
MSL 111969	Persta Resources	NW-27-48-20-W5M	Access Road
MSL 060815	Richards Oil & Gas	SW-32-49-21-W5M	Wellsite
MSL 001346	Sabre Energy	SE-4-49-21-W5M	Wellsite
MSL 961454	Sabre Energy	SW-3-49-21-W5M	Wellsite
MSL 021816	Suncor Energy	SW-16-49-21W5M	Wellsite
MSL 090382	Tourmaline Oil	SW-32-49-21-W5M	Sump Site
MSL 970709	Suncor Energy	NE-8-48-20-W5M	Wellsite
MSL 091443	Tourmaline Oil	NE-1-49-21-W5M	Wellsite
MSL 100608	Tourmaline Oil	NW-15-49-21-W5M SW-22-49-21 W5M	Wellsite
MSL 110825	Tourmaline Oil	SW-22-49-21 W5M	Wellsite
MSL 111908	Tourmaline Oil	SW-4-49-20-W5M	Wellsite
MSL 951585	Tourmaline Oil	NE-8-49-21-W5M	Wellsite

Table E.16-3 Surface Dispositions in Support of Oil and Gas Activity

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
MSL 100931	Tourmaline Oil	NW-1-49-21-W5M	Wellsite
MSL 941879	Conoco Phillips	NW-3-49-21-W5M	Wellsite
MSL 090511	Tourmaline Oil	SE-5-49-20-W5M	Remote Sump
MSL 9986	Suncor Energy	SW-17-48-20-W5M	Wellsite
PIL 080407	Persta Resources	NW-27-47-19-W5M	Pipeline
PIL 090161	Persta Resources	SW-5-48-19-W5M	Pipeline
PIL 090160	Persta Resources	NW-27-47-19-W5M	Pipeline
PIL 98007	Sabre Energy Ltd.	NE-32-47-19-W5M	Pipeline Installation
PIL 110371	Tourmaline Oil	SW-22-49-21-W5M	Valve Site
PIL 970098	Suncor Energy	SW-16-49-21-W5M	Pipeline Installation
PLA 930250	ConocoPhillips	SE-23-47-19-W5M NW; NE; SE-27-47-19-W5M SW; SE-33-47-19-W5M SW-5-48-19-W5M NE-32-47-19-W5M	Pipeline
PLA 930412	ConocoPhillips	NW-4-48-19-W5M NE; SW; SE-5-48-19-W5M	Pipeline
PLA 971518	ConocoPhillips	NE-6-48-19-W5M NW, SE, SW-7-48-19-W5M SW-18-48-19-W5M NE,SE-13-48-20-W5M NW-24-48-20-W5M	Pipeline
PLA 001544	Manitok Energy	SE-11-49-21-W5M	Pipeline
PLA 001780	Manitok Energy	NE-32-47-19-W5M NW-33-47-19-W5M SW-4-48-19-W5M	Pipeline
PLA 930586	Manitok Energy	NW;SE-13-47-19-W5M SE-23-47-19-W5M	Unknown
PLA 961511	Manitok Energy	SW, SE-4-49-20-W5M SW; SE-5-49-20-W5M NW; NE;SE-6-49-20-W5M SW-7-49-20-W5M	Pipeline
PLA 961512	Manitok Energy	NW; NE-9-49-21-W5M NE; SE-11-49-21-W5M NW; SW; SE-12-49-21-W5M	Pipeline
PLA 961513	Manitok Energy	SW-16-49-21W5M NE; SE-17-49-21 W5M NE-19-49-21 W5M	Pipeline
PLA 9900008	Manitok Energy	NE-19-49-21 W5M	Pipeline
PLA 08090934	Persta Resources	NW-27-47-19-W5M	Pipeline
PLA 100359	Pestra Resources	SE-1-48-20-W5M	Pipeline

Table E.16-3 Surface Dispositions in Support of Oil and Gas Activity

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
		SW-6-48-19-W5M	
PLA 090467	Persta Resources	NW-27-47-19-W5M NE-32-47-19-W5M SW; SE-33-47-19-W5M SW-5-48-19-W5M	Pipeline
PLA 111469	Persta Resources	NW-27-47-19-W5M	Pipeline
PLA 111505	Persta Resources	NW-27-47-19-W5M	Pipeline
PLA 110993	Pestra Resources	SW-5-48-19-W5M	Pipeline
PLA 1119014	Pestra Resources	SW-6-48-19-W5M	Pipeline
PLA 972461	Sabre Energy	NE-32-47-19-W5M SW-5-48-19-W5M NE-6-48-19-W5M NW; SW; SE-7-48-19-W5M NE: SE-13-48-20-W5M SW-18-48-19-W5M NW; SE-24-48-20-W5M	Pipeline
PLA 000580	Suncor Energy	NE 19-48-20-W5M NW-28-48-20-W5M NE; SW; SE-29-48-20-W5M NE, SE-33-48-20-W5M NW-34-48-20 W5M	Pipeline
PLA 001930	Suncor Energy	SW-19-48-20-W5M	Pipeline
PLA 010346	Suncor Energy	SE, SW-4-49-21-W5M	Pipeline
PLA 013599	Suncor Energy	NE-8-48-20-W5M NW; SW; SE-17-48-20-W5M NE-18-48-20-W5M SW-19-48-20-W5M	Pipeline
PLA 032047	Suncor Energy	NE-8-49-21-W5M NW-9-49-21-W5M SW-16-49-21W5M	Pipeline
PLA 042034	Suncor Energy	NE-8-48-20-W5M	Pipeline
PLA 042099	Suncor Energy	NE-8-48-20-W5M SW; SE-17-48-20-W5M	Pipeline
PLA 051640	Suncor Energy	NW; SE; SW-7-48-19-W5M NE; SE-13-48-20-W5M NW; NE-6-48-19-W5M SW-18-48-19-W5M NW; SE-24-48-20-W5M	Pipeline
PLA 810452	Suncor Energy	NW-28-48-20-W5M NE; SW; SE-29-48-20-W5M NE-33-48-20-W5M NW-34-48-20 W5M	Pipeline
PLA 810453	Suncor Energy	SW-29-48-20 W5M NE-19-48-20-W5M	Pipeline
PLA 970722	Suncor Energy	SW-16-49-21W5M	Pipeline
PLA 970722	Suncor Energy	NE-8-49-21-W5M NW-9-49-21-W5M	Pipeline

Table E.16-3 Surface Dispositions in Support of Oil and Gas Activity

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
PLA 992238	Suncor Energy	SW-19-48-20-W5M	Pipeline
PLA 000580	Suncor Energy	NW 28-48-20-W5M NE; SW; SE-29-48-20-W5M NE; SW; SE-33-48-20 W5M	Pipeline
PLA 810452	Suncor Energy	NW-28-48-20-W5M NE; SW; SE-33-48-20 W5M	Pipeline
PLA 890456	Suncor Energy	SW-17-48-20-W5M	Pipeline
PLA 070866	Tourmaline Oil	NW-15-49-21-W5M NE; SE-21-49-21-W5M SW-22-49-21-W5M	Pipeline
PLA 110214	Tourmaline Oil	SW-32-49-21-W5M	Pipeline
PLA 110219	Tourmaline Oil	SE-11-49-21-W5M NE-12-49-21-W5M	Pipeline
PLA 112002	Tourmaline Oil	SE, SW-4-49-20-W5M	Pipeline
PLA 110897	Tourmaline	NW-15-49-21-W5M	Pipeline
PLA 111998	Tourmaline	NE-8-48-20-W5M	Pipeline
PLA 961184	Yellowhead Gas	NE; SE-13-48-20-W5M	Pipeline
PLA 820393	Yellowhead Gas	NE-12-49-21-W5M SE-14-49-21-W5M	Pipeline
PLA 920393	Yellowhead Gas	SE-14-49-21-W5M	Pipeline
PLA 961184	Yellowhead Gas	NE; SE-12-48-20-W5M SE-24-48-20-W5M	Pipeline

E.16.2.3 Forestry

The proposed Project is located predominately within the West Fraser Mills Ltd. (West Fraser) Forest Management Area (FMA). West Fraser holds FMA agreement number 8800025 with the Province of Alberta that covers an area of 995,781 ha. A small portion of the Project area is within FMA No. 9700032 held by Sundance Forest Industries Ltd.

West Fraser maintains a system of logging roads throughout the area as access to ongoing timber harvesting and forest management activities (Figure E.16.-6, Table E.16-4). Wood is hauled to the Hinton mill. West Fraser has also established a number of permanent sample plots (PSPs) for long-term research purposes within the Project area (Table E.16-4).

Table E.16-4 Forestry

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
ISP 020719	West Fraser	LSD 16-8-49-21-W5M LSD-13-9-49-21-W5M LSD 4-16-49-21W5M LSD 1-17-49-21 W5M	PSP
ISP 020721	West Fraser	LSD-4-4-49-21-W5M LSD 4-4-49-20 W5M	PSP

Table E.16-4 Forestry

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
ISP 70140	West Fraser	NW-23-48-20-W5M	PSP
ISP 070036	West Fraser	NW-5-49-20-W5M NW-6-49-20-W5M	PSP
ISP 070116	West Fraser	SW-6-48-19-W5M	PSP
ISP 070136	West Fraser	SE-3-48-19-W5M	PSP
ISP 020721	West Fraser	LSD 4-4-49-21-W5M	PSP
ISP 070742	West Fraser	LSD 4-6-49-20-W5M	PSP
ISP 020745	West Fraser	LSD 16-12-49-21-W5M	PSP
ISP 020757	West Fraser	LSD 16-8-48-20-W5M LSD 1-17-48-20-W5M	PSP
ISP 020758	West Fraser	Section 22-48-20-W5M LSD 4-26-48-20-W5M LSD 1-27-48-20-W5M	PSP
ISP 020759	West Fraser	LSD 1-29-48-W5M LSD 4-28-48-W5M LSD 16-20-48-20-W5M	PSP
ISP 020760	West Fraser	LSD-13-33-48-20-W5M LSD 1-5-49-20-W5M	PSP
ISP 020782	West Fraser	LSD 16-32-47-19-W5M LSD 4-4-48-19-W5M LSD 1-5-48-19-W5M	PSP
ISP 020783	West Fraser	LSD 1-5-47-18-W5M LSD 1-27-47-19-W5M LSD 13-23-47-19-W5M	PSP
ISP 020808	West Fraser	LSD 13-7-47-18-W5M LSD-1-13-47-19-W5M	PSP
ISP 020817	West Fraser	LSD 16-8-41-18-W5M	PSP
ISP 020845	West Fraser	LSD 1-27-46-18-W5M	PSP
ISP 020846	West Fraser	LSD 16-32-46-18-W5M	PSP
ISP 20799	West Fraser	LSD 1-13-48-20-W5M LSD 13-7-48-19-W5M LSD 4-18-48-19-W5M LSD 16-12-48-20-W5M	PSP
LOC 628	West Fraser	NE-20-49-21-W5M NW-21-49-21-W5M SW-22-49-21-W5M NE-25-49-22-W5M SW; SE-29-49-21-W5M NW; NE; SE-30-49-21-W5M	Access Road
LOC 1315	West Fraser	SE-31-49-21-W5M	Access Road
LOC 2489	West Fraser	NE-12-49-21-W5M SE-14-49-21-W5M	Access Road

Table E.16-4 Forestry			
Disposition	**Disposition Holder**	**Location (within mine permit boundaries)**	**Purpose**
LOC 3966	West Fraser	NW; NE;SW;SE-33-46-18-W5M NW: SW-27-46-18-W5M SW-34-46-18-W5M SW-3-47-18-W5M NW; NE; SE-4-47-18-W5M NE-8-47-18-W5M	Access Road
LOC 3980	West Fraser	SW-32-49-21-W5M	Access Road
LOC 5787	Sundance Forest Industries Ltd.	NE; SW; SE-18-47-18-W5M	Access Road
LOC 012313	West Fraser	NE; SW; SE-19-48-20-W5M NW; NE-20-48-20-W5M NW-21-48-20-W5M	Access Road
LOC 013639	West Fraser	NW-17-48-20-W5M	Access Road
LOC 013640	West Fraser	NE-18-48-20-W5M	Pipeline
LOC 020934	West Fraser	SW-34-46-18-W5M SW-3-47-18-W5M SE; NE 32-46-18-W5M NW-27-46-18-W5M NE-28-46-18-W5M NW; SW-33-46-18-W5M SE-4-47-18-W5M	Access Road
LOC 041632	West Fraser	NE-12-49-21-W5M	Access Road
LOC 810792	West Fraser	NE-14-48-20-W5M NW; NE-22-48-20-W5M NW; NE; SW; SE-33-48-20 W5M NW; SW; SE--5-49-20-W5M NW; SW-13-48-20-W5M NW; SW-27-48-20-W5M SW-23-48-20-W5M SW-34-48-20 W5M NE-28-48-20-W5M	Access Road
LOC 920489	West Fraser	NW; SW-3-48-19-W5M SE-4-48-19-W5M	Access Road
LOC 920491	West Fraser	NW-3-48-19-W5M	Access Road
LOC 941322	West Fraser	SW-3-48-19-W5M	Access Road
LOC 951411	West Fraser	NW; SW-18-47-18-W5M	Access Road
LOC 961593	West Fraser	SW; SE-4-49-20-W5M SW-5-49-20-W5M SE-4-49-20-W5M	Access Road

Table E.16-4 Forestry			
Disposition	**Disposition Holder**	**Location (within mine permit boundaries)**	**Purpose**
LOC 961594	West Fraser	NE-27-48-20-W5M SE-33-48-20-W5M NW-26-48-20-W5M SW; SE-34-48-20 W5M	Access Road
LOC 961595	West Fraser	NW; NE-27-48-20-W5M SE-27-48-20-W5M SE-33-48-20-W5M SW-34-48-20 W5M	Access Road
LOC 961596	West Fraser	NE-29-48-20-W5M NW-28-48-20-W5M NE-29-48-20 W5M SW-33-48-20 W5M	Access Road
LOC 961597	West Fraser	NW-21-48-20-W5M SW-28-48-20-W5M NW; NE; SE-29-48-20-W5M SW-32-48-20-W5M SE-5-49-20-W5M	Access Road
LOC 961598	West Fraser	NW; SW; SE-6-49-20-W5M NW; NE-1-49-21-W5M NE-31-48-20 W5M SW-12-49-21-W5M	Pipeline
LOC 961414	West Fraser	NW-3-47-18-W5M NE-4-47-18-W5M	Access Road
LOC 961601	West Fraser	NW-12-49-21-W5M	Access Road
LOC 961995	West Fraser	NE-28-48-20-W5M	Access Road
LOC 971995	West Fraser	NW-22-48-20-W5M	Access Road
LOC 972002	West Fraser	NW; SW-28-48-20-W5M	Access Road
LOC 972003	West Fraser	SW-28-48-20-W5M	Access Road
LOC 9719999	West Fraser	NW-29-48-20 W5M SW-29-48-20 W5M	Access Road
LOC 991020	West Fraser	SW-32-49-21-W5M	Access Road

E.16.2.4 Utilities

There are three electrical transmission lines held by Altalink Management Limited (Altalink) that encroach on the Project area as service to local communities and the Robb-Hanlan Gas Plant. These facilities are generally adjacent to Highway 47. The powerlines are maintained (vegetation control) by Altalink and Fortis Alberta Incorporated (Fortis Alberta). Surface dispositions associated with utility infrastructure are listed in Table E.16-5 and shown on Figure E.16-6.

Table E.16-5 Utility Dispositions within the Proposed Mine Permit Area

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
EZE 2186	Altalink	SW-3-49-21-W5M	Powerline
EZE 830170	Altalink	NW, SW-3-49-21-W5M SE-4-49-21-W5M	Powerline
EZE 870165	Altalink	NW, SW-3-49-21-W5M SE-4-49-21-W5M	Vegetation
EZE 810213	Altalink	NE-12-49-21-W5M	Powerline
EZE 870181	Altalink	NE-12-49-21-W5M	Vegetation
EZE 100215	Fortis Alberta	SW-7-49-20-W5M NE-12-49-21-W5M SE-14-49-21-W5M	Vegetation
EZE 870152	Fortis Alberta	SW-3-49-21-W5M	Vegetation

E.16.2.5 Transportation

The area is serviced by Highways 47 (RRD 7721038 and 8320328). Highway 47 provides access from Edson south to Robb and then joins with Highway 40 Figure E.16-6.

E.16.2.6 Aggregates

West Fraser has one surface materials lease within the Project area and has a quarter section subject to a conservation and reclamation business plan. The dispositions are respective locations are identified in Table E.16-6 and shown on Figure E.16-6.

Table E.16-6 Surface Material Lease Disposition within the Proposed Mine Permit Area

Disposition	Disposition Holder	Location (within mine permit boundaries)	Purpose
CRB 080002	West Fraser	SE-27-46-18-W5M	Unknown
SML 810025	West Fraser	SE-27-46-18-W5M	Sand and Gravel

E.16.2.7 Other

There are a number of consultative notations assigned to lands within the mine permit boundary. There is an existing consultation notation (CNT 040053) held by Alberta Sustainable Resource Development for the Coal Branch Tourist & Commerce Association to use snowmobile trails.

Other consultative notations are held by Alberta Sustainable Resource Development (CNT 090039 and 020224) and Mancal Coal Inc. (CNC 990002).

E.16.3 NON INDUSTRIAL LAND USES

E.16.3.1 Hunting

The proposed development area is area is located within Wildlife Management Units #438 and #340 with a small section east of the Pembina River in # 339. Local hunters and a number of professional outfitters licensed by Alberta Fish and Wildlife have access to this area.

E.16.3.2 Adventure Tour Operators

There are numerous guides and outfitters that utilize the regional area. All of these have been contacted through the public engagement program.

E.16.3.3 Off Highway Vehicle Use

Coalspur and Robb function as 'staging areas' for local residents for snowmobile and ATV access in and around the areas of activity. Another staging area exists along Highway 47 near the main CVM mine entrance. A network of logging roads and cutlines provides access to the Project area and are used for off-highway vehicle use.

E.16.3.4 Campgrounds

The coal branch area is extensively used by recreationists. As a result the area campgrounds are well utilized and random camping occurs in several locations throughout the area. Commonly used sites are along the Embarras River and are used for parties involved in quad tours and general recreation. There a campsite located near Robb to the northeast outside the Project area.

The nearest designated campground is the Coalspur Provincial Recreation Area (PRA) which is operated under PRA 008001. This campground is located at NE 28-48-21-W5M (Figure E.16-8).

E.16.3.5 Cultural and Historical Sites

Various cultural sites and historical sites have been identified through consultation with local community groups and historical assessments conducted by resource companies involved in developments within the area. A historical resource impact assessment has been completed on the majority of the Project area. Assessment results are provided in detail in Section E.4 and CR# 4. Development can proceed only when regulatory agencies are satisfied that adequate mitigation strategies are in place for these resources and clearance is obtain from ACCS under the *Historical Resources Act*.

Through consultation with local aboriginal communities several 'cultural sites' have been identified and located for planning of future development in the area. Such sites include gravesites, ceremonial sites and traditional land use areas. The Traditional Land Use Report is included as CR# 12 and summarized in Section E.12.

E.16.3.6 Cemeteries

Cemeteries are located throughout the Coal Branch area at or near the former mining communities. In some instances solitary gravesites have been identified by locals and the aboriginal community. Gravesites have been identified during the Traditional Land Use studies (CR# 12) near the Project area.

E.16.3.7 Trapping Areas

There are five trapping area (TPA) dispositions within in the Project area (Table E.16-7, Figure E.16-9). CVRI has established compensation programs with owners of registered fur management areas which are impacted by existing mining activity.

Table E.16-7 Trapper Dispositions

Disposition	Location
TPA 1516	NE-19-48-20-W5M NW; NE-20-48-20-W5M LSD 13-21-48-20-W5M LSD 15, 16-22-48-20-W5M LSD 12,13, 14, 15, 16-23-48-20-W5M NW; SW; SE-26-48-20-W5M LSD 3,5,6, NW; NW; SE-27-48-20-W5M LSD 4,5, 15, 16-28-48-20-W5M LSD 9, 10, 15, SW; SE-29-48-20-W5M NE-31-48-20-W5M LSD 2, 7, 8, NE; SW-32-48-20-W5M LSD 3, 5, 6, NE; NW; SE-33-48-20-W5M Section 34-48-20-W5M Section 4; 5; 6; 7-49-20-W5M Section 1; 3; 4; 8; 9; 11; 12; 14; 15; 16; 17; 19; 20; 21; 22; 28; 29-49-21-W5M NW; NE; SE-30-49-21-W5M LSD 1, 2, 3, 4, 8-31-49-21-W5M LSD 3, 4, 6, SE-49-21-W5M LSD 9, 10, 16 SW; SE-25-49-22-W5M
TPA 1527	LSD 3, 4, 6, 11, 12, NE; SE-31-W5M LSD 5, 6, 7, 9, 10, 16, 16, NW-49-21-W5M
TPA 2064	LSD 3, 4, 5, 6, 11, 12, 13, 14, NE-31-49-21-W5M LSD 3, 6, 7, 9, 10, 15, 16, NW-25-49-22-W5M Section 49-36-49-22-W5M
TPA 2619	NW-27-47-19-W5M Section 32, 33-47-19-W5M LSD NW; SW; SE-34-47-19-W5M Section 3, 4, 5, 6, 7, 8, 18-48-19-W5M NE-8-48-20-W5M LSD 1, 12, 13, 14, 17, 18-48-20-W5M SW; SE-19-48-20-W5M NE; SW; SE-20-48-20-W5M LSD 11, 12, 13-21-48-20-W5M LSD 9, 10, 15, 16, NW-22-48-20-W5M LSD NW; NE, SW, SE, SW-22-48-20-W5M LSD 2, 12, SW 24-48-20-W5M LSD 2, 12, NW-27-48-20-W5M LSD 9, 15, 16, NW: SW-28-48-20-W5M

Table E.16-7 Trapper Dispositions

Disposition	Location
	LSD 8, NE-29-48-20-W5M LSD SE-32-48-20-W5M LSD SW-33-48-20-W5M
TPA 2256	LSD 7,8, NW; NE-27-46-18-W5M LSD 10,15; SW 27-46-18-W5M Section 28; 32; 33; 34-46-18-W5M Section 3; 4, 5; 7; 8; 18;19-47-18-W5M Section 13; 23; 24; 26-47-19-W5M LSD 4-47-19-W5M NE; SE-27-47-19-W5M LSD 11, 12, 14, NE; SE-34-47-19-W5M

E.16.4 Potential Impacts

E.16.4.1 Industrial Users

A majority of the coal leases within the Project area are held by CVRI or held by companies within a royalty arrangement to CVRI. There is a small coal lease held by others in the Robb West mining area. Prior to mining in this area CVRI will consult with this owner to enable mining of this lease.

As indicated in Table E.16-3 there are a number of companies with oil and gas activities in the proposed Project area. As development plans progress over the life of the mine CVRI will consult with these companies that may be impacted by the mining activities and will attempt to negotiate similar agreements as for the existing mining activities.

An agreement is currently under negotiation between CVRI and West Fraser to remove lands to be mined as part of the Project from the FMA. The agreement will include plans for West Fraser to log merchantable timber within the mine footprint. This type of agreement has been adopted by both companies over the past several years. A very small portion (half section) of the Robb East area near the Pembina River falls within the FMA held by Sundance Forest Industries. Prior to mining in this area CVRI will consult with Sundance to remove lands from the FMA.

The majority of the utilities in the development area are along the main highway corridor. CVRI will discuss the proposed development with Altalink and Fortis Alberta in order to ensure that they are not impacted by the mining activities. Potential impact will not require any alterations to the existing powerlines as proposed development only requires that the haulroads pass under the existing powerlines.

E.16.4.2 Non Industrial Land Uses

As part of the public engagement program CVRI has undertaken discussions with many of the non-industrial users that may be impacted by the proposed development. Results of the ongoing discussions are included in Section G. CVRI will continue to work with the public with respect to expressed concerns.

E.16.4.3 Traditional Land and Resource Use

CVRI has been working with the aboriginal communities in the area for many years. As part of the proposed Project a Traditional Land Use and Ecological Knowledge assessment has been conducted. This report is included as CR# 12 and summarized in Section E.12.

E.16.5 Mitigation and Monitoring

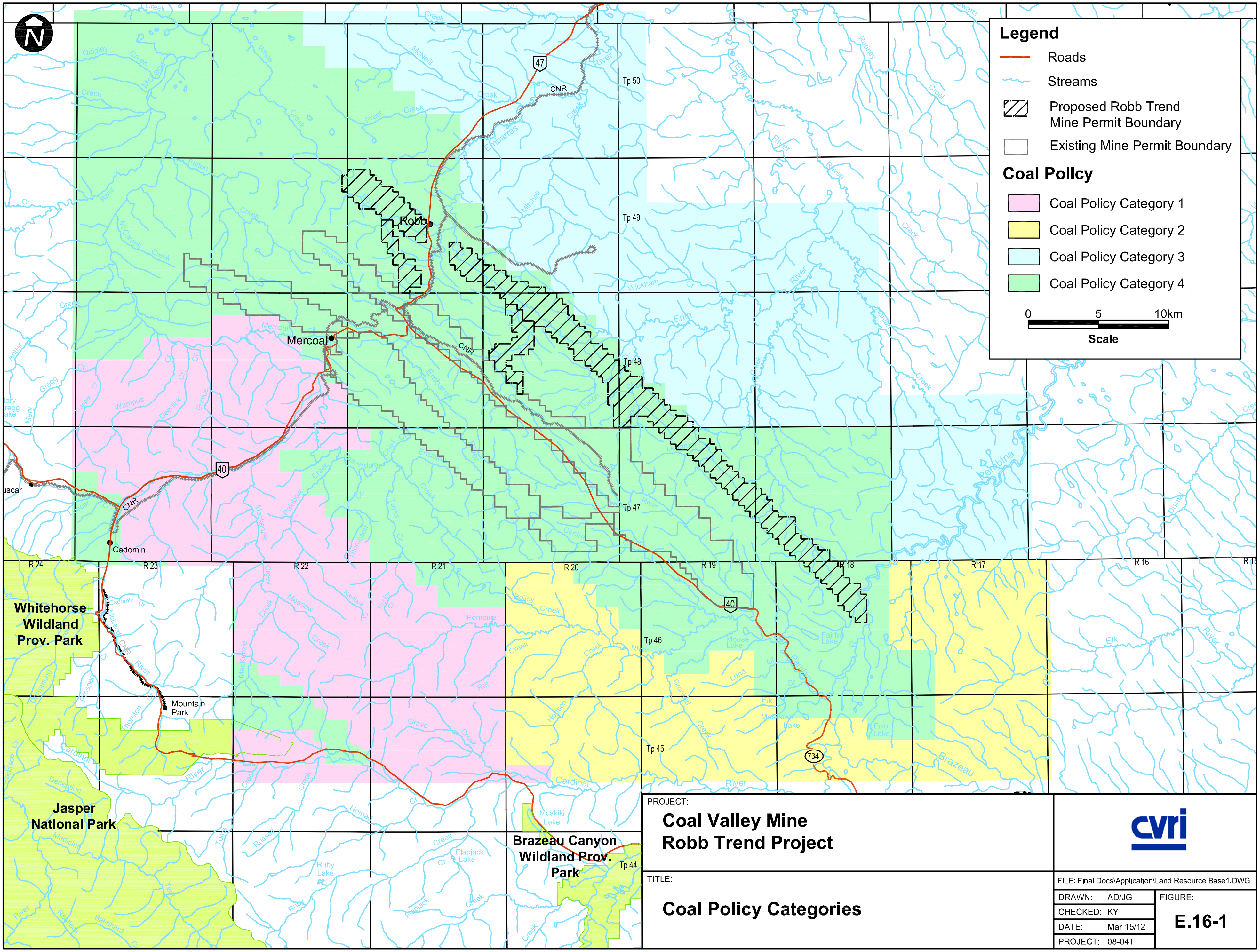
E.16.5.1 Mitigation

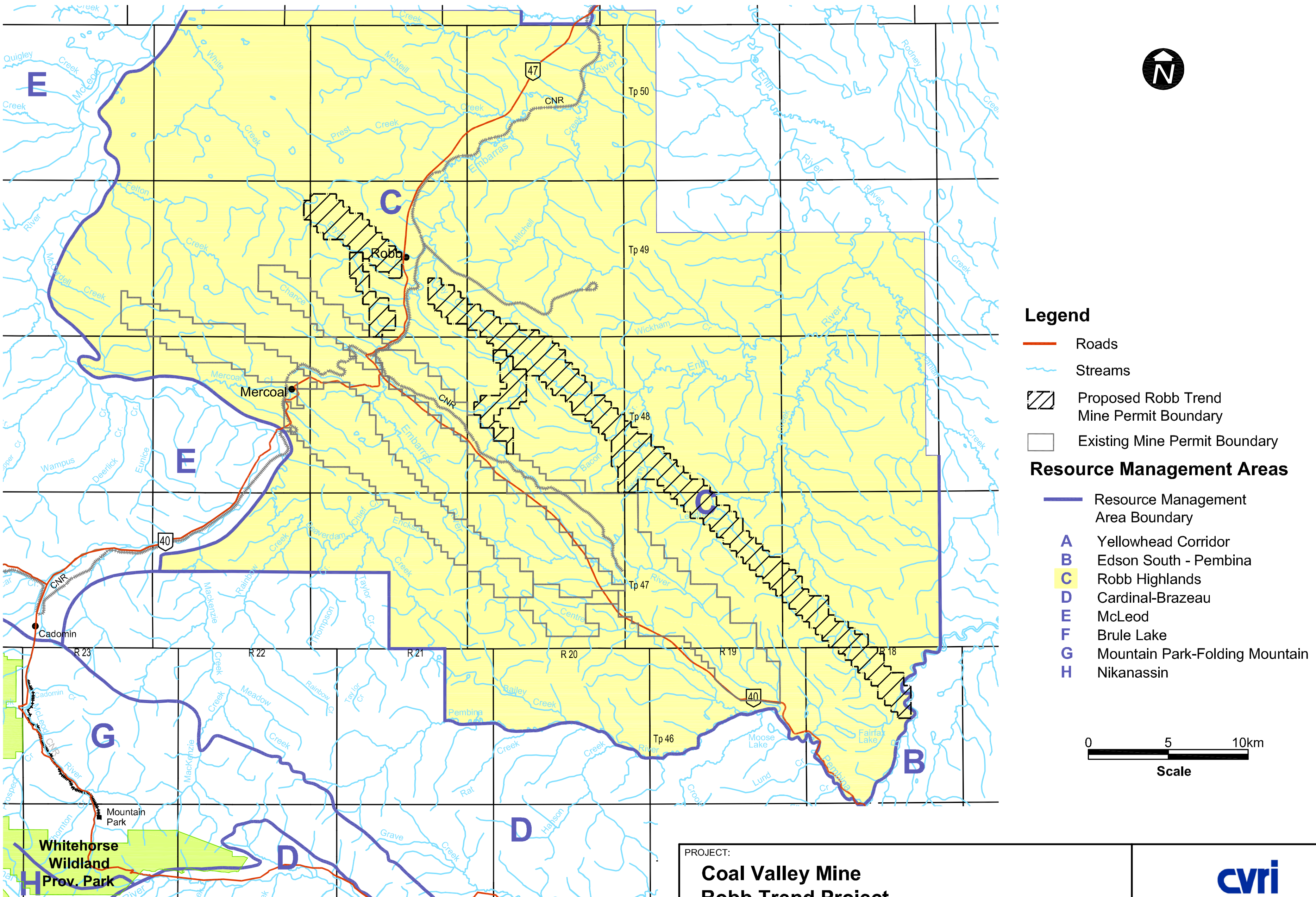
Mitigation proposed to address specific environmental concerns (such as air and water quality) associated with land use in the area are found throughout Section E. In addition to the mitigation already proposed CVRI will:

- continue to communicate with West Fraser and Sundance Forest Industries as to the salvage of merchantable timber;
- discuss with other industrial developers opportunities to maximize resource use and minimize development conflicts;
- continue with CVRI's trapper compensation program; and
- continue with CVRI's public engagement program.

E.16.5.2 Monitoring

CVRI will continue to consult with stakeholders as development of the Project area progresses over the life of the mine area.


Legend
Roads
Streams
Proposed Robb Trend Mine Permit Boundary
Existing Mine Permit Boundary
Coal Policy
Coal Policy Category 1
Coal Policy Category 2
Coal Policy Category 3
Coal Policy Category 4
0
5
10km
Scale
Robb
Mercoal
Cadomin
Mountain Park
CNR
Whitehorse Wildland Prov. Park
Jasper National Park
Brazeau Canyon Wildland Prov. Park
Tp 50
Tp 49
Tp 48
Tp 47
Tp 46
Tp 45
Tp 44
R 24
R 23
R 22
R 21
R 20
R 19
R 18
R 17
R 16
47
40
734
PROJECT:
Coal Valley Mine
Robb Trend Project
cvri
TITLE:
Coal Policy Categories
FILE: Final Docs\Application\Land Resource Base1.DWG
DRAWN: AD/JG
CHECKED: KY
DATE: Mar 15/12
PROJECT: 08-041
FIGURE:
E.16-1



PROJECT:

Coal Valley Mine
Robb Trend Project

cvri

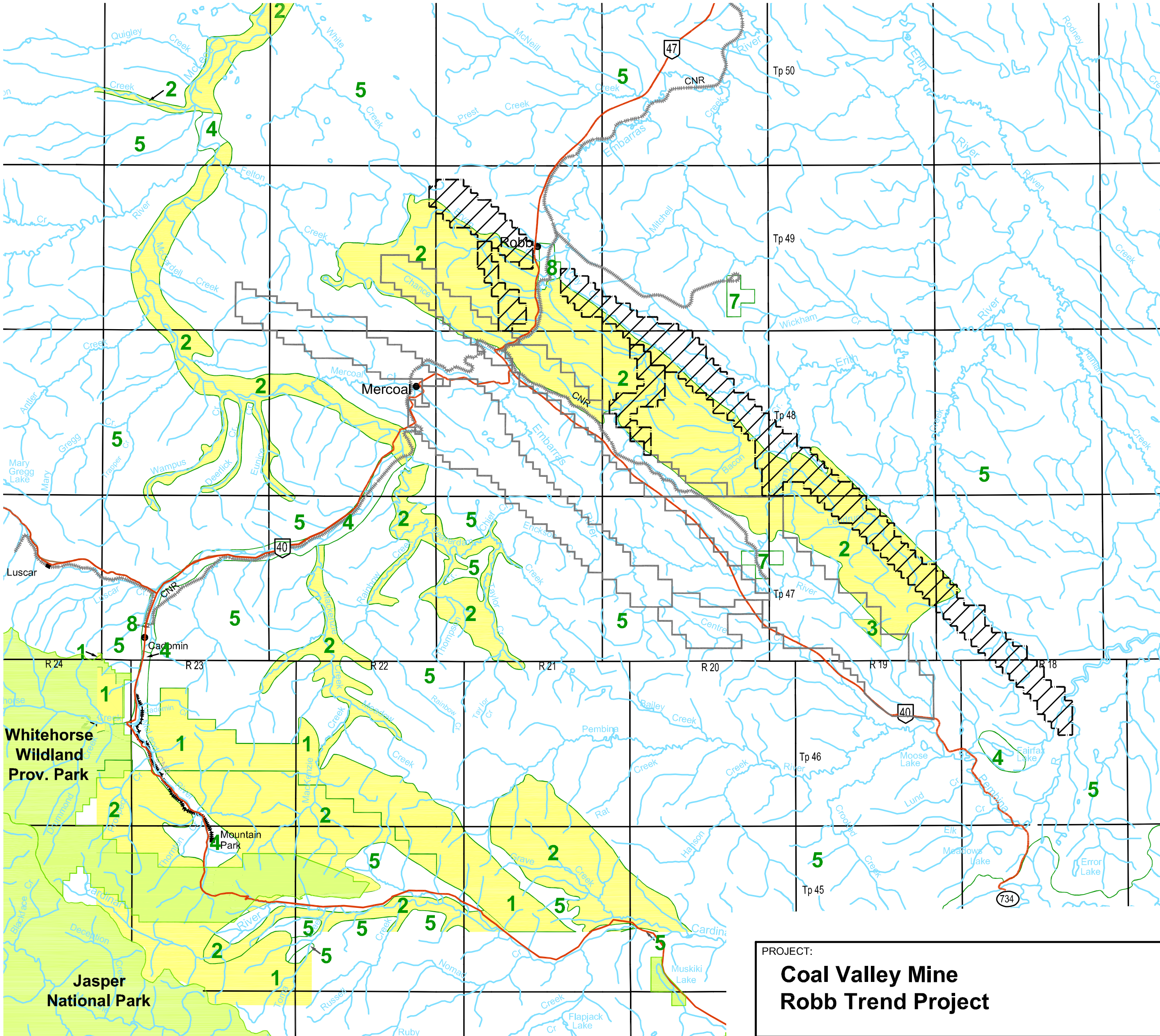
TITLE:

Coal Branch Sub-Regional IRP
Resource Management Areas

FILE: Final Docs\Application\Land Resource Base1.DWG

DRAWN:	AD/JG
CHECKED:	KY
DATE:	Mar 15/12
PROJECT:	08-041

FIGURE: **E.16-2**



Legend

- Roads
- Streams
- Proposed Robb Trend Mine Permit Boundary
- Existing Mine Permit Boundary

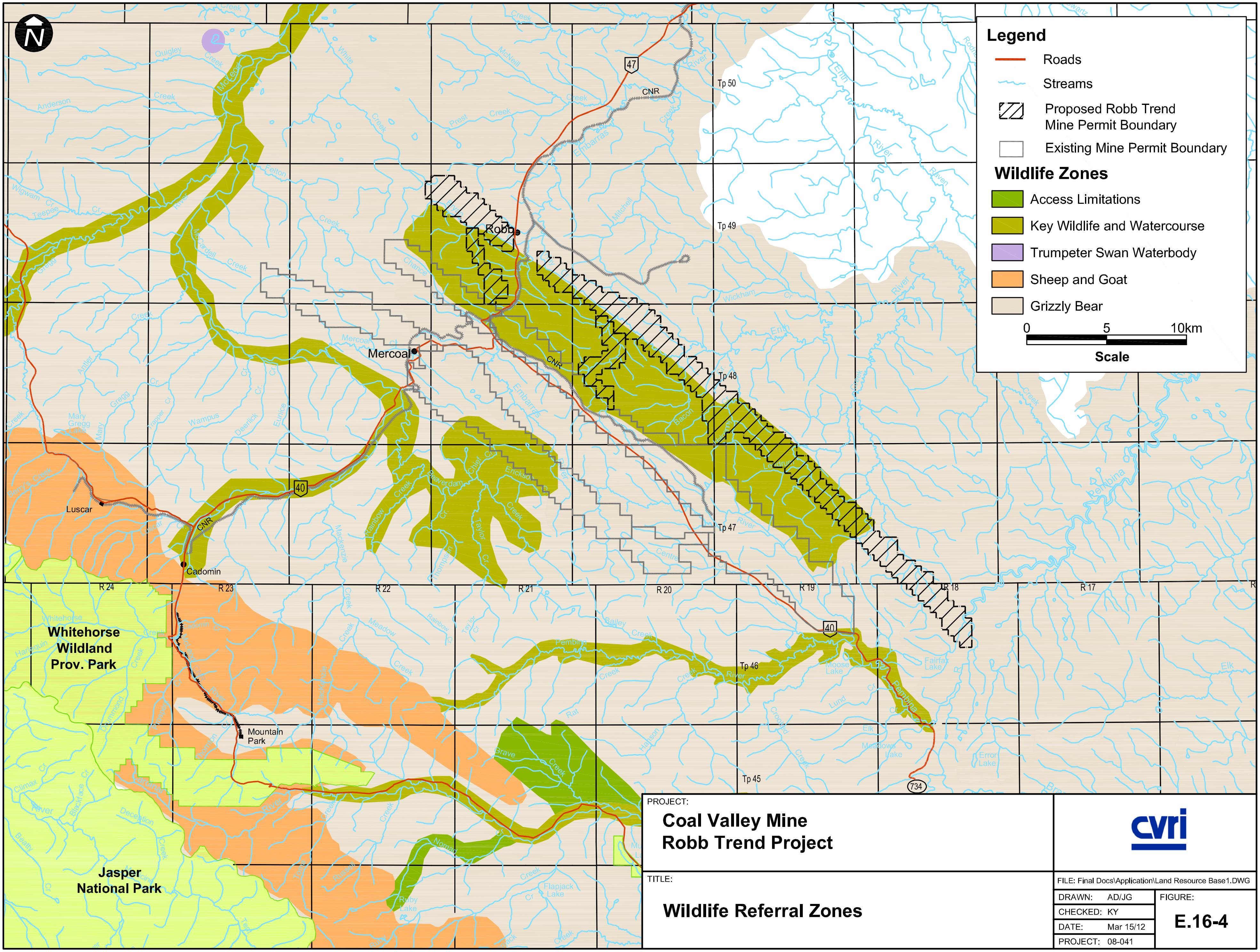
Refined Eastern Slopes Zoning

1. Prime Protection
2. Critical Wildlife
3. Special Use
4. General Recreation
5. Multiple Use
6. Agriculture
7. Industrial
8. Facility

7 Zoning Boundary

0 5 10km
Scale

PROJECT: **Coal Valley Mine Robb Trend Project**	cvri
TITLE: **Coal Branch Sub-Regional IRP Zones**	FILE: Final Docs\Application\Land Resource Base1.DWG
	DRAWN: AD/JG
	CHECKED: KY
	DATE: Mar 15/12
	PROJECT: 08-041
	FIGURE: **E.16-3**



PROJECT:

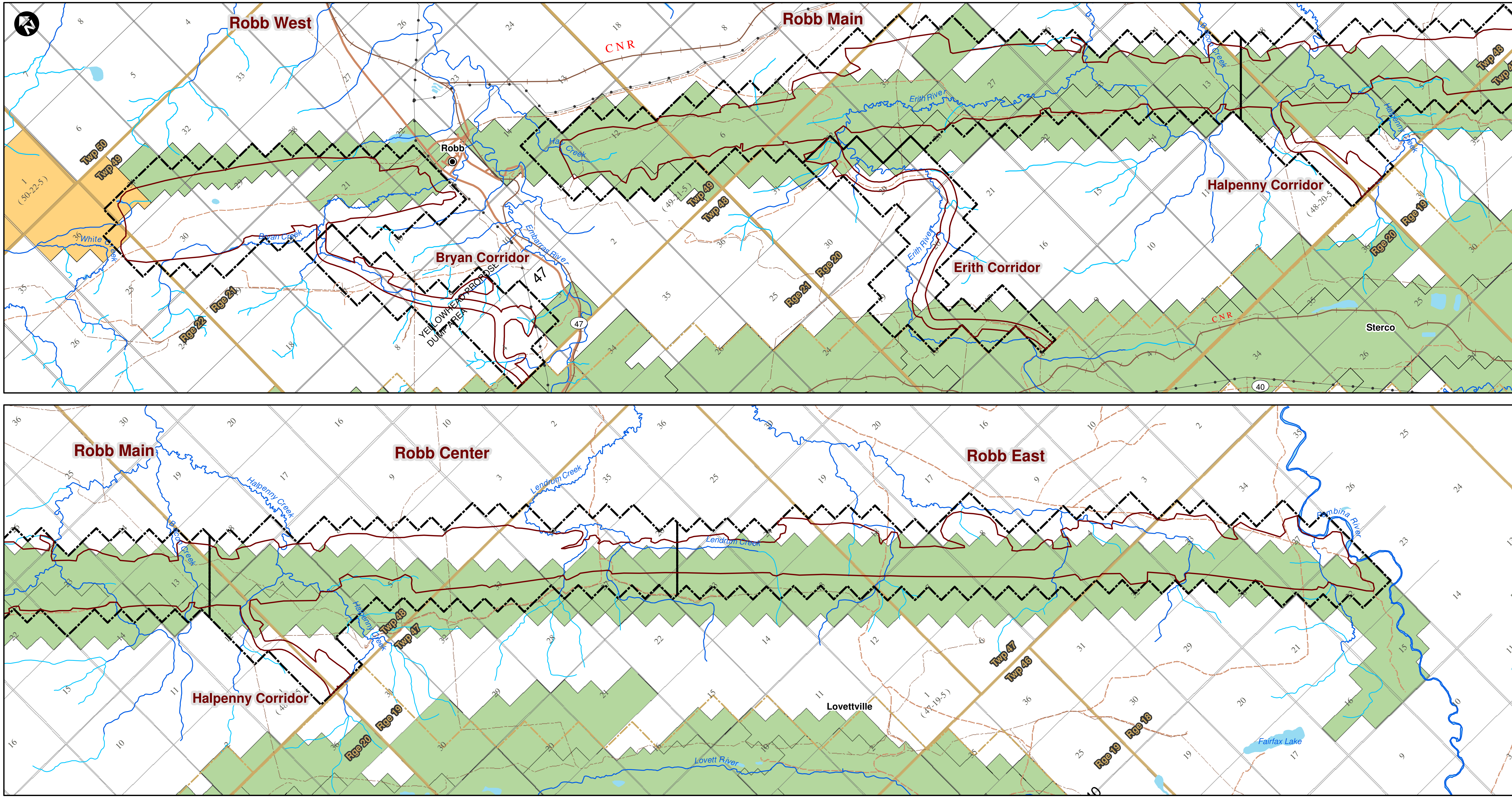
Coal Valley Mine
Robb Trend Project

TITLE:

Wildlife Referral Zones

FILE: Final Docs\Application\Land Resource Base1.DWG

DRAWN: AD/JG	FIGURE:	E.16-4
CHECKED: KY		
DATE: Mar 15/12		
PROJECT: 08-041		



Legend

- Coal Lease - CVM
- Coal Lease - MANCAL
- Proposed Robb Trend Mine Permit Boundary
- Proposed Footprint
- Existing Mine Permit Boundary
- Permanent Watercourse
- Intermittent Watercourse
- Waterbody

0 0.75 1.5 3
Kilometres

REF: CVRI, Robb Trend Project Extents 2B.dwg, Feb 7, 2011.

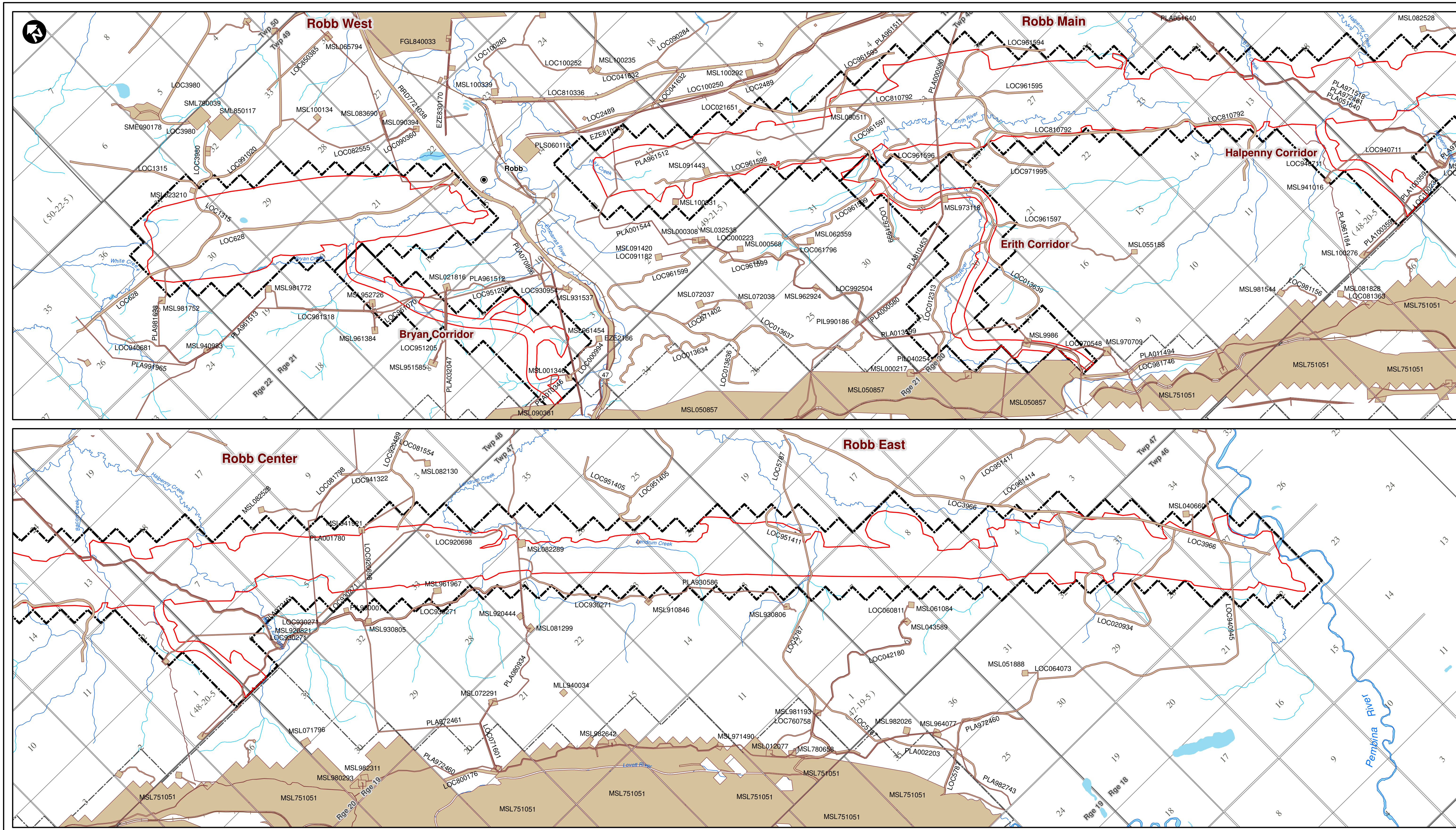
PROJECT:
Coal Valley Mine
Robb Trend Project

cvri

TITLE:
Industrial Development Subsurface Dispositions

DRAWN: PS/JG
CHECKED: KY
DATE: Mar 15/12
PROJECT: 08-041

FIGURE:
E.16-5



Legend
- Proposed Robb Trend Mine Permit Boundary
- Proposed Footprint
- Existing Mine Permit Boundary
- Railway
- Permanent Watercourse
- Intermittent Watercourse
- Waterbody

0 1 2 4
Kilometres

REF: CVRI, Robb Trend Project Extents 2B.dwg, Feb 7, 2011.

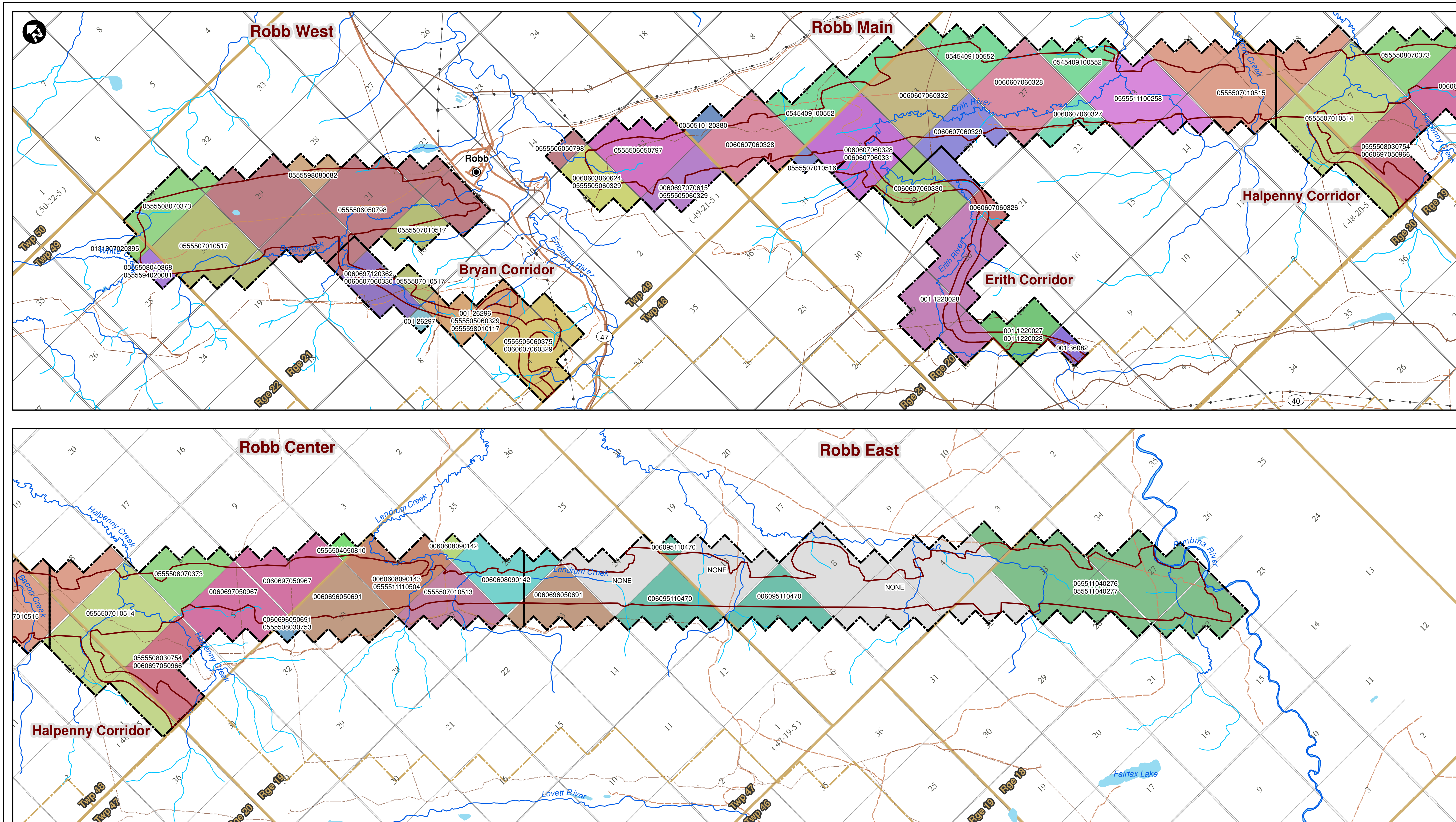
PROJECT:
Coal Valley Mine
Robb Trend Project

cvri

TITLE:
Industrial Development Surface Dispositions

DRAWN:	PS
CHECKED:	KY
DATE:	Mar 20/12
PROJECT:	08-041

FIGURE:
E.16-6



Legend

- Proposed Robb Trend Mine Permit Boundary
- Proposed Footprint
- Existing Mine Permit Boundary
- Permanent Watercourse
- Intermittent Watercourse
- Waterbody

0 0.75 1.5 3
Kilometres

REF: CVRI, Robb Trend Project Extents 2B.dwg, Feb 7, 2011.

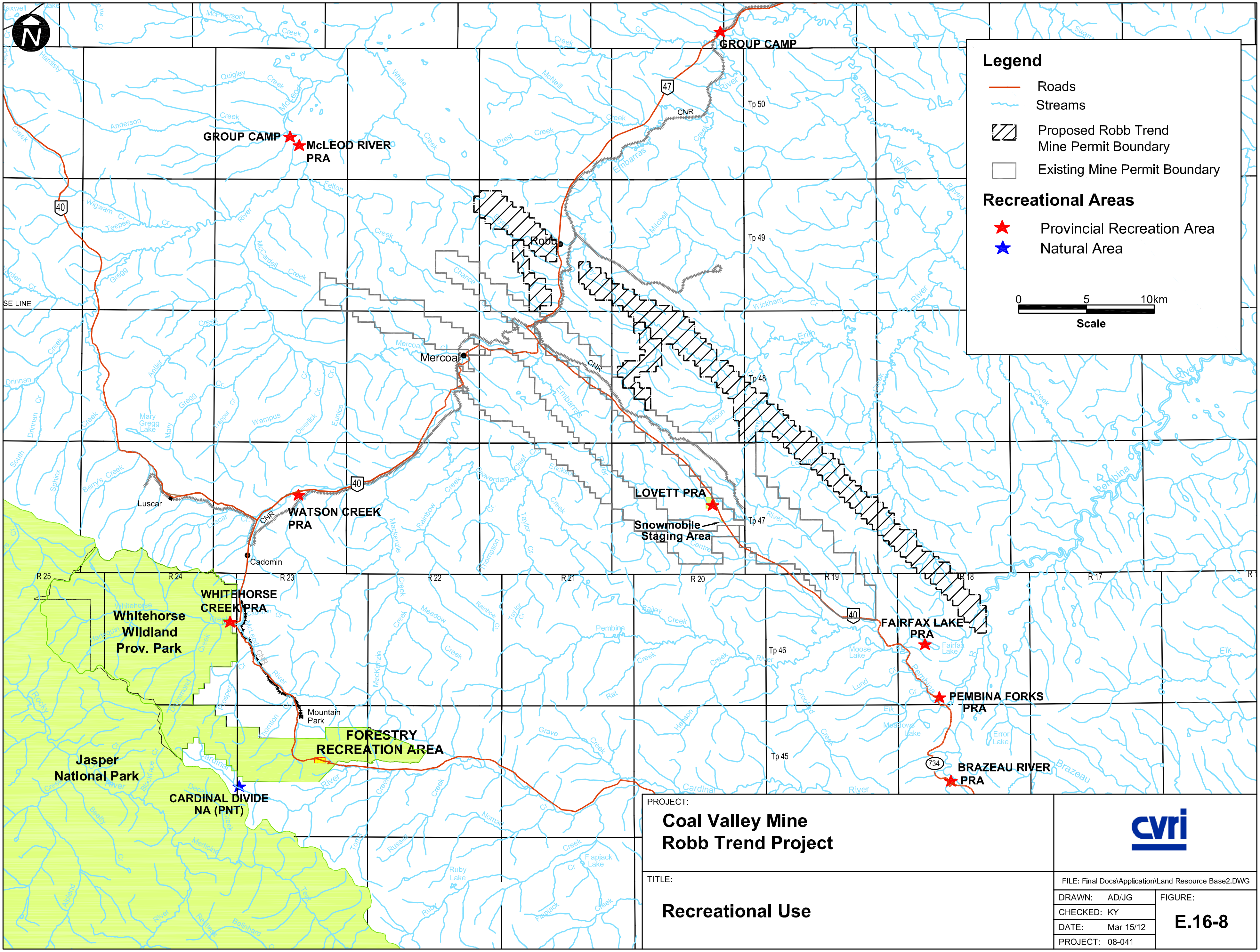
PROJECT:
Coal Valley Mine
Robb Trend Project

TITLE:
Petroleum and Natural Gas Leases and Licences

cvri

DRAWN:	PS
CHECKED:	KY
DATE:	Mar 15/12
PROJECT:	08-041

FIGURE: **E.16-7**



PROJECT:

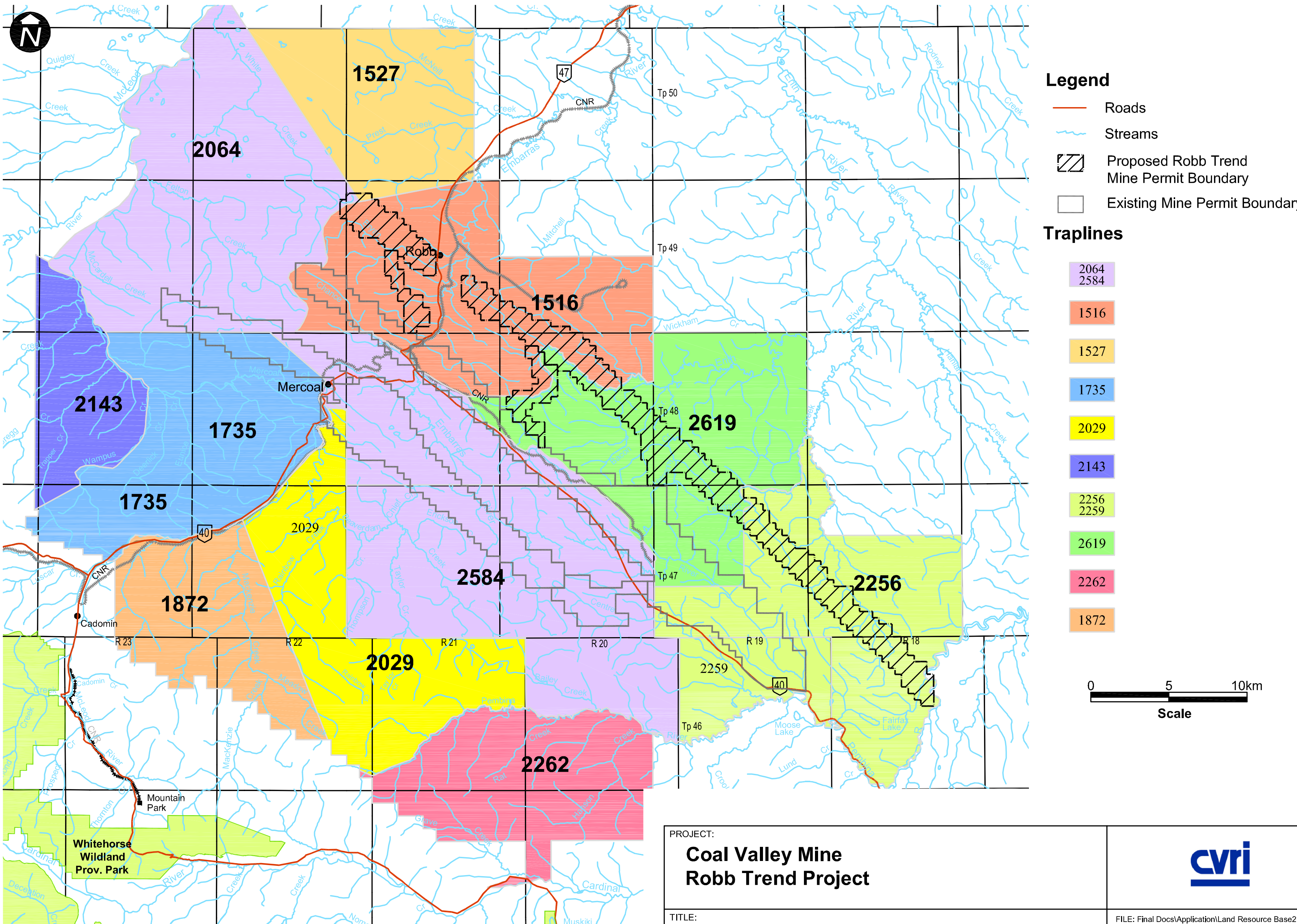
Coal Valley Mine
Robb Trend Project

TITLE:

Recreational Use

FILE: Final Docs\Application\Land Resource Base2.DWG

DRAWN: AD/JG	FIGURE:	
CHECKED: KY	E.16-8	
DATE: Mar 15/12		
PROJECT: 08-041		



PROJECT:

Coal Valley Mine
Robb Trend Project

cvri

TITLE:

Traplines

FILE: Final Docs\Application\Land Resource Base2.DWG	
DRAWN: AD/JG	FIGURE:
CHECKED: KY	E.16-9
DATE: Mar 15/12	
PROJECT: 08-041	